Manual of

Clinical Procedures in Dentistry

Edited by ***Nairn Wilson and Stephen Dunne***

WILEY Blackwell

Manual of Clinical Procedures in Dentistry

Manual of Clinical Procedures in Dentistry

Edited by

Nairn Wilson and Stephen Dunne
King's College London Dental Institute (KCLDI)

WILEY Blackwell

Registered Offices
John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA
John Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex, PO19 8SQ, UK

Editorial Office
9600 Garsington Road, Oxford, OX4 2DQ, UK

For details of our global editorial offices, customer services, and more information about Wiley products visit us at www.wiley.com.

Wiley also publishes its books in a variety of electronic formats and by print-on-demand. Some content that appears in standard print versions of this book may not be available in other formats.

Library of Congress Cataloging-in-Publication Data

Names: Wilson, Nairn H. F., editor. | Dunne, Stephen M., editor.
Title: Manual of clinical procedures in dentistry / edited by Nairn Wilson, Stephen Dunne.
Description: Hoboken, NJ : Wiley, 2018. | Includes bibliographical references and index. |
Identifiers: LCCN 2017037697 (print) | LCCN 2017038532 (ebook) | ISBN 9781119389606 (pdf) | ISBN 9781119389576 (epub) | ISBN 9780470670521 (paper)
Subjects: MESH: Dental Care–standards | Oral Surgical Procedures | Diagnosis, Oral | Tooth Diseases | Mouth Diseases
Classification: LCC RK63 (ebook) | LCC RK63 (print) | NLM WU 29 | DDC 617.6–dc23
LC record available at https://lccn.loc.gov/2017037697

Cover image: © sturti/Gettyimages
Cover design by Wiley

Set in 10/12 pt Warnock by SPi Global, Pondicherry, India

10 9 8 7 6 5 4 3 2 1

Contents

Preface

Dentistry is a complex healthcare science, oral health being of considerable importance to general health and wellbeing, let alone comfort and confidence in eating, tasting, swallowing, speaking, conveying a range of emotions through facial expressions, including smiling, and other forms of interpersonal interaction, notably kissing.

This manual provides guidance on procedures in primary dental care. In contrast to the countless, traditional books detailing the knowledge and science behind specific aspects of dentistry, this manual is a comprehensive, practical guide to the delivery of effective, state of the art oral healthcare – the 'what, when and how' of clinical practice.

It is acknowledged that desirable clinical outcomes in dentistry may typically be achieved in a number of different ways and, despite the efforts of generations of clinical academics and practitioners engaged in research, the evidence base to adopt one approach or technique over another remains limited in many situations. The approaches and techniques advocated in this manual reflect current thinking and teaching by the exceptionally large, highly qualified team of clinicians, past and present, who, by virtue of their expertise, are collectively responsible for King's College London Dental Institute (KCLDI) – the largest dental clinical academic centre in Europe, enjoying substantial national and international standing as an outstanding centre of clinical excellence. Indeed, KCLDI is one of the top five dental clinical academic centres in the world, irrespective of whatever measures and criteria are employed for such ranking.

Given the above, this manual is considered to be unique and, as a consequence, an important, new addition to existing dental literature; its style, scope and purpose are unparalleled. Furthermore, as elements of primary dental care underpin advanced and specialist clinical practice, it is considered that this manual should find application in every sector of dentistry – a ubiquitous manual which is intended to have a place in all clinical environments.

All those who have contributed to the production of this manual are to be thanked and congratulated. It has been a huge KCLDI team effort, backed up by an equally huge effort by the team at Wiley. It is impossible to put a figure on the number of expert and specialist 'man hours' invested in the production of this publication, which from the outset put quality, immediate clinical relevance, ease of use and, above all else, excellence in clinical care first and foremost. Nothing would give the entire team behind this manual more pleasure and professional satisfaction than knowledge that their individual and collective effort helps enhance patient care and promote trans-national harmonisation of teaching and training in the art and science of the clinical practice of dentistry.

Is this manual intended to be read and studied cover to cover? No! It has been designed to enable members of the dental team at all levels to dip into the wealth of guidance brought together under one title, according to individual needs and interests. That said, much may be learnt from systematically working through the manual, and this has been catered for in the order of contents, starting with the changing nature of the practice of dentistry and an overview of patterns and trends in oral and dental diseases, and culminating with guidance on audit and procedures for the management of patient concerns and complaints in everyday practice. Apologies to anybody who feels that insufficient weight and density of detail has been assigned to their area of practice; every effort has been made to present equitable, balanced, conflict-free guidance across the ever-increasing spectrum of the clinical practice of dentistry.

More than enough from the Editors. Time for you to get into the meat of the manual. Hopefully, the more you read, the more you will value the manual, and share the view that every member of the dental team should have access to a copy.

Nairn Wilson and Stephen Dunne

List of Contributors

Syedda Abbas
Consultant in Oral and Maxillofacial Surgery
King's College Hospital
London

Manjeet Ahlowalia
Specialist Clinical Teacher, KCLDI

Shariff Anwar
General Medical Practice
London

Koula Asimakopoulou
Reader in Health Psychology
KCLDI

Subir Banerji
Programme Director MSc Aesthetic Dentistry, Senior Clinical Teacher, KCLDI

Justin Barnes
Specialist in Endodontics
London

Warren Birnbaum
Former Consultant and Honorary Senior Lecturer in Restorative Dentistry and Head of Acute Dental Care
KCLDI

Igor Blum
Director, King's College Maurice Wohl Dental Centre, Head, Department of Primary Dental Care, Consultant and Honorary Senior Lecturer in Restorative Dentistry
KCLDI

Carole Boyle
Consultant and Honorary Senior Lecturer in Special Care Dentistry, KCLDI

Edward Brady
Specialist Clinical Teacher, KCLDI

Jackie Brown
Consultant and Honorary Senior Lecturer in Dental and Maxillofacial Radiology, KCLDI

Catherine Bryant
Consultant in Oral Surgery, KCLDI

Mary Burke
Consultant in Special Care Dentistry, KCLDI

Ravi Chauhan
Specialty Registrar in Restorative Dentistry
King's College Hospital, London

Martyn Cobourne
Professor of Orthodontics, Honorary Consultant and Academic Head of Orthodontics, KCLDI

David Craig
Consultant and Honorary Senior Lecturer in Special Care Dentistry and Head of Sedation and Special Care Dentistry, KCLDI

Blánaid Daly
Professor and Consultant in Special Care Dentistry
Dublin Dental University Hospital, Trinity College Dublin, Ireland
Former Senior Clinical Lecturer, KCLDI, and KCLDI Head of the Academic Unit and Discipline Lead in Special Care Dentistry at King's College Hospital

Jonathan Davies
Consultant in Dental and Maxillofacial Radiology, Birmingham Dental Hospital
Former Consultant in Dental and Maxillofacial Radiology, KCLDI

Serpil Djemal
Consultant in Restorative Dentistry, King's College Hospital and Honorary Senior Clinical Teacher
KCLDI

Nikki Doyle
Hosted Employee and Graduate Academy Manager, Clinical Professionals, Berkshire, formerly Clinical Research Administrator, Oral Clinical Research Unit
KCLDI

Stephen Dunne
Emeritus Maurice Wohl Foundation Professor of General Dental Practice, Specialist in Restorative Dentistry
King's College London Dental Institute (KCLDI)

Julie Edwards
Consultant in Special Care Dentistry
KCLDI

Michael Escudier
Professor of Oral Medicine, Honorary Consultant, Academic Head of Oral Medicine and Dean of Education (Strategy)
KCLDI

Kathleen Fan
Consultant and Honorary Senior Lecturer in Oral and Maxillofacial Surgery
KCLDI

Nikolas Fanaras
Medical Foundation Trainee
London

Michael Fenlon
Professor of Prosthodontics, Honorary Consultant in Restorative Dentistry and Service Lead for Restorative Dentistry
KCLDI

Dominic Flanagan
Clinical Teacher
KCLDI

Richard Foxton
Senior Lecturer and Specialist in Restorative Dentistry
KCLDI

Jenny Gallagher
Newland-Pedley Professor of Oral Health Strategy, Honorary Consultant in Dental Public Health and Head of Population and Patient Health
KCLDI

Ellie Heidari
Senior Specialist Clinical Teacher
KCLDI

Mark Ide
Reader and Honorary Consultant in Periodontology, Academic Lead for Implant Dentistry and Postgraduate Programme Lead for Periodontology
KCLDI

Rahul Jayaram
Sydney Head and Neck Cancer Institute Fellow
Chris O'Brien Lifehouse Hospital
Sydney, Australia

Richard Johnson
Associate Professor in the Institute of Vocational Learning
South Bank University
London
Former Senior Clinical Teacher in Applied Dental Science: Foundations of Dental Practice
KCLDI

David Jones
Specialist Clinical Teacher
KCLDI

Suranjana Lahiri
Former Senior House Officer in Oral and Maxillofacial Surgery
King's College Hospital
London

Joy Lewis
Dental Hygienist/Therapist
KCLDI

Francesco Mannocci
Professor, Honorary Consultant and Head of Endodontics
KCLDI

Claire McCarthy
Adjunct Professor, Department of Periodontology & Implant Dentistry, NYU College of Dentistry
Former Course Coordinator and Senior Clinical Teacher, Department of Periodontology
KCLDI

Shamir Mehta
Deputy Programme Director MSc Aesthetic Dentistry, Senior Clinical Teacher
KCLDI

Rebecca Moazzez
Reader in Oral Clinical Research, Honorary Consultant in Restorative Dentistry and Director of Oral Clinical Research Unit
KCLDI

Sukina Moosajee
Consultant in Special Care Dentistry, KCLDI

Tim Newton
Professor of Psychology as Applied to Dentistry, KCLDI

Najla Nizarali
Consultant in Special Care Dentistry, KCLDI

Richard Palmer
Emeritus Professor of Implant Dentistry and Periodontology, and Honorary Consultant and Head of Restorative Dentistry, KCLDI

Heather Pitt-Ford
Former Associate Specialist and Honorary Senior Lecturer in Paediatric Dentistry, KCLDI

Barry Quinn
Senior Specialist Clinical Teacher and Honorary Consultant in Restorative Dentistry, KCLDI

Lakshmi Rasaratnam
Specialty Registrar in Restorative Dentistry
King's College Hospital
London

Tara Renton
Professor, Honorary Consultant and Head of Oral Surgery, KCLDI
Lead for Orofacial Pain Services
Kings College Hospital
London

Andrew Ross
Speciality Trainee Paediatric Surgery
John Radcliffe Hospital
Oxford

Sasha Scambler
Senior Lecturer in Health Psychology
KCLDI

Suzanne Scott
Senior Lecturer in Health Psychology
KCLDI

Malissa Sikun
Specialist in Endodontics
London

Sanjeev Sood
Senior Specialist Teacher and Honorary Consultant in Paediatric Dentistry
KCLDI

Leandros Vassiliou
Specialist Registrar in Oral and Maxillofacial Surgery
King's College Hospital
London

Saman Warnakulasuriya
Emeritus Professor of Oral Medicine
KCLDI
Former Professor and Honorary Consultant in Oral Medicine
KCLDI

Nairn Wilson
Emeritus Professor of Dentistry
King's College London Dental Institute (KCLDI)
former Dean and Head of KCLDI

1

The Changing Nature of the Practice of Dentistry

Nairn Wilson

This introductory chapter gives an overview of the changing nature of the practice of dentistry, highlighting current and anticipated future issues and challenges.

Big Picture

Dentistry is a fast developing biomedical healthcare science which should be viewed as an integral element of mainstream healthcare – oral health having been recognised to be important to general health and wellbeing. Moving on from the long-established, experienced-based, mechanistic approach to treating different forms of oral and dental pain, discomfort and disease, dentistry is evolving into a patient-centred, evidence-based, preventatively orientated, minimum intervention system of care to establish and maintain oral health – a health- rather than a disease-management service. This, however, only holds true for dentistry in forward-looking, typically well-developed countries of the world. In other countries, where there are provisions for oral healthcare, dentistry may be found to be caught, to different degrees, in a twentieth century time warp, with treatment focusing on pain relief, often by means of traditional, interventive restorative procedures and the extraction of teeth, with or without prosthetic replacement. Elsewhere in our diverse, unequal world, billions of people have no, or at best very limited access to any form of dental care.

This chapter, in common with the rest of the manual, considers arrangements, procedures and techniques for patient-centred, evidence-based, preventatively orientated approaches to oral healthcare provision – best practice.

Oral and Dental Disease

The social determinants of oral and dental disease are largely universal: exposure to an unhealthy diet, tobacco use, excessive consumption of alcohol, and poor oral hygiene all contribute to poor oral health. In addition, many adults do not help themselves limit their exposure to oral and dental disease, by, for example, indulging in the frequent consumption of sugar, forgetting to brush their teeth, not bothering with interdental cleaning, and only seeking dental care when in pain or experiencing a problem.

In most developed countries overall levels of dental disease, in particular amongst children, have shown improvements in recent years, but behind such encouraging statistics there tend to be widening health inequalities, with levels of oral and dental disease increasing amongst the children of the poorest members of society. At the other end of the age spectrum, there is increasing longevity, with many more teeth being retained into old age; however, oral health among older people is generally poor, with levels of xerostomia and advanced periodontal disease being a particular cause for concern. In adolescents and young adults pathological tooth wear is now relatively common, and oral mucosal disease, notably the incidence of oral cancer, is increasing. So, while much has been achieved through the application of advances in the prevention of oral and dental disease, much remains to be done, and new forms of disease such as peri-implantitis, albeit limited to those who have been fortunate enough to access implant dentistry, are generally considered to be a 'ticking time bomb'. Overall, it may be concluded that there continues to be widespread exposure to the determinants of oral and dental disease, the most prevalent forms of which – caries and periodontal disease – are opportunistic and given the chance will affect patients of all ages. Furthermore, as discussed in detail in Chapter 2, it may be concluded that oral and dental diseases continue to be a major public health problem, in large part because of the failure of individuals to practise the most basic of preventative measures.

In helping to address oral and dental disease issues, dental teams should seek to find ways, in the community in which they operate, to help reduce oral health

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

inequalities and increase public awareness of the importance of oral health and how it may be achieved and maintained. Such a service to society, if undertaken by all dental teams, would make an enormous difference to oral health in general.

The Dental Team

Modern oral healthcare is best provided by a dental team. The day of the single-handed general dental practitioner, attempting to meet most, if not all of the many different dental needs of a diverse population of patients of all ages, is widely considered to be a thing of the past. For maximum efficiency and effectiveness, the dental team, led by one or more dentists and supported by a network of specialists in different, distinct branches of dentistry, should comprise:

- Oral health therapists, which may comprise (dental) therapists with skills and expertise in oral hygiene, or therapists together with dental hygienists.
- Dental nurses, trained together with other members of the dental team, with roles and responsibilities, over and above chairside participation in the provision of treatment, ranging from the recording of simple intraoral radiographic images to the application of preventive measures (e.g. fluoride varnishes) and oral health education. Dental nurses in modern practice environments must have well-developed skills in running, or at least overseeing, state of the art decontamination and sterilisation procedures.
- Dental technologists, including clinical dental technologists, to work with the chairside team in the provision of indirect restorations, removable prostheses and other appliances. Increasingly, dental technologists are critical to developments in digital dentistry, including, for example, the production of restorations from digital images and CAD CAM (computer assisted design–computer assisted milling). It is anticipated that dental technologists of the future may have as many information technology (IT) skills as traditional manual skills.
- Practice managers with wide-ranging roles and responsibilities to ensure the safe, efficient running of the practice or dental health centre. Practice managers' skills and expertise may usefully include, by way of example, business development and marketing, practice accounting, consumables logistics and the management of human resources within the practice or centre.
- Dental receptionists as the patient's first and most common point of contact with the dental team. In this role, receptionists require excellent human relationship and communication skills, together with skills in diary management, aimed at the best use of the time and skills of the various members of the dental team. Dental receptionists, in addition to requiring good telephone and face to face communication skills, are extending their roles to include multimedia communications with patients. Receptionists may also pay crucial roles in patient satisfaction surveys and the initial response to concerns and complaints.

As leaders of dental teams, dentists, amongst the many other challenges they face, must develop the necessary leadership skills during their formative years in clinical practice. Leadership courses are anticipated to become an important element of postgraduate dental education.

The Practice Environment

With the further demise of 'old-style', single-handed dental practices, in favour of multisurgery practices, if not dental health centres, the practice environment will continue to change. General dental practitioners of the future, more often than not with advanced skills and knowledge in some aspect of dentistry, may increasingly find themselves working in the same environment as specialists, as part of a 'full service' dental team. The facilities to support dental teams of different sizes and composition will grow in sophistication to take advantage of anticipated advances in dental technologies, some of which may be transformational, and possible changes in the scope of dentistry to facilitate the shared care of patients with other healthcare professionals. Innovations in IT, ergonomically enhanced ways of working, new devices and different forms of instrumentation, novel presentations of materials and growing patient expectations are some of the many factors which will individually and collectively shape and fashion the practice environment of the future. Above all else, the practice environment, apart from being welcoming and comfortable for patients and a good work environment for the dental team, must become an increasingly safe place for both patients and all those involved in their care.

Regulation

It is hoped that the clinical practice of dentistry will come to be regulated by modern, 'right touch' regulation, based on the following qualities:

- *Proportionate*: Regulatory intervention only when necessary, with measured, cost-effective remedies appropriate to the risk posed.

- *Consistent*: Interrelated rules and standards implemented fairly.
- *Targeted*: Focused arrangements fit for purpose.
- *Transparent*: Open, simple, user-friendly regulation.
- *Accountable*: Subject to, and satisfying public scrutiny.
- *Agility*: Forward-looking and evolving to meet changing needs.

Good regulation should first and foremost protect the public, but with measures which support and encourage the profession to comply with the relevant code of conduct.

The main elements (pillars) of codes of conduct relevant to the practice of dentistry are anticipated to remain:

- Patient respect and autonomy.
- Do no harm (non-maleficence).
- Act in the best interest of the patient – 'do good' (beneficence).
- Honesty and truthfulness (veracity).

In essence, treat others the way you would wish to be treated.

Developments in regulation will sooner or later include revalidation (recertification) including requirements for lifelong learning (continuing professional development, CPD) and possibly some form of self-assessment and peer review or appraisal. Transformational innovations in dental technologies may bring about the need for top-up training, or new arrangements for dental specialties, possibly including the demise or merger of existing specialties and the introduction of new specialties. To remain fit for purpose, the regulation of dentistry must change with changes in, amongst other factors, clinical practice, the regulation of other healthcare professionals, the dental workforce, relevant technologies and the needs and expectations of patients and the public.

The day of self-regulation, once considered to be a defining characteristic of a profession, may have passed, in favour of 'lay dominated' regulation, but this should not disadvantage or cause concern to the vast majority of regulated dental healthcare professionals who practise ethically, satisfy expectations of '24/7' professional behaviour, and always put the interests of their patients first and foremost.

Scope of Practice

With the growing body of evidence that oral health is important to general health and wellbeing, the challenge of many more older, dentate patients with increasingly complex medical and dental histories, the ever increasing sophistication of existing techniques, innovations in, for example, regenerative techniques and salivary diagnosis, trends towards the shared care of patients, and new evolving expectations of treatment, the scope of dentistry will need to be updated and modernised. With anticipated expansion in the scope of dentistry, it is considered unlikely that dentists can continue to graduate and remain competent in the many different, diverse procedures involved in the provision of comprehensive primary dental care. As a consequence, dentistry may have to look to adopting a medical model of skill mix, with a range of primary care procedures being delegated to team members. With such developments, dentists will, in all probability, become as much oral physicians as dental surgeons.

Patient-Centred Care

Gone are the days of 'just do as you think best' or, worse, clinical paternalism: 'I have decided that that you should have…'. To practise patient-centred care, the patient must be involved in treatment decision-making. To achieve this, the patient must understand the problem, the need for treatment, and the 'pros' and 'cons' of the various treatment options. This can be time consuming, in particular when a patient presented with complex treatment needs. However, such patient involvement is considered central to obtaining informed consent, prior to commencing any programme of care.

In providing patient-centred care there may be conflicts between practising clinical excellence and complying with the wishes of the patient. For example, clinical excellence may only be achieved in a case by providing surgery and reconstruction, but the patient, who is not experiencing any pain or discomfort and is unconcerned by their compromised dental appearance, simply wishes to be monitored and given advice as to how best to prevent further deterioration of their condition. In such situations, detailed clinical records, which should be a matter of routine, will be a safeguard against possible future criticism of less than ideal care, let alone supervised neglect.

Preventatively Orientated Care

Prevention is always better than cure. In dentistry, prevention, unlike vaccination against an infectious disease, does not impart immunity; it merely reduces susceptibility and the risk of disease – primary and recurrent.

The guidance available on the prevention of dental disease tends to be supported by a substantial body of evidence, a notable exception being tooth wear. Indeed, preventive dentistry may be considered to be the most evidence-based aspect of clinical practice.

The application of best preventive practice in the provision of treatment is what constitutes preventatively oriented care. This is in sharp contrast to treatment which leaves a patient more susceptible to disease. For example, if an early occlusal lesion of caries were to be managed by means of fissure sealing, or a preventive resin restoration, this would be best practice, both in terms of preservation of tooth tissues and preventatively orientated care. In contrast, if the lesion were to be managed by means of aggressive restoratively orientated care, resulting in weakening of the remaining tooth tissues and a restoration susceptible to secondary caries, overall the benefits to the patient may quickly be outweighed by the negative consequences.

Minimum Intervention

Very often, the easy option in dentistry is to extract a tooth, resort to a full coverage crown, or extirpate a troublesome pulp. Much more challenging, skilful and professionally rewarding, let alone beneficial for the patient, is to identify and successfully apply the least interventive, yet effective means to resolve presenting problems and establish and subsequently maintain oral health. Once lost or removed, tooth and associated soft tissues are lost for life, certainly until such times that major, anticipated advances in regenerative dentistry can be translated into clinical practice. Furthermore, the loss of tooth tissues leaves remaining tooth tissues substantially weakened and possibly more susceptible to disease. As a general rule, the less interventive the care, the more beneficial treatment is to the patient, both immediately and in the longer term, assuming the care is effective and the patient maintains good oral health. It is encouraging that increasing attention is being paid to the long-term consequences of interventive forms of treatment, recognising that the only 'permanent' restorations and prostheses are the ones patients die with, and that 'replacement dentistry' invariably results in the further loss of irreplaceable tissues. Minimum intervention dentistry is a key feature of care aimed at achieving 'teeth for life'. All that said, there are circumstances where interventive forms of treatment are indicated, if not necessary to achieve a satisfactory clinical outcome. Under such circumstances, all possible efforts should be made to limit the immediate and longer-term iatrogenic effects of the care.

Patient Empowerment

Based on the premise that the maintenance of oral health is the responsibility of the patient, rather than the dental team, which is the 'occasional visitor' in the patient's mouth, patients need to be educated and charged with undertaking all the measures necessary to prevent new disease. Identifying these measures and styling education to best meet the needs of the patient may best be achieved through risk assessment. Success in patient empowerment often involves behavioural interventions, aimed at behavioural change. As with most behavioural changes, such as smoking cessation and weight loss, the tipping point in oral health maintenance is patient acceptance: acceptance that they must look after the teeth they wish to retain, hopefully for life – only clean the teeth and gums you want to keep! 'Teeth for life' may also be viewed as partnership working between the patient and the dental team, with the patient assuming responsibility for the control of risk factors and day to day measures, and the dental team monitoring and, where necessary, prescribing and explaining changes to the agreed oral health regimen – in effect an oral health 'contract', which is amended from time to time by mutual agreement.

Pain and Anxiety

Regrettably, fear of pain and anxiety remain barriers to many individuals seeking and reaping the benefits of dental care. Developments in the fields of pain control and anxiety management (anxiolysis) have been remarkable, with dentistry being at the forefront of certain elements of relevant research and innovation. Although certain dental procedures may not be pleasant, they should be pain free, with a minimum of discomfort. For anxious patients, various forms of anxiety management, up to and including conscious sedation, should be available to facilitate acceptance of care. In many cases, anxiety and fear of pain associated with dental procedures stem from a traumatic episode, often early in life, highlighting the value and benefits of effective prevention in early childhood. Reaching out to and engaging anxious patients can be one of the most demanding challenges in addressing unmet treatment needs in a community. Success in such endeavours not only transforms the dental prognosis for those who become regular dental attenders, but can give a sense of huge professional fulfilment.

Funding

Where third party funding of oral healthcare exists, it tends to be under ever increasing budgetary pressure, with the available funding tending to be directed to care of the most vulnerable members of society, individuals with special needs and severe forms of disease, and to addressing ever expanding health inequalities – poor oral health and disease tending to increase in low-income families in many countries. Funding through insurance schemes and private contract should, as a consequence, be set to

increase with increasing interest in dental attractiveness and appreciation of the importance of oral health to general health and wellbeing, in particular amongst the 'worried well' with disposable income. For many practices the shift from the bulk of income coming from third party funding to insurance and private contract arrangements may be transformational – running a business rather than providing a service. Whatever the future arrangements for funding, there will be an expectation of value for money, with value being judged more by the health enjoyed rather than the number of procedures undertaken.

Continuous Quality Improvement

As in most, if not all aspects of modern life there is an expectation that there is always opportunity to enhance quality, if for no other reason as a consequence of new advances in knowledge, understanding and technologies. Dentistry is no exception. Setting aside savings through the dental industry responding to demands for 'faster, quicker, easier and cheaper' materials and devices, efficiency gains and effectiveness may be achieved through audit, critical self-assessment by the dental team, and constructive feedback from patients. In addition, good management of patient complaints and concerns, including bottoming out causation, can help identify ways to do things better. For patients who tend to have several months, if not a year or more between encounters with the dental team, the cumulative effect of many small, quality enhancing changes can be immediately apparent, helping them 'bond' with the practice as a 'go ahead' enterprise.

Ethics versus Cosmetics

Growing interest and the new value being placed in dental attractiveness plays a large part in dentistry moving away from the service to the business model. In particular, growth in the demand for cosmetic procedures (as distinct to aesthetic treatments to address a need) is increasing the 'business element' of dentistry. In providing cosmetic enhancements to a patient's smile, the dental team must strike the correct balance between meeting the demands of the patient, maintaining professional standards and acting ethically, despite powerful financial incentives to just seize the opportunity. Professionalism – the set of values, behaviours and relationships that underpins the trust the public has in the dental team – must not be sacrificed by unethical approaches to the provision of cosmetic dentistry. There is no justification for any breach of the professional code of conduct in providing enhancements to dental attractiveness, albeit that certain cosmetic procedures which a dental team may provide may not be considered to constitute the practice of dentistry.

The Unexpected

Futurology is far from being an exact science. In particular, expectations of what the future may hold cannot take account of the unexpected. In dentistry, the unexpected may take many different forms, for example, some new form of disease, a ground-breaking development in regenerative dentistry or dental biomaterials science, or new evidence which questions the value of some long established approach to patient care. Dealing with the unexpected in the provision of dental care can draw heavily on the knowledge and understanding of the dental team, and may involve the adoption of new procedures and mastering new competences. Any long established practitioner will confirm that clinical practice has undergone profound, unexpected change in their professional career. There is no reason to believe that things will be different for future generations of practitioners. This, it is suggested, adds to the appeal and challenge of a career in dentistry.

Further Reading

Department of Health (UK) and British Association for the Study of Community Dentistry (2014) Delivering better oral health: an evidence-based toolkit for prevention, 3rd edn. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/367563/DBOHv32014OCTMainDocument_3.pdf (accessed 27th June, 2017).

Trathen, A. and Gallagher, J.E. (2009) Dental professionalism: definitions and debate. British Dental Journal 206:249–253.

Wilson, N.H.F. (ed.) (2009) Clinical Dental Medicine 2020. London: Quintessence Publishing Co. Ltd.

Wilson, N.H.F., Woolford, M. (2012) The future of dentistry. Faculty Dental Journal 3:142–145.

2

An Overview of Patterns and Trends in Oral and Dental Diseases

Jenny Gallagher

Introduction

What do people from different parts of the world have in common (Figure 2.1)? They will almost all suffer from one or more oral diseases at some stage in their lives, diseases that are largely preventable. As a result they will require oral and dental care. Some will be fortunate and receive high-quality dental care in a timely manner; others will not, continuing to suffer either from the symptoms of disease or at the hands of non-qualified personnel in its treatment. As dental professionals, we should do everything possible to improve oral health and to ensure equitable access to oral healthcare for everyone in the world. Getting to grips with patterns and trends in oral health can assist us with this challenge and help us think through our roles and responsibilities. Even in high-income countries with well-developed dental services many adults suffer from urgent conditions and the impact of disease.

Oral Diseases

1) Sixty to ninety per cent of schoolchildren and nearly 100% of adults worldwide have dental caries
2) Severe periodontal disease, which may result in tooth loss, is found in 15–20% of middle-aged (35–44 years) adults
3) About 30% of people aged 65–74 have no natural teeth
4) Oral disease in children and adults is higher among poor and disadvantaged population groups

Data from WHO, 2012a.

Why Is It Important to Examine Population Oral Health?

Why should clinicians who are largely concerned about the health of individuals be concerned with the health of populations? And the global population at that? Why not skip this chapter to discover more about the business of dentistry given that as dental professionals we are largely trained to identify and treat disease? Can I suggest a few reasons to explore these issues in more detail?

First, we are health professionals and therefore have a professional responsibility to be advocates for oral health and the patients whom we serve. Many think of dentistry as a business and, taking that approach, any business needs to understand the market, which for dentistry includes the population whom we serve, their health trends and the determinants of health. This will equip us better in our overarching goal to improve oral health – the ultimate business of dentistry.

Second, they can act as a mirror to our professional action. As dentists we become absorbed in minutiae; trained to consider details, we often fail to stand back and look at the big picture. Once in a while it is helpful to do so. One example which had a particular impact on me was the story of an epidemiologist who visited the same schools in England at regular intervals to undertake surveys of dental caries in 12-year-old schoolchildren during the period when oral health was improving. The team identified that caries prevalence (numbers of Decayed, Missing and Filled Teeth = DMFT) was not reducing in one school and they explored why this was the case. It came down to the fact that the local dentist was using an outmoded treatment approach and the profile of fillings in primary molars, the 'F' component, was

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

Figure 2.1 Global connections. *Source:* https://commons.wikimedia.org/wiki/File:GDJ-World-Flags-Globe.svg. Public Domain.

excessive. Once one first permanent molar became — carious, there was the assumption that all would do so. After discussions with that dental practice, the pattern of treatment changed and, interestingly, so did the epidemiology statistics for that school. So this reminds us that monitoring trends in oral health has wide implications including informing the practice of appropriate dental care in support of oral health.

Third, global mobility means that clinicians are increasingly faced with new patient groups from different parts of the world. Furthermore, clinicians themselves may take the opportunity to work in different countries during their professional careers. Data on oral health are available from many countries across the globe and within countries. Even within the UK there is significant variation between different geographic areas. An understanding of population health information helps us to better understand the risk factors amongst different communities and their impact on oral health. For example Chinese populations have a higher prevalence of nasopharyngeal cancer (Yu and Yuan, 2002; Donaldson et al., 2012) and Bangladeshis have a higher rate of oral cancer (Efroymson et al., 2001; Donaldson et al., 2012), associated with viruses and cultural health behaviours respectively.

Fourth, and finally, consideration of trends in oral health and the determinants of health should therefore empower us to challenge environmental factors in culture, society and politics in support of health and inform our provision and planning of oral and dental care to individuals. This is the best way to promote health and address inequalities. Given the importance of promoting health and preventing disease, this chapter therefore links closely with Chapter 7 on prevention of oral diseases.

This chapter will provide you with an overview of global oral health patterns and trends and consider the public health implications for us as health professionals wherever we practise. As an introduction to considering trends and patterns in oral health, it is important to start first with the demography or composition of the global population.

The Global Population

It is staggering to consider how the world is changing in our lifetime. The global population has doubled in the past 50 years and will continue to expand exponentially. Between 2011 and 2050, the world population is expected to increase by 2.3 billion, from 7.0 to 9.3 billion (United Nations, 2011). Websites such as http://www.worldlifeexpectancy.com/world-population-pyramid show how the age-based population pyramid changes over time from a traditional pyramid with a large base towards a more rectolinear shape.

We each view the world map from our physical perspective – usually our country is centre stage– but also in relation to land mass (Figure 2.2); however, the global population is not evenly distributed, as demonstrated by Figure 2.3 which cleverly adapts the land mass to represent population size, providing us with a startling view of the world.

In more developed regions of the world, the majority of the population live in cities whilst in less developed regions the majority live in rural populations; however, this is predicted to change as outlined below.

The population living in urban areas is projected to increase by 2.6 billion, rising from 3.6 billion in 2011 to 6.3 billion by 2050 (United Nations, 2011). The United Nations (UN) also suggest that the rural population is projected to decrease from 3.1 to 2.9 billion over the same time period. Therefore, the urban areas of the world are expected to absorb all the anticipated population growth over the next four decades while at the same time drawing in some of the rural population. There are currently 23 megacities (>10 million) and by 2025 this is expected to increase to 37. By 2025, the population living in megacities is expected to reach almost 8% of the overall world population; one in 13 people globally will then reside in a megacity (United Nations, 2011).

According to UN reports, most of the predicted growth will be absorbed by developing countries (United

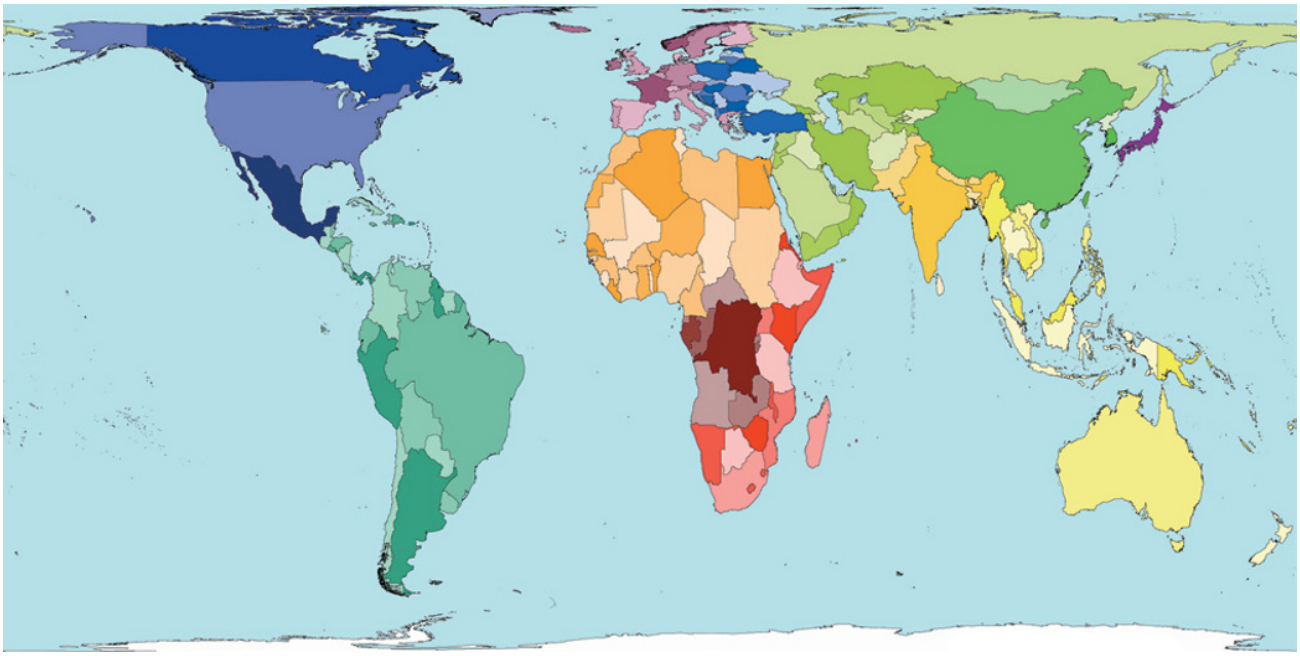


Figure 2.2 Global perspective: land area. *Source:* http://www.worldmapper.org/display.php?selected=1. © Copyright Worldmapper.org / Sasi Group (University of Sheffield) and Mark Newman (University of Michigan).

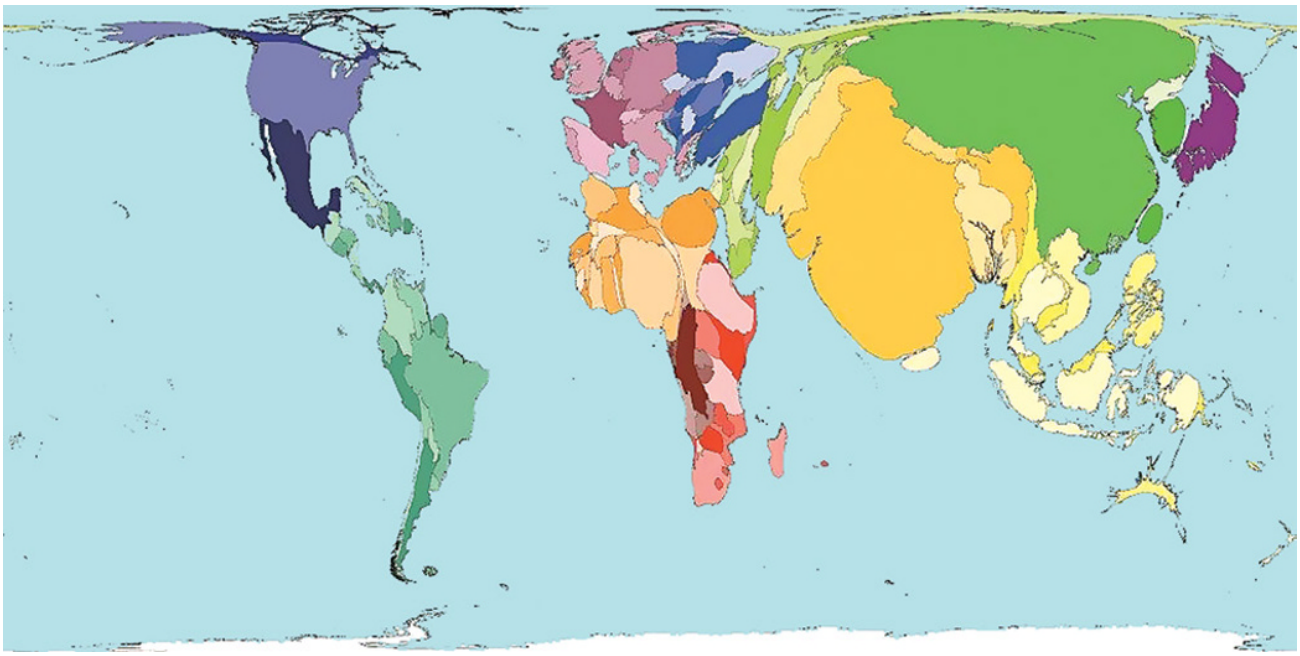


Figure 2.3 Global perspective: total population (population cartogram). *Source:* http://www.worldmapper.org/display.php?selected=1. © Copyright Worldmapper.org / Sasi Group (University of Sheffield) and Mark Newman (University of Michigan).

Nations, 2011). Whereas between 2011 and 2050 the population of the more developed regions will remain largely unchanged at 1.3 billion inhabitants, the population of the less developed regions is projected to rise from 5.7 billion in 2011 to 8 billion in 2050. At the same time, the population of the least developed countries is projected to more than double from 851 million inhabitants in 2011 to over 1.7 billion in 2050. Consequently, by 2050, 90% of the world's population is expected to live in the less developed regions, including 18.6% in the least developed countries, whereas only 14% will live in the more developed regions (Figure 2.4).

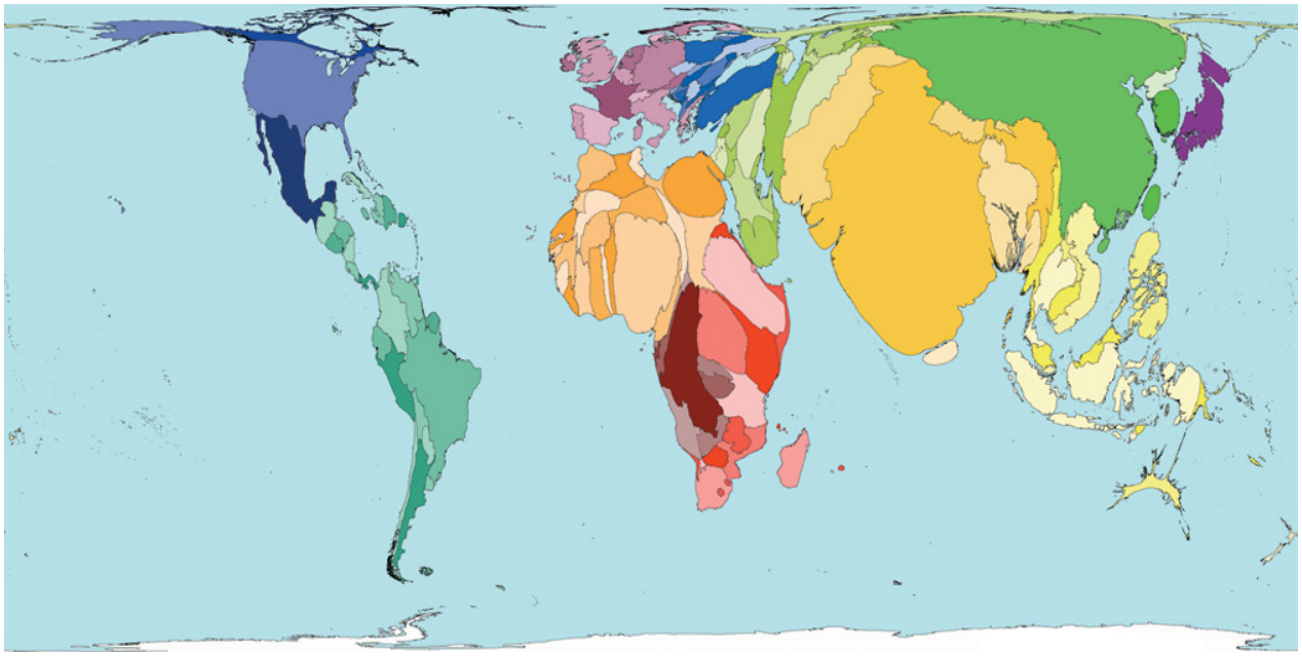


Figure 2.4 Global population prediction: 2050. *Source:* http://www.worldmapper.org/display.php?selected=2. © Copyright Sasi Group (University of Sheffield) and Mark Newman (University of Michigan).

To properly interpret the significance of health trends it is really important to consider the size and distribution of the population within our geographical sphere of work. Relatively low levels of disease in a large population may represent a much bigger challenge than high levels of disease in a small population, particularly because many larger countries tend to be less affluent at present and have less well developed health promotion and treatment services.

Oral Health

A recent definition from the World Dental Federation (FDI) highlights that 'oral health is multifaceted and includes the ability to speak, smile, smell, taste, touch, chew, swallow, and convey a range of emotions through facial expressions with confidence and without pain, discomfort, and disease of the craniofacial complex' (Glick et al., 2016).

Poor oral health can limit the ability to eat, speak and socialise. Oral diseases are largely preventable and yet remain common in most societies across the lifespan (WHO, 2012a). Within any community, there is great diversity of oral health by age, gender, geography and socioeconomic status, as well as changes over time. Diseases and conditions that threaten oral health may be considered a 'silent epidemic' affecting our most vulnerable citizens in society (Benzian, Monse and Helderman, 2011).

Oral Health Needs

This chapter focuses on oral health needs globally as well as some local examples, particularly from the UK. 'Need' is a concept that requires some 'unpacking'. Bradshaw's taxonomy provides a simple overview of the concept of 'need' (Bradshaw, 1972) and has remained an important concept in health and social care over recent decades (Cookson, Sainsbury and Glendinning, 2013). Bradshaw described different types of need as normative, expressed and perceived, as outlined in Table 2.1.

Oral health needs, as considered from the clinician's perspective, or that of an epidemiologist, are termed 'normative' need. In public health circles, when we describe oral health and oral health trends we generally use epidemiological data that report the clinical epidemiologist's perspective on need. Examples include the wealth of data collected in national decennial surveys (The Information Centre for Health and Social Care, 2011a), or by the public health service in England (Public Health England, 2014). In more recent years we have begun to place more emphasis on perceived oral health with the development of special questionnaire instruments to measure the impact on health and wellbeing for which there is a raft of measures such as the Oral Health Impact Profile (Slade and Spencer, 1994). Expressed oral health needs tend to be measured as the level of uptake of dental care, i.e. the use of dental services. None of these measures alone provides a perfect overview of oral health, but

Table 2.1 Bradshaw's taxonomy of need.

Type of need	Definition	Example of how this need is measured
Normative need	Need that is defined by experts. Normative needs are not absolute and there may be different standards laid down by different experts.	Epidemiological surveys
Felt need	Need perceived by an individual. Felt needs may be limited by individual perceptions and knowledge of services.	Quality of life indicators
Expressed need or Demanded need	Felt needs turned into action. Help seeking.	Uptake of dental care (emergency and routine)
Comparative need	Individuals (or populations) with similar characteristics to those receiving help.	Comparison between areas and populations

Adapted from Bradshaw, 1972.

together they contribute a population profile that can assist in setting targets for improvement. Comparative need is the difference between two populations. In addition to the above, 'unmet need' is the difference between perceived and expressed need.

At an individual patient level, the same applies. Patients may perceive a need and complain of pain and express their need by attending for dental care, whilst others may suffer pain or discomfort without expressing their need (unmet need). When we as clinicians identify the presence of dental caries following clinical and/or radiological examination, this is evidence of 'normative need', which may or may not relate to perceived need.

As with individual patient care, it is important to understand the needs of the population, their help-seeking behaviour and how they are changing over time.

Chapter Aims

Having set the scene by examining the importance of understanding our population and their health needs, the aims of this chapter are as follows: first, to outline very briefly how oral health is measured, and provide examples of oral health surveys; second, to describe key trends and patterns in oral diseases and conditions; third, to highlight inequalities in health and wellbeing; and fourth, to explore the implications of these oral health trends for policy makers and clinicians.

Surveys of Oral Health – Epidemiology

Epidemiology can help to answer some important questions. What are the trends and patterns of oral health? What sections of society are most affected? What are the risk factors for the disease or condition? This includes social, physical, behavioural and genetic factors. Epidemiology is the study of disease or condition (*logos*) upon (*epi*) a population (*demos*) and has been defined by Mausner, Kramer and Bahn (1985) as 'the orderly study of diseases and other conditions in human populations where the group rather than the individual is the unit of interest'.

Unlike many aspects of general health, oral disease and morbidity can be measured directly. However, this is an expensive process as it generally involves using dentists, and support staff who have been trained and calibrated, to undertake epidemiological surveys. Epidemiologists first need to be trained to measure dental disease according to set criteria so that when we consider trends over time or compare one survey finding with another we can be reasonably confident that we are comparing like with like. Epidemiological surveys of oral health generally involve dental examinations of a representative or random sample of the population. Most of our data come from cross-sectional surveys and thus reflect the prevalence of a disease or condition. Cross-sectional studies give us a snapshot in time, and trends over time may be inferred from regular cross-sectional studies in the population. Longitudinal studies are particularly important to look at changes over time but are much more difficult and expensive to conduct given population mobility. They can, however, provide rich data on the incidence rate of a disease, i.e. the number of new cases per population at risk in a given time period. A good example of a current longitudinal study which is providing the global dental community with important and interesting findings is the Dunedin study in New Zealand, where the birth cohort of 1972–73 has been followed up regularly over the decades (Dunedin Health and Multidisciplinary Research and Development Unit, 2014). Great effort is made to follow up as many people as possible, even those who have left the country. The findings are reviewed at key points in this chapter.

Some studies will combine an epidemiological survey or normative needs assessment with a questionnaire survey to explore perceived needs, thereby providing a better overview of the population's oral health. Where resources permit, this may be undertaken in conjunction with questionnaire surveys which examine perceived oral health and wellbeing, the impact of oral disease and health behaviours. The latter include diet, oral hygiene, tobacco, alcohol, fluoride use and dental attendance.

A wide range of oral diseases is measured by means of epidemiological surveys including those listed in Table 2.2. From the data collected, other dimensions of oral health may be reported such as edentulousness, having 'excellent' oral health or a 'functional dentition', as explored in later sections of this chapter. Other conditions such as cancers tend to be measured through health services data, both from registries (all cancer data have to be shared with the national cancer registry) and routine activity data where diagnoses are part of the data set.

As one would expect, the most commonly measured diseases are the most prevalent: dental caries and periodontal diseases. The World Health Organization (WHO) global oral health database is currently held by Malmo University, http://www.mah.se/CAPP/, and the periodontal database in Japan, on behalf of WHO/FDI, http://www.dent.niigata-u.ac.jp/prevent/perio/contents.html. They provide a very useful, but sadly sometimes outdated, source of information, either because national surveys have not been undertaken, or not reported to the WHO. Additionally the FDI is launching a new oral health observatory app on which it is possible to look at available data by country: https://www.fdiworlddental.org

National statistics on oral health need to be treated with caution because they are not all collected at the same time and may not be fully representative of their country, depending on whether they come from a national survey involving a random sample of the population or a local survey of a particular area. They may include data on age ranges rather than one specific age. Whatever data are presented, we recognise that even within one country patterns of oral health will vary greatly, so even where data are representative of the national picture, they are average values and will not reflect the variation within society. Therefore clinicians may find themselves practising in areas where disease levels are higher or lower than the national average.

The incidence and prevalence of other serious conditions such as oral cancer are measured in high-income countries, such as the UK, by means of data from cancer registries, and supplemented by information from health services. Similarly, there is also registration of cleft lip and palate and HIV/AIDS which require formal reporting, thus providing robust information at local and national levels. In low-income countries the incidence may be estimated based on hospital activity and registries in the urban areas only. Hence, many of these diseases and conditions are likely to be under-reported and the incidence and prevalence likely to be much greater than the statistics suggest. For example, information on oral cancer in India only exists for patients who attend urban hospitals, whilst many attend only rural hospitals, or none. Global data must therefore be interpreted in light of data quality as outlined in subsequent sections.

Table 2.2 Data sources on the prevalence of oral diseases and conditions.

Epidemiological surveys	Health services registry and activity data
Dental caries	Cancers (oral, oropharyngeal, etc.)
Periodontal diseases	Cleft lip and/or palate
Tooth wear	Noma
Fluorosis	HIV/AIDS
Trauma to teeth	
Orthodontic need	
Other, e.g. soft tissue abnormalities	

Challenges of Measuring Oral Diseases and Conditions

Ethics

Epidemiology is generally undertaken for population rather than direct individual benefit. People are encouraged to take part for the good of society. Thus, it is important that the data from epidemiological surveys or questionnaire surveys are used to inform the planning of oral health services including health promotion. A further ethical consideration is that individuals taking part in epidemiological examinations should have the opportunity to have any serious oral health needs addressed appropriately; thus, all survey protocols should outline how someone with an acute or serious lesion will be facilitated to access care in a timely manner.

Sampling

Population studies are rarely conducted as they are expensive and generally not necessary; instead a representative sample is selected. Sampling of populations is informed by science but requires practical consideration of which sections of the population may be measured and where. There is always consideration of keeping costs to a minimum whilst ensuring that the sample is large enough to be

representative but selected in a random manner. Hence, the majority of what is known about common oral diseases and conditions comes from cross-sectional studies involving a random sample of the population. It is always worth checking if nationally available data come from a national or a local sample randomly selected or merely a convenience sample; and also whether there have been power calculations to check if the sample size is sufficient. This will provide an indication of its representativeness. Birth cohort studies involve following up a specific section of the population, e.g. the birth cohort of 1972–73 in Dunedin, New Zealand (Dunedin Health and Multidisciplinary Research and Development Unit, 2014), or the Avon Longitudinal Study of Parents and Children (ALSPAC, 2014), both of which are population-based, prospective cohort studies, with an important oral health component.

Indices

Table 2.3 shows the most common indices of oral health used in surveys, of which dmft/DMFT is the most frequently used. Dental caries has been measured by epidemiologists and clinicians counting the number of decayed [dt or DT], missing [mt or MT] and filled [ft or FT] teeth. This provides a composite score or number of affected teeth. This index was first described by Klein and colleagues in 1938 and adapted by the World Health Organization in 1986. It has been universally used in dentistry and advocated by the WHO in their 'Survey Methods' (WHO, 2013a).

Lower case 'dmft' denotes the primary dentition and upper case the permanent dentition; dmft/DMFT numerically expresses caries prevalence and is obtained by calculating the number of affected teeth at 'tooth' or 'surface' level. If the data relate to tooth surfaces, then they are reported as dmfs or DMFS and teeth dmft or DMFT. In countries where caries prevalence is high, the simple measure of dmft/DMFT is sufficient. The index does have a number of limitations in that caries is cumulative and therefore it is less helpful in adults than in children, particularly when teeth have been extracted.

Indices for measuring dental caries are undergoing further development: where caries levels are lower, there is increasing emphasis on developing more sophisticated dental indices to measure the depth and extent of dental caries, and to link the index to clinical care. Where disease levels are low and careful planning of both preventative and treatment services is required, it is important to begin to explore the use of more sophisticated clinical indices. An increasingly used index in clinical care is ICDAS, which may also be used as an epidemiological tool. ICDAS is the International Caries Detection and Assessment System (ICDAS Foundation, 2014), which is a 'system for detection and classification of caries in dental education, clinical practice, dental research, and dental public health'.

Historically, the majority of surveys of oral health worldwide have been conducted in schoolchildren for the following reasons. First, because most children attend school, they are the easiest section of the population to identify and access. Second, given that oral disease is one of the most prevalent conditions in children, it is important to measure in childhood, before (5 or 6 years) and after (12 or 14/15 years) they develop their permanent dentition. Third, it is important to inform action such as oral health promotion and plan healthcare so that children are given the best start in life with healthy lifestyle and free from disease. This is particularly important because much oral disease is cumulative and patterns of oral health are established at an early age. However, as all countries have an ageing population it becomes increasingly important to understand and reflect on how best to address the various sub-groups, giving increasing importance to the oral health needs of the older population (Petersen and Yamamoto, 2005). Cohort studies in high-income countries are now suggesting that older people are a caries-active group, experiencing new disease at a rate which is at least as great as that of adolescents (Thomson, 2004).

Training and Calibration

Much effort goes into planning an oral health survey. It is important to develop a clear written protocol for the study and ensure that all those administering a survey are trained in the criteria for diagnosing and recording diseases and conditions. Once staff have been trained then they need to be calibrated against a 'gold standard', to assess how accurately they use the survey criteria. Epidemiologists need to be reliable both internally and externally. Their findings should correlate with the 'gold standard', thus confirming that they are externally reliable. Internal consistency is demonstrated by re-examining a sub-sample of subjects (usually 10%), and comparing the scores to determine their level of consistency.

Surveys of Health and Wellbeing

Increasingly, information on the perceived needs of populations' oral health and wellbeing is being collected. This involves using quality of life surveys, often as part of a general or oral health survey. One of the most popular indices is the Oral Health Impact Profile; the main measure has 49 items (Slade and Spencer, 1994), and the short-form OHIP-14 has 14 (Slade, 1997). It is one of the most common measures used in national surveys (Nuttall et al., 2006; The Information Centre for Health and Social Care, 2011b).

Table 2.3 Epidemiological indices by disease and condition.

Diseases and conditions	Index name (abbreviation)	Reference	
		Authors	Year
Dental caries	deft/defs: primary dentition (usually younger children) d – decayed e – tooth indicated for extraction f – filled t – teeth *or* s – surfaces of the teeth	Gruebbel	1944
	dmft/dmfs: primary dentition d – decayed m– missing f – filled t – teeth *or* s – surfaces of the teeth	H. Klein, C.E. Palmer, and J.W. Knutson Modified by WHO	1938 1986
	DMFT/DMFS: permanent dentition D – decayed M– missing F – filled T – teeth *or* S – surfaces of the teeth	H. Klein, C.E. Palmer, and J.W. Knutson Modified by WHO	1938 1986
	Root caries index	R.V. Ratz	1979
	Significant caries index	D. Bratthall	2000
	Care index = FT/DMFT%	n/a	n/a
	The International Caries Detection and Assessment System, or ICDAS, is a simple, logical, evidence-based system for detection and classification of caries in dental education, clinical practice, dental research, and dental public healthhttps://www.icdas.org/	Ismail et al.	2007
Periodontal diseases	Periodontal index	A.L. Russell	1956
	Gingival index (GI)	J. Silness and H. Loe	1963
	Plaque index (PI)	H. Loe and J. Silness	1964
	Community Periodontal Index of Treatment Needs (CPITN)	World Health Organization (WHO) and Fédération Dentaire Internationale (FDI)	1978
Orthodontic conditions	IOTN – Index of Orthodontic Treatment Need	P.H. Brook and W.C. Shaw	1989
	PAR Index – Peer Assessment Rating	S. Richmond et al.	1992
	ICON – Index of Complexity, Outcome and Need	C. Daniels and S. Richmond	2000
Tooth wear	Eccles index for dental erosion of non-industrial origin	J.D. Eccles	1979
	TWI – tooth wear index	B.G. Smith and J.K Knight	1984
	Lussi's index for erosion	A. Lussi	1996

Table 2.3 (Continued)

Diseases and conditions	Index name (abbreviation)	Reference	
		Authors	Year
	O'Sullivan index	E.A. O'Sullivan	2000
	Simplified TWI (tooth wear index)	P.F. Bardsley, S. Taylor and A. Milosevic	2004
	Basic erosive wear examination (BEWE). http://elearningerosion.com/en/elearning_erosion/scientific-background/erosion-diagnosis/basic-erosive.html	Bartlett et al.	2008
Fluorosis	Dean's index	H.T. Dean	1934
	TF Index – Thylstrup and Fejerskov's index for fluorosis	A. Thylstrup and O. Fejerskov	1978
	Horowitz et al. index of fluorosis	H.S.Horowitz, W.S. Driscoll, R.J. Meyers, S.B. Heifetz, and A. Kingman	1984
Dental trauma	Trauma index: developed during Child Dental Health Survey in the UK	M. O'Brien	1993

How Are Data Used?

Epidemiological and quality of life data may be used in the planning of oral health services and preventive programmes. One of the most dramatic uses of epidemiology in the last century was the study of fluoride in water by Trendley Dean, who in his '21 cities study' identified the optimal level of fluoride in water to reduce dental caries whilst minimising the level of fluorosis and therefore bring great benefit to oral health; a good example of public health initiatives (Murray et al., 2003).

Evidence of poor oral health, obtained through population surveys, can stimulate action on tooth brushing and application of fluoride varnish in schools, together with action to improve the uptake of dental care, as with the Childsmile programme in Scotland (NHS Scotland, 2014). However, in many countries without state funded dental services there is not always such obvious use of information for planning dental care because of the way dentistry is organised and delivered – largely as a business. However, as outlined in the introduction, the use of epidemiology and health service data to demonstrate unmet need can be extremely helpful when considering where to invest existing time and resources and perhaps gain additional resources to address problems.

How Does Epidemiology Differ from Screening?

Sometimes there is confusion between screening for oral disease and epidemiology – often because the two have historically been combined for schoolchildren. Screening has been defined as 'A public health service in which members of a defined population, who do not necessarily perceive they are at risk of, or are already affected by a disease or its complications, are asked a question or offered a test, to identify those individuals who are more likely to be helped than harmed by further tests or treatment to reduce the risk of a disease or its complications' (UK National Screening Committee, 2014). Essentially epidemiology is primarily conducted for the benefit of the population, and screening for the benefit of the individual. People testing positive at screening are sent for an examination and further investigations.

In dentistry, oral screening for dental caries or cancer generally involves a visual examination to determine if there is possible disease, which means it is easy to get epidemiology and screening confused.

Global Oral Health

The World Health Organization (WHO), working closely with the World Dental Federation (Fédération Dentaire Internationale, or FDI), plays an important role

in monitoring oral health. This involves producing a manual, *Oral Health Surveys – Basic Methods*, which is now in its fifth edition (WHO, 2013a). This guidance, which includes advice on pathfinder surveys, is available online via WHO publications. The WHO manual has encouraged countries to conduct standardised oral health surveys that are comparable internationally. It facilitates development of procedures for management and analysis of data based on the use of information technology. The findings of national surveys are lodged in the Global Oral Health Data Bank, which is an important component of the Country/Area Profile Programme information system.

Because there may be so much difference in oral health within a population, it is important to ensure that there are robust data on key age groups to enable comparison over time and across countries. The key age groups as advised by the WHO (2013a) are:

- 5 years: dental caries in primary teeth (or later if children start school at 6 or 7 years).
- 12 years: dental caries in secondary teeth.
- 15 years: dental caries in secondary teeth.
- 35–44 and 65–74 years for dental caries in permanent teeth and periodontal disease.
- 65 years and over: edentulousness.

Pathfinder survey methods outlined by the WHO (2013b) are designed to assist those beginning epidemiological work in a given country and to assist in planning the provision of oral healthcare or further survey work and thus provide a practical, economic survey sampling method. A pathfinder survey is a stratified cluster sampling technique of key age groups. The sites are usually based on administrative districts and include the most important population sub-groups likely to have different disease levels. For example, a sample design for a national pathfinder survey for each 'index age' as shown in Box 2.1 may include 300 per group.

Box 2.1 Sampling for national pathfinder survey by index age and location as advised by WHO (2013b).

Urban:

- 4 sites in the capital city or metropolitan area ($4 \times 25 = 100$)
- 2 sites in each of 2 large towns ($2 \times 2 \times 25 = 100$)

Rural:

- 1 site in each of 4 villages in different regions ($4 \times 25 = 100$)

Total for one index age or age group:

- 12 sites × 25 subjects = 300

Data from WHO, 2013b.

At the time of writing there are 196 countries in the world. Countries are encouraged to report their epidemiological findings centrally. The WHO oral health databank contains information on the oral health of many countries for certain diseases and the key age groups. The most common data held relate to dental caries in 12-year-olds. Data on 12-year-olds are available for over 90% of countries worldwide, http://www.mah.se/CAPP/. There are some data on periodontal diseases in adults, http://www.dent.niigata-u.ac.jp/prevent/perio/contents.html, and oral cancer data are available through Cancer Today at http://gco.iarc.fr/today/home

What Do We Learn from Countries with Surveys of Oral Health?

The following sections will examine oral health using a series of markers relating to the common oral conditions as well as perceived oral health. Each section will examine global information on the size of the problem, as well as reviewing risk factors and interesting facts. Each section will conclude with consideration of the relevant global targets for oral health which should be formulated at country level (Hobdell et al., 2003a) to reflect the local disease levels rather than having the same targets for all. Finally, each section explores the challenges for those of us who seek to promote oral health.

The most basic of marker of oral health, and the easiest to measure, is whether people have retained any natural teeth; this will be considered first.

Edentulousness

Becoming edentate is the ultimate marker of dental morbidity and has significant implications for general health and wellbeing. Interestingly, as surveys of adults are less common than those of children, there are limited data on edentulousness worldwide.

Size of the Problem

The CAPP (WHO/FDI) database has information on adults of 65 years and over (CAPP, 2014a). Looking across global oral health data, it is clear that relatively few countries (n = 56) have conducted surveys of adults in older age groups and that data that are available cover several decades, thus the findings are not directly comparable. Furthermore, there is little indication of the extent to which the data are representative of the population as a whole. Nonetheless, there are some interesting findings and the variation in reported levels

of edentulousness is marked across continents and countries. Looking at the countries listed – and absent – Europe has more data (57% of the listed countries are European) (CAPP, 2014b) and higher levels of edentulousness, whereas Africa (CAPP, 2014c) has much less data coverage.

Although the global picture on edentulousness must be viewed with caution, total tooth loss appears to be common in high-income countries with a western diet and many dentists (Figure 2.5). The USA is a notable exception where edentulousness is low; this may be related to widespread water fluoridation which has benefits for all age groups in the population.

Trends in Edentulousness

Countries which have a wealth of epidemiological data on edentulousness over time present an interesting story. They suggest that levels of edentulousness, which were highest in the latter part of the twentieth century, are falling. For example in the UK, edentulousness has fallen from 29% to 6% in just three decades (1978–2009); however, many people who lost all their teeth are still alive and so we see high levels of edentulousness in older people (Kelly et al., 2000). Who removed all their teeth? For the majority this involved professional intervention by dentists. Within the UK, the odds of being edentate have been shown to be almost nine times higher for those adults with no qualification and four times higher for those with qualifications below degree level. Being from the north of Great Britain was also a factor that had an effect, with the odds of having no teeth rising as distance from the south of England increased (Treasure et al., 2001).

Trend analysis in the USA highlights that is also now a rare condition in high-income households, and it has contracted geographically to states with disproportionately high poverty. Thus, with the passing of generations born in the mid-twentieth century, 'the rate of decline in edentulism is projected to slow, reaching 2.6% (95% prediction limits: 2.1%, 3.1%) by 2050' (Slade et al., 2014). Slade et al. suggest that the continuing decline will be offset only partially by population growth and population ageing such that the predicted number of edentulous people in 2050 (8.6 million; 95% prediction limits: 6.8 million, 10.3 million) will be 30% lower than the 12.2 million edentulous people in 2010 (Slade et al., 2014).

Looking back, it is clear that some of the dental profession were practising within the focal infection paradigm and were of the view that all pain and sepsis could be avoided by the removal of all teeth. This occurred without thought of the pain and discomfort and social embarrassment associated with long-term denture wearing. This view was also accepted by the local population. For example within certain regions of the UK, most notably the north of England (Treasure et al., 2001; Steele et al., 2000), where edentulousness is highest, women were provided with a dental clearance and complete dentures for their twenty-first birthday present or as a wedding present from parents – just in case the husband-to-be could not afford to provide for his wife!

Risk Factors for Edentulousness

The main risk factors for edentulousness appear to be extensive disease, particularly dental caries, and demography (age, educational and social status), together with professional practice and population norms regarding appropriate dental care. Surveys around the world suggest that periodontal diseases are less often a cause of total tooth loss than one might expect.

The philosophy or paradigm in which dentists are practising and available facilities will contribute to the care available, together with patient behaviour in seeking regular care or preferring to attending later in the disease process when they are 'in trouble'.

Interesting Facts Regarding Edentulousness

- There is national level evidence in Great Britain from older people's national diet and nutrition survey that maintaining a natural and functional dentition (defined as having more than 20 teeth into old age) plays an important role in having a healthy diet rich in fruits and vegetables, a satisfactory nutritional status, and an acceptable body mass index (BMI) (Marcenes et al., 2003).
- Edentulous adults are less likely to attend dental services as they do not perceive a need for dental care (Kelly et al., 2000).

Global Targets

Suggested goals for oral health relating to edentulousness are outlined in Box 2.2.

Meeting the Challenge – So What Do We Do?

As oral health improves (The Information Centre for Health and Social Care, 2011c), edentulousness is increasingly not a useful marker of oral health, thus other markers of health are being tested such as having positive attributes, e.g. 'functional dentition' or 'excellent oral health' (The Information Centre for Health and Social Care, 2011c), or negative markers, e.g. 'PUFA', or 'high complexity'. All of these markers recognise improvements in oral health and that adults will retain some or all of their natural teeth into older age and probably for life.

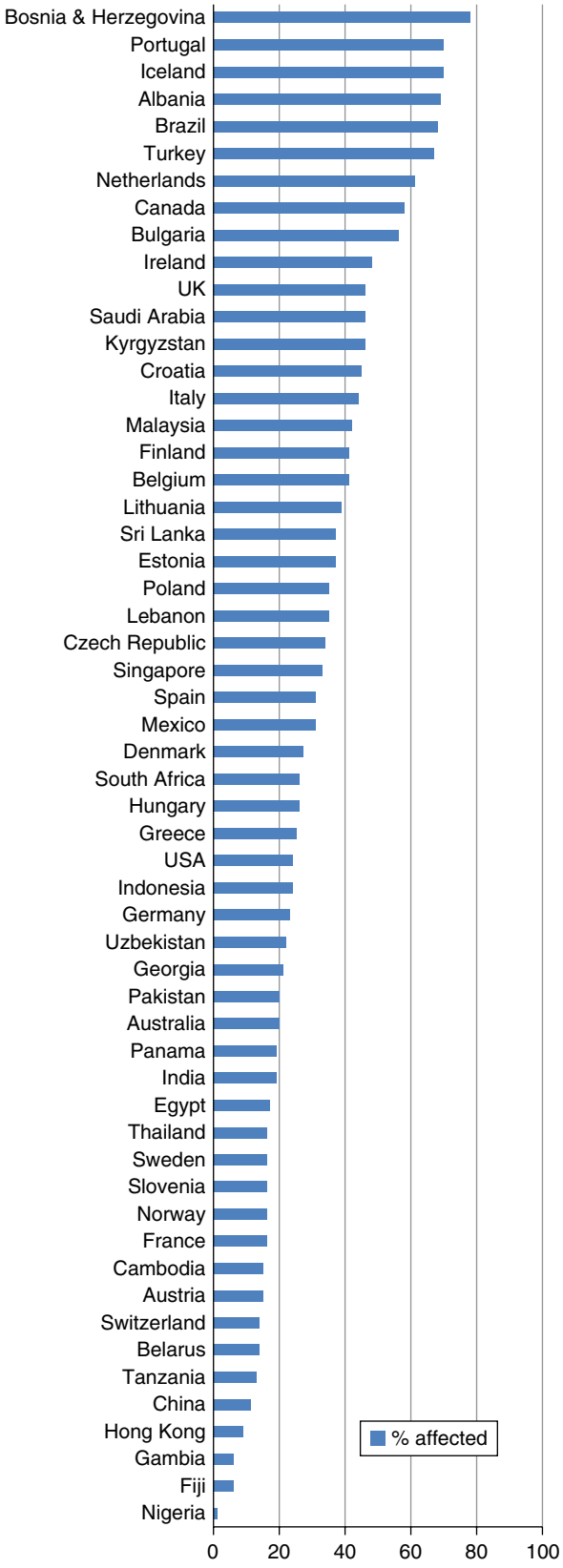


Figure 2.5 Edentulousness in adults aged 65 years and over. Adapted from CAPP. Oral Health Country Area Profile Project, 2014a.

Box 2.2 Global targets: edentulousness.

- To reduce the number and proportion of edentulous adults
- To increase the average number of natural teeth present in adults
- To reduce inequalities in edentulousness

Adapted from Hobdell et al., 2003a.

Where information on edentulousness is collected, given the ageing global population, it is important to ensure that data are collected and reported by age band including older people aged 65 years and over so that there is greater understanding of those in need. The data from high-income countries such as the UK (The Information Centre for Health and Social Care, 2011c) suggest that edentulous adults are increasingly old, therefore special domiciliary denture services may be required for older and more vulnerable house-bound people.

Reflecting on history, it is really important that we as a profession think about the paradigm underpinning our patient care, moving away from a merely restorative and surgical approach to ensure that dental caries is managed preventatively and conservatively (Baelum et al., 2007; Fejerskov et al., 2013).

Functional Dentition

It is important that adults retain the ability to eat, speak and socialise throughout life. There is evidence that having 20 or more natural teeth enables dentate individuals to eat what they want in comfort, without the need for partial dentures; this is known as having a 'functional dentition'(Gotfredson and Walls, 2007). Within the UK, 21 or more teeth, or two thirds of the permanent dentition, is used as the marker for having a 'functional dentition', with patients having a 'shortened dental arch'. In 2009, 86% of dentate adults across England, Wales and Northern Ireland were reported as having a functional dentition (21 or more natural teeth). Furthermore, whilst almost all young adults had a functional dentition, this reduced with age.

Interesting Facts about Functional Dentition

There is national level evidence from a national diet and nutrition survey that maintaining a natural and functional dentition, which is defined as having 20 or more teeth into old age, plays an important role in having a healthy diet rich in fruits and vegetables, a satisfactory nutritional status, and an acceptable body mass index (BMI) (Marcenes et al., 2003).

Box 2.3 Global targets: tooth functional dentitions.

- Increasing the number and proportion of adults with functional dentitions (i.e. either ≥20 or ≥21 or more natural teeth)

Adapted from Hobdell et al., 2003a.

Global Targets

Suggested targets in relation to achieving a functional dentition are outlined in Box 2.3.

Meeting the Challenge

Retaining a functional dentition, ideally with opposing pairs of teeth, must as far as possible become a long-term goal of patients and clinicians, at least where there are resources to do so.

Excellent Oral Health

The UK Adult Dental Health Survey 2009 instituted a category of 'excellent' oral health for the first time, defined by five features (The Information Centre for Health and Social Care, 2011c):

- Number of teeth – 21 or more natural teeth.
- Number of sound and untreated natural teeth – 18 or more.
- Decay – no decay at any site.
- No periodontal loss of attachment (LOA) >4 mm.
- No bleeding or calculus.

Overall, 10% of the adult population were reported as having excellent oral health, ranging from 23% of 16 to 24-year-olds through to only 5% of adults in the 45 to 54-year-old age group (The Information Centre for Health and Social Care, 2011c); only 1% of those aged over 55 years were recorded as having excellent oral health. As with improvements in functional dentitions, this marked transition could be associated with access to fluoride whereby older adults, who did not have access to fluoride when their adult dentition was emerging, did not have as much protection against dental caries. Adults aged 45 years and below will have benefitted from fluoride in products such as toothpaste and/or water in retaining their natural dentition, together with changes in caries management (Baelum et al., 2007; Fejerskov et al., 2013). Despite decades of improvements in oral health, it is still salutary to realise just how few adults have good oral health.

Global Targets for Oral Health

There are no global targets relating to excellent oral health. However, this is something that should actively be considered by clinicians and patients, from childhood onwards, as oral diseases, particularly dental caries, are cumulative.

Meeting the Challenge

Patients' expectations are rising, particularly in high-income countries and amongst socially affluent individuals (Clow, Fischer and O'Bryan, 1995). Retaining excellent oral health into adult life is clearly possible as highlighted above, but maintaining this state through adult life and into older age increasingly becomes a challenge for individuals in relation to their self-care and wider psychosocial and environmental conditions.

Clinicians should be encouraging those with good oral health to maintain excellent oral health. It is notable amongst children and young people that more lesions will arise in the section of the population who appear to be disease free, i.e. 'low risk', than in those who are 'high risk' (Batchelor and Sheiham, 2002, 2006). However, wider environmental influences can support or detract from oral health so not everything is as much under the control of individuals as we would like to think. Our behaviours are heavily influenced by environmental, cultural and social norms.

Urgent Conditions

The last UK Adult Dental Health survey reported on 'urgent' conditions using an index called PUFA (Box 2.4). This index was first used in the Philippines amongst schoolchildren to report the clinical consequences of untreated dental caries (Benzian et al., 2011a; Monse et al., 2011). It was designed to provide additional information to inform healthcare planning. PUFA (pulp, ulceration, fistula, abscess) provides a measure of badly diseased and broken down teeth which have been attacked by dental decay and are causing significant problems in need of early attention. It is now advocated for use by the FDI as a tool that can help to stress the importance of tackling dental caries to planners (Benzian et al., 2011b). It is interesting to note that in the UK, where there have been massive improvements in oral health, some 7% of dentate adults (adults with teeth) had one or more conditions. A PUFA score of one or more was more common in men than women, adults from lower social groups than more affluent, amongst adults who reported brushing less than once a day than amongst those who brushed once or twice, and amongst smokers rather than

Box 2.4 PUFA index criteria.

P – pulp involvement is recorded when the opening of the pulp chamber is visible or when the coronal tooth structures have been destroyed by the carious process and only roots/root fragments are left
U – ulceration due to trauma is recorded when sharp edges of a dislocated tooth with pulp involvement or root fragments have caused traumatic ulceration of the surrounding soft tissues, e.g. tongue or buccal mucosa
F – fistula is scored when a pus-releasing sinus tract related to a tooth with pulp involvement is present
A – abscess is scored when a pus-containing swelling related to a tooth with pulp involvement is present

Source: Monse et al., 2011; Health and Social Care Information Centre, 2011c.

Box 2.5 Global targets: pain.

- Reduction in episodes of pain of oral and craniofacial origin
- A reduction in inequalties in relation to pain of oral and craniofacial origin

Adapted from Hobdell et al., 2003a.

non-smokers. These findings contrast with the Philippines where over half (56%) of 12-year-olds had PUFA lesions (Monse et al., 2011). The evidence from UK adults is that having a PUFA score was very strongly associated with perceived poor oral health (The Information Centre for Health and Social Care, 2011b; Monse et al., 2011).

Suggested targets proposed in relation to acute conditions can best be related to pain as presented in Box 2.5, since many oral and dental conditions involve pain.

Meeting the Challenge

Even in countries where there are established dental services and state subsidies to support care for low-income families, there is still a section of the population that attends only when in trouble and even then delays dental attendance for as long as possible (The Information Centre for Health and Social Care, 2011d). This impacts on disease levels and the restorability of lesions. It is important to address this because retaining a functional dentition must as far as possible become a long-term target of patients and clinicians, at least where there are resources to do so.

Complexity

In order to make sense of the data on adult oral health and the implications of the burden of disease for maintenance and care, the researchers involved in the latest UK adult dental health survey have helpfully created a complexity score (The Information Centre for Health and Social Care, 2011e). There are eight possible indicators of how adults with a combination of issues may lead to a degree of complexity in management. The index includes the factors listed in Box 2.6.

Box 2.6 Complexity indicators.

- In the top quintile for restored surfaces (based on all dentate adults; 32+ surfaces restored)
- In the top quintile for crowns (based on all dentate adults; 3 or more)
- Having any denture, bridge or implant
- Having one or more sextant with pocketing of 6 mm or more or loss of attachment of 9 mm or more
- Having any active decay of crown or root
- In the top quintile for active decay
- PUFA score greater than zero or an unrestorable tooth (pulp, ulceration, fistula, abscess)
- Reporting at least one of the Oral Health Impact (OHIP-14) problems as having been experienced very or fairly often over the last 12 months

Source: Health and Social Care Information Centre, 2011c.

In the UK, one third of adults had no complexity and 45% had only one or two items whereas 19% per cent had three or more and 8% of adults had four or more indicators of complexity (The Information Centre for Health and Social Care, 2011e). The difference was quite marked by age with only 6% of adults in the 16–24 age category having three or more impacts, compared with 32% of those aged 65–74. Extreme complexity was apparent in 0.65% of the UK adult population, which would account for over a quarter of a million adults. This measure is particularly important because in high-income countries with established dental services there is a growing number of adults aged 50 years and over with large fillings and crowns, which now require significant maintenance and frequently require complex treatment (Watt et al., 2013).

Oral Health Related Quality of Life

The most common measure of oral health related quality of life is the shortened form of the Oral Health Impact Profile (OHIP–14). The purpose of using this index is to provide a comprehensive measure of self-reported dysfunction, discomfort and disability arising from oral conditions. The original Oral Health Impact Profile (OHIP), a 49-item questionnaire instrument, was devised by Slade and Spencer (1994), to assess individuals' oral health related quality of life. It was based on Locker's

adaptation of the WHO's classification of impairments, disabilities and handicaps (Locker, 1998). Each of the seven dimensions of impact in the original scale was assessed from questions on the type of problems experienced (a total of 49 questions). The shortened version (OHIP-14) was later developed based on a subset of two questions for each of the seven dimensions, making 14 in total (Slade, 1997).

There is widespread support for this measure as being a valid global self-reported oral health measure (Thomson et al., 2012), providing a useful adjunct or alternative to clinical surveys. This measure has been used in both the UK child and adult dental health surveys as a measure of perceived oral health (Nuttall et al., 2006; White et al., 2012).

Amongst children, oral health impacts are common. One or more oral health impacts during the previous 12-month period has been reported in 22% of 5-year-olds, 26% of 8-year-olds, 34% of 12-year-olds and 28% of 15-year-olds (Nuttall et al., 2006).

Amongst UK adults (excluding Scotland), 39% of adults experienced one or more of the problems included in OHIP-14 occasionally or more often in the previous 12 months (The Information Centre for Health and Social Care, 2011b). Thirty per cent of adults had experienced physical pain, and 19% had experienced psychological discomfort (The Information Centre for Health and Social Care, 2011b). There was a clear socio-economic gradient in the adult population with those from lower social groups reporting more problems. There was no difference between dentate and edentate adults. Overall the impact reduced from the previous survey in 1998 in parallel with general improvements in oral health as dental caries experience reduces in the population (The Information Centre for Health and Social Care, 2011b).

Global Targets for Oral Health Related Quality of life

Suggested targets for oral-health-related quality of life are listed in Box 2.7.

Meeting the Challenge

Just as in clinical encounters it is important to understand patients' perceptions of their oral health, so it is with quality of life measures. These measures are of increasing importance in measuring oral health as part of wider surveys of health and wellbeing when a clinical dental examination is not possible. To consider the parallel situation in the care of individuals, it is equally important in clinical care that the patient's perception is taken into account to ensure that their oral health needs are met and their quality of life is enhanced.

Box 2.7 Global targets: oral health related quality of life.

- A reduction in episodes of pain of oral and craniofacial origin
- A reduction in the number of days absent from school, employment and work resulting from pain of oral and craniofacial origin
- A reduction in the numbers of people experiencing difficulties in chewing, swallowing, socialising and speaking/communicating because of a problem with their teeth or mouth

Adapted from Hobdell et al., 2003b.

Dental Caries (Tooth Decay)

Size of the Problem

Dental caries is the most prevalent chronic condition in the world and a global health problem (Beaglehole et al., 2009). Caries affects the majority of the world's population at some time in their lives despite being a preventable disease (WHO, 2012a). Decay arises when dietary sugars and oral bacteria in the oral biofilm are present on a tooth surface over time (Selwitz, Ismail and Pitts, 2007); the consequences are pain, suffering, dental care (which for many in the world is inaccessible and/or unaffordable) and potentially tooth loss.

Worldwide a staggering 60–90% of school children and nearly 100% of adults have experienced dental caries (WHO, 2012a). This disease causes much pain and suffering as well as days lost from school and work. Analysis of the global burden of disease (GBD) showed that untreated caries in permanent teeth was the most prevalent condition evaluated for the entire GBD 2010 Study (global prevalence of 35% for all ages combined) (Marcenes et al., 2013). In addition, untreated caries in deciduous teeth was the tenth most prevalent condition, affecting 9% of the global population (Marcenes et al., 2013).

Twelve years of age has been determined as the global indicator age group for international comparisons and surveillance of dental caries. It was selected as it is a pivotal point in the permanent dentition and a time when most children can be surveyed through schools. Most countries of the world have surveyed the oral health of their 12-year-olds (n = 189 in 2011) (Table 2.4). The global weighted mean DMFT value for 12-year-olds in 2011 was 1.67 (WHO, 2012b).

The data in the WHO global oral health databank, whilst hopefully being the most recent available for the country, may or may not be representative of the average levels of oral health. First, not all countries have the

Table 2.4 Mean levels of dental caries by WHO region and globally, 2004 and 2015.

	DMFT in 12-year-olds	
WHO region	**2004**	**2015**
African	1.15	1.06
Americas	2.76	2.08
Eastern Mediterranean	1.58	1.64
European	2.57	1.81
South East Asia	1.12	2.97
Western Pacific	1.48	1.05
Global	**1.61**	**1.67**

Data from CAPP http://www.mah.se/CAPP/Country-Oral-Health-Profiles/According-to-Alphabetical/Global-DMFT-for-12-year-olds-2011/

resources, human and financial, available to conduct a national survey of oral health. Second, not all surveys are conducted at the same time. Third, not all will have used the same criteria for diagnosing caries. All these issues make comparisons difficult. Fourth, and finally, increasing emphasis on obtaining positive consent from parents for their child's participation in a survey means that some children will be excluded, and there is some evidence that amongst younger children they will be those from socially deprived backgrounds who are more likely to suffer from dental caries.

Trends over Time

Globally, the data suggest that overall caries prevalence in 12-years olds has fallen from 1980 when the global average was 2.43 (Leclercq et al., 1987) to 1.67 in 2011 (Natarajan, 2011). Most high-income countries have shown great improvements in oral health. For example Switzerland has achieved a reduction from 8.1 DMFT in 1964 to 0.8 in 2009 amongst 12-year-olds in the Canton of Zurich (CAPP, 2014b). Dental caries within Europe appears to be highest in eastern countries such as Croatia and Serbia (CAPP, 2014b).

Globally, some of the poorest countries, particularly in the African region, appear to be stable, possibly due to a failure to continue epidemiological surveys, whereas certain middle income countries have rising levels of dental caries. The American region has the highest mean levels of decay with Central and South American countries most affected (CAPP, 2014d).

The management of dental caries is one of the public health success stories of the twentieth century with the discovery of fluoride as a preventive measure against the effects of sugars in the diet (Centers for Disease Control and Prevention, 2013). Tooth decay has moved from being a national epidemic amongst children in many high-income countries such as the USA and the UK to being a disease of poverty and of older age. Although vulnerable groups bear a disproportionate amount of disease (US Surgeon General, 2000), the global data show that most individuals will experience dental caries at some stage in their lifetime. A representative survey of children aged 11–12 years in the Philippines, a country which has some of the highest caries levels in the south east Asian region, showed a significant association between caries and body mass index (BMI), and particularly between odontogenic infections and 'below normal' BMI (Benzian et al., 2011a).

Risk Factors for Dental Caries

Risk factors for dental caries include social factors – low income, low education, social deprivation – and behavioural factors including a diet high in sugar, lack of optimal fluoride on a regular basis and poor plaque removal. Diet is the main behavioural risk factor and is common to many other non-communicable diseases, including obesity, metabolic syndrome and cardiovascular diseases.

Interesting Facts about Dental Caries

- Sheiham and Sabbah (2010), suggest 'universal patterns of caries, in terms of prevalence, incidence, frequency distribution and rates of progression, in permanent teeth that can be applied when planning dental care' as follows:
  - Caries levels follow trend lines, therefore knowing the caries level at one age can be used to predict the levels at later ages in that cohort by looking at the trend line for that cohort.
  - The distribution of dental caries of a population exhibits the following characteristics: as the mean DMFT increases, the percentage of caries-free individuals falls and the caries distribution widens.
  - There is a specific mathematical relationship between the mean DMFT and mean DMFS.
  - There is a hierarchy of caries susceptibility by tooth type and sites on teeth; for a given DMFT or DMFS, there is a specific intraoral pattern of caries by tooth type.
  - Changes in mean DMFT scores for individuals and groups are not linear, but 'stepped'; there are groupings of teeth and tooth sites that may have similar 'resistance' to caries.
  - As the mean DMFT declines, the post eruptive time for initiation of caries increases and the progression rate of caries through enamel decreases.

- In most high-income countries dental caries is associated with social deprivation (Harris et al., 2004; Pitts and Harker, 2004).
- Dental caries in early childhood has been shown to be associated with maternal patterns of caries (Pitts and Harker, 2004).
- In managing dental caries, it is important to note that more new caries lesions develop in children who were previously 'caries free' (Batchelor and Sheiham 2002, 2006) hence challenging the adoption of a high-risk strategy for prevention.
- There is some evidence that stress has been shown to be associated with early childhood caries (Boyce et al., 2010). This convergence of psychosocial infectious and stress-related biological processes appears to be implicated in the production of greater cariogenic bacterial growth and in the conferral of an increased physical vulnerability of the developing dentition (Boyce et al., 2010).
- Older people become more susceptible to dental caries, including root caries in later life (Thomson, 2004).
- Older people in care homes have higher levels of dental caries than their counterparts in the community when matched for age and sex (Steele et al., 1998).
- Good social relations are important in older age. A study amongst dentate older people who lived in community settings surveyed as part of the Kungsholmen Elders Oral Health Study (KEOHS) in Sweden suggests that social relations are related to the oral health status of old-old individuals. It was found that those who lived alone or who became alone during the 7 years prior to the dental examination had greater odds of having coronal caries than those who continually lived with others, and that those who were continuously dissatisfied with the frequency of their social contacts were more likely to have root caries than those who reported a sustained satisfaction with the frequency of their social contacts (Avlund et al., 2003).
- Dental caries continues as a disease of adulthood, remaining important beyond childhood and adolescence, and rates of dental caries over time remain relatively constant (Broadbent et al., 2013).

Meeting the Challenge – So What Do We Do?

It is very important to avoid a simplistic approach to understanding dental caries. As dental professionals we should be aware of the wider psychosocial and environmental influences on oral health as well as the biological factors, which together produce both modifiable and non-modifiable risk factors. Our approach to caries management must move away from merely a simplistic behavioural approach to working on the wider determinants of health in tandem with modifiable risk factors. Thus actions should include:

- Support action against sugar to address the level of sugar consumption in society.
- Support community interventions such as healthy school initiatives.
- Lead action in support of fluoride availability through water, toothpastes, varnish, etc.
- Ensure careful assessment of caries prevalence and consider using ICDAS as a tool which also reflects caries management.
- Assess caries risk factors during patient care and support individuals in reducing their caries risk.

Suggested targets are listed in Box 2.8.

Box 2.8 Global targets: dental caries.

- Increasing the proportion of caries-free children at key ages: particularly 5/6 and 12 years
- Reduction in average caries experience levels in key age groups
- Decreasing inequalities in dental caries experience
- Reducing risk factors for dental caries, e.g. sugar consumption and ensuring optimal fluoride

Adapted from Hobdell et al., 2003a.

Periodontal Diseases

Periodontal diseases are highly prevalent and can affect up to 90% of the world's population (Pihlstrom, Michalowicz and Johnson, 2005). Hughes estimates that periodontal diseases have increased significantly over the past decade and are becoming 'the new caries' as the challenge for our dental professions (Hughes, 2014). Evidence from Dunedin suggests that 'periodontitis commences relatively early in adulthood, and its progression accelerates with age, particularly among smokers' (Thomson et al., 2013). The term 'periodontal diseases' covers a wide range of conditions which have been categorised by Armitage (1999) as follows:

- Gingival diseases: plaque (gingivitis) or non-plaque induced.
- Chronic periodontitis: the most common form of periodontitis resulting in attachment loss and tooth loss for much of the world's population.
- Aggressive periodontitis: patients are otherwise healthy, show progressive destruction and there is a familial aggregation of this condition.

- Periodontitis as a manifestation of systemic disease.
- Necrotising periodontal diseases.
- Abscesses of the periodontium.
- Periodontitis associated with endodontic lesions.
- Developmental or acquired deformities and conditions.

Gingivitis, which is the mildest form of periodontal disease, and reversible, is caused by the dental biofilm that accumulates on teeth adjacent to the gingivae but does not affect the underlying structures, although it may do so in time. In contrast, periodontal diseases result in the loss of connective tissue and bone support and are a cause of tooth loss in adults (Pihlstrom, Michalowicz and Johnson, 2005).

There have been a range of indices developed to measure aspects of periodontal diseases including: bleeding, pocket depth, attachment loss, tooth mobility, presence and severity of dental plaque (Table 2.3). None of the indices used to date on their own has widespread support and the variety of indices used, and the lack of consistency in scoring indices mean that detailed comparisons are not meaningful.

Partial mouth recordings are generally used in epidemiological surveys; however, this approach tends to lead to an underestimation of disease, an important point when epidemiological findings are reviewed. A database of periodontal epidemiology is held as part of the Country Area Profile Project (CAPP) (2014e). What is striking about the database is that much of the data are not contemporary. Whatever the reasons, it could reflect the fact that there is less emphasis on collecting oral health data or that surveys which are being undertaken are not representative of the country, or that data being collected are just not being reported to the WHO. It is important, therefore, that efforts are made to ensure that this resource for international surveillance is regularly kept up to date.

Size of the Problem

Gingivitis is the most common periodontal condition, affecting four out of five adults worldwide (Pihlstrom, Michalowicz and Johnson, 2005). It is increasingly evident that severe periodontal disease occurs in a few teeth of a subsection of the population which generally ranges from 5% to 20% of the 34 to 44-year-old population (WHO, 2012); within the UK it is considered to be 10–15%. Severe forms are found only in a portion of the adult population who show abnormal susceptibility (GEnco and Borgnakke, 2000).

The GBD study ranked severe periodontal disease as the sixth most prevalent condition worldwide in 2010 (Vos et al., 2012; Marcenes et al., 2013). Three case definitions of severe periodontitis were used in the GBD study, depending on which one was used in the publication:

- Community Periodontal Index score of 4 mm
- clinical attachment loss of more than 6 mm, or
- gingival pocket depth of more than 5 mm.

Disability adjusted life years (DALYs) due to severe periodontitis increased since 1990 and this was considered to be due to population growth and ageing (Murray et al., 2012).

National surveys such as those undertaken within the UK provide an in-depth overview and evidence of trends (The Information Centre for Health and Social Care, 2011a, 2011f). Periodontal disease was measured by bleeding on probing, calculus and pocketing in each sextant. In adults aged 55 and over, attachment loss (LOA) was also recorded. The overall findings provide a pattern of disease within a high-income country where the majority of the population are regular or occasional dental attenders of dental care (The Information Centre for Health and Social Care, 2011a, 2011f):

- Only 17% of dentate adults had very healthy periodontal tissues and no evidence of bleeding, calculus, pocketing of 4 mm or more or loss of periodontal attachment of 4 mm or more anywhere in their mouth.
- The majority of dentate adults had some periodontal disease, albeit generally at a low or moderate level.
- Gingival bleeding on probing was present in 54% of adults.
- 45% of dentate adults had LOA of 4 mm or more and this increased with age.
- 37% of dentate adults had pocketing of 4mm-5.5 mm which is considered 'mild'.
- 8% had pocketing of 6 mm or more present and just 1% had 9 mm or more.
- LOA is an indication of damage over a lifetime and takes into account gum recession. In dentate adults over 55 years of age, 66% had a LOA of 4 mm or more, 21% 6 mm or more, and 4% over 9 mm.
- Periodontal health was positively associated with reported regular dental attendance and regular tooth brushing (twice per day or more).
- Periodontal health was negatively associated with smoking.
- Females generally had better periodontal health than males.
- A social gradient was apparent only in moderate and severe periodontitis.

Further in-depth analysis revealed that periodontal disease was associated with quality of life independent of socio-demographic characteristics and other conditions present in the mouth (Bernabé and Marcenes, 2010).

The 2003 UK Child Dental Health Survey revealed that just over half (52%) of 15-year-olds had some evidence of inflammation and 63% had plaque present (White and Lader, 2004). Only data on gingival health, plaque and calculus were collected. The findings suggested that gingivitis, plaque and calculus levels were generally higher than 10 years previously and there was some evidence of variation associated with social variables.

Moving from considering the findings of cross-sectional studies over time to a longitudinal study, the Dunedin study in New Zealand revealed that:

- Periodontitis commences relatively early in adulthood, and its progression accelerates with age, particularly among smokers (Thomson et al., 2007).
- Current and long-term smoking in young adults is detrimental to periodontal health, but smoking cessation may be associated with a relatively rapid improvement in the periodontium (Thomson et al., 2007).
- Site-specific periodontal attachment loss due to dental caries or restorative events occurs in adults in their third and fourth decades of life (Thomson et al., 2013).

Risk Factors for Periodontal Disease

Plaque is a risk factor for periodontal diseases, as are tobacco, systemic infections, stress, genetic disorders and localised factors which predispose to the accumulation of plaque (Petersen and Ogawa, 2012). Localised factors include calculus, malaligned teeth, partial dentures and overhanging fillings.

Smoking is one of the most significant risk factors associated with the development of gum disease. Additionally, smoking can lower the chances for successful treatment. Hormonal changes in girls/women can make gums more sensitive and make it easier for gingivitis to develop. Diabetes involves higher risk for developing infections, including gum disease. Diseases such as cancer or AIDS and their treatments can also negatively affect the health of gums.

Some people are more prone to severe gum disease than others and appear to have a genetic susceptibility. The association between periodontal and systemic diseases – an increasingly important aspect of research – is well recognised (Petersen and Ogawa, 2005; Kinane and Bouchard, 2008; Petersen and Ogawa, 2012). Additionally, medications can increase risks, either directly by leading to abnormal overgrowth of the gum tissue or indirectly through reduced salivary flow.

Research which suggests that socio-economic status variables alone account for approximately 50% of the differences in the prevalence of periodontitis at 35–44 years of age is noteworthy and places in perspective efforts to improve individual health by changing behaviour and lifestyle as the sole focus of preventive strategies (Hobdell et al., 2003b).

There is evidence from the Dunedin longitudinal study that localised periodontal disease can be associated with restorative dentistry. For example, where a caries/restorative event had occurred on an inter-proximal tooth surface before age 26, attachment loss at the corresponding periodontal site was approximately twice as likely to be ≥3 mm than if the adjacent tooth surface had remained sound (Broadbent et al., 2006). This was also the case where a caries/restorative event had occurred subsequent to age 26 (Broadbent et al., 2006).

Interesting Facts about Periodontal Disease

A consensus document highlights the evidence from epidemiological research of the *association* between periodontal diseases and other conditions such as cardiovascular diseases; however, there is to date no compelling evidence that preventive periodontal care or therapeutic intervention will influence general health (Kinane and Bouchard, 2008).

Meeting the Challenge – So What Do We Do?

Measurement: the WHO has been working on new approaches to measure periodontal diseases. The current data are relatively weak and there needs to be robust discussion as to whether periodontal disease is a sufficiently severe oral health problem to warrant greater time and investment in its measurement and, above all, prevention of periodontal diseases (Petersen and Ogawa, 2005). Given the cost of treating periodontal disease, there are arguments for doing so. Longitudinal studies will be important in contributing to a greater understanding of who goes on to develop periodontal disease, the associations with other systemic diseases and the underlying pathogenesis, together with mechanisms for intervention.

Dental clinicians: it is important for dental practitioners to ensure that a thorough oral examination has been undertaken, including a periodontal charting. Patients must be made aware of their periodontal condition early in the process and assisted with its management (Public Health England et al., 2017).

Global Targets for Oral Health: Periodontal Diseases

Suggested targets are listed in Box 2.9.

Box 2.9 Global targets: periodontal diseases.

- Reducing the average number of teeth lost to periodontal diseases amongst adults
- Reducing the prevalence of necrotising forms of periodontal diseases
- Reducing the prevalence of periodontitis disease in adults and children with healthy gums
- Reducing risk factors for periodontal diseases, e.g. smoking and poor oral hygiene

Adapted from Hobdell et al., 2003a.

Tooth Wear

Tooth wear or tooth surface loss (TSL) is the loss of tooth tissue that is not related to dental caries. It involves one or more of the following: attrition, abrasion, erosion and abfraction (Bartlett and Dugmore, 2008). It is increasingly perceived as an oral health problem, particularly when pathological. It is a natural feature of ageing and involves the loss of hard tissue by physical (e.g. eroded by toothbrush and abrasive paste), chemical (e.g. acidic from diet and gastric reflux) and mechanical (e.g. grinding contact between opposing arches of teeth) means or often a combination of all three. The prevalence of tooth wear is difficult to estimate because of the range of indices or methods of measuring the disease, some of which are best used in clinical or epidemiological studies and others which may be used in laboratory research. (Bardsley, 2008).Dental erosion appears to be a growing problem in a number of countries, associated with the ingestion of beverages containing acid. Bartlett, Phillips and Smith (1999) suggest that tooth wear has received more emphasis in European countries than North America and that erosion appears to be the most common of the above aetiological factors.

Evidence from the UK, where information on tooth wear is collected in cross-sectional national surveys, reveals the following. In UK (excluding Scotland) adults, the prevalence of tooth wear extending into dentine was high, with over 77% of dentate adults showing some tooth wear in their anterior teeth (The Information Centre for Health and Social Care, 2011f). Overall, 15% showed moderate and only 2% severe wear. Almost half (44%) of dentate 75 to 84-year-olds had moderate tooth wear; however even in this age group only 6% had severe wear (The Information Centre for Health and Social Care, 2011f). When tooth wear occurs in younger adults it is a potential threat to their retaining their natural teeth; however, in older adults, who are much less likely to lose their teeth from tooth decay, it is a feature of ageing. Moderate or severe wear in young adults is therefore of greater clinical concern and needs to be detected early and managed. Examination of trends over time in England did not reveal evidence that tooth wear in older people was higher than in the previous survey in 1998 (White et al., 2010).

It was possible to examine trends in tooth wear in England between 1998 and 2009. The greatest increase in moderate wear between the 1998 and 2009 surveys was in young adults aged less than 45 years. Adults who cleaned less than twice a day had more wear than those who cleaned twice a day or more. There was an association with other health behaviours: adults who attended a dentist less often (5 or more years since their last dental visit) were more likely to have evidence of tooth wear (White et al., 2011).

In UK children, the last national survey in 2003 revealed the following, with TSL being more common on the lingual than the buccal surfaces of incisors (Chadwick and Pendry, 2004):

- In 5-year-olds, 20% had evidence of TSL on the buccal surface of primary upper incisors and 2% had TSL involving dentine or pulp.
- TSL of lingual surface primary upper incisors was present in 53% of children; in 22% of children this involved dentine or pulp on the lingual/incisor surfaces.
- In the permanent incisor teeth of 15-year-olds, 14% showed evidence of TSL on the buccal surface and 33% on the lingual surfaces.
- TSL on the occlusal surface of first permanent molars rose with age so that at 15 years 2% had TSL affecting the occlusal surface; 4% of the total had dentine involvement. Lower molars were more likely to be affected than uppers.

Following systematic review of the prevalence of tooth wear in children and adolescents, Kreulen et al. (2010) reported that prevalence of wear involving dentine ranged from 0 to 82% for deciduous teeth in children up to 7 years; regression analysis showed age and wear to be significantly related. The results of this systematic review indicate that the prevalence of tooth wear leading to dentine exposure in deciduous teeth increases with age (Kreulen et al., 2010). Most of the studies in the permanent dentition showed low levels of dentine exposure, with only a few reporting high prevalence (range 0–54%); increase in wear of permanent teeth with age in adolescents up to 18 years old was not substantiated (Kreulen et al., 2010).

Risk Factors

The aetiology of dental erosion includes intrinsic sources of acid (gastro-oesophageal reflux) and extrinsic sources

such as consumption of demineralising acidic foods and drinks.

Meeting the Challenge – So What Do We Do?

Some tooth wear is a natural feature of ageing. Once there are signs of pathological tooth wear in relation to age, it is necessary to identify the risks and address them to avoid more severe wear occurring. The implications of tooth wear for an individual can be devastating, leading to sensitivity and possible loss of teeth. The importance of regular dental visits is that tooth wear can be detected early in the process and the risks managed to minimise further tooth loss.

Interesting Facts about Tooth Surface Loss

Normal wear is age-dependent; however, pathological wear does not appear to be (Bartlett and Dugmore, 2008). There is some evidence to suggest that tooth wear may be managed by preventative measures such as fissure sealant application to affected surfaces (Bartlett et al., 2011).

Global Targets for Oral Health

None exist because tooth wear is not a recognised public health problem.

Orthognathic Abnormalities

Within the UK there has been seminal work to look at orthodontic need in children and young people (Brook and Shaw, 1989). There are two components to the index: a normative component whereby the examining dentist determines the need, and an aesthetic component whereby the patient is graded in relation to 10 photographs in relation to their 'attractiveness'. In the UK, this assessment of oral health was a component of the 1993 and 2003 national child dental health surveys.

Size of the Problem

The UK oral health surveys provide a helpful overview as they suggest that 35% of 12-year-olds have a great, or very great, orthodontic need for treatment, with similar levels of need between boys and girls (Chestnutt et al., 2006). At age 15 years, 21% still had an identified need; however, the level of need was greater in boys (24%) compared with girls (19%). More of the 15-year-olds were receiving treatment (31%). Around one third (32%) overall had had some experience of orthodontics. There was no difference in the level of need by social class; however, at 15 years of age inequalities were apparent. Those 15-year-olds from schools with evidence of deprivation were less likely to be receiving care (10% compared with 15%) and more likely to have an identified need (24% compared with 20%).

In the USA, there is evidence that, of children under 12 years of age, 17.2% had a definite orthodontic need, with clear differences by age, sex, social class and ethnic group (Christopherson, Briskie and Inglehart, 2009). While the provider-assessed treatment need was higher for white children than for black children, black children were less happy with their smiles than white children, and wanted braces more than white children (Christopherson, Briskie and Inglehart, 2009).

A survey of 12-year-olds in India provided very different findings. It suggested that the level of great or very great orthodontic need as determined by WHO criteria was very low at around 5% (Singh et al., 2011).

Risk Factors for Orthodontic Need

The majority of orthodontic need is genetically determined. In essence, both dummy and thumb sucking are associated with increased orthodontic need, the former associated with an increased risk of developing a posterior cross bite.

Interesting Facts about Orthognathic Abnormalities

There is some evidence that the level of orthodontic need appears to vary by ethnic group (Proffit et al., 1998; Singh et al., 2011).

There is evidence that young people who have received, or are receiving, orthodontic treatment report having fewer impacts on daily living associated with their occlusion and thus a better quality of life (Bernabe et al., 2008).

The occlusal and psychosocial outcomes from orthodontics funded through Medicaid and private care in the UK were comparable, despite worse malocclusions in the young people treated through Medicaid at baseline (King et al., 2012).

Global Targets for Oral Health

A suggested target is listed in Box 2.10.

Box 2.10 Global targets: orthodontics.

- To increase detection and management of severe orthodontic malocclusions
- To reduce inequalities in access to care

Adapted from Hobdell et al., 2003a.

Oral Cancer

Oral cancer is a global public health problem. It is among the ten most common cancers worldwide affecting men. It is generally denoted by the International Classification of Diseases (ICD10) as C00–C08); however, some studies use slightly different groups of codes which means that care is required in comparing different studies and datasets. Oral cancer data are held by the International Agency for Research on Cancer through the WHO.

Each year, more than 30,000 new cases of cancer of the oral cavity and pharynx are diagnosed and over 8,000 deaths due to oral cancer occur in the USA http://www.cdc.gov/oralhealth/oral_cancer/index.htm

Size of the Problem

The incidence of oral cancer varies across the world. In the countries of south central Asia, such as India, the age standardised rate is 12.5 per 100,000 population. Not all countries have accurate data so indicating lower levels of cancer incidence presents more of a challenge. Oral cancer is generally higher in males and parallels the use of tobacco in many countries. There are marked inequalities within societies; for example in the USA there is great disparity between white and black males. For further information visit 'Cancer Today' at http://gco.iarc.fr/today/home

Risk Factors for Oral Cancer

Risk factors for the majority of head and neck cancers include tobacco (Parkin, 2011a), alcohol (Parkin, 2011b), human papilloma virus (Parkin, 2011c), and poor diet (lack of vitamin C) (Parkin and Boyd, 2011). Demographic factors include increasing age, being male and lower socio-economic status (Conway et al., 2010a, 2010b). There is substantial evidence that the modifiable risk factors of tobacco and alcohol in combination increase risks significantly. There is also evidence that 'paan' or betel quid chewing in south east Asia involving a mixture of betel leaf, lime, areca nut and tobacco is a major risk factor for oral cancer. Other forms of smokeless tobacco are risk factors for oral cancer, such as paan masala, khat and snus. Water pipe smoking involving shisha is also becoming a recognised risk (WHO, 2005; Jackson and Aveyard, 2008).

A new, emerging risk factor is human papilloma virus associated with oral sex which is leading to increased levels of oropharyngeal cancer (Panwar et al., 2014). Dietary deficiencies in vitamins are also considered predisposing factors. Risk factors are more prevalent, and often cluster, in lower socio-economic groups where people delay access to healthcare later in the process with concomitant implications for outcomes.

Interesting Facts about Oral Cancer

For those interested in reading about inequalities there is an important publication by Johnson et al. (2011). Risk factors may be considered as outlined below:

- A large number of major lifestyle, dietary and environmental risk factors – tobacco, alcohol, four elements of diet (consumption of meat, fruit/vegetables, fibre and salt), overweight, lack of physical exercise, occupation, infections, radiation (ionising and solar), use of hormones and reproductive history (breast feeding) – make a major contribution to cancers in the UK (Parkin et al., 2011).
- 73% of upper aerodigestive tract cancers (including oropharyngeal) may be attributed to tobacco and/or alcohol (Anantharaman et al., 2011).
- It is important to note that as high-income countries introduce tobacco controls, tobacco companies are targeting low-income countries for sales (WHO, 2011).
- With global mobility there is some evidence that oral cancer is higher in ethnic groups from south and east Asia living in London (Tataru et al., 2017).

Meeting the Challenge – So What Do We Do?

Oral cancer and increasingly oropharyngeal cancer are amongst the greatest public health challenges we have. Global targets for oral health stress the importance of setting targets for oropharyngeal cancer to reduce prevalence and improve survival. With early detection and rapid referral, exposure to risk factors is minimised and access to multidisciplinary specialist care facilitated (Hobdell et al., 2003a). Given the psychosocial impact of oral cancer and its poor long-term outcomes, the emphasis must be on reducing the modifiable risk factors.

The management of oral cancer involves one or more of the following: surgery, radiotherapy and chemotherapy, depending on the stage of presentation. The 5-year survival rate remains low compared with many other outcomes but is improved with earlier detection of the cancer. Unfortunately, many groups who are most at risk present late in the disease process which means that the outcome is poor.

Oral cancer has a major impact on wellbeing because of its implications on the ability to eat, speak, socialise, etc. Thus, prevention is vital if we are to improve oral health and wellbeing.

Box 2.11 Global targets: oral cancer.

- To reduce the prevalence of oral cancer
- To increase early detection
- To reduce risk factors e.g. tobacco in all forms, and alcohol, and to improve nutrition
- To increase access to multidisciplinary specialist care
- To improve survival rates

Adapted from Hobdell et al., 2003a.

Global Targets for Oral Health

Suggested targets are listed in Box 2.11.

Trauma to Teeth

Trauma to teeth may be considered a public health problem because of the cost of managing the impact of this condition and its implications for wellbeing. Trauma can result in anything from a chipped tooth through to luxation or avulsion and form part of more severe trauma in which tooth trauma is a low priority for management.

Size of the Problem

The prevalence of trauma to teeth is now recorded in comprehensive oral health surveys in high-income countries. For example, in the UK, a national survey of schoolchildren shows that 11% of 12-year-olds and 13% of 15-year-olds had suffered trauma to their front teeth (Nuttall et al., 2006). These figures under-represent trauma because teeth replaced as a result of trauma will not be included. Trauma increases with age and is more common in boys than girls. Interestingly this represents a fall in prevalence from the previous survey, which in one sense was good news; the prevalence had reduced to 5.9 per thousand central incisors at age 15 in 2003 from 14.7 per thousand in 1993 (Nuttall et al., 2006). This may be associated with greater prevention through wearing mouth guards for contact sports; however, given the sedentary nature of the lives of many children and young people and rising levels of obesity, from a public health perspective it may be better to accept higher levels of trauma to teeth arising from participation in regular forms of exercise, whether in the playground or in the form of contact sports. Interestingly, the UK survey suggests that between 82% and 73% of traumatised incisors remain untreated; this includes teeth where the dentine is exposed (Nuttall et al., 2006).

Risk Factors for Trauma

Trauma to teeth can arise as a result of contact sports, falls, accidents or violence; individuals having a large overjet have an increased risk of trauma. Accidents to teeth may have a major impact on wellbeing and quality of life, predominantly if trauma is severe and a tooth has been avulsed (Viegas et al., 2014).

Meeting the Challenge – So What Do We Do?

Prevention involves wearing a mouth guard when playing contact sports and, for children and young people with a large overjet, having the appropriate orthodontic management. The most important action that dentists can take is take an interest in the social history of children and young people and to provide high-quality mouth guards for those involved in contact sports.

However, we should never discourage children from playing sport as this is good for their general heath. In fact, if levels of sport and exercise increase, levels of trauma may rise unless practitioners ensure that mouth guards are used.

Global Targets for Oral Trauma

Suggested targets for trauma are listed in Box 2.12.

Noma

Noma, or cancrum oris, is one of four global oral health infections which has been identified as a serious public health problem (Challacombe et al., 2011). Noma is a severe gangrenous condition that results from complex interactions between malnutrition, infections and compromised immunity (Enwonwu, Falkler and Phillips, 2006; Baratti-Mayer et al., 2013). More recently, it appears that HIV infection may be causing an upsurge in prevalence. Noma disfigures the face within days, attacking both hard and soft tissues.

Box 2.12 Global targets: dental trauma.

- To increase early management of moderate and severe dental trauma
- To ensure education and training of healthcare providers competent to diagnose and provide emergency care

Adapted from Hobdell et al., 2003a.

Risk Factors for Noma

Diseases that commonly precede noma include measles, malaria, severe diarrhoea and necrotising ulcerative gingivitis. Further research is required to understand more about this condition which commonly occurs in areas of the world where clinicians and researchers are not present and health service information is not readily available. Noma is thought to start with acute necrotising gingivitis. It particularly affects young children, and the scale of the problem is unknown because it is believed that many children are hidden away because of the horrible facial disfigurement that occurs.

Size of the Problem

Noma is most common in sub-Saharan Africa, but also occurs in the poorest parts of Asia and South America. It is usually fatal if left untreated. Compared to the oral diseases outlined earlier in this chapter it does not appear to be nearly as prevalent (Beaglehole et al., 2009); however, it is one of the most serious conditions affecting the oral cavity. There is evidence from hospital data that around 140 000 patients per year present with noma, although the real figure is estimated to be much higher (Beaglehole et al., 2009). WHO data suggest that 90% of the 3- to 5-year-olds with noma die without treatment. Those who survive must live with permanent disfigurement and therefore disability. It is important to train community health workers to recognise and treat this condition early with antibiotics in order to give the children the best chance of survival and reduce the risk of major disfigurement. This condition is a stark reminder of global health inequalities and the importance of prevention through addressing the wider determinants of health.

Meeting the Challenge – So What Do We Do?

The research challenges for the profession are clearly laid out by Challacombe et al. (2011). Prevention has to involve eradication of poverty and malnutrition which is beyond the sphere of routine dentistry. However, recent research revealed the role of pathogens associated with periodontal diseases, suggesting that educating mothers in good oral healthcare may assist with prevention (Baratti-Mayer et al., 2013; Mullan, 2013). Where children survive this condition, maxillofacial surgeons can contribute to reconstruction if patients have access to specialist care. There are several agencies working globally to tackle this challenge and requiring professional support.

Box 2.13 Global targets: noma.

- To increase early detection and management of noma
- To reduce risk factors for noma such as malnutrition, poor hygiene and lack of immunisation
- To improve access to healthcare workers trained to manage noma

Adapted from Hobdell et al., 2003a.

Global Targets for Noma

Suggested targets are listed in Box 2.13.

HIV/AIDS

Oral manifestations of HIV/AIDS are considered to have a significant impact on quality of life. They fall into three broad categories including seven cardinal lesions (oral candidosis, hairy leukoplakia, Kaposi sarcoma, linear gingival erythema, necrotising ulcerative gingivitis, necrotising ulcerative periodontitis, and non-Hodgkin lymphoma) that are strongly associated with HIV infection (Coogan, Greenspan and Challacombe, 2005). Other associated conditions include atypical ulcers, salivary gland diseases, viral infection such as cytomegalovirus (CMV), herpes simplex virus (HSV), papillomavirus (HPV) and herpes zoster virus (HZV), and even diffuse osteomyelitis and squamous cell carcinoma (Leao et al., 2009).

Size of the Problem

HIV/AIDS is closely monitored by the WHO. Current data suggest that there are over 35 million people living with HIV globally; 2.1 million people were newly infected in 2013 and there were 1.5 million deaths, of which 13% were children (WHO, 2014a). The majority of the global HIV burden (71%) is to be found in sub-Saharan Africa (WHO, 2014b).

There is some evidence that the frequency of oral manifestations is influenced by socio-economic and cultural conditions, family structure and income, access to information concerning AIDS and adherence to treatment (Grando et al., 2003). Oral manifestations of AIDS can be specifically diagnostic, indicating a significant role for dentists within health teams (Challacombe et al., 2011).

Risk Factors for HIV/AIDS

These include unprotected sex, intravenous drug abuse and, for children, maternal to child transmission.

Box 2.14 Global targets: oral manifestations of HIV infection.

- To reduce the prevalence of opportunistic orofacial infections in people with HIV
- To improve access to early diagnosis and contemporary management of HIV for all

Adapted from Hobdell et al., 2003a.

Meeting the Challenge – So What Do We Do?

The most obvious challenges include inequalities in incidence and management of the infection. There is unequal global distribution so individuals in America and Western Europe have much better access to therapy compared with those in sub-Saharan Africa. There is an ongoing need for prevention of transmission, early identification of disease and access to anti-retroviral therapies, which have had a significant impact in turning HIV/AIDS into a chronic and manageable disease (Iyidogan and Anderson, 2014).

Global Targets for HIV/AIDS

Suggested targets are listed in Box 2.14.

Cleft Lip and/or Palate (CL&P)

Size of the Problem

Clefts are one of the most common craniofacial abnormalities, affecting 1 in 700 live births (Mossey et al., 2011). The incidence varies with geography, ethnicity and socioeconomic status and there is wide variation in access to care and the quality of care (Mossey et al., 2011). The International Database on Craniofacial Anomalies (ICDFA) has been established to monitor incidence and risk factors and enable research in this field with a view to informing interventions (Mossey, 2007). It is collecting data from Europe, the USA and the wider world (Mostroiacovo et al., 2011). Currently 62 registries covering 2 million births per year contribute to a database along with information on the size and type of studies used to collect the information, any variation in ascertainment and on the inclusion of syndromes and associated abnormalities (Mossey, 2007). There is no information for some parts of the globe including parts of Africa, Asia and Eastern Europe. The prevalence of cleft lip is reported at 3.28 per 10 000, and that of cleft lip and palate, 6.64 per 10 000 (IPDTOC Working Group, 2011). Cases with greater dysmorphological severity of cleft lip with or without cleft palate were more likely to include malformations of other systems (Mostroiacovo et al., 2011).

Risk Factors for Clefts

Risk factors include maternal smoking during pregnancy, maternal alcohol use, maternal metabolism and nutrition related to diabetes, obesity and being underweight (Mossey et al., 2011). Other possible risk factors include lack of vitamins and folic acid and specific nutrients such as zinc or riboflavin.

Meeting the Challenge – So What Do We Do?

Mossey et al. (2011) have helpfully outlined the clinical challenges in addressing inequalities which relate to access and quality of care. The costs associated with surgical repair are recognised to be high and the social costs of unmet or partially met needs high (Mossey et al., 2011). Patients in low-income countries often present for treatment at a later stage in life.

Interesting Facts about CL&P

There are a range of resources online to support families and patients which clinicians and healthcare teams should be encouraged to promote in support of families: http://www.clapa.com/ and http://www.nhs.uk/conditions/Cleft-lip-and-palate/Pages/Introduction.aspx

Oral Health and General Health

It is increasingly apparent that there are links between general and oral health, with research showing evidence of an association of oral health problems with having a preterm birth, cardiovascular disease, diabetes, aspiration pneumonia, osteoporosis, etc. (Peterson and Ogawa, 2012). This is perhaps not surprising given the wider determinants of health and the clustering of diseases that occur. It is important to stress that these associations are not cause and effect, but nonetheless a reminder of the way the human body functions as a whole, highlighting important areas of research in future.

Population Diversity: Implications in Different Sections of the Community

This section will consider the oral health needs of particular groups within the population, with particular reference to developed countries which have a greater wealth of data available to profile the national picture of health.

Children and Young People

Children's oral health has improved dramatically in western or high-income countries in recent years and the oral health of the permanent dentition in older children and young people is still continuing. The level of change that has occurred in several decades is quite remarkable and much of this improvement has been attributed to fluoride in its various delivery systems from water to restorative materials. Countries such as Scotland where oral health of children remained poor have used data from national surveys to gain the backing of policy makers and obtain funding for wholescale public health action. Childsmile (NHS Scotland, 2014) involves tooth brushing, application of fluoride varnish and facilitating dental attendance for nursery and primary school children in a scheme which is being closely evaluated.

Despite the fact that oral health has improved it is important to recognise that inequalities in oral health exist within nations and local communities. Sadly, those in society who carry the largest burden are also those least likely to access dental care in a timely manner and thus their treatment outcomes are worse (Mejia et al., 2014). Examples include children with HIV (Eldridge and Gallagher, 2000), adults with learning disabilities (Tiller, Wilson and Gallagher, 2001), and older people (National Working Group for Older People, 2005). This presents us with a professional responsibility to find new ways to prevent oral diseases and facilitate access to preventative oral care for those most in need. However, professional efforts need to be at work across the population because it is clear that whilst individual children with established oral disease are most at risk of developing new lesions, it is the rest of the population that will experience more of the new lesions in terms of volume (Milsom and Tickle, 2010). This means that there is evidence within dentistry to support 'proportionate universalism' as outlined by Marmot (2010) (Box 2.15).

Box 2.15 Marmot principles for achieving a fair society and healthy lives.

1) Giving every child the best start in life
2) Enabling all children, young people and adults to maximise their capabilities and have control over their lives
3) Creating fair employment and good work for all
4) Ensuring a healthy standard of living for all
5) Creating and developing sustainable places and communities
6) Strengthening the role and impact of ill-health prevention

Data from Marmot, 2010.

What does this mean in reality? Everyone needs preventive advice and action, but those at high risk will require additional support to assist them in achieving health.

Adults

Most adults develop dental caries at some stage in their lives. Most also have gingivitis. In high-income countries the emerging profile is of young adults with low levels of dental caries experience. In marked contrast, adults in middle age who have the legacy of higher disease levels and different patterns of care have fewer sound teeth. Those who did not benefit from fluoride and have been cared for in the restorative paradigm have heavily restored dentitions and high expectations of retaining their natural teeth into older age; they represent a significant challenge to the dental profession in forthcoming years and will require good operative skills and preventive care as part of their management.

Older People

Older adults who experienced dental care during a previous treatment paradigm and have lost many of their teeth are the most likely to be edentulous. Older adults who do retain their teeth are more likely to have heavily restored dentitions, some missing teeth and increasing levels of periodontal diseases. Managing the oral health of older people will be a significant challenge to the dental profession in future decades as many of these adults have heavily restored dentitions at a time in life when increasing physical frailty, medical compromise, medications and cognitive decline present challenges to the profession. Furthermore this section of the population is increasing in all countries and the WHO has highlighted the negative impact of poor oral conditions on the quality of life of older adults as an important public health issue which must be addressed by policy-makers (Petersen and Yamamoto, 2005). Clinicians, public health and policy makers need to examine how we should all best support patients across their 'life course', particularly as people are living longer and increasingly wish to retain their natural teeth.

Oral Health – Largest 24 Countries Globally

When we are considering the size of the oral health challenges globally, it is particularly interesting to look at the state of oral health amongst the largest populations in the globe (Table 2.5). As dentists we do not manage one disease in isolation and therefore this information provides some indication of the burden of disease at national level and the distribution and growth of the population.

Table 2.5 Largest 24 countries in the world: demography and oral health.

	Country	Population 2016[a]	Average annual rate of population change[b]	% urban[c]	Average 12-year-old DMFT[d]	Date	6–19 years with dental caries experience (highest value)[d]	Date	Edentulousness in adults 65 years and over %[d]	Date	Oral cancer (males) rate per 100 000)[e]	Oral cancer (females) rate per 100 000[e]
1	China	1 378 665	0.5	57	0.5	2005	55%	1995–96	11%	1995–96	1.1	0.7
2	India	1 324 171	1.1	33	1.6	2012	83%	2003	19%	2005	12.5	7.5
3	United States	323 128	0.7	82	1.2	1999–2004	78%	1999–2004	24%	1999–2002	7.9	3.4
4	Indonesia	261 115	1.1	55	0.9	2007	89%	2005	24%	1995	1.5	1
5	Brazil	207 ,653	0.8	86	2.8	2002–03	89%	2002–03	68%	2002	8.3	1.7
6	Pakistan	193 203	2.0	39	1.4	2003	—	—	20%	2003	14.7	14.7
7	Nigeria	185 990	2.6	49	0.5	2003–4	46%	1990–91	1%	1998–99	2.6	1
8	Bangladesh	162 952	1.1	35	1.0	2000	46%	2000	—	—	13.4	16.8
9	Russian Federation	144 342	0.2	74	2.5	2008	—	—	—	—	6.9	1.5
10	Mexico	127 540	1.3	80	1.1	2010	81%	1997	31%	2002–03	2.7	2
11	Japan	126 995	–0.1	94	1.4	2011	16%	1995	—	—	2.8	—
12	Philippines	103 320	1.6	44	3.3	2011	97%	2005–06	—	—	5.7	4.7
13	Ethiopia	102 403	2.5	20	1.3	2012–13	45%	1990	—	—	7.7	2.9
14	Egypt, Arab Rep.	95 689	2.0	43	0.4	2001–02	37%	2001–02	17%	1991	0.7	7.9
15	Vietnam	92 701	1.1	34	1.9	2001	84%	2001	—	—	3.8	2.8
16	Germany	82 668	1.2	76	0.7	2005	54%	2005	23%	2005	11.1	0.2
17	Iran, Islamic Rep.	80 277	1.1	74	1.9	2004	48%	2003	—	—	2.9	1.7
18	Turkey	79 ,512	1.6	74	1.9	2004/5	85%	2001–02	67%	2007	3.2	1.7
19	Congo, Dem. Rep.	78 736	3.3	43	0.4–1.1	1987–91	31%	1982	—	—	2.3	4.2
20	Thailand	68 864	0.3	52	1.3	2012	88%	2000–01	16%	1994	4.5	
21	France	66 896	0.4	80	1.2	2006	81%	1991	16%	2000	14.8	2.7
22	United Kingdom	65 637	0.8	83	0.7	2008–09	54%	1997	46%	1998	4.5	4.2
23	Italy	60 601	–0.2	69	1.2	2012	59%	2002	44%	1995–98	7.1	1.9
24	South Africa	55 909	1.6	65	1.1	1999–2002	60%	1999–2000	26%	1998	11.2	2.9

Adapted from:
[a] World Bank (2017) http://data.worldbank.org/data-catalog/Population-ranking-table (accessed 19th July, 2017).
[b] World Bank (2017) http://data.worldbank.org/indicator/SP.POP.GROW (accessed 19th July, 2017).
[c] World Bank (2017) http://data.worldbank.org/indicator/SP.URB.TOTL.IN.ZS (accessed 19th July, 2017).
[d] CAPP (2014) Oral Health Country Area Profile Project, 2014. http://www.mah.se/capp/
[e] WHO (2014) International Agency for Research on Cancer. http://gco.iarc.fr/today/home

China and India stand out because of their dominant size; together these two nations encompass over one third of the global population. The data in Table 2.5 suggest that, of the two, India may have a more challenging problem with dental caries, a higher level of edentulousness and a massive problem with oral cancer, the latter affecting both males and females, with males presenting at a higher rate. Furthermore, given challenges in accessing healthcare, as much of the population is rurally based and services are scarce, cancer rates may even be higher than indicated by cancer registry data reports.

The eight countries below China and India in Table 2.5 demonstrate diverse patterns of disease. Of these eight countries, Brazil and Russia have the highest level of disease in 12-year-olds.

The final group of countries demonstrate a range of patterns of oral health. Dental caries is highest in the Philippines and appears to be lowest in Egypt. Oral cancer is highest in males in France, South Africa and Germany and amongst females in Ethiopia. Most dramatic of all in this selection of countries is the challenge faced by Ethiopia and the Democratic Republic of the Congo, which have the lowest levels of dental workforce amongst the world's largest countries. This underlines the particular workforce challenges in the African region, which also does not appear to have recent oral health data to inform strategic planning and development of a sustainable dental workforce.

Global Oral Health Goals

It is important to reflect on the challenges set for oral health to the year 2020 for dental professionals and policy makers (Hobdell et al., 2003a). The two overarching goals are outlined in Box 2.16. However, there is an imperative to collect data to monitor goals.

Box 2.16 Global goals for oral health, 2020.

1) To minimise the impact of diseases of oral and craniofacial origin on health and psychosocial development, giving emphasis to promoting oral health and reducing oral disease amongst populations with the greatest burden of such conditions and diseases
2) To minimise the impact of oral and craniofacial manifestations of systemic diseases on individuals and society, and to use these manifestations for early diagnosis, prevention and effective management of systemic diseases

Data from Hobdell et al., 2003a.

Summary

Good oral health contributes to health and wellbeing. Oral diseases, whilst very common, are largely preventable. Further reading can include the FDI's *The Challenge of Oral Disease: a call for global action* (FDI, 2015). To address oral health challenges requires a strong public health approach and a re-orientation of healthcare towards prevention; in continents such as Africa it will require a different approach to developing a dental workforce that is fit for purpose and economically viable.

Implications

In this globalised world in which communication and knowledge sharing are increasingly easy, there is much to be said for having a global understanding of oral diseases and conditions and their implications for health. The WHO plays an important role in this process as do professional associations and national governments. This involves monitoring oral health through surveys and health service data to inform understanding of population health needs. A clear statement of health needs will enable policy makers and professionals to consider how the oral health needs of a population may best be addressed. The findings have definite implications for action at all levels from health policy down to individual health behaviours of the public and clinical care provided by the profession. We can learn from one another's successes and failures as well as their future plans. In western countries where dental caries prevalence and incidence has fallen, we must remember that we have perhaps only controlled the disease (through access to low-level fluoride exposure) and not eradicated it – we are still ingesting too much sugar in our diets!

Do Dentists Make a Difference to Oral Health?

'There is no health without a workforce' (Campbell et al., 2013). There has been a great debate over the contribution of dentists to oral health given that much dental care has traditionally been orientated towards repair rather than prevention of disease. Importantly, there is now a strong evidence base for prevention which dental professionals are encouraged to use for *all* patients based on their level of disease risk (Public Health England et al., 2017). Where oral health is better, there is a debate over whether people who attend more regularly value their oral health more and are therefore more likely to have positive health behaviours, of which dental attendance is just one factor. Yet all remain at risk of disease.

Interestingly, the Dunedin longitudinal study from New Zealand has shown that at any given age, routine attenders in the Dunedin study had 'better-than-average oral health, fewer had teeth missing due to caries, and they had lower mean numbers of decayed surfaces (DS) and dental caries experience (DMFS) scores' (Thomson et al., 2010; Crocombe et al., 2012). Furthermore, by age 32, 'routine attenders had better self-reported oral health and less tooth loss and caries'. Thomson et al. conclude that 'the longer routine attendance was maintained, the stronger the effect'. This prospective study supports the view that routine dental attendance is associated with better oral health outcomes. It is therefore appropriate for current oral health messages to strongly promote regular dental visiting (Thomson et al., 2010) provided that the care delivered is high quality and better still preventatively orientated. Given the relationship between irregular dental attendance and poor clinical and quality of life measures, it is suggested that improving dental visiting behaviour among low socio-economic status groups would have the greatest effect on improving oral health and reducing oral health impacts (Crocombe et al., 2012).

In England, a recent Health Future Forum suggested the importance of 'making every encounter count for health', highlighting the high volume of interactions with healthcare professionals each day, which includes a quarter of a million dental visits (NHS Future Forum, 2012). This fits with the concept of an oral health physician who provides patients with a clear diagnosis, support and advice using pharmacological rather than surgical methods, although payment systems must be re-orientated to support such an approach to care. Ensuring sufficient health workforce is a global challenge in support of world health and facilitating universal access to healthcare (Global Health Workforce Alliance, 2014; WHO, 2016).

In parallel, we need to recognise wider determinants of health and ensure effective dental leadership to challenge global influences on health for the population. We also need strategic leadership to help us frame our decisions about clinical care towards improving population oral health in future and not merely treating the outcome. It is important to recognise the major challenges for dentistry in the twenty-first century outlined by Hayashi et al. (2014), which includes the following: 'wealthy members of society demand high-end expensive treatment, much of it cosmetic rather than necessary to deal with disease, whereas many millions of poor people in developing countries cannot afford basic dental treatment and may never see a dentist'

We have to be realistic about the ability of low and middle income countries to deliver healthcare and support the development of mid-level providers of dental care, rather than focusing mainly on dentists. This leads into debates over future dental education: where to train, who to train, and how? Should we train dental professionals together as members of the dental or healthcare teams??

We also need to have realistic debates on the funding of care (i.e. who funds what), including better communication with patients and the public so that any paradigm shifts towards prevention are appropriately funded.

So as you explore the rest of this manual to develop your skills in clinical dentistry, remember the challenge of seeing the right person in the right place at the right time, assessing disease risk – and promoting health!

References

ALSPAC. (2014) Avon Longitudinal Study of Parents and Children: children of the 90's. University of Birmingham. Available from: http://www.bristol.ac.uk/alspac/ (accessed 26th June, 2017).

Anantharaman, D., Marron, M., Lagiou, P., et al. (2011) Population attributable risk of tobacco and alcohol for upper aerodigestive tract cancer. Oral Oncology 47(8):725–731.

Armitage, G.C. (1999) Development of a classification system for periodontal diseases and conditions. Annals of Periodontology 4(1):1–6.

Avlund, K., Holm-Pedersen, P., Morse, D.E., et al. (2003) Social relations as determinants of oral health among persons over the age of 80 years. Community Dentistry and Oral Epidemiology 31(6):454–452.

Baelum, V., Van Palenstein Helderman, W., Hugoson, A., et al. (2007) A global perspective on changes in the burden of caries and periodontitis: implications for dentistry. Journal of Oral Rehabilitation 34(12):872–906.

Baratti-Mayer, D., Gayet-Ageron, A., Hugonnet, S., et al. (2013) Risk factors for noma disease: a 6-year, prospective, matched case-control study in Niger. The Lancet Global Health 1(2):e87–e96.

Bardsley, P.F. (2008) The evolution of tooth wear indices. Clinical Oral Investigations 12 Suppl 1:S15–S19.

Bartlett, D., Dugmore, C. (2008) Pathological or physiological erosion – is there a relationship to age? Clinical Oral Investigations 12:S27–S31.

Bartlett, D., Phillips, K., Smith, B.G. (1999). A difference in perspective—the North American and European interpretations of tooth wear. International Journal of Prosthodontics 12:401–408.

Bartlett, D., Sundaram, G., Moazzez, R. (2011) Trial of protective effect of fissure sealants, in vivo, on the

palatal surfaces of anterior teeth, in patients suffering from erosion. Journal of Dentistry 39(1):26–29.
Batchelor, P.A, Sheiham, A. (2002) The limitations of a high risk approach for the prevention of dental caries. Community Dentistry Oral Epidemiology 30:302–312.
Batchelor, P.A., Sheiham, A. (2006) The distribution of burden of dental caries in school children: a critique of the high caries prevention strategy for population. BMC Oral Health [Internet]. 2006 31.05.10; 6:[3 p.]. Available from: http://www.biomedcentral.com/1472-6831/6/3 (accessed 26th June, 2017).
Beaglehole, R., Benzian, H., Crail, J., Mackay, J. (2009) In: FDI World Dental Federation, ed. The Oral Health Atlas. Brighton: Myriad Publications.
Benzian, H., Monse, B., Helderman, WvP. (2011) A silent public health crisis: the burden of untreated caries and dental infections in the Philippines National Oral Health Survey 2006. Journal of Epidemiology and Community Health 65:A359-A.
Benzian, H., Monse, B., Heinrich-Weltzien, R., et al. (2011a) Untreated severe dental decay: a neglected determinant of low Body Mass Index in 12-year-old Filipino children. Bmc Public Health 11.
Benzian, H., Monse, B., Heinrich-Weltziehn, R., et al. (2011b) Dental indices must not be CAST in stone. International Dental Journal 61(4):238–239.
Bernabé, E., Marcenes, W. (2010) Periodontal disease and quality of life in British adults. Journal of Clinical Periodontology 37(11):968–972.
Bernabe, E., Sheiham, A., Tsakos, G., de Oliveira, C.M. (2008) The impact of orthodontic treatment on the quality of life in adolescents: a case-control study. European Journal of Orthodontics 30(5):515–520.
Boyce, W.T., Den Besten, P.K., Stamperdahl, J., et al. (2010) Social inequalities in childhood dental caries: The convergent roles of stress, bacteria and disadvantage. Social Science & Medicine 71(9):1644–1652.
Bradshaw, J. (1972) A taxonomy of social need. In: McLachlan G., ed. Problems and Progress in Medical Care. Maidenhead: NPHT/Open University Press.
Broadbent JM, Williams KB, Thomson WM, Williams SM. Dental restorations: a risk factor for periodontal attachment loss? Journal of Clinical Periodontology. 2006;33(11):803-10.
Broadbent, J.M., Page, L.A.F., Thomson, W.M., Poulton, R. (2013) Permanent dentition caries through the first half of life. British Dental Journal 215(7):E12-E.
Brook, P.H., Shaw, W.C. (1989) The development of an index of orthodontic treatment priority. European Journal of Orthodontics 11:309–320.
Campbell, J., Dussault, G., Buchan, J., et al. 0000A universal truth: no health without a workforce. Forum Report, Third Global Forum on Human Resources for Health, Recife, Brazil.
CAPP. (2014a) Oral Health Country Area Profile Project 2014 [01.09.2014]. Available from: http://www.mah.se/CAPP/Country-Oral-Health-Profiles/ (accessed 26th June, 2017).
CAPP. (2014b) Oral Health Country Area Profile Project: country oral health profile Euro 2014 [01.09.2014]. Available from: http://www.mah.se/CAPP/Country-Oral-Health-Profiles/EURO/ (accessed 26th June, 2017).
CAPP. (2014c) Oral Health Country Area Profile Project: country oral health profile AFRO 2014 [01.09.2014]. Available from: http://www.mah.se/CAPP/Country-Oral-Health-Profiles/AFRO/ (accessed 26th June, 2017).
CAPP. (2014d) Oral Health Country Area Profile Project: country oral health profile AMRO 2014 [01.09.2014]. Available from: http://www.mah.se/CAPP/Country-Oral-Health-Profiles/AMRO/ (accessed 26th June, 2017).
CAPP. (2014e) Periodontal Country Profiles Japan: Niigata University Graduate School of Medical and Dental Sciences; 2014 [01.09.2014]. Available from: http://www.dent.niigata-u.ac.jp/prevent/perio/contents.html (accessed 26th June, 2017).
Centers for Disease Control and Prevention. (2013) Ten Great Public Health Achievements in the 20th Century. Available from: https://www.cdc.gov/about/history/tengpha.htm (accessed 21st July, 2017).
Chadwick, B., Pendry, L. (2004) Children's dental health in the United Kingdom, 2003: Non-carious dental conditions. London: Office for National Statistics.
Challacombe, S., Chidzonga, M., Glick, M., et al. (2011) Global oral health inequalities: oral infections-challenges and approaches. Advances in Dental Research 23(2):227–236.
Chestnutt, I.G., Burden, D.J., Steele, J.G., et al. (2006) The orthodontic condition of children in the United Kingdom, 2003. British Dental Journal 200(11):609–612.
Christopherson, E.A., Briskie, D., Inglehart, M.R. (2009) Objective, subjective, and self-assessment of preadolescent orthodontic treatment need – a function of age, gender, and ethnic/racial background? Journal of Public Health Dentistry 69(1):9–17.
Clow, K.E., Fischer, A.K., O'Bryan, D. (1995) Patient expectations of dental services. Image affects expectations, and expectations affect perceived service quality. Journal of Health Care Marketing 15(3):23–31.
Conway, D.I., McMahon, A.D., Smith, K., et al. (2010a) Components of socioeconomic risk associated with head and neck cancer: A population-based case-control study in Scotland. British Journal of Oral & Maxillofacial Surgery 48(1):11–17.
Conway, D.I., McKinney, P.A., McMahon, A.D., et al. (2010b) Socioeconomic factors associated with risk of upper aerodigestive tract cancer in Europe. European Journal of Cancer 46(3):588–598.

Coogan, M.M., Greenspan, J., Challacombe, S.J. (2005) Oral lesions in infection with human immunodeficiency virus. Bulletin of the World Health Organization 83(9):700–706.

Cookson, R., Sainsbury, R., Glendinning, C. (2013) Jonathan Bradshaw on Social Policy, 1972–2011. York: York Publishing Services Ltd.

Crocombe, L.A., Broadbent, J.M., Thomson, W.M., et al. (2012) Impact of dental visiting trajectory patterns on clinical oral health and oral health-related quality of life. Journal of Public Health Dentistry 72(1):36–44.

Donaldson, C.D., Jack, R.H., Moller, H., Luchtenborg, M. (2012) Oral cavity, pharyngeal and salivary gland cancer: Disparities in ethnicity-specific incidence among the London population. Oral Oncology 48(9):799–802.

Dunedin Health and Multidisciplinary Research and Development Unit. Dunedin Study 2014 [25.10.2014]. Available from: http://dunedinstudy.otago.ac.nz/publications (accessed 26th June, 2017).

Efroymson, D., Ahmed, S., Townsend, J., et al. (2001) Hungry for tobacco: an analysis of the economic impact of tobacco consumption on the poor in Bangladesh. Tobacco Control 10(3):212–217.

Eldridge, K., Gallagher, J.E. (2000) Caries experience and dental health behaviour in HIV infected children. International Journal of Paediatric Dentistry 10:19–26.

Enwonwu, C.O., Falkler, W.A.J., Phillips, R.S. (2006) Noma (cancrum oris). Lancet 8(368(9530)):147–156.

FDI. (2015) The Challenge of Oral Disease: a call for global action, 2nd edn. Geneva: FDI World Dental Federation.

Fejerskov, O., Escobar, G., Jøssing, M., Baelum, V. (2013) A functional natural dentition for all – and for life? The oral healthcare system needs revision. Journal of Oral Rehabilitation 40(9):707–722.

Genco, R.J., Borgnakke, W.S. (2013) Risk factors for periodontal disease. Periodontology 62(1):59–94.

Glick, M., Williams, D.M., Kleinman, D.V., et al. (2016) A new definition for oral health developed by the FDI World Dental Federation opens the door to a universal definition of oral health. The Journal of the American Dental Association 147(12):915–917.

Global Health Workforce Alliance. (2014) Health Workforce 2030. Geneva: WHO. Available from: http://www.who.int/workforcealliance/knowledge/resources/strategy_brochure9-20-14.pdf?ua=1 (accessed 26th June, 2017).

Gotfredsen, K., Walls, A.W.G. (2007) What dentition assures oral function? Clinical Oral Implants Research 18:34–45.

Grando, L.J., Yurgel, L.S., Machado, D.C., et al. (2003) [The association between oral manifestations and the socioeconomic and cultural characteristics of HIV-infected children in Brazil and in the United States of America]. Revista Panamericana de Salud Publica 14(2):112–118.

Harris, R., Nicoll, A.D., Adair, P.M., Pine, C.M. (2004) Risk factors for dental caries in young children: a systematic review of the literature. Community Dental Health 21(1S):71–85.

Hayashi, M., Haapasalo, M., Imazato, S., et al. (2014) Dentistry in the 21st century: challenges of a globalising world. International Dental Journal 64:333–342.

Hobdell, M.H., Petersen, P.E., Clarkson, J., Johnson, N.W. (2003a) Global goals for oral health 2020. International Dental Journal 53:285–288.

Hobdell, M.H., Oliveira, E.R., Bautista, R., et al. (2003b) Oral diseases and socio-economic status (SES). British Dental Journal 194(2):91–96.

Hughes, F. (2014) Periodontitis – the new caries? British Dental Journal 217(8):387.

ICDAS Foundation. International Caries Detection and Assessment System 2014 [25.10.2014]. Available from: https://www.icdas.org/ (accessed 26th June, 2017).

IPDTOC Working Group. (2011) Prevalence at birth of cleft lip with or without cleft palate: Data From the International Perinatal Database of Typical Oral Clefts (IPDTOC). The Cleft Palate-Craniofacial Journal 48(1):66–81.

Iyidogan, P., Anderson, K.S. (2014) Current perspectives on HIV-1 antiretroviral drug resistance. Viruses 6(10):4095–4139.

Jackson, D., Aveyard, P. (2008) Waterpipe smoking in students: Prevalence, risk factors, symptoms of addiction, and smoke intake. Evidence from one British university. Bmc Public Health 8(174).

Johnson, N.W., Warnakulasuriya, S., Gupta, P.C., et al. (2011) Global oral health inequalities in incidence and outcomes for oral cancer: causes and solutions. Advances in Dental Research 23(2):237–246.

Kelly, M., Steele, J., Nuttall, N., et al. (2000) Adult Dental Health Survey, Oral Health in the United Kingdom, 1998. London: The Stationery Office.

Kinane, D., Bouchard, P. (2008) Periodontal diseases and health: Consensus report of the Sixth European Workshop on Periodontology. Journal of Clinical Periodontology S8:333–337.

King, G.J., Kiyak, H.A., Greenlee, G.M., et al. (2012) Medicaid and privately financed orthodontic patients have similar occlusal and psychosocial outcomes. Journal of Public Health Dentistry 72(2):94–103.

Kreulen, C.M., Van't Spijker, A., Rodriguez, J.M., et al. (2010) Systematic review of the prevalence of tooth wear in children and adolescents. Caries Research 44(2):151–159.

Leao, J.C., Ribeiro, C.M., Carvalho, A.A., et al. (2009) Oral complications of HIV disease. Clinics (Sao Paulo, Brazil) 64(5):459–470.

Leclercq, M.H., Barmes, D.E., Sardo-Infirri, J., et al. (1987) Oral health: Global trends and projections. World Health Statistics Quarterly 40:116–128.

Locker, D. (1998) Measuring oral health: a conceptual framework. Community Dental Health 5:5–13.

Marcenes, W., Steele, J.G., Sheiham, A., Walls, A.W.G. (2003) The relationship between dental status, food selection, nutrient intake, nutritional status, and body mass index in older people. Cadernos de saude publica / Ministerio da Saude, Fundacao Oswaldo Cruz, Escola Nacional de Saude Publica 19(3):809–816.

Marcenes, W., Kassebaum, N.J., Bernabé, E., et al. (2013) Global burden of oral conditions in 1990-2010: a systematic analysis. Journal of Dental Research 92(7):592–597.

Marmot, M. (2010) Fair Society Health Lives: Strategic Review of Health Inequalities in England post-2010. London: UCL Institution of Health Equity.

Mastroiacovo, P., Maraschini, A., Leoncini, E., et al. (2011) Prevalence at birth of cleft lip with or without cleft palate: data from the International Perinatal Database of Typical Oral Clefts (IPDTOC). Cleft Palate-Craniofacial Journal 48(1):66–81.

Mausner, J.S., Kramer, S., Bahn, A.K. (1985) Epidemiology, 2nd edn. Philadelphia: Saunders.

Mejia, G., Jamieson, L.M., Ha, D., Spencer, A.J. (2014.) Greater inequalities in dental treatment than in disease experience. Journal of Dental Research 93:966–971.

Milsom, K.M., Tickle, M. (2010) Preventing decay in children: dare we risk the 'risk assessment' model in practice? British Dental Journal 209(4):159–160.

Monse, B., Benzian, H., Heinrich-Weltzien, R., et al. (2011) PUFA: an innovative index to measure the consequences of untreated dental decay. Journal of Epidemiology and Community Health 65:A135-A.

Mossey, P. (2007) Epidemiology underpinning research in the aetiology of orofacial clefts. Orthodontics & Craniofacial Research 10(3):114–120.

Mossey, P.A., Shaw, W.C., Munger, R.G., et al. (2011) Global oral health inequalities: challenges in the prevention and management of orofacial clefts and potential solutions. Advances in Dental Research 23(2):247–258.

Mullan, Z. (2013) The good, the bad, and the neglected. The Lancet Global Health 1(2):e55.

Murray, C.J.L., Vos, T., Lozano, R., et al. (2012) Disability-adjusted life years (DALYs) for 291 diseases and injuries in 21 regions, 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 380(9859):2197–2223.

Murray, J.J., Nunn, J.H., Steele, J.G. (2003) Prevention of Oral Disease. Oxford: Oxford University Press.

Natarajan, N. (2011) Cariogenicity: macrosocioeconomics vs saccharophagy. Role of socio-politicoeconomics and sugar consumption in tooth decay among 12 year olds. A global ecological crossectional study. Lund University, Sweden.

National Working Group for Older People. (2005) Meeting the challenges of oral health for older people: a strategic review. Gerodontology 22(SI.).

NHS Future Forum. (2012) Summary report: second phase [07.07.2012]. Available from: http://www.dh.gov.uk/prod_consum_dh/groups/dh_digitalassets/documents/digitalasset/dh_132085.pdf (accessed 26th June, 2017).

NHS Scotland. (2014) Childsmile – improving the oral health of children in Scotland 2014. Available from: http://www.child-smile.org.uk/ (accessed 26th June, 2017).

Nuttall, N.M., Steele, J.G., Evans, D., et al. (2006) The reported impact of oral condition on children in the United Kingdom, 2003. British Dental Journal 200(10):551–555.

Panwar, A., Batra, R., Lydiatt, W.M., Ganti, A.K. (2014) Human papilloma virus positive oropharyngeal squamous cell carcinoma: A growing epidemic. Cancer Treatment Reviews 40(2):215–219.

Parkin, D.M. (2011a) Tobacco-attributable cancer burden in the UK in 2010. British Journal of Cancer 105:S6–S13.

Parkin, D.M. (2011b) Cancers attributable to consumption of alcohol in the UK in 2010. British Journal of Cancer 105:S14–S18.

Parkin, D.M. (2011c) Cancers attributable to infection in the UK in 2010. British Journal of Cancer 105:S49–S56.

Parkin, D.M., Boyd, L. (2011) Cancers attributable to dietary factors in the UK in 2010 I. Low consumption of fruit and vegetables. British Journal of Cancer 105:S19–S23.

Parkin, D.M., Boyd, L., Walker, L.C. (2011) The fraction of cancer attributable to lifestyle and environmental factors in the UK in 2010 Summary and conclusions. British Journal of Cancer 105:S77–S81.

Petersen, P.E., Ogawa, H. (2005) Strengthening the prevention of periodontal disease: the WHO approach. Journal of Periodontology 76(12):2187–2193.

Petersen, P.E., Ogawa, H. (2012) The global burden of periodontal disease: towards integration with chronic disease prevention and control. Periodontology 2000 60(1):15–39.

Petersen, P.E., Yamamoto, T. (2005) Improving the oral health of older people: the approach of the WHO Global Oral Health Programme. Community Dentistry and Oral Epidemiology 33(2):81–92.

Pihlstrom, B.L., Michalowicz, B.S., Johnson, N.W. (2005) Periodontal diseases. The Lancet 366(9499):1809–1820.

Pitts, N., Harker, R. (2004) Obvious decay experience. In: Children's Dental Health in the UK, 2003. London: The Stationery Office.

Proffit, W.R., Fields, H.W. Jr., Moray, L.J. (1998) Prevalence of malocclusion and orthodontic treatment need in the United States: estimates from the NHANES III survey. The International Journal of Adult Orthodontics and Orthognathic Surgery 13(2):97–106.

Public Health England. (2014) Oral health survey of three-year-old children 2013: A report on the prevalence and severity of dental decay. London: Public Health England.

Public Health England, Department of Health, NHS England, British Association for the Study of Community Dentistry. Delivering better oral health: An evidence-based toolkit for prevention. London: Public Health England, 2017.

Selwitz, R.H., Ismail, A.I., Pitts, N.B. (2007) Dental caries. The Lancet 369(9555):51–59.

Sheiham, A., Sabbah, W. (2010) Using universal patterns of caries for planning and evaluating dental care. Caries Research 44(2):141–150.

Singh, A., Purohit, B., Sequeira, P., et al. (2011) Malocclusion and orthodontic treatment need measured by the Dental Aesthetic Index and its association with dental caries in Indian schoolchildren. Community Dental Health 28(4):313–316.

Slade, G.D. (1997) Derivation and validation of a short-form oral health impact profile. Community Dentistry Oral Epidemiology 25:284–290.

Slade, G.D., Spencer, A.J. (1994) Development and evaluation of the Oral Health Impact Profile. Community Dental Health 11(1):3–11.

Slade, G.D., Akinkugbe, A.A., Sanders, A.E. (2014) Projections of U.S. Edentulism prevalence following 5 decades of decline. Journal of Dental Research 93(10):959–965.

Steele, J., Sheiham, A., Marcenes, W., Walls, A. (1998) National Diet and Nutrition Survey; adults aged 65 and over. London: Office for National Statistics.

Steele, J.G., Treasure, E., Pitts, N.B., et al. (2000) Total tooth loss in the United Kingdom in 1998 and implications for the future. British Dental Journal 189(11):598–603.

Tataru, D., Mak, V., Simo, R., et al. (2017) Trends in the epidemiology of head and neck cancer in London. Clinical Otolaryngology 42:104–114.

The Information Centre for Health and Social Care. (2011a) Executive Summary: Adult Dental Health Survey, 2009. London: The Health and Social Care Information Centre. Available from: http://content.digital.nhs.uk/pubs/dentalsurveyfullreport09 (accessed 21st July, 2017).

The Information Centre for Health and Social Care. (2011b) Theme 7. Outcome and impact – a report from the Adult Dental Health Survey 2009. London: The Health and Social Care Information Centre. Available from: http://content.digital.nhs.uk/pubs/dentalsurveyfullreport09 (accessed 21st July, 2017).

The Information Centre for Health and Social Care. (2011c) Theme 1. Oral health and function – a report from the Adult Dental Health Survey, 2009 London: The Health and Social Care Information Centre. Available from: http://content.digital.nhs.uk/pubs/dentalsurveyfullreport09 (accessed 21st July, 2017).

The Information Centre for Health and Social Care. (2011d) Theme 8. Access and barriers to care – a report from the Adult Dental Health Survey, 2009. London: The Health and Social Care Information Centre. Available from: http://content.digital.nhs.uk/pubs/dentalsurveyfullreport09 (accessed 21st July, 2017).

The Information Centre for Health and Social Care. (2011e) Theme 4. Complexity and maintenance – a report from the Adult Dental Health Survey, 2009. London: The Health and Social Care Information Centre. Available from: http://content.digital.nhs.uk/pubs/dentalsurveyfullreport09 (accessed 21st July, 2017).

The Information Centre for Health and Social Care. (2011f) Theme 2. Disease and related disorders – a report from the Adult Dental Health Survey, 2009 London: The Health and Social Care Information Centre. Available from: http://content.digital.nhs.uk/pubs/dentalsurveyfullreport09 (accessed 21st July, 2017).

Thomson, W.M. (2004) Dental caries experience in older people over time: what can the large cohort studies tell us? British Dental Journal 196(2):89–92.

Thomson, W.M., Broadbent, J.M., Welch, D., et al. (2007) Cigarette smoking and periodontal disease among 32-year-olds: a prospective study of a representative birth cohort. Journal of Clinical Periodontology 34(10):828–834.

Thomson, W.M., Williams, S.M., Broadbent, J.M., et al. (2010) Long-term dental visiting patterns and adult oral health. Journal of Dental Research 89(3):307–311.

Thomson, W.M., Mejia, G.C., Broadbent, J.M., Poulton, R. (2012) Construct validity of Locker's Global Oral Health Item. Journal of Dental Research 91(91):1038–1042.

Thomson, W.M., Shearer, D.M., Broadbent, J.M., et al. (2013) The natural history of periodontal attachment loss during the third and fourth decades of life. Journal of Clinical Periodontology 40(7):672–680.

Tiller, S., Wilson, K.I., Gallagher, J.E. (2001) Oral health status and dental service use of adults with learning disabilities living in residential institutions and in the community. Community Dental Health 18:167–171.

Treasure, E., Kelly, M., Nuttall, N., et al. (2001) Factors associated with oral health: a multivariate analysis of results from the 1998 Adult Dental Health survey. British Dental Journal 190(2):60–68.

UK National Screening Committee. Welcome to the UK Screening Portal: The gateway to information on

screening in the UK 2014 [25.10.2014]. Available from: http://www.screening.nhs.uk/ (accessed 26th June, 2017).
United Nations. (2011) World Population Prospects: The 2010 Revision. New York: United Nations.
US Surgeon General. (2000) Oral Health In America. Atlanta: Centers for Disease Control.
Viegas, C.M., Paiva, S.M., Carvalho, A.C., et al. (2014) Influence of traumatic dental injury on quality of life of Brazilian preschool children and their families. Dental Traumatology 30(5):338–347.
Vos, T., Flaxman, A.D., Naghavi, M., et al. (2012) Years lived with disability (YLDs) for 1160 sequelae of 289 diseases and injuries 1990-2010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 380(9859):2163–2196.
Watt, R.G., Steele, J.G., Treasure, E.T., et al. (2013) Adult Dental Health Survey 2009: implications of findings for clinical practice and oral health policy. British Dental Journal 214(2):71–75.
White, D., Lader, D. (2004) Periodontal Condition, Hygiene Behaviour and Attitudes to Oral Health. London: The Stationery Office.
White, D., Pitts, N., Steele, J., et al. (2010) Chapter 2. In: Disease and Related Disorders – a Report from the Adult Dental Health Survey 2009. London: The Information Centre for Health and Social Care, NHS & National Statistics.
White, D., Pitts, N., Steele, J., et al. (2011) 2: Disease and related disorders – a report from the Adult Dental Health Survey 2009. London: The Health and Social Care Information Centre. http://content.digital.nhs.uk/catalogue/PUB01086/adul-dent-heal-surv-summ-them-the2-2009-rep4.pdf (accessed 21st July, 2017).
White, D.A., Tsakos, G., Pitts, N.B., et al. (2012) Adult Dental Health Survey 2009: common oral health conditions and their impact on the population. British Dental Journal 213(11):567–572.
World Health Organization. (2005) Waterpipe tobacco smoking: health effects, research needs and recommended actions by regulator: tobacco reg advisory note. Geneva: World Health Organization.
World Health Organization. (2011) WHO report on the global tobacco epidemic, 2011: warning about the dangers of tobacco. Geneva: World Health Organization.
World Health Organization. (2012a) Oral Health: key facts. Geneva: World Health Organization. Report No.: Contract No.: No 318.
World Health Organization. (2012b) Oral Health Database: CAPP. In: Project OHCAP, ed. University of Malmo.
World Health Organization. (2013a) Oral Health Surveys: Basic Methods, 5th edn. Geneva: World Health Organization.
World Health Organization. (2013b) Pathfinder Surveys (Section 1.1.5). In: Oral Health Surveys: Basic Methods. 5th edn. Geneva: World Health Organization; pp. 18–21.
World Health Organization. (2014a) Global summary of the HIV/AIDS epidemic, 2013. Geneva: World Health Organization. Available from: http://www.who.int/hiv/data/epi_core_dec2014.png?ua=1 (accessed 27th June, 2017).
World Health Organization. (2014b) Number of all people (of all ages) living with HIV by WHO region. Geneva: Global Health Observatory Data repository.
World Health Organization. (2016) Global strategy on human resources for health: Workforce 2030. Geneva: World Health Organization; 2016. Available from: http://www.who.int/hrh/resources/pub_globstrathrh-2030/en/ (accessed 27th June, 2017).
Yu, M.C., Yuan, J-M. (2002) Epidemiology of nasopharyngeal carcinoma. Seminars in Cancer Biology 12(6):421–429.

3

Requirements in the Clinical Environment

Barry Quinn and Richard Johnson

Infection Control Requirements

Hand Hygiene

Introduction

All healthcare workers have a duty of care towards patients; a key component of care is preventing the hands from becoming a vehicle for cross-infection and preventing the transfer of micro-organisms to susceptible individuals. Staff compliance with guidelines for hand hygiene is often poor (Handwashing Liaison Group, 1999). The reasons why staff do not wash their hands include lack of available hand hygiene products, lack of time and the personal belief that they will not spread infection. Effective hand decontamination results in a significant reduction in the carriage of potential pathogens on the hands.

Hands must be decontaminated immediately before and after each and every episode of direct patient contact/care, and after any activity or contact that potentially results in hands becoming contaminated.

Considerations made prior to hand decontamination must include:

- The level of the anticipated contact with the patient.
- The extent of the contamination that may occur.
- The patient care activities being performed.
- The susceptibility of the patient.

The method of decontamination must be determined by the practitioner's assessment of whether it is necessary to remove transient and/or resident hand flora.

Key factors in ensuring effective hand hygiene and the maintenance of skin integrity include:

- The duration of hand decontamination.
- The exposure of all aspects of the hands to the preparation.
- The use of vigorous rubbing to create friction.
- Thorough rinsing and ensuring that the hands are completely dry.

Basic Requirements to Achieve Effective Hand Hygiene

- Cover all cuts and abrasions with waterproof dressings.
- Keep nails short and clean.
  Do not wear nail varnish, artificial fingernails or extenders. Artificial nails and nail extensions harbour higher levels of micro-organisms than natural fingernails, and these micro-organisms are not removed easily during hand hygiene. It should be noted that artificial fingernails can also fall off, and this may pose an added risk during surgical procedures.
- Do not wear wristwatches, stoned jewellery, bracelets or rings (other than one plain band).
- Do not use nail brushes for hand hygiene levels 1 and 2 as scrubbing can irritate the skin, leading to increased risk of harbouring micro-organisms.
- Long sleeves should be rolled up to ensure that effective hand hygiene may be applied to hands and wrists.

Micro-organisms Found on the Skin

These can be described as:

- Resident flora: normal flora or 'commensal organisms', forming part of the body's normal defence mechanisms and protecting the skin from invasion by more harmful micro-organisms. They rarely cause disease and are of minor significance in routine clinical situations. However, during surgery or other invasive procedures, resident flora may enter deep tissues and establish infections. Removal of these organisms is desirable in these situations, by following the surgical scrub technique.
- Transient flora: those acquired by touch, e.g. from the environment, touching patients, laundry, equipment, etc. They are located superficially on the skin, readily transmitted to the next thing touched, and are responsible for most healthcare-associated infections. They are easily removed by hand decontamination.

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

Technique for Hand Hygiene

An effective hand washing technique involves three steps: preparation, washing and rinsing, and drying (Figure 3.1). Preparation requires wetting hands under tepid running water before applying liquid soap or an anti-microbial preparation.

Facilities Required

Adequate facilities must be provided to enable staff to wash and dry their hands regularly and appropriately, to use alcohol hand gel, and to protect their skin with moisturiser. Clinical areas should have a dedicated hand wash basin, with no plug or overflow, that is easily accessible

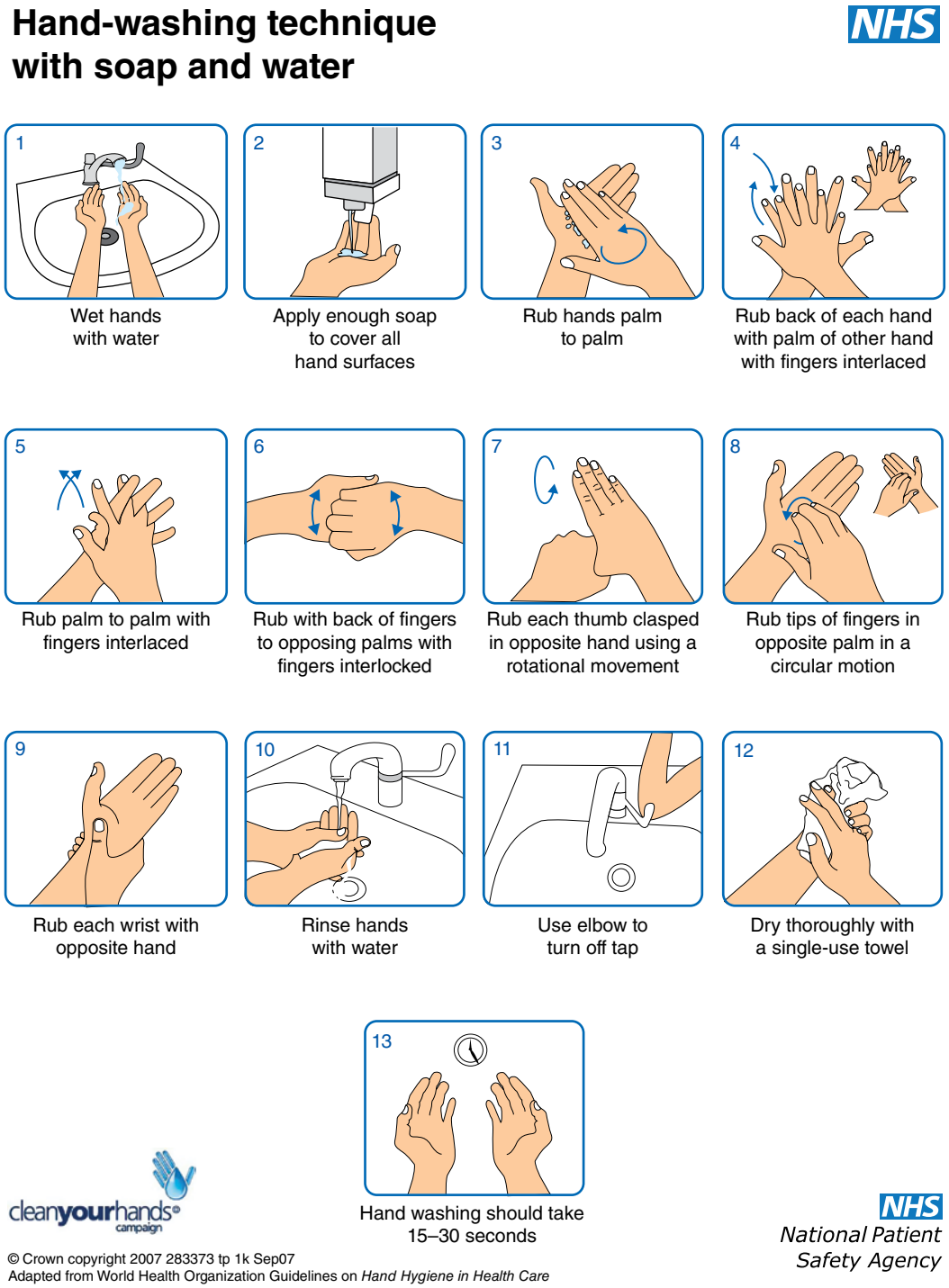


Figure 3.1 National Health Service guide to hand washing. Reproduced courtesy of the Open Government Licence.

with elbow or foot operated taps (separate to a dedicated sink for cleaning equipment, etc.).

A wall-mounted liquid soap dispenser, with an adequate supply of liquid soap, and a wall-mounted paper towel dispenser should be available.

Each clinical area must also have easily accessible alcohol handrubs/gels (with emollients). Moisturising cream should also be available to maintain skin integrity. This should be supplied in wall-mounted dispensers, located in suitable positions.

Liquid Soap

Liquid soap and running water will remove transient organisms and render the hands 'socially clean'. The hands must be rubbed together vigorously for a minimum of 15–20 seconds, paying particular attention to the tips of the fingers, the thumbs and the areas between the fingers. This is sufficient for general social contact and most clinical care activities and must be used when dealing with patients who are known to be *Clostridium difficile* positive. Hands must be rinsed thoroughly prior to drying.

Clinical staff working in non-clinical settings should be provided with liquid soap to utilise in settings where it is not available.

Alcohol-Based Handrubs

Alcohol-based handrubs (Figure 3.2) are a practical and acceptable alternative to hand washing (especially when facilities are limited). An effective handrub technique involves ensuring that all surfaces of the hands are coated with the handrub, paying particular attention to the tips of the fingers, the thumbs and the areas between the fingers.

It is important to note however that handrubs must not be used unless the hands are free of dirt and organic matter. The handrub needs to have evaporated from the skin before contact with the patient; this should take a minimum of 20 seconds. For physically clean hands, disinfection with alcoholic handrub is quicker and less likely to lead to skin irritation than repeated hand washing. It is recommended that soap and water be used after every five applications of handrub, as the emollients build up on the skin, making it sticky.

When dealing with patients with viral diarrhoea or other transmissible disorders the use of alcoholic handrub is mandatory. This is because hand washing is not effective at removing viruses from the hands whereas alcoholic handrub is effective at killing most viruses. In the event of a *Clostridium difficile* or norovirus infection, hand washing with soap and water must be carried out as alcohol gel is not effective at killing these microbes.

Anti-Microbial Agents

Anti-microbial agents (e.g. chlorhexidine, povidone-iodine) are used mainly in secondary care environments during the undertaking of invasive procedures into sterile body sites, especially on particularly susceptible individuals such as immunocompromised patients to reduce transient micro-organisms and some resident flora.

Hand Drying

A good quality paper towel should be used for hand drying. Paper towels must be disposed of in a foot-operated bin to avoid recontamination of hands.

Skin Care

Damaged or dry skin leads to loss of smooth skin surface and increases the risk of skin colonisation with resistant organisms such as meticillin-resistant *Staphylococcus aureus* (MRSA). Staff should have access to a good quality, non-perfumed hand cream that does not negate the properties of antiseptics in other hand hygiene products or the integrity of gloves. Communal tubs of hand cream should not be used as these can become contaminated during use. Hand cream should be applied regularly to protect the hands from the drying effects of hand decontamination.

Any skin breaks must be covered by an impermeable waterproof dressing. Any skin irritation must be reported to your general practitioner. Staff with acute or chronic skin lesions/conditions/reactions should seek advice from their general practitioner.

Personal Protective Equipment

Introduction

The provision and use of personal protective equipment (PPE) is governed by the Personal Protective Equipment at Work Regulations 1992 and its subsequent amendments.

The regulations define PPE as: 'All equipment (including clothing affording protection against the weather) which is intended to be worn or held by a person at work and which protects them against one or more risks to their health and safety'. Selection of PPE to be worn must be made by the dental care professional following a risk assessment of the potential hazards associated with the procedure to be performed including the possibility of transmission of micro-organisms.

Only PPE carrying the European CE mark denoting the product has met specified performance standards should be used because under European law PPE is classified as a medical device. Regulation requires that PPE is:

- Properly assessed to use to ensure suitability.
- Maintained and stored properly.

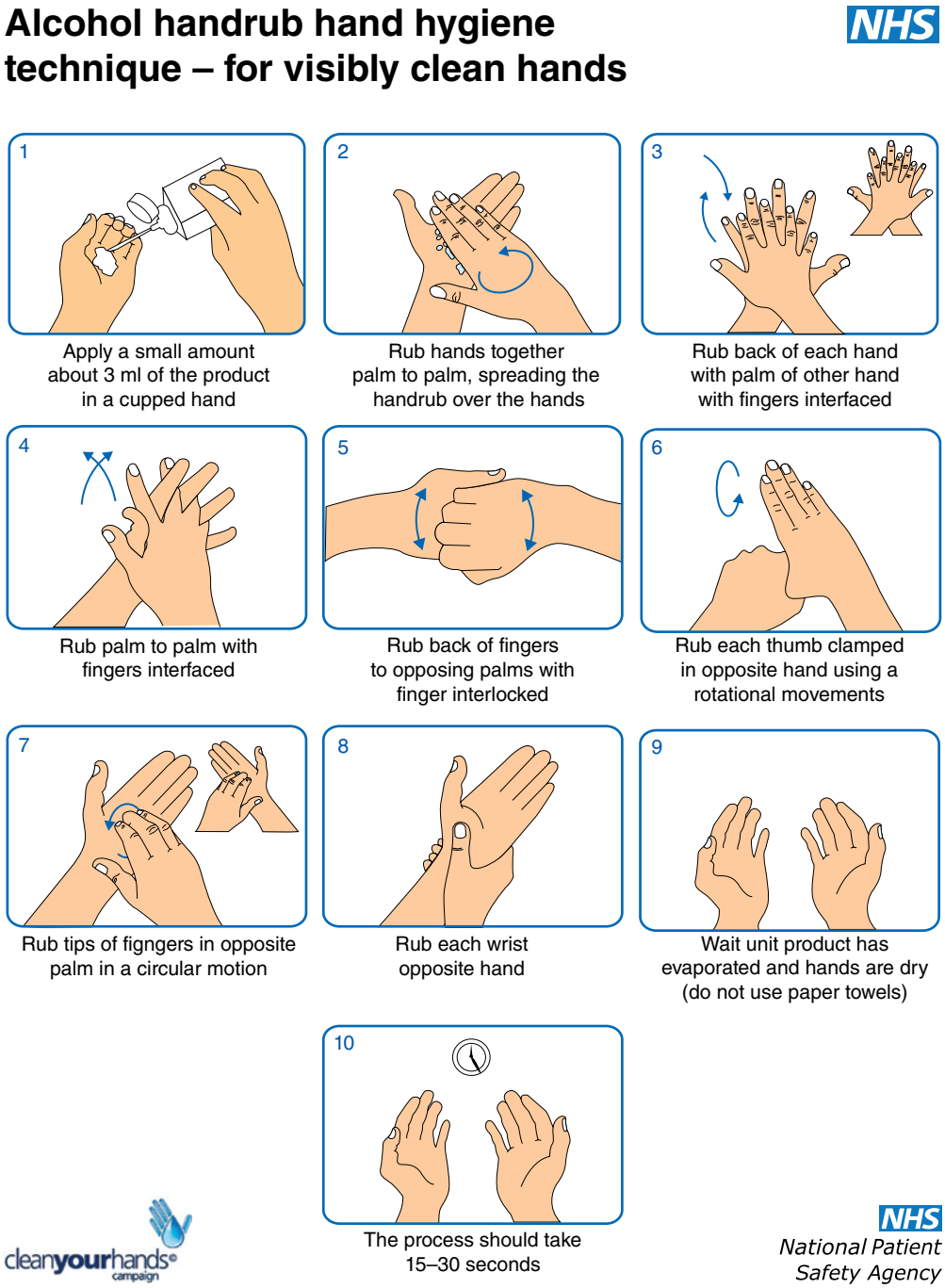


Figure 3.2 National Health Service guide to alcohol handrub hygiene technique. Reproduced courtesy of the Open Government Licence.

- Provided with instructions on how to use it safely.
- Used correctly by employees.

Protective clothing is used to reduce the risk of acquiring and transmitting micro-organisms by:

- Protecting skin, eyes, mouth, respiratory system and clothing of staff from potentially infectious excretions, secretions and chemicals.
- Preventing contamination of skin and clothing by transient micro-organisms which may pass to another patient.

Use of PPE

- PPE is used in addition to normal clothing and uniforms.
- Standard uniforms are not considered PPE.

- The need for protective equipment should be on a care episode related approach not disease specific.
- Selection of protective equipment should be selected based on an assessment of the risks of transmission of micro-organisms to the patient and the risk of contamination of healthcare practitioners' clothing and skin by patients' blood, body fluids, secretions and excretions.
- PPE protects intact skin. Cuts, abrasions, exposed fresh unhealed body piercings, i.e. facial or exposed unhealed tattoos, must be covered by a waterproof plaster or other suitable dressing in addition to PPE.
- Hand decontamination must be used before and after PPE use.
- Arms must be 'bare below the elbow' to prevent contamination of clothing.
- PPE will not protect against sharps injuries; avoid the use of sharps where possible.
- Personal protective clothing identified by the manufacturer as single-use must not be kept for reuse.

Clothing, Uniforms and Laundry

- Clothing worn to undertake decontamination should not be worn outside the clinical area. Neither should clinical clothing. Short sleeves are best practice; staff can protect their forearms by wearing long-cuffed gloves or disposable long-sleeved gowns.
- Clothing/uniforms become easily contaminated with micro-organisms, so freshly laundered uniforms should be worn each day. Machine washing as per manufacturer's instruction with a suitable detergent at a minimum temperature of 65°C will reduce microbial contamination.

Putting on PPE

Resources Required

- Plastic apron.
- Surgical face mask.
- Protective eyewear.
- Gloves – latex free to avoid allergic reaction.

Process

1) Remove watches and rings to facilitate effective hand washing.
2) Cover broken skin, cuts and abrasions with waterproof dressings.
3) Put on surgical face mask.
4) Put on protective eyewear.
5) Wash and dry hands thoroughly using disposable paper towels.
6) Put on gloves by holding one glove at the cuff, put opposite hand inside the glove and pull onto the hand. Repeat with the other glove. Gloves must fit properly and should be low in extractable proteins (<50 µg/g), low in residual chemicals and powder free. Latex gloves are used frequently in dentistry although some users report long-term allergies. The use of vinyl or nitrile gloves may be a satisfactory substitute.

Removing PPE

Resources Required

- Plastic apron.
- Surgical face mask.
- Protective eyewear.
- Gloves.

Process

1) Remove gloves by grasping the glove at the cuff and pulling downward, so the glove turns inside out. Place gloves into a clinical waste bin.
2) Wash and dry hands thoroughly.
3) Remove eyewear by using ear rests (as not contaminated). Place eyewear on a disposable towel until it can be cleaned and disinfected.
4) Slide the fingers of each hand under the elastic strap in front of your ears and remove the mask. Place the mask into a clinical waste bin.
5) Remove the plastic apron by turning it inside out and place in a clinical waste bin.

Dental Instrument Management

Legal Framework in the UK

Health and Safety at Work Act, 1974

This Act establishes the employer's and employee's responsibility for health and safety issues, such as providing safe equipment, e.g. how to handle contaminated dental instruments.

Consumer Protection Act, 1987

Inadequately decontaminated dental instruments that cause an infection in a patient may lead to civil liability action being taken with payments for damages, for injuries received from a defective product.

Provision and Use of Work Equipment Regulations 1998

These regulations require that equipment such as decontamination equipment (autoclave, ultrasonic bath, washer/disinfector) is suitable for the intended use, safe for use, maintained in a safe condition and inspected. Staff using the equipment should be trained in its use.

Management of Health and Safety at Work Regulations 1999

These regulations require employers to make a systematic assessment of all the risks to the health and safety of their employees and others, arising from work activities.

Pressure Systems Safety Regulations 2000

Benchtop sterilisers must comply with these regulations, which are intended to prevent risk of injury from stored energy because of a failure of a pressure system.

Control of Substances Hazardous to Health (COSHH) Regulations 2002

COSHH regulations relate to biological and chemical risks. These regulations require a risk assessment to be carried out of all potentially hazardous substances.

Medical Devices Regulations 2002

Medical devices on sale within the UK must carry a CE marking and information on the processes to allow reuse, including cleaning, disinfection, packaging and, where appropriate, the method of sterilisation of the device and any restriction on the number of reuses. Equipment such as benchtop steam sterilisers and washer/disinfectors is covered by these regulations.

HTM 01-05: Decontamination in Primary Care and Dental Practices for Guidance on Conducting Decontamination at Local Level 2013

Dental nurses responsible and accountable for dental instrument management should refer to the Department of Health (DH) document HTM 01-05: Decontamination in primary care and dental practices for guidance on conducting decontamination at local level.

Risk of Infection Assessment

Dental equipment can be categorised according to the risk of infection that the procedure poses during treatment (Table 3.1).

Decontamination Control Assurance Standards require that a system should be in place that ensures that all reusable dental instruments are decontaminated prior to reuse, and that the risks associated with the decontamination process and facilities are managed. A record must be made and kept of each time dental instruments are used and decontaminated to provide demonstrable evidence that the equipment was functioning effectively and consistently in the unlikely event of an adverse incident. Records must be retained for the lifetime of the dental instrument plus 5 years.

The Medical and Healthcare products Regulations Agency (MHRA) defines the following terms:

Cleaning

Manual or ultrasonic cleaning of dental instruments should be undertaken prior to the chemical disinfection or sterilisation process. It is a method of decontamination for non-invasive (low-risk) items but should not be used for medium- or high-risk dental instruments, where sterilisation or disinfection is required. The removal of all visible contamination reduces the number of relevant micro-organisms present but does not destroy all micro-organisms.

The reduction of microbial contamination will depend upon many factors including the efficiency of the cleaning process and the initial contamination. A further reduction will occur on drying, as some micro-organisms cannot multiply on a clean dry surface. Thorough cleaning reduces the possible transmission of all micro-organisms, including the abnormal prion protein that causes variant Creutzfeldt–Jakob Disease (vCJD).

Manual Cleaning

- Appropriate PPE must be worn.
- A designated 'dirty' area for instrument cleaning must be used. A deep sink should be used so that instruments can be fully submerged.
- Use a clean disposable cloth or brush for cleaning.
- Use warm water and detergent.
- A separate sink for rinsing the instruments must be available.
- Dry thoroughly using a clean disposable cloth or paper towels.

Table 3.1 Risk of infection assessment for instrumentation.

Risk level	Definition	Suitable processes	Example
Low (non-sterile)	Items of equipment that have contact with intact skin or mucous membranes	Cleaning following manufacturer's recommendations	Aspirator tubing
Medium	Items of equipment that are used in procedures where there may be a breach of the integrity of skin or mucous membranes	Sterilisation or use of single-use items	Ultrasonic scaler
High	Items of equipment which penetrate or have contact with broken skin, mucous membranes or enter sterile areas	Sterilisation or use of single-use items	Scalpel blade and handle

Adapted from: Medical Devices Agency (2002) Guidance in Decontamination from the Microbiology Advisory Committee to the Department of Health. London: Medical Devices Agency.

- Instruments must be visibly checked to ensure all organic material has been effectively removed.

Ultrasonic Cleaning

Ultrasound energy is used for the mechanical removal of contaminated waste or debris from dental equipment.

- Ultrasonic cleaners must comply with HTM 01-05.
- Gross contamination should be removed by manual cleaning.
- Use as per manufacturer's instructions, particularly on how long the instruments should stay in the bath for effective cleaning, ensuring regular change of water and regular decontamination of machine.
- Fill the bath with warm water and put in solution, which must contain a detergent or a disinfectant with detergent, not just a disinfectant.
- Place the instruments in the ultrasonic bath.
- Use the manufacturer's recommended time for cleaning.
- Take the instruments out and rinse under clean water.
- Check for any residual debris.
- The water in the bath must be changed daily or sooner if gross soiling is evident.
- Use the manual cleaning method if debris is found.

Disinfection

Disinfection will not achieve the same reduction in microbial contamination levels as sterilisation. Disinfection is defined as a process used to kill or remove pathogenic micro-organisms but which cannot usually kill bacterial spores.

Heat Disinfection

The microbicidal effects of heat are used to achieve disinfection, e.g. a washer/disinfector with a heating cycle reaching 80°C for a minimum of 1 minute.

Chemical Disinfection

Appropriate chemicals are used to inactivate micro-organisms and achieve disinfection. There are high and low levels of chemical disinfection:

- High-level chemical disinfection, e.g. using peracetic acid. This is used in specialist settings for items which cannot withstand heat disinfection/sterilisation.
- Low-level chemical disinfection, e.g. chlorine releasing agents or alcohol.

Maintenance

- Maintenance of equipment must be in accordance with HTM 01-05.
- All maintenance to be carried out according to relevant dental team protocols.

Sterilisation

Sterilisation 'is a process used to render the object free from viable micro-organisms, including bacterial spores and viruses'. Single-use items avoid the need for re-sterilisation and are a practical and safe method. Pre-sterilised items must be stored using a stock rotation system according to the manufacturer's instructions. Sterilisation of dental instruments must be carried out in accordance with the manufacturer's instructions.

Benchtop Sterilisers

Ideally, sterile items should be processed and obtained from a sterile services department (SSD). Where it is not possible to use an SSD, a validated benchtop steam steriliser may be used to reprocess reusable dental instruments.

Validated benchtop steam sterilisers are unsuitable for processing:

- Porous products (e.g. drapes, dressings).
- Dental instruments that are hollow or have lumens (either wrapped or unwrapped).
- Dental instruments that are wrapped.

Vacuum benchtop steam sterilisers have a pre-sterilisation active (vacuum) air removal stage to ensure steam penetration throughout the load. They also have a post-sterilisation drying stage before the steriliser door is opened because dental instruments that are not dry cannot be considered to be sterile.

After the steriliser has been purchased it should be able to be validated and tested periodically according to prevailing standards.

Inspection

All instruments that have been through the decontamination process must be inspected to ensure they are clean, functional and in good condition.

A dedicated clean area with good lighting and access to an illuminated magnifier is recommended to allow inspection of instruments to observe for residual contamination, debris or damage. All cleanliness failures should be recorded in a fault log and regularly reviewed. Instruments that are blunt, bent, rusted or damaged or show any signs of pitting or other corrosion must be discarded in a clinical waste container.

Single Patient Use Dental Instruments

Reprocessing dental instruments designated as single patient use has legal implications and requires extensive

testing, validation and documentation. Dental practices reprocessing or reusing devices intended by the manufacturer for use on a single occasion take full responsibility for their safety and effectiveness. All legal obligations that would have fallen to the original manufacturer under Medical Devices Regulations will fall to the dental practice when a single patient use item is reprocessed and used again.

Reprocessing single-use dental instruments may affect the capabilities and/or the materials from which the instrument is made. Single-use instruments are not designed to allow thorough decontamination or re-sterilisation processes.

Single-Use Dental Instruments

Dental single-use instruments are to be used on an individual patient during a single procedure and then discarded. It must be remembered that single-use refers to single occasion of use and not a single patient.

- All single-use items are classified as clinical waste after use and must be disposed of in a clinical waste container.
- Sharps should be disposed of at point of use in a sharps container.
- Packaged single-use items should be stock rotated and stored in a dust free, clean and dry storage area.

Dental instruments that are difficult to clean effectively should be rendered single-use. These include matrix bands, steel burs, aspirator tips, 3 in 1 tips, saliva ejectors, plastic impression trays and all endodontic files.

Storage

All instruments must be completely dry when stored because dampness encourages growth of micro-organisms and corrosion of instruments. Dental instruments must not be stored loose in drawers or on open trays, on open shelving or on work surfaces in clinical areas.

Dental instruments should be stored in clean, orderly, enclosed cupboards and drawers in covered instrument trays in a manner that avoids damaging the wrapping and allows for stock rotation to ensure sterilised items are used within their shelf-life. Storage areas must be clean and dry and be away from sources of direct sunlight, heat, waste and water. Storing instruments in a separate environment away from the clinical area (this may be the clean area of the decontamination room) is considered best practice.

Training

Any member of the dental team involved in the use or management of any decontamination equipment or process must have successfully completed competence based training, which is documented and updated. General Dental Council registrants must complete at least 5 hours of decontamination training in a 5-year continuing professional development cycle.

Clinical Waste Disposal

Introduction

Practices should have a local waste disposal policy and procedures to ensure dental waste disposal service is safe, economical and meets all legal requirements.

The local policy should include the disposal of dental materials including silver, amalgam and sharps as well as hard and soft clinical waste, such as:

- Local anaesthetic sharps.
- Amalgam separator waste.
- Amalgam waste.
- Lead foils.
- Fixer and developer.

All clinical wastes are hazardous waste, with two exceptions:

- Segregated non-hazardous medicines.
- Clinical wastes from non-healthcare activities.

Wastes are normally clinical waste due to the presence of hazardous chemicals or pharmaceuticals, or because they may cause infection. With the exception of medicines that are classified as non-hazardous, clinical waste is therefore normally classified as hazardous waste.

Any medicine that possesses one or more of the following hazardous properties is classified as 'cytotoxic and cytostatic' and is a hazardous waste:

- Toxic.
- Carcinogenic.
- Mutagenic.
- Toxic for reproduction.

This is a wide group of medicines including those found in community pharmacies and general practice.

Other medicines are not hazardous waste. Where they possess hazardous properties, these should be entered on waste documentation for duty of care purposes.

Legal Framework

As healthcare waste producers, dental practices have a duty of care to ensure all clinical and general waste is managed and disposed of properly. There are three separate legal areas that govern waste generated on healthcare premises:

- Environment and waste.
- Transport.
- Health and safety.

The following legislation applies to waste generation in healthcare premises:

- The Environmental Protection Act 1990 (c.43).
- Environmental Protection (Duty of Care) Regulations (England, Scotland and Wales) 1991.
- The Carriage of Dangerous Goods and Use of Transportable Pressure Equipment Regulations (Carriage Regulations) 2004.
- Schedule 3 of the Control of Substances Hazards to Health Regulations (COSHH) 2002.
- Health and Safety at Work Act 1974.
- The Health and Safety (Consultation with Employees) Regulations 1996.
- The Hazardous Waste (England and Wales) Regulations 2005.
- The Environment Act 1995.
- The Control of Substances Hazardous to Health Regulations 2002.
- Health Service Advisory Committee, Safe Disposal of Clinical Waste.
- The Waste Management Regulations 1994 and all associated legislation.
- HTM 07-01 (2013)

Categories of Waste (Table 3.2)

For dental purposes waste is considered as clinical or non-clinical.

Clinical Waste

The definition of clinical waste has historically been used to describe waste produced from healthcare and similar activities that pose a risk of infection or that may prove hazardous. Clinical waste may be divided into infectious, sharp or non-sharp; non-infectious sharp or non-sharp.

Clinical waste is defined by The Controlled Waste (England and Wales) Regulations 2012 as any waste that consists wholly or partly of:

- Blood or other bodily fluids.
- Drugs or other pharmaceutical products.
- Excretions.
- Human or animal tissue.
- Swabs or dressings.

Infectious Waste

Infectious waste is material containing viable micro-organisms or their toxins which are known to cause disease in man or animals. Infectious waste is divided into two categories: A and B.

Category A: an infectious substance that when transported is capable of causing permanent disability or life threatening or fatal disease to humans or animals, e.g. waste contaminated with pathogens presenting the most severe risk of infection such as Ebola virus. This waste must be treated on site by autoclaving prior to transfer to a disposal facility. Category A waste should be placed in a yellow bag, however it is unlikely to be generated in a dental setting.

Category B: an infectious substance which does not meet the criteria for inclusion in category A. This waste does not need to be treated prior to transfer to a disposal facility. Most infectious clinical waste generated within a dental setting will fall into this category, and should be placed in an orange bag.

Sharps waste: sharps are items that could cause cuts or puncture wounds, including needles, burs, and scalpel blades. Sharps waste may be infectious or non-infectious, medicinally contaminated or non-medicinally contaminated. In the dental setting all sharps are disposed of in a sharps container.

Sharps containers are yellow with an orange lid for non-medicinally contaminated such as scalpel blades or burs and yellow with a yellow lid for medicinally contaminated sharps such as local anaesthetic syringes or midazolam ampoules. All sharps contaminated with cytotoxic/cytostatic medicines must be placed in purple-lidded sharps bins. However, such medicines will not be used within the dental surgery.

Care must be taken when assembling sharps containers to ensure that the lid is securely in place. Sharps containers must be sealed, labeled and replaced when three quarters full. If the sharps container is seldom used, it should be replaced after a maximum of 3 months regardless of the filled capacity. Sharps containers must always be kept at waist height on a level surface (or in a wall bracket) in a clinical area to prevent injury.

Extracted Teeth Extracted teeth that do not contain amalgam can be disposed of in a sharps container. Extracted teeth containing amalgam are considered hazardous waste and cannot be incinerated, so they must not be put into a sharps container. Extracted teeth containing amalgam should be treated (e.g. sprayed) with a disinfectant that does not contain bleach or chlorine, air dried, and stored in a sealed container. This container should be collected and disposed of separately by a waste collection company.

Non-Sharp Waste

Liquid waste: any liquid clinical waste being placed within the clinical waste stream, e.g. suction fluids or urine, must be solidified with an appropriate gelling agent to prevent leakage, spillage and overflow and therefore reduce the risk of cross contamination. Wherever possible, pre-gelled suction liners must be used.

Waste radiographic fixer and developer solutions are classified as hazardous and should be collected by a licensed material recovery company. If recovery is not

Table 3.2 Summary of arrangements for waste disposal.

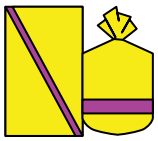
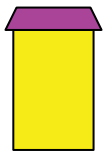
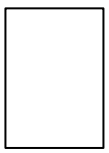
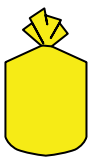
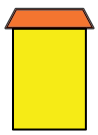
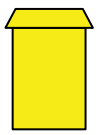
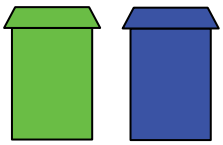
Waste receptacle	Description	Example contents
 Yellow with purple stripe	Infectious waste contaminated with cytotoxic and /or cytostatic medicinal products.	Dressings/tubing from cytotoxic and/or cytostatic treatment. Not used in dental practice.
 Yellow with purple lid	Sharps contaminated with cytotoxic and/or cytostatic medicinal products.	Sharps used to administer cytotoxic products. Not used in dental practice.
 White	Amalgam waste.	Dental amalgam waste.
 Yellow	Infectious waste, Category A Yellow.	Category A – unlikely to be generated in a dental practice. Waste which requires disposal by incineration. Infectious and other waste requiring incineration. Includes anatomical waste, diagnostic specimens, reagent or test vials, and kits containing chemicals.
 Orange	Category B Orange.	Category B – most infectious clinical waste falls in this category. Waste which may be 'treated'. Infectious and potentially infectious.
 Orange top	Non-medicinally contaminated sharps.	Sharps from phlebotomy. Minor oral surgery instruments, burs, scalpel blades.
 Yellow top	Medicinally contaminated sharps.	Ampoules such as midazolam and local anaesthetic syringes and needles.
 Yellow/black stripe	Offensive waste.	Non-contaminated face masks, gowns, non-infectious disposable equipment, plaster casts/models of teeth.

Table 3.2 (Continued)

Waste receptacle	Description	Example contents
 Black bag or clear bag is acceptable	Domestic waste.	General refuse, including flowers, etc.
 Green/blue/clear	Mixed recycling.	Paper, cardboard, tins, cans, plastic, glass.

appropriate, fixer and developer solution should be incinerated at licensed facilities. Any packaging containing residues of, or contaminated by, dangerous substances such as lead foil is classified as hazardous waste and should be disposed of as such.

Non-Infectious Waste

Offensive Waste Offensive waste is unpleasant and may cause offence to those coming into contact with it. However, it is considered non-hazardous. It may include outer dressings and protective clothing, e.g. masks, gowns and gloves that are not contaminated with body fluids, as well as autoclaved laboratory waste.

Offensive waste does not include any of the following: sharps, body parts such as teeth or dental amalgam. These are classified as hazardous.

Offensive waste should be placed in a 'tiger bag', a yellow bag with one or more broad black stripes. This waste must not be placed in clinical waste or in a black refuse bag.

The practice must ensure that the waste is stored, handled, recycled or disposed of safely and meet the legislation as this is a duty of care. Offensive waste may be disposed of by incineration or non-hazardous landfill. Most clinical waste treatment sites are not authorised to dispose of offensive waste as it is not infectious. You must make sure that the site receiving your waste is authorised to deal with your particular type of waste.

Dental Amalgam Dental amalgam in any form is classified as hazardous waste; this includes materials contaminated with amalgam. Amalgam waste should be collected by suitable licensed or permitted waste management facilities where the waste undergoes a mercury recovery process prior to final disposal.

Dental practices that use amalgam must install amalgam separators and ensure the amalgam collected is disposed of as hazardous waste. Separators should meet the British Standard requirements for dental equipment: amalgam separators (BS ISO EN 11143: 2000). Simple filters and gauze material do not comply with legislation.

Necessary Documentation

Waste Transfer Notes

Waste tracking is a major element of the duty of care. The practice is responsible for taking adequate steps to ensure that the waste is managed safely and kept secure, transferring it only to an authorised or exempt person.

When waste is transferred from one party to another, the person handing it on, the 'transferor' (the practice) must complete a Waste Transfer Note. The transferor and the recipient, the 'transferee' (the waste disposal company) sign the note; both take and keep a copy of it. An Annual Transfer Note may be used to cover all the movements of regular consignments of the same waste, between the same parties. Copies of transfer notes must be kept by the transferor and transferee for a minimum of 2 years. A transfer note must state:

- The quantity of waste transferred (by weight where possible).
- How it is packed.
- The type of container.
- A description of the waste.

The description of the waste should include:

- The European Waste Catalogue code.
- The type of premises or business from which the waste comes.
- The name of the substance or substances.
- The process that produced the waste.
- A chemical and physical analysis.

The description of waste must provide enough information to allow its safe handling and disposal. The Department of Health's guidance, *Safe Management of Healthcare Waste* (HTM 07-01; 2013a), provides advice on waste disposal best practice and what information is required.

European Waste Catalogue Codes

Hazardous Waste

- 09 01 03 Solvent-based developer solutions.
- 09 01 04 Fixer solutions.
- 15 01 10 Packaging containing residues of or contaminated by dangerous substances (i.e. lead foil).
- 18 01 03 Clinical waste.
- 18 01 08 Cytotoxic and cytostatic medicines.
- 18 01 10 Dental amalgam waste.

Non-Hazardous Waste

- 18 01 01 Sharps (except 18 01 03).
- 18 01 02 Body parts and organs including blood bags and blood preservatives (except 18 01 03).
- 18 01 04 Offensive waste.
- 18 01 09 Medicines other than those mentioned in 18 01 08.

Standard Industrial Classification (SIC) Code Hazardous Waste Consignment Notes also require the addition of a Standard Industrial Classification code. The code for dental practices' activities is 85.13.

Hazardous Waste Consignment Notes Each collection of hazardous waste must be accompanied by a Hazardous Waste Consignment Note. Waste collection companies are entitled to charge a fee for a consignment note. Practitioners may produce their own consignment note, use consignment notes supplied by a waste contractor, or use an Environment Agency note. Consignment note blank templates are available to purchase from the Environment Agency.

Registration with the Environment Agency

Dental practices are exempt from notifying the Environmental Agency if the total amount of hazardous waste produced in any 12-month period is less than 200 kg, however the practice owner must notify the Agency if this limit is to be exceeded. Non-healthcare related hazardous waste also needs to be taken into consideration when deciding if the 200 kg weight threshold is exceeded. Registration can be made through the Environment Agency website: www.environment-agency.gov.uk

Non-Clinical Waste

All non-clinical wastes are classified under the provisions of the Environmental Protection Act 1990, Controlled Waste Regulations 1992, as controlled waste. Non-clinical waste can be divided into a number of categories:

- Non-clinical domestic waste placed in black bags.
- Recyclable materials such as cardboard or office paper.
- Large items of broken furniture or other items.
- Confidential waste.

Confidential information is deemed to be any information or combination of information which contains confidential details about a person or an organisation or which identifies them, e.g. name, address, telephone number, including written on such items as 'post it' notes.

Practices usually have a contract with a confidential waste disposal company to dispose of confidential waste. Each contract will have a timescale and process for dealing with the confidential waste and the process detailed by each organisation must be adhered to. When dealing with confidential waste the following must be adhered to:

- All confidential waste should be placed in supplied containers.
- Containers must be made secure once full so loss of data cannot occur.
- Containers must be stored in a secure location.

Many electrical items that are classified as domestic waste are governed by the Waste Electrical, Electronic, Equipment Directive (WEEE Directive). This means that all electrical items must be recovered, recycled, or reused and not disposed of at landfill. Disposal of such items must be discussed with the local authority.

Waste Management – Best Practice

Best practice is to reduce waste output. It is best not to produce waste in the first place:

- Buy products with packaging that can be recycled.
- Consider mobile digital imaging: no chemical waste, less exposure.
- Choose suppliers with take back facilities and order 'just in time' to avoid out of date stocks.
- Use paper double sided or as scrap paper.
- Composting. Biodegradable wastes can be composted on site (garden waste, cardboard, paper and small wood).

Recycling and reuse:

- Buy recycled goods.
- Find a supplier that will take back your computers/packaging to be recycled.
- Try to get permission to use council recycling banks or bring sites.
- Separate recyclables at source: office paper, cardboard, glass, hazardous.

Do not
(breaches of duty of care or licensing regulations):

- Use other people's skips, with or without consent.
- Take waste home for recycling or composting.
- Burn waste on site, especially not plastics, oils or chemicals.
- Give waste to unlicensed people who then act as waste management companies.

Risk Assessment

Introduction

All employers are obligated under the Health and Safety at Work Act 1974 to ensure all their employees are appropriately trained and competent to undertake their duties safely. Under the Control of Substances Hazardous to Health Regulations 2002 (COSHH), employers have a duty to assess the risk of hazardous substance related injury or ill health arising from work activities, and under the Health and Safety at Work Act 1974 to take measures to control that risk.

Health and Safety at Work Act 1974

The Health and Safety at Work Act 1974, sometimes called the HASAW or HSW, is the primary piece of legislation covering occupational health and safety in the United Kingdom. The Health and Safety Executive is responsible for enforcing the Act and a number of other Acts and Statutory Instruments relevant to the working environment.

The Control of Substances Hazardous to Health Regulations 2002 (COSHH)

The COSHH Regulations describe a number of substances hazardous to health as:

- Substances or mixtures of substances classified as dangerous for supply within the meaning of the Chemicals Regulations 2002 (Hazard, Information and Packaging). An indication of danger for such substances will be specified (i.e. very toxic, toxic, harmful, corrosive or irritant).
- Substances assigned a Workplace Exposure Level (WEL).
- Any biological agent.
- Any dust at a concentration specified within the COSHH Regulations; any material, mixture or compound used at work, or arising from work activities which can harm people's health.

In dental practice the following classification of substances requiring a COSHH assessment can be used:

- General cleaning materials.
- General disinfectants.
- Glutaraldehyde.
- Formaldehyde.
- Methyl methacrylate.
- Dental amalgam.
- Laboratory flammables.
- Office materials (toners, glues, pastes).
- Photocopier materials (dust, ozone).
- Inhalational sedation gases.
- Low-risk pharmaceuticals (antibiotics/analgesics, e.g. paracetamol).
- Blood and body fluids.
- Laboratory materials (dental plaster, adhesives).
- Work related dust (from trimming casts and dentures).
- Air conditioning (*Legionella*).

The following materials are not substances hazardous to health under COSHH:

- Asbestos and lead (which have their own regulations).
- Substances which are hazardous only because they are radioactive, simple asphyxiants, at high pressure, at extreme temperatures, or have explosive or flammable properties (other regulations may apply).
- Biological agents if they are not directly connected with the work and they are outside the employer's control, such as catching a cold from a colleague.

The Health and Safety Executive (HSE) has introduced eight principles of good practice to control exposure to hazardous substances. These are:

1) Design and operate processes and activities to minimise emission, release and spread of substances hazardous to health.
2) Consider all relevant routes of exposure – inhalation, e.g. mercury vapour, skin absorption and ingestion– when developing control measures.
3) Control exposure by measures that are proportionate to the health risk.
4) Choose the most effective and reliable control options which minimise the escape and spread of substances hazardous to health.
5) Where adequate control of exposure cannot be achieved by other means, provide, in combination with other control measures, suitable personal protective equipment.

6) Check and review regularly all elements of control measures for their continuing effectiveness.
7) Inform and train all employees on the hazards and risk from substances with which they work and the use of control measures to minimise risk.
8) Ensure that the introduction of control measures does not increase the overall risk to health and safety.

To comply with health and safety legislation it is essential that risk assessments are carried out at least on an annual basis or earlier if organisational or clinical practice changes have taken place. A review of these risk assessments will always take place immediately after an incident.

Risk Assessment in Dental Practice

The dental team is exposed to a wide variety of risks in the workplace, therefore it is important that practices perform annual risk assessments to maintain health and safety standards. A hazard analysis is a process used to assess risk, but let us first define a hazard. The World Health Organization (2007) defines a hazard as 'A circumstance, agent or action that can lead to or increase risk'.

Risk management is the identification, assessment and prioritisation of risks followed by coordinated and economical application of resources to minimise, monitor, and control the probability and/or impact of unfortunate events. It is also referred to as root cause analysis.

Most accidents can be traced to one or more of four levels of failure:

- Organisational influences.
- Unsafe supervision.
- Preconditions for unsafe acts.
- The unsafe acts themselves

Such research has led to the realisation that medical error can be the result of 'system flaws, not character flaws', and that individual greed, ignorance, malice or laziness are not the only causes of error.

Risk Assessment Process

For the most part, this process consists of the following elements, performed usually in the following order:

- Identify, characterise and assess threats.
- Assess the vulnerability of staff and patients to specific threats.
- Determine the risk (i.e. the expected consequences of specific types of hazards on staff and/or patients).
- Identify ways to reduce those risks.
- Prioritise risk reduction measures based on a strategy.

The US Department of Defense categorises risk management decisions as:

- Avoid.
- Control.
- Accept.
- Transfer.

Not all risks can be eliminated and thus control measures are aimed towards reducing risks to an acceptable level (ALARP – As Low As Reasonably Practicable).

Demonstrating Control of Risks

The dental team are encouraged to develop individual and collective responsibility for risk assessment – a systematic of work activities to identify what could go wrong and cause harm and whether adequate controls are in place. Risk assessment should be an ongoing exercise to identify hazards (anything which can cause harm), assess those at risk, and determine actions and controls to minimise those risks (Table 3.3).

Dental Team Responsibilities

The senior dentist and/or practice manager should undertake the role of risk management for the practice and hold the following responsibilities:

- Maintain an inventory of all hazardous substances within the practice.
- Ensure that a suitable and sufficient assessment is carried out for all hazardous substances identified.
- Ensure that appropriate control measures are introduced to prevent or control exposure to any substance hazardous to health.
- Ensure colleagues are trained in the safe use of hazardous substances.
- Ensure that chemicals are only used in accordance with manufacturer's recommendations.
- Ensure hazardous substances are stored and used in accordance with the manufacturer's instruction and all containers are fit for purpose.
- Ensure a FIFO (First In First Out) system is in place to ensure shelf-life does not expire.
- Ensure procedures are in place to deal with spillage and fire.
- Ensure there is written evidence of risk assessments having taken place with details of when they are due to be reassessed.

However, all staff are responsible for their own acts or omissions under the eyes of the law via the Health and Safety at Work Act 1974. Employee responsibilities are as follows:

- Compliance with all rules relating to the use of work equipment, dangerous substances, systems of work and safety devices.

Table 3.3 Examples of risk assessments.

Significant hazard	Those at risk	Existing controls or action required
Effective hand decontamination technique not followed.	• Dentist • Dental nurse • Dental hygienist • Dental therapist • Clinical dental technician	Arrange training. Ensure posters on appropriate technique are visible for staff. Audit hand washing technique.
Sharp items not disposed of immediately after use into the correct container.	• Dentist • Dental nurse • Dental hygienist • Dental therapist • Clinical dental technician	Arrange training. Ensure posters on appropriate technique are visible for staff. Audit use of sharps containers.
Total number of high-risk practices identified in baseline assessment:		**Total number of high-risk practices remaining after risk reduction initiatives:**

- Report to their practice manager/senior dental nurse/principal dentist any shortcomings in safe systems of work.
- Attend mandatory training when nominated.
- Report incidents and near misses.
- Follow any instructions specified by the COSHH assessment (including safe working method statements).
- Not endanger themselves or others through exposure to substances hazardous to health.
- Use control measures provided, wear suitable personal protective equipment (PPE), store PPE appropriately and remove PPE prior or eating or drinking.
- Attend training to use PPE correctly.
- Report any defects discovered in control measures or PPE immediately.

Table 3.4 Dental exposure prone procedure categories.

Category	Associated risk	Example of dental procedure
1	Lowest risk of bleedback as the worker's hands are usually visible outside the mouth.	Giving a local anaesthetic
2	Intermediate risk of bleedback. Hands are partially visible but if bleedback occurs it would be recognised and acted on quickly.	Extraction of a tooth
3	Greatest risk of significant injury and unrecognised bleedback.	Osteotomy

Sharps Injuries and Exposure Prone Procedures

Introduction

An exposure prone procedure (EPP) is defined as a clinical procedure where there is a possibility of an unrecognised bleedback into the patient's open tissues. In dentistry, these are classified into three broad categories based on the degree of visibility of the hands and the risk of significant sharps injury occurring during the procedure (Table 3.4).

Background

Studies suggest that approximately 100 000 sharps injuries occur every year in the UK. It is recognised that many injuries go unreported, so this is possibly a large underestimate of the total number.

Personal injury claims for sharps injuries have increased dramatically with the improvement in reporting procedures.

The vast majority of sharps injuries are avoidable, and occur when sharps are handled or disposed of in an unsafe manner.

What Are Blood-Borne Viruses?

The risk of any sharps related injury is the possibility of exposure to blood-borne viruses. In dentistry, this can involve patient to patient, patient to dental staff, and dental staff to patient infection. The main viruses concerned in dentistry are:

- Hepatitis B (HBV).
- Hepatitis C (HCV).
- Human immunodeficiency virus (HIV).

Estimated risk of transmission from known contaminated blood:

- Hepatitis B virus (HBV) – 1 in 3.
- Hepatitis C virus (HCV) – 1 in 30.
- Human immunodeficiency virus (HIV) – 1 in 300.

Healthcare workers have contracted blood-borne viruses (hepatitis B, hepatitis C and HIV) because of a sharps sustained injury. Several have died, and many more have suffered severe health consequences.

Hepatitis B (HBV)

There is a greater risk of becoming infected with hepatitis B than with other viruses. The hepatitis B vaccine can be given to anyone who is exposed to blood, even if the blood is not known to carry hepatitis B. The vaccine is usually given at the time of exposure and repeated 1 month and 6 months later to fully protect against future infection. If the source of the blood is known to be positive for hepatitis B and the exposed person has not previously had the hepatitis B vaccine, treatment with hepatitis B immune globulin (HBIG) is recommended. Hepatitis B immune globulin contains antibodies that provide temporary protection against the infection. Hepatitis B immune globulin is an injection, which should be given as soon as possible after exposure, preferably within 24 hours. A dose of hepatitis B vaccine is recommended at the same time. Hepatitis B immune globulin is not required if the individual has already received hepatitis B vaccine.

Hepatitis C (HCV)

Hepatitis C can cause a form of hepatitis that leads to chronic liver disease. There is no known way to prevent this infection following exposure. Blood tests should be done immediately after exposure to measure the liver function and test for the presence of hepatitis C; the tests should be repeated after 4–6 weeks and again after 4–6 months or sooner if symptoms of hepatitis develop.

Symptoms of hepatitis C include abdominal pain, loss of appetite, nausea, darkening of urine, light stools, or jaundice (yellowing of the skin or whites of the eye).

Human Immunodeficiency Virus (HIV)

Prophylactic treatment is available to reduce the risk of becoming infected with HIV after exposure.

The benefits of prophylactic treatment (e.g. reduced risk of infection) must be weighed against the risks (e.g. side effects of treatment, interactions with other medications, cost of treatment). All women of childbearing age should be tested for pregnancy before beginning treatment, although being pregnant does not mean that a woman cannot take anti-HIV medications. Anyone who is exposed to potentially infected blood or bodily fluids should be tested for HIV at the time of exposure (known as the baseline test) and at 6 weeks, 3 months, and 6 months post exposure.

Public Health England (2014) state 'practising Health Care Workers (HCW) who undertake EPPs are under a professional duty to seek medical advice on the need to be tested as soon as they are aware they may have been exposed to HIV infection, occupationally or otherwise… and if found to be positive, to obtain and follow appropriate clinical and occupational health advice. Being HIV positive, or declining a test for HIV, will not affect the employment or training of HCWs who will not perform EPPs'.

What Reduces the Risk of Contracting Blood-Borne Viruses?

The standard safety procedures followed in dentistry for the prevention of sharps injuries are known as standard or universal precautions, with all blood and body fluids being considered to contain infectious agents, and treated as such. Recommendations include:

- Hand washing after each patient contact and after contact with blood or body fluids.
- Using PPE.
- Disposable gloves should be worn whenever working with blood or body fluids.
- Disposable plastic aprons/impermeable gowns should be worn when splashing with blood or body fluids may occur.
- Eye protection (visors, goggles or safety spectacles) should be worn when blood, body fluids or flying contaminated debris/tissue might splash into the face.
- Covering any cuts or abrasions with waterproof plasters.
- Immediate and safe disposal of sharps into appropriate, puncture-proof sharps bins.
- Not overfilling sharps containers.
- Never re-sheathing needles.
- Sterilisation of dental instruments.
- Use of single-use items.

Single-Use Items

Items marked as single-use must only be used on a single occasion and then discarded. Single-use devices should never be used on multiple occasions on a single patient or on different patients. You will be personally liable if you cause any damage or injury by reusing an item marked for single-use only.

If a medical device is marked for single patient use, it can be used multiple times on one patient and then it must be discarded. Examples of single patient use devices include plastic syringes and suction tubing. Some form of decontamination may be necessary between use on the same patient; manufacturer's instructions should always be followed.

Pre-packed sterile single-use or single patient use medical devices should be checked to ensure the packaging is intact and that the content is within its use-by date. Stock should be stored in a clean area, stored off the floor and rotated to ensure that older stock is used before it reaches its expiry date.

Single-use devices should always be used where possible, if this does not compromise the clinical outcome.

Action to be Taken Following a Sharps Injury or Exposure to Body Fluids

The following actions should be undertaken immediately:

- Stop treatment and attend to the wound.
- Bleeding must be encouraged by squeezing puncture wounds for 2 minutes (do not suck the wound).
- Wash the site with soap and water without scrubbing.
- Dry the wound and cover with a waterproof dressing.
- Irrigate or rinse mucous membranes, e.g. mouth, nose, ears or eye, with large quantities of water as appropriate.
- Check the medical history of the source patient to determine the risk of contamination.
- If the source patient is a known or suspected carrier of HIV the local hospital designated specialist, for example the Consultant in Communicable Disease Control or Consultant Medical Microbiologist* should be contacted so that antiviral treatment can commence within the hour. The contact number should be included in the practice sharps injury policy.
- How the injury occurred and the actions taken need to be registered in the practice accident book and reported to the senior dentist and local occupational health contact.

*Healthcare professionals who wish to discuss or obtain advice on a general health protection or public health matter, report a local notifiable disease or outbreak of infection or have a vaccination enquiry out of office hours, should contact their local public health protection team.

Dental Surgery Design

Introduction

Dental care environment design begins by eliminating environmental characteristics that are known to be stressful or do not support infection prevention and control. Supportive design goes a step further by the inclusion of characteristics and opportunities in the environment that research indicates can calm patients, reduce stress, and strengthen coping resources and healthcare processes (Ulrich, 1999). The following general guidelines are recommended for creating supportive healthcare environments:

- Foster control, including privacy.
- Promote social support.
- Provide access to nature and other positive distractions.

When thinking about surgery design and layout, the dental team must take the following into consideration: health and safety, infection prevention, patient expectations, rising costs and the changing nature of the regulation of dental healthcare.

Health and Safety

Staff physical and mental wellbeing can be influenced through environmental measures. Poor ergonomic design of dental surgeries leads to back stress, fatigue, and other injuries amongst dental staff. Reducing staff stress by ergonomic interventions, as well as careful consideration of other issues such as air quality, noise and light, can have significant impact on staff wellbeing and performance.

Much research has been undertaken looking at the impact of healthcare environment design on patient outcome, however there is a growing and convincing body of evidence suggesting that improved designs have a positive influence on staff effectiveness.

Dental care professionals are under increasing pressure to work more efficiently within financial and regulation constraints. The physical environment may be linked to performance in the following areas:

- Improve staff health and safety through environmental measures
  (e.g. indoor air quality, thermal environment).
- Improve patient safety.
- Reduce staff fatigue.
- Reduce stress and improve outcomes.
- Reduce noise.
- Reduce spatial disorientation (wayfinding).
- Improve overall healthcare quality.

Infection Prevention

The UK Department of Health believes that infection control best practice is achieved through improvements in premises and equipment, and changes in practice management and culture.

The layout of a dental practice should be simple and uncluttered. Clean and dirty areas within the surgery should be clearly defined. A systematic approach to the cleaning and sterilisation of instruments after use will ensure that dirty instruments are segregated from clean.

The dental team should ensure the environment is designed to meet best practice in infection control by bearing in mind the following:

- The surgery layout should allow areas for the dentist and for the dental nurse.
- The dentist requires ease of access to the turbines, 3 in 1 syringe, slow handpiece, bracket table, operating light and an elbow- or foot-operated hand washing sink.
- The dental nurse requires ease of access to the suction line, the 3 in 1 syringe, curing light and the cabinetry containing the dental materials, in addition to an elbow- or foot-operated sink.
- A designated area for clinical waste.
- Within these areas the design should facilitate a workflow from clean to dirty.
- The work surfaces should be seamless and remain clutter free, with covered ends that prevent the accumulation of contaminated material and facilitate cleaning.
- Ideally the decontamination of dental instruments should take place in a designated room within the practice. Where this is not possible a recognised separate area that is away from the dentist's clean area of the surgery is required. The decontamination room/area should include two deep sinks, ultrasonic cleaner and/or washer/disinfector, autoclave and mechanical handpiece maintenance system. A separate hand washing sink is required in the designated decontamination room.
- Flooring must be washable, impervious, non-slip and be seamless or have sealed seams. The flooring must continue up the wall to cover the junction between the floor and the wall. The floor should not allow pooling of liquids and should be impervious to fluids.
- During dental procedures aerosol and environmental contamination can be limited by ensuring that the surgery is well ventilated, preferably by mechanical means. Ventilation systems require regular maintenance and cleaning as advised by the manufacturer, and a record of maintenance and repairs should be kept. Avoid free-standing fans as these merely circulate aerosols around the surgery.

Room Size

A dental surgery should be of sufficient size to allow easy access to the dental chair without hindrance when performing a procedure for both the dentist and the nurse. There should be no trip hazards for patient or staff. A typical sized surgery is about 17 m^2.

Treatment Zone

The highest level of cleaning must be applied to the treatment zone in which instruments and materials are placed. The treatment zone will vary for each surgery but usually it includes the bracket top or cart top and/or surrounding worktop space. It is best practice to mark this area with tape, to highlight the treatment area.

Surfaces of the treatment zone must be disinfected at the start of the day, between each patient and at the end of the day. Sterile materials and instruments should be placed in this zone only. The bracket table or cart top can be covered with a sterile tray for instruments and the worktop can be disinfected or given a sterile cover for each patient.

Treatment Fringe

Instruments which need to be disinfected between each patient, e.g. handpieces, x-ray machines, operating light, suction hoses, spittoon, buttons to move the chair, and taps at the sink, are used within the treatment fringe.

Rest of the Room

This is the non-clinical area of the surgery which is unlikely to come into contact with the patient's body fluids. Contamination of these areas can be minimised by good surgery ventilation which will reduce the presence of aerosols.

Health Technical Memorandum

The introduction of the Health Technical Memorandum (HTM 01/05) Decontamination (DH, 2009) had a major impact for all dental practices within the UK. This was superseded by Health Technical Memorandum 01-05 (DH, 2013b) that reflects the consensus on patient safety in the area of storage of dental instruments.

It is recognised that potentially infectious recontamination of sterilised dental instruments is event-related rather than time-dependent. Within dental practices, there is a rapid turnaround of the most regularly used dental instruments.

Dental instruments are used in contaminated body areas. Any environmental contamination that takes

place would have a minimal impact on patient safety compared with contamination with another patient's blood or body fluid, which would be a significant hazard to patients. Thus, the emphasis is on ensuring effective decontamination and preventing contamination with another patient's blood and body fluid rather than on preventing environmental contamination of sterilised instruments.

The guidance document has also been updated to reflect the changes to the NHS infrastructure following the Health and Social Care Act 2012 (DH, 2013b).

This document is a guide for those conducting decontamination at a local level – that is, within the dental practice itself. However, this policy statement respects the option to transfer instruments/medical devices to other organisations for reprocessing under the Medical Devices Regulations 2002 (DH, 2013b).

Best Practice Requirements

These include:

- Installing a modern validated washer/disinfector of adequate capacity to remove the need for manual washing.
- The use of a decontamination room or rooms to provide more complete separation from other work activities, enhancing the distinction between clean and dirty workflows. Access should be restricted to those staff performing decontamination duties.
- Suitable instrument storage away from the surgery to reduce exposure to air and possible pathogenic contamination. Systems should ensure instruments are easily identified for selection and are used on a first-in, first-out principle within the recommended time frames.

References

Department of Health (DH). (2013a) Health Technical Memorandum 07-01 (HTM 01-07). Safe Management of Healthcare Waste. London: Department of Health. Available from: https://www.gov.uk/government/publications/guidance-on-the-safe-management-of-healthcare-waste (accessed 5th July, 2017).

Department of Health (DH). (2013b) Health Technical Memorandum 01-05 (HTM 01-05). Decontamination in Primary Care Dental Practices. London: Department of Health. Available from: https://www.gov.uk/government/publications/decontamination-in-primary-care-dental-practices (accessed 5th July, 2017).

Department of Health (DH). (2015) The Health and Social Care Act 2008: code of practice on the prevention and control of infections and related guidance. London: Department of Health. Available from: https://www.gov.uk/government/publications/the-health-and-social-care-act-2008-code-of-practice-on-the-prevention-and-control-of-infections-and-related-guidance (accessed 5th July, 2017).

Handwashing Liaison Group (1999) Handwashing: a modest measure – with big effects. British Medical Journal 318:686.

Health and Safety Executive (HSE). Personal Protection Equipment. London: HSE. Available from: http://www.hse.gov.uk/toolbox/ppe.htm (accessed 5th July, 2017).

Medical Devices Agency. (2002) Guidance in Decontamination from the Microbiology Advisory Committee to the Department of Health. London: Medical Devices Agency.

Public Health England. (2014) The management of HIV infected healthcare workers who perform exposure prone procedures: updated guidance. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/333018/Management_of_HIV_infected_Healthcare_Workers_guidance_January_2014.pdf (accessed 5th July, 2017).

Ulrich, R.S. (1999) A theory of supportive design for healthcare facilities. Available from: https://www.researchgate.net/publication/12761803_A_theory_of_supportive_design_for_healthcare_facilities (accessed 5th July, 2017).

World Health Organization. (2007) A safer future: global public health security in the 21st century. Geneva: World Health Organization.

Further Reading

British Dental Association. (2015) Infection Control (England, Northern Ireland, Scotland and Wales), London: British Dental Association.

Care Quality Commission. (2010) Essential Standards of Quality and Safety. London: CQC. https://services.cqc.org.uk/sites/default/files/gac_-_dec_2011_update.pdf (accessed 5th July, 2017).

4

Communicating With Patients

Koula Asimakopoulou, Tim Newton, Sasha Scambler and Suzanne Scott

Introduction

This chapter will provide you with an understanding of why good communication is important in dental settings by:

- Considering theoretical models of communication and health behaviour, which have attempted to explain who is responsible for communication in the dental environment and the purpose of communication.
- Describing the basic principles underpinning good clinical communication skills.
- Breaking down the components of verbal, paralinguistic and non-verbal communication.
- Describing a tool used to measure communication skills in the dental surgery.
- Describing a simple communication method used to change behaviour in healthcare settings in day to day practice.

Objectives

When you have read this chapter you should be able to:

- Explain some of the features underlying communication in healthcare settings.
- Describe some models of health communication.
- List some of the key verbal, non-verbal and paralinguistic skills that are important in good dentist–patient communication and note ways in which these can be assessed.
- Describe some of the processes involved in giving patients bad news.
- Outline the role of motivational interviewing in helping patients change their oral health behaviour.

What Is Communication?

Communication is the process of imparting and sharing information. Some communication theorists describe communication in terms of a sender (i.e. the person emitting the information), a receiver (i.e. the person for which the information is meant), and a channel through which such information might be transferred (e.g. a consultation).

We usually communicate in more ways than simple verbal utterances and frequently with more than one recipient at the same time. Often, it is not really what we say, but the way we say it that tells (or fails to tell) the recipient what we have in mind. Gestures, posture, pitch, eye contact and proximity are only some of the factors that might help recipients interpret any verbal statements we make. Laughing at someone's joke tells the person you enjoyed listening to it. Not laughing when laughter is expected will also convey a message.

We propose that communication is the transfer of information between senders and receivers, using one or several channels, settings, verbal and non-verbal cues, all of which may contribute differently to the outcomes of the communication event.

The Purpose of Communication in Healthcare Settings

Ong et al. (1995) suggest that there are three purposes behind communication between doctors and patients. These are:

- Creating a good interpersonal relationship.
- Exchanging information.
- Making treatment-related decisions.

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

Only one third of the process of a successful consultation involves talking about treatment. According to Ong et al., the main functions of a consultation between healthcare practitioners (HCPs) and patients are to create a good interpersonal relationship and exchange information. It is those two processes that will help frame the part of the consultation that involves offering the patient treatment. In other words, it could be argued that it is pointless to offer the patient treatment options and involve them in relevant treatment-related decisions unless the dentist has created a relationship that is conducive to such an exchange. Exchanging information, in a manner which the patient can understand and engage with, is also an important factor of a successful consultation.

It must be noted that Ong et al. primarily described doctor–patient, rather than dentist–patient communication. It could be rightly suggested that consultations taking place in dental settings are quite different from those happening in medical settings. As Newton and Brenneman (1999) note:

- The general dental practice setting involves much more treatment than any medical encounter.
- During inspection of the oral cavity, verbal communication is compromised.
- Patients visiting a dentist are much more likely to be anxious than patients visiting a general medical practitioner.

As a result, findings from the medical setting literature may not be directly transferable to a dental setting. At the same time, we argue that dental clinical examinations and consultations do not happen in a vacuum; dentists work on people's dentition, but to the extent to which the oral cavity resides within the person, a more holistic view of the consultation is necessary. In this sense, and given the paucity of research findings which have arisen from work in dental settings, we take the view that medical encounter setting findings, such as Ong et al.'s suggestions about the purposes behind HCP–patient communication, are applicable here.

Models of Communication in Healthcare Settings

The extent to which HCPs engage with the consultation process along the lines proposed by Ong et al. (1995) will often be determined by the way HCPs see the positions that they and their patients occupy within the health system. Positions here have to do with concepts such as responsibility and power, i.e. deciding who has the most responsibility and/or power in a healthcare consultation. It is proposed that patients' and HCPs' inherent models of 'who should do what', or in other words, the different roles that patients and HCPs occupy within the surgery, will influence what gets communicated and how information is conveyed.

Researchers such as Roter and Hall (2004) identified four different HCP–patient communication relationships that might explain how information is communicated in healthcare settings and by whom. Conceived in terms of who is responsible for communication in the dental surgery, they correspond to the following four models:

1) *The 'traditional' medical model.* This model proposes that the dentist knows what is best for the patient. The patient is seen to be a passive recipient of care whose role is to listen to the expert HCP and where patients are expected to do what the dentist tells them to do. The dentist's role is that of an expert clinician; they know what is best in terms of dental care, have the knowledge and skills to deliver it, and are in a strong position to be an authority figure within their surgery. In this model, patient responsibility for the communication is low, whilst the dentist carries all of that responsibility.
2) *The 'patient as expert' model.* Here it is proposed that although dentists might be technical experts, what is important is the expertise of the person presenting with the health problem. In this model, patients are perceived as experts in their condition. This expertise arises from the fact that it is patients rather than dentists who have lived with the health problem and will have to live with the treatment consequences. They know what symptoms they are experiencing, how severe these are and what impact they have on their daily lives. They also know how well or not they can live with any treatment side effects and consequences. Because of this expertise that, according to the model, only the patient possesses and can communicate, it is patients rather than dentists who should be responsible for leading the communication in the consultation. In this model, clinician responsibility for communication is low.
3) *The consumerist model.* As the name would suggest, the dental surgery and the consultation are seen as a market place, with the dentist providing services for sale and the patient being the potential consumer of such services. In this model, dental care is seen as a service that is purchased by a patient who is predominantly a consumer. As such, it is the patient-purchaser who is primarily responsible for the verbal exchange during such a sale of goods and services, whilst the dentist has a more passive role.
4) *The transformed medical model.* This approach sees both dentists and patients as experts, albeit in different fields. The model acknowledges that dentists are

technical experts who have the knowledge and skills to deliver expert healthcare. On the other hand, patients are seen as experts in their own life, their symptoms and the impact of those symptoms on their oral health. It is therefore proposed that patients can inform the consultation by bringing in information which will help the expert technician fit the clinical service they are about to provide to that particular patient, with their particular anxieties, feelings and activities of daily living. In this model, patients and dentists are seen as equals where expertise and knowledge from both parties need to be combined in order to ensure that the work delivered will meet the psychosocial and clinical needs of the person seeking it. Here, responsibility for the communication episode is shared between HCP and patient.

Clearly there is not an 'one size fits all' model which dentists should all adopt for ever more. Things that are beyond a dentist's personal control, such as the length of time they are given to spend with patients (and the length of the queue in their waiting room!), the sort of patient they are treating (e.g. a middle class, middle-aged, professional as opposed to a working class, of limited education, elderly person with dementia and dental anxiety), the reason why they are seeing the patient (e.g. an urgent referral because the patient is in excruciating pain as opposed to a routine dental check-up) and the patient's experience of dentists and expectations of what their and the dentist's role might be in the surgery, might all constrain (or in some cases enable) the dentist's choice of a communication model. In fact, research work from the medical field (see Asimakopoulou (2007) and Newton and Asimakopoulou (2008)) has highlighted the dangers of advocating that any model applied in a 'one size fits all' approach is best for patients.

Some limited but illustrative evidence from the dental field further supports the idea that patient participation in a dental visit is not as straightforward as these models would suggest. In a recent Dutch study with emergency dental patients, patient participation during the dental consultation was examined in a naturalistic setting (Schouten, Hoogstraten and Eijkman, 2003). Eighty-three dental patients receiving emergency dental care had their consultations videotaped. Numerous variables were assessed to include the dentist's communicative behaviour (i.e. the dentist's verbal behaviour during the opening phase of the consultation, during examination and treatment and finally at the closing stage of the session), the number and type of questions the patient asked and the patient's self-reported desire for information and wish to participate in the consultation. The findings were interesting and resembled those seen in medical settings. What was found was that although patients expressed the need for more information about their dental treatment, this wish was not translated into an increased number of questions being asked of the dentist. The medical settings communication literature tells a similar story; it is often the case that most patients want answers to several questions, yet they do not feel able or willing to ask these questions themselves! In the Schouten et al. study, it was found that although patients self-reported that they wished to participate in the decision-making process about dental treatment, they also said that they felt more comfortable handing over responsibility for problem-focused decision-making regarding their treatment to their dentist. So, it would appear that some participation is something that patients appreciate; however, when it comes to important decisions about treatment, they expect responsibility to be passed back onto their treating dentist.

Dentist–Patient Communication: Basic Components and their Assessment

Work from medical settings has been helpful in shaping our understanding of the sort of communication behaviours that take place in a consultation between HCPs and patients. On a general level, Roter and Hall (1989) describe two sorts of tasks that HCPs undertake in successful communication encounters in healthcare settings. These are what they broadly describe as 'instrumental tasks" and, second, 'socio-emotional tasks'. Both are seen as equally important if communication between HCPs and patients is going to be effective.

As one would expect, 'instrumental tasks' have to do with the basic instruments HCPs use when they communicate. Giving patients information, for example, is one of them. Asking patients questions and answering theirs is another example. Conversation that is designed to convey to the patient that the HCP is technically competent is the final type of instrumental task in the Roter and Hall model. Alongside instrumental tasks, these researchers argue that there are tasks whose aim is to look after the psychosocial aspects of the communication encounter. These are the sorts of things dentists might say in order to build a partnership with a patient; things like making social conversation, often at the start of the consultation; giving some positive talk about things patients have done well since you last saw them; and finally showing them that over and above being a dentist, the person about to treat them is also, generally, interpersonally competent. These 'socio-emotional tasks' are some of the behaviours that Roter and Hall suggest are as important as 'instrumental' activities in ensuring a successful communication encounter.

Although Roter and Hall have suggested this dichotomy of breaking down tasks in any communication encounter, numerous additional research papers have been written on the subject. The question of what should be the primary purpose of a consultation in particular has attracted a lot of attention, especially in the medical literature. For example, researchers have looked at medical consultations as a function of the HCP demographics such as gender, age, experience and so on, and how these influence whether the consultation is consultative (patient-centred) or directive (physician-led). Possible interactions between HCP communication styles and patient characteristics have also been investigated. The resulting effects of the combination of these factors on patient outcomes, such as satisfaction with the consultation and adherence to HCP advice, have also attracted a lot of attention. The general message seems to be that, quite unsurprisingly, male and female practitioners seem to approach the medical consultation differently. This difference is said to affect how patients respond to them, how satisfied they are and how well they adhere to medical recommendations.

Roter and Hall (2004) have written a detailed, critical review on the extent to which a HCP's gender might be related to how patient-centred a consultation might be. They combined the results of two meta-analytic reviews on the effects of HCP gender on communication in medical encounters. They found that female HCPs' consultations were longer than those of their male counterparts by about 2 minutes. During that time, female HCPs were said to perform more of those behaviours that are typically considered patient-centred. They asked more psychosocial questions, engaged in more active partnership behaviours (that is, behaviours to suggest that HCP and patient are equal partners) and more positive talk, and a lot of their consultation was focused on how patients felt. In return, these HCPs' patients were found to be speaking more than those treated by male practitioners, and disclosing more biomedical and psychosocial information about themselves.

So it would appear that a consultative, patient-centred, socio-emotional centred consultation, usually favoured by female HCPs, leads to patients being more talkative and disclosing more about themselves. This is not necessarily a positive outcome though. There is no convincing evidence as yet that patients are always happier having been through a consultative rather than a directive consultation. There is also no unequivocal evidence that patients will leave the consultation and adhere to a greater extent to medical advice when they have experienced a more satisfying consultation in the healthcare setting. For example, whereas some researchers have shown that a highly directive style on the part of the physician can enhance patient satisfaction (e.g. Savage and Armstrong, 1990), others (e.g. Bradley, Sparks and Nesdale, 2001) have argued the exact opposite, i.e. that it is consultative communication styles are seen as more satisfactory by patients. For example, Swenson et al. (2004)interviewed 250 adult patients who had viewed video clips of consultations that were either patient-centred or highly doctor-led. A third of these patients preferred a directive style. Amongst other predictors, older patients and those who described their own doctor as directive were more likely to prefer a directive consultation style. Directive doctors were also rated as more to the point and knowledgeable. At the moment, there is no one consultation style universally favoured by patients and which leads to elevated levels of patient satisfaction and adherence.

The picture is equally unclear in findings arising from research in dental settings. We know that female patients, older patients and patients who score low on neuroticism (that is, a measure of anxiety) tend to rate their dentist more highly in terms of how satisfied they are with the consultation, than others (Newton and Brenneman, 1999). The same authors also report evidence to show that patients tend to prefer an authoritative and more experienced dentist. At the same time, research work shows that patients are more satisfied when they are given a degree of choice in terms of the treatment they receive.

In some now fairly dated but nevertheless relevant research, Lefer, Pleasure and Rosenthal (1962) compared two groups of denture patients. Group A were offered a choice of either an individualised set of dentures made especially for them, or an 'average' set of dentures made to fit most people. Group B were not offered a choice but were given a set of individualised dentures made especially for them. The group given a choice of denture (Group A) were not only more satisfied with their dentures but also less likely to complain about them or refuse to wear them. This was despite the fact that most of Group A chose the 'average' set.

It would appear that there is no clear-cut evidence here to help one decide the sort of communication style that any patient would find best in any dental setting. Nevertheless, work has been carried out to show what kind of behaviours might be typical in a dentist–patient communication. If, rather than trying to prescribe what should go on in a dental surgery, we knew what communication episodes *routinely* take place in practice, we might be able perhaps to start assessing their frequency of occurrence and start observing them, recording them and trying to find out which work best, and under what circumstances. In doing so, we could start making predictions about what patterns of consultation seem to be predicting outcomes such as satisfaction with the dental consultation and adherence to oral health advice.

Newton and Brenneman's (1999) work in this respect is particularly important.

Building on Newton's (1995) theoretical model of dentist–patient communication which sees the latter as consisting of three broad stages (opening, examination/treatment and closing), Newton and Brenneman developed a measure to assess communication in the dental surgery. Known as the Communication in Dental Settings Scale (CDSS), the measure seeks to assess components of the dentist–patient communication separately for each of the three stages of the consultation as identified by Newton (1995).

There are 13 separate communication behaviours assessed by the questionnaire, scored on a Likert scale from 'Unacceptable' (scoring 0) to 'Good' (scoring 3) with 1 and 2 used to indicate 'Poor' and 'Acceptable' performance respectively. Total scores range from 0 to 39 with a higher total indicating better communication. The authors provide detailed guidance on how observers should allocate these points to each communication component, taking the view that a more patient-centred style is preferable. For example, where the dentist is assessed on discussing treatment options and plans, a dentist who was prescriptive, never involved the patient and never offered treatment alternatives would score 0, whereas a dentist who discussed treatment plans and options, considered the pros and cons of each and actively involved the patient in forming a final decision would score the maximum score of 3.

The list of behaviours assessed by the CDSS appears in Box 4.1. The scale has been tested and found to be both reliable and valid for use in clinical dental settings. As such, not only does it serve as a useful tool in breaking down the dentist–patient consultation into distinct tasks, it also offers a useful way to formally assess communication skills in dental settings.

Box 4.1 Components of the CDSS, per consultation stage.

Opening phase

1) Patient greeting
2) Establishes rapport with patient
3) Identifies the patient's problem
4) Identifies related problems

Examination and treatment

5) Puts patient at ease
6) Clarifies patient's problem
7) Discusses treatment options/plan
8) Determines action plan
9) Offers preventive advice/information
10) Checks patient understanding of the information

Closing phase

11) Summarises consultation
12) Checks patient understanding
13) Closes consultation

Verbal, Paralinguistic and Non-Verbal Communication

As can be seen, communication in healthcare settings is a far from straightforward topic to describe and evaluate. In an attempt to understand the topic better, researchers interested in communication often break down the topic into three subtopics. These examine:

1) The exchanged utterances, in other words, what gets said. This is broadly termed 'verbal communication'.
2) Those aspects of speech that are not words but which convey information, such as tone of voice, confirmatory noises. These aspects of the communication event are called 'paralinguistic communication'.
3) The behaviours and environmental factors that contribute to a communication event but are not actual words and yet people often interpret without conscious awareness. These aspects are studied under the term 'non-verbal communication'.

The next section shows that some verbal, paralinguistic and non-verbal behaviours are more helpful than others in supporting a directive or consultative style respectively.

Verbal Communication

Verbal communication refers to the actual words that are used and can be broken down into three communication subtypes.

1) Information seeking.
2) Information provision.
3) Aids to dentist and patient understanding.

The first category has to do with questions that aim to elicit information from the patient. As such, these questions can be 'open' (e.g. 'How are you?'), 'focused' (e.g. 'What sort of pain is it?') or 'closed' (e.g. 'Do you brush every day?'). Open questions allow maximum scope for the patient to engage with the HCP as they do not in any obvious way restrict what information the patient delivers. Closed questions, on the other hand, invite either a 'Yes' or a 'No' response and as such are highly directive; here, patient involvement is limited in that the sort of information they offer has already been pre-defined by the person asking the question. Focused questions are something like a happy medium where although the patient is allowed some leeway in how much information they convey to their dentist, the dentist has limited the conversation to a specific topic. Obviously, there is a time and place for each; it is not proposed that only open

questions ever get asked and that patients are never directed. However, some questions (e.g. open) are more suited to some stages of the consultation (e.g. the opening phase) than others.

Interestingly, there are three more categories of question that are relevant when considering verbal communication issues, mainly because they are best avoided at all times. These are: leading questions, i.e. questions that imply a specific answer ('You don't really floss twice a day do you?'); compound questions, which ask more than one question in one and can potentially confuse the patient (and the dentist!) ('Do you brush and floss daily?' – where an answer of 'Yes' could be said to apply to one but not the other of the two behaviours that are enquired about); and, finally, questions that contain jargon (e.g. 'You seem to be showing the typical symptomatology of chronic periodontitis to me, what do you think?').

The second category of verbal communication behaviour involves the dentist providing information. Information provision is not a simple matter of telling patients what a dentist believes patients should know. Bombarding patients with information in the forlorn hope they might remember it is unlikely to contribute to a collaborative consultation. Research has shown us that most patients quickly forget the vast majority of what HCPs tell them (e.g. Kessels, 2003). So, for information provision to be effective, it should be tailored to the specific patient's needs and wishes for information.

There are generally four stages that are involved in the process of giving information. Showing empathy/understanding is the first stage. Normally, people quickly dismiss information they are given unless the source of the information is one they trust, like and feel confident about. Showing empathy and understanding is likely to put the dentist in a situation where their patient is more likely to want to listen to what they have to say rather than if they perceive the dentist as an indifferent professional with no time for them.

The second stage of the process involves finding out what the patient already knows. Research into human memory tells us that people are more likely to remember information if (i) it makes sense to them and (ii) it fits in with what they already know. Finding out what patients already know is thus helpful in that it helps HCPs 'pitch' the new information at an appropriate level. A second obvious advantage is that it helps HCPs to avoid telling patients things they already know (hence wasting both the patient's and their own time). A third positive outcome of checking how much patients know first is that it gives dentists the chance to correct any misconceptions patients may have by establishing whether what they know already is accurate or not.

Giving information in a few small chunks is another useful skill. It is generally advisable to break down the information that needs to be delivered whilst at the same time telling the patient that this is what the dentist is doing. Long narratives and explanations are generally not helpful when giving information. Categorising the information about to be given and signposting on the other hand ('there are three important things I would like to tell you. Firstly…') build on the well-researched and evidenced principle that people find it easier to remember a limited number (normally no more than five) of information chunks at any one time. Chunking is thus likely to help patients recall the information later. Although chunking is a useful strategy, it must be stressed that an important aspect of information provision is to ensure that the information delivered matches the needs for information of each patient. Clearly, a highly educated, professional adult will have different information expectations and needs to a toddler; as such, chunking techniques will need to be adapted to one's audience.

The final stage of the information giving sequence is to check patient understanding. This sounds easier than it actually is in practice; essentially, the dentist's task is to test the patient's understanding which, in some cases (e.g. where the patient has fully understood), can appear to be quite patronising. This is one of those skills where the more one practises the better one is likely to become at it. A technique that is often used is to ask patients to re-state in their own words the information they have been given, as if they were telling a friend. This will again need to be adapted, to match the intellectual level of the patient the dentist is working with and their respective information needs.

The final category of verbal communication that this chapter will consider has to do with ways in which dentists can aid both their own and their patient's understanding. There are two ways in which the understanding of what is being said can be enhanced.

Paraphrasing is a useful technique often used to clarify or interpret what patients say. The way that this is accomplished is by simply using slightly different words to reiterate what has been said already, to check that what has been conveyed is actually true. For example, where a patient might complain 'I know I should brush but I don't because brushing makes my gums bleed' the dentist might paraphrase this with 'You are having trouble brushing because when you do, you find that your gums bleed and this worries you'. Where this paraphrasing takes place on the part of the dentist, what is conveyed is that (i) the dentist understands that the patient's gums bleed when they brush, that (ii) this is the main reason why they do not brush, and (iii) that the patient is worried about it. By paraphrasing, not only is the dentist conveying to the patient that they have indeed listened and understood, but they are also giving them another

chance to comment more fully (and thus disclose more, possibly helpful, information) on what they have said.

A second way to aid understanding is by offering patients a summary of what has been discussed in the consultation. Good summaries are selective; the point is not to objectively sum up everything that has been said, but to put together a few important signposts regarding those points of the consultation that the dentist would like the patient to take away from their verbal exchange.

This section has outlined some of the basic principles of effective verbal communication. It is not meant to be prescriptive or exhaustive but hopefully it should have alerted the reader to some of the ways in which verbal communication with patients can be enhanced.

Paralinguistic and Non-Verbal Communication

This section outlines some of those communication behaviours that supplement verbal communication and can either aid or hinder a collaborative or consultative style of communication. Things like the dentist's vocal cues (e.g. tone, pitch, rate, volume, silence, effect and responsiveness) and confirmatory noises (e.g. 'hmmm', 'aha') convey to patients important information about the type of communication episode between them and the dentist. The dentist's posture (e.g. whether they speak to their patient while they are lying flat on a chair while the dentist is standing), the dentist's facial expression (e.g. raised eyebrows, smiles, frowns), the amount of eye contact, the amount of physical space between them and the patient, as well as environmental features such as furniture placement, lighting and so on, will all give patients ideas about the sort of dentist one might be as well as what the dentist's expectations are about the way patients behave in their surgery.

It is long established that patients make judgements on the technical ability of dentists based on the appearance of the dental surgery. In an experimental study, respondents were more likely to rate as clinically competent a dentist whose surgery appeared modern and clean. This effect interacted with age where it was particularly strong if the dentist was young. Older dentists were assumed to have experience, which made up for their inadequate facilities, but a young dentist in an old-fashioned surgery was viewed as most incompetent.

It would appear that patients not only read a lot into what dentists tell them, but also into how and where they convey the information.

Special Issues in Communication: Giving Bad News

It might be the case that on some occasions during their professional career, dentists will be faced with a situation where they have to give their patients bad news. What patients interpret as bad news is likely to vary between patients, but generally things such as telling them they are going to lose one or more of their teeth, or that they require surgery to remove a lesion, or that the dentist has discovered symptoms that are suggestive of some systemic condition, for example oral cancer, are some of the instances that might reasonably be classified as 'bad news'. How patients take the bad news will, obviously, depend very much on the patient's predisposition. However, the way the news is communicated by the dentist is also likely to be extremely important in terms of the impact it will have.

Five key communication tasks, which might involve giving patients potentially 'bad news', are as follows:

- Screening for disease and communicating risk.
- Communicating a negative diagnosis.
- Providing information about treatment and pretreatment.
- Communicating following treatment and dealing with fear of recurrence.
- Discussing the end of life in diseases such as head and neck cancer.

In performing these specific communication tasks, the HCP draws upon a range of key communication skills common to all situations, using their expertise and experience to blend those skills in order to address the needs of the patient. The next section provides a brief overview of each communication situation, with specific reference to head and neck cancer.

Key Communication Skills

As the chapter has highlighted already, it is important to emphasise that effective healthcare communication incorporates not only medical information but also discussion of the patient's emotional and social wellbeing. As has also been discussed, it is important that the information provided is tailored to the patient's ability to understand; this element includes the issue of cultural sensitivity. For each patient, a key worker can be identified who they can contact for further information. This key worker can also act as a patient advocate, for example noting important choices and decisions the patient makes, and recalling them on behalf of the patient during the treatment process, since some patients may find it difficult to assert themselves in clinical encounters.

Screening for Disease and Communicating Risk

Individuals at high risk of developing oral disease require not only to be encouraged to change their behaviour, but also to have explained to them the purpose and possible outcomes of screening and the necessity to maintain

vigilance (Kiviniemi et al., 2009). In the case of screening for oral cancer, HCPs appear to be reluctant to inform patients that they are screening for cancer, and are reticent about discussing this possibility with patients (Scott et al., 2009). There is a need for the healthcare team to develop specific skills and willingness to engage in such discussions. The use of oral cancer leaflets has been found to be useful in this regard, as a facilitator of discussion (Humphris et al., 1999). Informing patients of their risk is complicated by the difficulty many people experience in understanding the mathematical concept of risk (Calman, 1996). Recently there has been much interest in designing more effective ways of presenting risk to patients, and a systematic review of this evidence suggests that personalised communications are more effective in promoting uptake of screening than generalised communications (Edwards et al., 2006). Healthcare professionals should be encouraged to address the issue of screening for oral cancer, and their patients' risk of developing head and neck cancer. Messages which are personalised to each patient and which are supported by written and visual materials appear to be of greater value than unsupported general information.

Communicating a Difficult Diagnosis

Giving bad news, while it may not be unexpected to the patient, will inevitably be distressing. The key principles of breaking bad news have been summarised as follows (McLauchlan, 1990; Newton and Fiske, 1999):

- Preparation. Ensure that there is sufficient time and privacy for the communication.
- Communicating the bad news.
  - State the news.
  - Elicit the response of the patient or carer or family member.
  - Deal with emotional response.
  - Ensure follow-up.
  - Arrange to meet with the patient or carer or family member.
- Discuss and review the situation both in terms of impact on the team and whether the communication could have been handled differently. What went well, what could be changed?

As noted earlier, patients are likely to recall only a small amount of the information that they are told at the initial diagnosis, and so a first consultation should focus on stating the news and dealing with that initial emotional response, while arranging a follow-up meeting or discussion by telephone within 1 or 2 days. Breaking bad news is difficult both for patient and HCP. Faulkner (1998) outlines a range of specific techniques to ensure that breaking bad news is done sensitively, and provides guidance on addressing the emotional response of patients and their carers as well as the healthcare team.

Individuals who have been given bad news are likely to need information in three main domains: the medical, the psychological and the social. Medical information will include the discussion of prognosis and treatment options. Marked emotional responses are possible and may be enduring. A simple technique to improve the identification of psychological distress would be to incorporate standardised psychological measures into the assessment of patients – typically either pencil and paper or computerised questionnaires (De Boer et al., 1999; Verdonck-de Leeuw et al., 2009). It is of course essential to discuss the findings of these with the patients. Where psychological distress is found, a stepped model of care is appropriate, with the most severe cases being referred for intensive psychological therapy (Pilling et al., 2009).

Providing Information about Treatment and Pretreatment

Evidence suggests that while patients are generally satisfied with the information they receive, communication in some areas could be improved. More specifically, this would appear to be the emotional and social domains. (Llewellyn, McGurk and Weinman, 2006; Chen et al., 2009).For example, Llewellyn and her colleagues (2006) suggest the need for tailored information for individuals with head and neck cancer concerning support groups, financial advice and the impact of treatment on ability to work, physical functioning and quality of life. Again, this may be facilitated by the use of structured assessment tools (Rogers, El-Sheika and Lowe, 2009).

Communicating Following Treatment and Dealing with Fear of Recurrence

For patients who have been diagnosed with head and neck cancer, there is a call for an active process of discussing and planning for the transition from patient to 'survivor' (Houlihan, 2009). Healthcare professionals can assist this by providing a detailed plan of follow-up. Fear of recurrence is common and distressing, and interventions aimed at using cognitive techniques to prevent patients from ruminating on the risks of recurrence have been shown to be effective, when coupled with provision of specific strategies to identify triggers for seeking help and support from the healthcare team (Hodges and Humphris, 2009; Humphris and Ozakinci, 2006).

Discussing End of Life

In discussing end of life options, it is of course important to assess the patient's level of knowledge and desired knowledge, both about the disease process in general

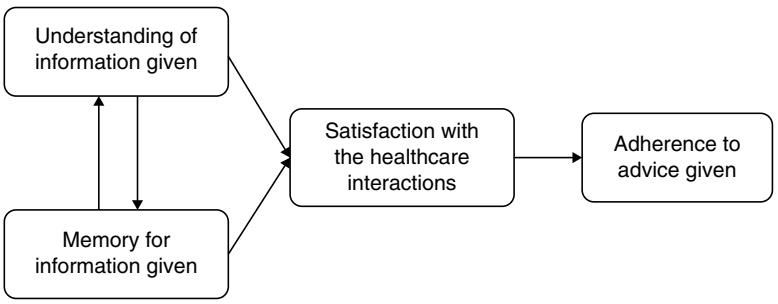


Figure 4.1 Ley's model of health behaviour.

and specifically the expected time to death. Jacobsen and Jackson (2009) provide a framework for understanding this process and examples of discussing these difficult topics. The components of a 'good death' have been suggested to be (Sciubba, 2009):

- Management of pain.
- Clear decision-making/reduction of the fear of pain.
- Preparation for death (funeral arrangements. wills, etc.).
- Completion or spirituality considerations.
- Contributing to others.
- Affirmation of the whole person.

Once the desires of the patient are known, these should be communicated with family, carers and other members of the healthcare team.

Special Issues in Communication: Motivating Behavioural Change

Often, dentists may find themselves talking to patients about oral health behaviours, or changes in their habitual, everyday behaviour such as snacking, with the ultimate aim to bring about change. In other words, dentists might often be engaged in giving people advice about changing their behaviour from one that is currently compromising their oral health, to one that, in their view, is going be beneficial for the patient's health. In this context, there is more to the communication episode than just giving information. What the dentist is probably also hoping is that patients will listen to, understand, remember and take away advice from the surgery and, ultimately, adhere to it.

Research in medical settings tells us that most patients visit their HCPs, listen to what they have to tell them and then walk away, not adhering to any of the advice they have received. Researchers in the field call this the problem of 'non-adherence'. A review of adherence studies published in the last 50 years (Di Matteo, 2004) estimated that of the approximate 760 million visits to healthcare providers that took place in the USA in 2000, around 200 million resulted in patients not following the advice they were given. On a wider societal level, patients who do not adhere to treatment and preventive regimens use up scarce health resources and deny others the opportunity to benefit from healthcare.

Non-adherence to health advice could be the result of several processes. The first one is motivation to adhere.

The following section will explore two aspects of motivation: first, changing the patient's beliefs and attitudes towards oral health and oral health related behaviour, and second, providing incentives for the patient to turn their positive beliefs and attitudes into action. The structure for this article will draw upon the work of Philip Ley, who outlined a model of the relationship between various psychological constructs and health-related behaviours. This model is shown in Figure 4.1.

This model proposes that the likelihood of an individual engaging in any particular healthy behaviour is related to three things: the patient's memory for the information, their understanding of the information, and their satisfaction with the interaction they have had with their healthcare staff. The rest of this section considers each of these three areas in turn. For each of these three broad areas some practical recommendations about how the dental team can improve patients' motivation will be made.

Improving Patients' Understanding of Healthy Behaviour

In order to follow advice given by healthcare staff, patients must first understand the information given. Patients often do not understand the meaning of words used by clinicians. Furthermore, patients may have their own ideas about illnesses and these may differ from the accepted orthodox ideas of HCPs. Where patients' ideas about illness differ from those of clinicians, patients will use their own framework of understanding to interpret the messages given. Thus it is important for the dental HCP to ascertain the patient's view of their illness and to correct any misconceptions which may be hampering the patient's motivation. For example, a patient may avoid brushing their teeth because when they do, their gums bleed. The patient interprets the bleeding as a bad sign. The dental practitioner, hygienist or other member of the dental team who understands the patient's misconception

can help the patient to correct their understanding. The positive aspects of the patient's view of illness can be built upon, so they do not feel they have been doing everything incorrectly, and create an impression where they feel that what they are doing is pretty good and just needs some tweaking here and there to be really effective.

When information is given to patients, misunderstandings may occur for two main reasons. The first is if it contains a lot of jargon which patients do not comprehend or there is excessive complexity and depth. Do patients really need to know the anatomy of the periodontium in order to improve their tooth brushing skills? Second, the general language and sentence structures used may not be understandable to patients.

Every profession has its own particular set of jargon and dentistry is no exception. There are several words and phrases which those of us who work in dentistry take for granted but which may not be understood by patients, for example:

- Periodontal disease.
- Gingiva.
- Plaque.
- Dental caries.

What proportion of the general population understands these terms? Some data collected among the patients at Guy's Hospital illustrate this. In Figure 4.2 it is shown that only a small proportion of patients understood these common terms.

Such confusions can occur even with such seemingly simple instructions as those given for taking medications. The dental HCP who is giving information should consider the best form of words to make the message understandable, and to consider simple ways of explaining jargon terms. Use the terms the patient uses to describe their oral conditions: gum disease, pyorrhoea, tooth decay, rotting teeth.

Aside from jargon, more generally the words and sentence structures used by HCPs may be more or less understandable. Short sentences containing words with few syllables are more understandable than sentences containing many polysyllabic words. In order to make our message clearer we need to make the sentences we use more understandable. This can be done in several ways:

- Use personal statements, for example 'I believe…' 'I think…'
- Avoid the passive voice.
- Keep sentences short.
- Avoid sub-clauses in sentences.

The content of the advice that is offered is also important. The public are becoming increasingly sceptical of advice health experts give because so much of it is conflicting or it changes. It is important that content is kept simple, scientifically sound, relevant and appropriate to the particular patient's oral health problem and concerns. The *Scientific Basis of Oral Health Education* (Levine, 2004) recommends the following key messages:

1) Reduce the frequency and quantity of consumption of food and drink containing sugars.
2) Clean your teeth twice a day with fluoride toothpaste.
3) Visit a dentist once a year.
4) Request your local water company to fluoridate the water supply to between 0.7 and 1 ppm.
5) Refrain from smoking.

Health education is a skill that requires as much learning and practice as any other activity in the dental surgery. Some dental HCPs are better at it than others and it is possible to improve one's skill. Good quality dental health education requires time and an appropriate environment. When the health education is provided is also important. Most

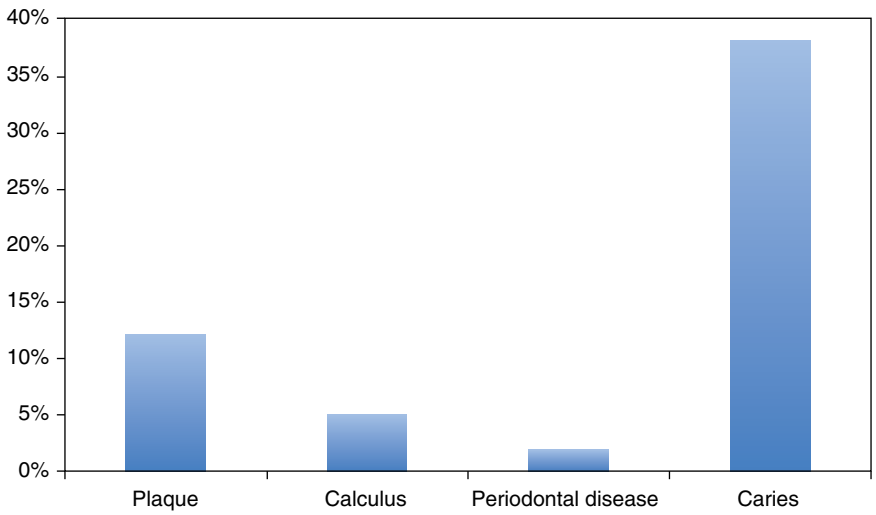


Figure 4.2 Graph showing the proportion of patients who correctly interpreted commonly used dental terms.

dentists take the opportunity to provide health education during a treatment appointment, but it might not always be the best atmosphere for the patient to be receptive to such advice. They may be anxious about the item of treatment they are going to receive, smells and clinical sounds.

Providing written information is one way in which to support the advice given to patients, and to ensure that they have understood it. In designing written materials it is important to note the following considerations:

- The readability of the materials designed for patients is immensely important. It is not hard to design materials that are easily readable – the readability of text can be checked in most word processing packages. To ensure that one's materials are widely accessible, it may be important that a low rather than a high level of readability is aimed at.
- The use of jargon should be considered carefully and complex detail should be avoided.
- Font size is another important aspect that will define how accessible one's reading materials are. The Royal National Institute for the Blind (RNIB) recommends 12-point text as a minimum for all written materials. Proportional spacing and non-justified text are features that will make the text physically easier to read. These issues are particularly important where many patients may be older adults who have difficulty reading small print.
- Quality of production (colour, use of photographs and illustrations). If the information given is produced in a high-quality format, it attracts the reader's attention and, as a result, can be more memorable.
- Quality of reproduction. Once a high quality of product has been prepared, it is important that the quality is maintained for all copies.
- It is important that key points are emphasised.
- It is suggested that involving patients and relatives in the design of leaflets might be a helpful activity. Patients and relatives are an invaluable resource for designing information because they will know what information they want to glean, and what is important to them. When patient materials are designed, it is important that some thought is given to the cultural and ethnic diversity of the reader. At all times, the materials need to be scientifically sound and age/condition-specific.

Improving Patients' Memory for Health Information

Once patients have been given information about the particular health behaviour(s) that the dental HCPs wish them to follow, it is important that the patients remember that information. As stated earlier, patients often forget much of what they are told. Surprisingly there is little relationship between the time that has elapsed from the giving of the information and its recall and how much information is recalled. That is to say, patients tend to remember what they are going to remember regardless of how long it is before they are asked to remember the information. Patients seem to remember best that information which they are told first and the information which they believe is the most important.

The next section offers several practical tips to improve patients' memory for healthcare advice:

1) Tell the patient the important points first. Patients remember best what they are told first. This is known as the primacy effect. It has been shown that using the primacy effect can increase recall of health information by up to 36%.
2) Let the patient know the most important points. Emphasise to the patient that information which is most important (this may increase recall by 13%).
3) Remember to make the message understandable. Making the message more understandable using the techniques outlined above can improve recall by 13%.
4) Categorise the information in an explicit manner to help the patient recall.
   Techniques which can be used include complex forms of categorisation, for example spider diagrams or other diagrammatic summaries; alternatively you could provide patients with mnemonic devices such as acronyms to help them recall particular points. Even simple categorisation can help to improve recall. For example, 'There are three points for you to remember…'.
5) Repeat important information.
6) Use specific statements rather than general statements. Making a message specific rather than general can improve recall of the message by up to 35%. For example, 'I would like you to keep your teeth cleaner' is general and provides the patient with only limited information about *how* they should go about changing their behaviour. This statement can be made more specific by stating more exactly what it is that the dentist would like the patient to do. For example, 'I would like you to do three things to help keep your mouth cleaner. First I want you to brush your teeth twice a day using the technique I showed you. Clean them for about 2 minutes each time. Try cleaning each section, bottom right, bottom left and so on for about 30 seconds each. Second I would like you to floss the gaps between your teeth twice a week, say once on Sunday and once on Wednesday. Third I would like you to rinse round your mouth with a mouthwash once a day in the morning after you have cleaned your teeth'.
7) Send out reminders. Telephone and email reminders for appointments may improve attendance by up to 17%. A phone call to let the patient know that they are expected the next day can reduce unexpected non-attendance and so decrease lost time and associated costs.

Improving Patients' Satisfaction with their Interactions with Healthcare Professionals

The key to improving patients' satisfaction with their HCP team lies in the interaction between the patient and the dental team. In the previous sections the importance of identifying the patient's understanding of their health and healthcare, and using specific communication techniques to improve patients' memory for healthcare information has been highlighted. In this section more general skills which have been demonstrated to be related to a good dentist–patient interaction are described.

A body of literature has identified the aspects of medical and dental consultations associated with the best outcome. These are summarised as follows:

1) Positive aspects.
   - Active listening.
   - Empathy.
   - Appropriate use of open questions.
   - Frequent summaries.
   - Clarification.
   - Negotiation of treatment plans.
   - Clear explanations.
   - Checking patient's understanding.
   - Checking patient's compliance with treatment.
2) Negative aspects.
   - Inappropriate use of closed questions.
   - Premature advice/reassurance.

The positive aspects are associated with a good outcome from the dentist–patient interaction – they are generally associated with patients feeling satisfied with their interactions with dental healthcare staff. The negative aspects are associated with dissatisfaction.

Active Listening

Although people generally believe that they are listening to somebody, it has been shown that generally we recall less than 25% of the information that we have been told. Active listening refers to a process where the individual listens and, at the same time, attempts to discern, interpret and summarise what the speaker is saying. This necessarily requires a great deal of attention on the part of the listener. This attention will be reflected in the body language and non-verbal communication of the listener. Active listening involves trying to understand a speaker's viewpoint and requires a degree of empathy on the part of the listener. Both active listening skills and empathy are related to patient satisfaction with the interview.

Empathy

Empathy refers to the feeling that the listener is making an effort to understand the situation from the speaker's point of view. Empathy may be conveyed in body language and tone of voice, and also in the way that the dental HCP talks about the patient's problems. A simple technique is to try to use the same phrases and words as the patient to describe the problem or difficulty they are facing. For example, if a patient talks about the difficulty of finding time to carry out oral hygiene routines, it is suggested that that framework is used to explore how they might improve their health related behaviour.

Check Compliance

Often dental healthcare staff assume that patients are following the oral health advice that has been given to them. It is a good idea to check the patient's progress in changing their behaviour. This should be done in a supportive environment which allows the patient to identify any problems they may have had. In this case, it is important that non-judgmental phrases such as 'How did you get on with…' or 'Did you find any particular problems with…' are used.

When patients are not following the advice they have been given, dentists can sometimes assume that they are not 'motivated'. It is important that one steps beyond this simple explanation and looks at the factors which might be causing the apparent non-compliance. There are two broad categories of reasons why patients may not follow health related advice: skills deficits and management deficits.

'Skills deficits' refers to those situations where a patient wants to follow the health related advice they have been given but simply lacks the knowledge or skill to perform the behaviour. In order to rectify such deficits the dental team should provide information and instruction to perfect the skill component. Techniques of observation and feedback are very effective in providing instruction. Written materials can support learning.

Management deficits are more complex. Here the patient understands what is required of them and has the requisite skills. However the patient finds it difficult to incorporate the behaviour change into their lifestyle, or difficult to maintain the behaviour change. It is akin to New Year resolutions. We have all made them, generally we know what to do to make the changes we have resolved to make, but it is difficult to maintain them. For management deficits the dental healthcare team need to adopt a different approach; this requires using the power of the environment to shape behaviour change.

Using the Power of the Environment

Much of our discussion to this point has focussed on changing patients' knowledge of and attitudes towards oral health related behaviours. The aim of this was to provide patients with information to encourage them to engage in these behaviours. This is an important component of motivation, what is generally described

as the 'cognitive' or 'thought' component of motivation. A second component refers to providing incentives for the individual to put these thoughts into action. We do this by producing an environment which is conducive to making the behavioural change. It is suggested that dental HCPs work with patients to plan how they will implement their behaviour changes. The plan should include the following:

- A specification of the goals that the patient and the dentist wish to achieve.
- A plan for the behaviour change.
- When to start.
- Opportunities to practise the new behaviour and perfect technique, e.g. tooth brushing or reading food and drink contents labels.
- A process of advising those close to the patient about the proposed change and a clear plan of how they will seek their support.
- A detailed plan of when and how the change will occur.
- A series of incentives for change.
- A plan to review progress and rectify problems.

Specifying Goals

The first step in planning any change in behaviour should be to specify goals. Working with patients to set goals, it is advisable that the set goals are:

- Short term.
- Realistic.
- Cumulative.
- Regularly reviewed.
- Valued by patients and important to them.
- Designed to address their concerns and needs.

Motivation is difficult to maintain, so it is better to set a target for a few weeks rather than a year, and to review progress regularly. In advising a patient to cut down on smoking it is more effective to set a target to cut down a little for a month, then to review, rather than to set a target to stop completely over the next year.

Goals should be realistic. Patients are unlikely to use floss every day, but setting a target of using floss once a week is achievable and an improvement if the patient has not been using floss at all before.

By successively modifying goals over time, the dental HCP can gradually build towards a significant goal.

Plan the Behaviour Change

Careful planning of any behaviour change will pay dividends, particularly if the behaviour change is likely to be significant not only for the individual patient but also their family and friends. For example, a patient who decides to quit smoking will require the support of family and friends.

Picking a significant date on which to start any behaviour change helps to highlight the importance of the change and will motivate the patient. It is important that dentists plan with the patient how the patient will carry out the details of the behaviour change. For example, if the dentist would like the patient to floss their teeth twice a week, it would help if the dentist thought through with the patient when the patient will have the time to do it. It is often a good idea to build in a reminder to prompt the patient, for example writing in their diary, or putting a chart in the bathroom cabinet.

Rewards or other tangible incentives can help support behaviour change, even if these are devised by the patient themselves. The advantages of changing health related behaviours are in general remote. If the patient cleans their teeth well they are likely to benefit over a period of years rather than weeks. By building more short-term incentives for behaviour change the dental team can help to motivate patients. This is particularly easy with child patients, where dentists are already accustomed to providing incentives with stickers and so on. However for adults it is probably best to let them decide on their own incentives.

Review Progress and Rectify Problems

Regular reviews of progress can themselves provide an incentive for change because patients are reminded of the changes they are supposed to be making. Reviews also provide the opportunity for identifying and rectifying problems. The common problems that occur in behaviour change are:

- Skills deficits.
- The goal is too difficult.
- The consequences of the behaviour are too far removed.
- 'Forgetting'.

Skills deficits are easily rectified through education and instruction. A common problem is to expect too great a behaviour change in a short time. The dental practitioner or other member of the dental team may negotiate behaviour change with their patient and then discover that the change did not occur. This may lead them to reject the notion of behaviour change and to describe the patient as 'lacking motivation'. But the problem may be that the change required was too big, and too difficult for the patient to make. When faced with a 'failure' at behaviour change, it is advisable to try breaking the behaviour change down into smaller steps. If the patient is finding it difficult to floss all their teeth then the dentist could ask them to floss only one or two for a few weeks, then once they have acquired the skill and incorporated flossing into their routine, to gradually increase the number of teeth they are required to floss. It is important to note

that the size of change that an individual can manage will show variation between people. It is suggested that dentists ought to tailor their approach to the particular patient and what he or she can manage.

For children in particular, the consequences or rewards for oral health related behaviours such as cleaning their teeth are too far removed to be realistic. Oral health behaviours are often ignored in favour of more immediately rewarding activities. Parents can be encouraged to make the consequences more immediate, for example making more favoured activities contingent on the less favoured activity(e.g. the child must clean their teeth before they are allowed to watch TV or have their bedtime story).

Much of people's behaviour is said to be driven by stimuli, sights and sounds, which tell people what actions to perform. Often people do o notice them. A common stimulus to human behaviour is time – it tells people when to get up, when to eat, when to go to work and so on. Forgetting to carry out an oral health related behaviour may result from the behaviour not being incorporated into the routine. It is important that dentists work with their patients to decide on a time and place when they will carry out the change. The power of environmental cues can be helpful in this case, to drive the behaviour change. This might also include introducing new stimuli to prompt. For example, wall charts or sticker charts can be provided for children.

Section Summary

We can motivate patients by providing them with knowledge and skills to carry out oral health related behaviours. This on its own is insufficient. We also need to create the conditions which make it easier for the patient to follow this advice. This can be achieved by encouraging patients to plan their behaviour change, through providing prompts or reminders which cue patients to engage in oral health related behaviours, and by providing tangible incentives for changing behaviour.

KEY POINTS

- Communication is a process that involves verbal and non-verbal/paralinguistic components
- Most of the ideas we have available in communication research in healthcare settings have been developed as a result of research in medical settings with very limited research in dental settings
- Communication varies depending on the communicators' ideas as to who is mainly responsible for decision-making in the dental surgery
- Giving bad news to patients is a process that consists of several distinct stages, each requiring different communication skills
- Motivational interviewing principles may be applicable in dental settings when attempting to guide patients towards behavioural change

References

Asimakopoulou, K.G. (2007) Empowerment in the self-management of diabetes: are we ready to test assumptions? European Diabetes Nursing 4(3):94–97.

Bradley, G., Sparks, B., Nesdale, D. (2001) Doctor communication style and patient outcomes: gender and age as moderators. Journal of Applied Social Psychology 31(8):1749–1773.

Calman, K.C. (1996) Cancer: Science and society and the communication of risk. British Medical Journal 313(7060):799–802.

Chen, S.C., Lai, Y.H., Liao, C.T., Chang, J.T., Lin, C.C. (2009) Unmet information needs and preference in newly diagnosed and surgically treated oral cavity cancer patients. Oral Oncology 45(11): 946–952.

De Boer, M.F., McCormick, L.K., Pruyn, J.F.A., Ryckman, R.M., van den Borne, B.W. (1999) Physical and psychosocial correlates of head and neck cancer: a review of the literature. Orolaryngology–Head and Neck Surgery 120(3):427–436.

DiMatteo, M.R. (2004) Variations in patients' adherence to medical recommendations: a quantitative review of 50 years of research. Medical Care 42(3):200–209.

Edwards, A.G.K., Evans, R., Dundon, J., Haigh, S., Hood, K., Elwyn, G.J. (2006) Personalised risk communication for informed decision making about taking screening tests. Cochrane Database of Systematic Reviews (4):CD001865.

Faulkner, A. (1998) ABC of palliative care: Communication with patients, families and other health care professionals. BMJ 316(7125):130–132.

Hodges, L.J., Humphris, G.M. (2009) Fear of recurrence and psychological distress in head and neck cancer patients and their carers. Psycho-Oncology 18(8):841–848.

Houlihan, N.G. (2009) Transitioning to cancer survivorship: plans of care. Oncology 23(8 Suppl): 42–48.

Humphris, G.M., Duncalf, M., Holt, D., Field, E.A. (1999)The experimental evaluation of an oral cancer information leaflet. Oral Oncology 35(6):575–582.

Humphris, G.M., Ozakinci, G. (2006) Psychological responses and support needs of patients following head and neck cancer. International Journal of Surgery 4(1):37–44.

Jacobsen, J., Jackson, V.A. (2009) A communication approach for oncologists: understanding patient coping and communicating about bad news, palliative care and hospice. Journal of the National Comprehensive Cancer Network 7(4):475–480.

Kessels, R.P.C. (2003) Patient's memory for medical information. Journal of the Royal Society of Medicine 96:219–222.

Kiviniemi, M.T., Hay, J.L., James, A.S., et al. (2009) Decision making about cancer screening: An assessment of the state of the science and a suggested research agenda from the ASPO Behavioural Oncology and Cancer Communication Special Interest Group. Cancer Epidemiology, Biomarkers & Prevention 18:3133–3137.

Lefer, L., Pleasure, M., Rosenthal, L. (1962) A psychiatric approach to the denture patient. Psychosomatic Research 6:199–207.

Levine, R. (2004) The scientific basis of oral health education. Community Dental Health 21:131–133.

Llewellyn, C.D., McGurk, M., Weinman, J. (2006) How satisfied are head and neck cancer (HNC) patients with the information they receive pre-treatment? Results from the satisfaction with cancer information profile (SCIP). Oral Oncology 42(7):726–734.

McLauchlan, C.A.J. (1990) ABC of major trauma: Handling distressed relatives and breaking bad news. British Medical Journal 301(6761):1145–1149.

Newton, J.T. (1995) Dentist/patient communication: a review. Dental update. 22(3):118–122.

Newton, J.T., Brenneman, D.L. (1999) Communication in Dental Settings Scale (CDSS): Preliminary development of a measure to assess communication in dental settings. British Journal of Health Psychology 4(3):277–284.

Newton, J.T., Fiske, J. (1999) Patient care: Breaking bad news: a guide for dental healthcare professionals. British Dental Journal 186(6):278–281.

Newton, P., Asimakopoulou, K.G. (2008) Response to Professor Anderson's commentary on Empowerment article by Asimakopoulou, K. European Diabetes Nursing 5(1):36.

Ong, L.M., de Haes, J.C., Hoos, A.M., Lammes, F.B. (1995) Doctor-patient communication: a review of the literature. Social Science & Medicine 40(7):903–918.

Pilling, S., Anderson, I., Goldberg, D., Meader, N., Taylor, C. (2009) Depression in adults, including those with a chronic physical health problem: summary of NICE guidance. British Medical Journal 339:b4108.

Rogers, S.N., El-Sheika, J., Lowe, D. (2009) The development of a Patients Concerns Inventory (PCI) to help reveal patients concerns in the head and neck clinic. Oral Oncology 45(7):555–561.

Roter, D.L., Hall, J.A. (1989) Studies of doctor-patient interaction. Annual Reviews 10:163–180.

Roter, D.L., Hall, J.A. (2004) Physician gender and patient-centered communication: a critical review of empirical research. Annual Review of Public Health 25(1):497–519.

Savage, R., Armstrong, D. (1990) Effect of a general practitioner's consulting style on patient satisfaction: a controlled study. British Medical Journal 301:968–970.

Schouten, B.C., Hoogstraten, J., Eijkman, M.A.J. (2003) Patient participation during dental consultations: the influence of patients' characteristics and dentists' behavior. Community Dentistry and Oral Epidemiology 31(5):368–377.

Sciubba, J.J. (2009) End of life considerations in the head and neck cancer patient. Oral Oncology 45(4-5):431–434.

Scott, S.E., Grunfeld, E.A., Auyeung, V., McGurk, M. (2009) Barriers and triggers to seeking help for potentially malignant oral symptoms: implications for interventions. Journal of Public Health Dentistry 69(1):34–40.

Swenson, S.L., Buell, S., Zettler, P., White, M., Ruston, D.C., Lo, B. (2004) Patient-centered communication. Journal of General Internal Medicine 19(11):1069–1079.

Verdonck-de Leeuw, I.M., de Bree, R., Keizer, A.L., et al. (2009) Computerized prospective screening for high levels of emotional distress in head and neck cancer patients and referral rate to psychosocial care. Oral Oncology 45(10):e129–e133.

Further Reading

Candlin, C.N., Hyland, K (2000) Writing: Texts, Processes and Practices. Taylor and Francis.

Ewles, L., Simnett, I. (1998) Promoting health: a practical guide. London: Scutari Press.

Humphris, G., Ling, M. (2000) Behavioural Sciences for Dentistry. Churchill Livingstone, Edinburgh.

This text provides an excellent introduction to the place of behavioural sciences in dentistry, including information on motivating patients.

Ley, P. (1988) Communicating with Patients. Croom Helm, London.

A good guide to the literature exploring patients' adherence to advice given by healthcare professionals.

Kent, G., Croucher, R. (1998) Achieving Oral Health. London: Wright.
Excellent introductory guide to the place of psychology in dentistry.

Miller, W.R., Rollnick, S.R. (2002) Motivational Interviewing. London: The Guildford Press.

Newton, T. (1995) Dentist/patient communication: A review. Dental Update 22:118–122.
An overview of the skills involved in dentist–patient communication and how these relate to patients' satisfaction with treatment as well as other health outcomes.

Newton, T. (1995) The readability and utility of general dental practice patient information leaflets. British Dental Journal 178:329–332.
Provides guidelines on devising written materials for patients.

Silverman, K., Kurtz, S., Draper, J. (1998) Skills for Communicating with Patients. Oxford: Radcliffe Medical Press.

Sondell, K., Solderfeldt, B. (1997) Dentist-patient communication: A review of relevant models. Acta Odontica Scandinavica 55:116–126.

5

Obtaining Valid Consent

Igor Blum, Rebecca Moazzez and Nikki Doyle

Introduction

Obtaining a patient's valid consent prior to any examination or the delivery of treatment is a fundamental aspect of the provision of dental care. Without a thorough understanding of the principles of gaining valid consent to investigations and/or treatment, dentists, therapists and hygienists may find themselves susceptible to legal repercussions, not least those of assault and/or negligence – which in turn could lead to criminal charges and/or civil claims. A growing number of complaints reported to the General Dental Council (GDC) and allegations against dentists in GDC fitness to practise investigations are focusing upon the subject of consent. However, more importantly, it is every patient's right to have a thorough understanding of what is going to happen to them, be agreeable to going ahead with what is suggested, and provide necessary and appropriate consent. If this is not carried out properly, with due consideration to the legal implications, the patient may not only lose trust in the dental professional involved but also the profession.

This chapter looks at recent changes in case law in relation to obtaining valid consent and considers key guidance on the subject of consent, including professional and clinical standards (Royal College of Surgeons of England, 2016), *Consent: Patients and Doctors Making Decisions Together* (General Medical Council (GMC), 2008), *Reference Guide to Consent for Examination or Treatment* (Department of Health, 2009), *Standards for the Dental Team* (GDC, 2013) and *Consent* (Dental Protection, 2015). It aims to offer dentists and other dental care professionals practical advice on how to meet the legal and regulatory requirements around the consent process and how to protect a patient's rights to make decisions about their treatment.

In addition, consideration is given to some of the key areas of note, while also offering practical and real-world advice. The chapter will briefly describe the process of consent in relation to clinical research. The intention is not to provide comprehensive information about the regulations related to consent across the UK, let alone elsewhere in the world, but merely to help the reader understand the principles, ethical as well as legal, that they need to consider in relation to consent. Readers are advised to find out about the regulations applicable to them locally and ensure they have a thorough understanding of the relevant regulations and their responsibilities.

Patient Autonomy

Respect for patients' autonomy is expressed in consent law; to impose care or treatment on people without respecting their wishes and right to self-determination is not only unethical, but illegal. Touching another person without permission is the definition of battery, so the patient's consent is a necessary step prior to starting any patient examination or treatment.

Update in Law in Relation to Consent

The law is continually changing and developing as the courts interpret both the common law and legislation. The doctrine of precedent means that judgements from a higher court will bind a lower court.

The *Montgomery* Case – a New Era of Consent in Dentistry?

The law in relation to consent has changed following the handing down of the Supreme Court judgement in Montgomery v Lanarkshire Health Board in March 2015. The *Montgomery* standard states that legally, clinicians, including dentists and other dental care professionals, must take now take reasonable care to ensure that

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

patients are aware of any risks that are material to them, and they should inform their patients of alternative treatments. Although this case has changed the law, it has simply brought the law into line with GDC standards (2013) that were already applicable when obtaining consent.

The concept in England and Wales was, therefore, until the case of Montgomery, that of the prudent dentist. When disclosing risks, what would a 'prudent dentist' explain to a patient? The answer, found in Bolam v Friern, was 'the information which a dentist in that situation would normally be expected to explain to a patient who needs that information'. However, the Montgomery case changed this and the Bolam principle no longer applies to the provision of information about risks of proposed treatment. It should be noted that the Bolam principle still applies in all other aspects of clinical practice apart from consent.

Material Risk

The perspective of the 'prudent dentist' needs to be balanced first against that of the 'prudent patient', that is, what would a normal patient of sound mind reasonably expect to know before being able to make a decision as to whether or not to proceed with the treatment? The Montgomery case emphasised the need to tailor information to the specific and individual needs and wishes of the patient before deciding whether or not to proceed with treatment. D'Cruz and Kaney's (2015) advice is that, '…it is prudent to get to know your patients so that you can discuss with them risks that any patient would want to know, plus any risks that you would consider would be relevant to the particular patient concerned'. This resolute move away from the paternalistic traditional model of consent towards a more patient-centred perspective requires a change in attitude from practitioners in discussions about consent, as they are no longer the sole arbiter of determining what risks are material to their patients. No treatment should ever be undertaken without giving the patient the opportunity to ask questions and/or raise any concerns or fears. An inadequate consent process can damage the dentist–patient relationship and result in legal challenges and litigation.

Assumptions about a patient – based on, perhaps, their appearance, religious beliefs, dental attendance patterns, disability, apparent inability to articulate their dental problem or the fact that they make a decision with which the practitioner disagrees – are unwise. You should not make assumptions regarding the wishes of a patient and what they might perceive as the best option available, perhaps resulting in restricted offers of options for treatment. Furthermore, you should not assume that the patient has the same set of values, wishes or life priorities as you would have in a similar situation. It should be acknowledged that the patient as an individual has his or her own views (Mills et al., 2014).

Informed Consent versus Valid Consent

The 2009 Department of Health England *Reference guidance to consent for examination or treatment* emphasises the term 'valid consent' rather than 'informed consent'.

Principle Three of the General Dental Council's 2013 Standards focuses on how to 'Obtain Valid Consent'.

So, what is the difference between informed consent and valid consent?

Traditionally, healthcare professionals have understood that merely providing a patient with information about what is going to happen to them and the patient then agreeing to give consent (i.e. informed consent), is enough to assume patient consent. Although the provision of information to the patient is an enormous part of the consent process, it should not be considered to be sufficient to be all that is required. Informed consent and valid consent should not be viewed on equal terms; informed consent is an element in the process of gaining valid consent.

The document *Consent: Supported Decision-Making – a good practice guide* published by The Royal College of Surgeons of England (2016) states that for consent to be valid, it must be:

- Given by a person with the capacity to make the decision in question.
- Given voluntarily.
- Based on appropriate information (informed) and understood.

If any of these factors are missing, the patient is not considered to have given valid consent and therefore has not granted permission to proceed to treatment.

It is the responsibility of the treating practitioner to assess the capacity of their patients to make decisions about their care. In this assessment, practitioners must comply with the Mental Capacity Act 2005 (England and Wales), the Adults with Incapacity (Scotland) Act 2000, and the Mental Capacity Act (Northern Ireland) 2016, including the Codes of Practice.

The consent must be continuous throughout each stage of examination or treatment and it must be understood by the patient as something that can be withheld or withdrawn even during treatment.

Practitioners must be satisfied that their patient has received and understood sufficient information about

their diagnosis, as well as the proposed treatment and its implications, to allow them to make a decision they deem to be in line with their own values and wishes.

Failure to Obtain Valid Consent

A significant proportion of clinical negligence claims are settled simply because valid consent was not obtained. In theory, where harm has befallen the patient and consent was not obtained, this could also give rise to claims for assault or battery and, in extreme cases, criminal charges, but fortunately this is exceptionally rare. Disregarding the GDC's standard on consent can result in charges of professional misconduct and action by the GDC on the dental registrant's registration.

Record Keeping

The signing of a consent form by a patient does not constitute proof that the consent was valid and is not sufficient evidence of validity in a court of law. If there is any dispute over whether valid consent was obtained, the key issue will not be whether the patient signed a form or not, but whether they were given all the appropriate information they needed in a way that they could understand sufficiently well to make a considered decision. It is, therefore, crucial that the essential elements of discussions with the patient are documented in the patient's clinical records.

The notes do not need to be exhaustive but should state the nature of the proposed procedure or treatment and the reasons for reaching the decision, and itemise the risks, benefits and alternatives brought to the attention of the patient, even if the patient decided not to undergo a procedure, or have any treatment. Any fears or concerns raised by the patient should also be noted.

Competence

To understand the information provided, and to give the necessary authority for consent, a patient must be competent. 'Competence' in this context means the patient's ability to understand the explanations given about:

- The nature and purpose of a particular procedure.
- Its likely effects and risks.
- Any alternative treatment and how these alternatives might compare.

Only if a patient is competent to consent can the patient's consent be considered valid.

Children

In England and Wales, the Children Act 1989 defines who has parental responsibility and the consequent right to give consent to a child's treatment. Understanding who holds parental responsibility is not always straightforward and, depending on the child's date of birth, a father may hold parental responsibility for one child but not for their older sibling.

All mothers have automatic parental responsibility. Parental responsibility rests with both parents, provided they are named on the birth certificate and regardless of whether they are married or not, for children whose births were registered from:

- 15th April 2002 in Northern Ireland.
- 1st December 2003 in England and Wales.
- 4th May 2006 in Scotland.

In England and Wales, the relevant legislation for defining the age at which children can normally be considered capable of making their own decisions is to be found within the Family Law Reform Act 1969. It permits an individual of 16 years of age or over, and of sound mind, to give legally valid consent to dental treatment; it does not preclude children under 16 years of age from also giving consent.

Many readers will be familiar with the Gillick (1986) case in England, which related to the provision of contraceptive aids to girls under 16 years of age without parental consent. Because of this case, the view is generally held that children, if they can fully understand the proposed treatment, can give consent to that treatment. Practitioners should always try to confirm that both the child and the parent understand the treatment to be given. Even in cases where it is believed that the child may be capable of giving consent which (according to Gillick) would negate the need to obtain parental consent, it is still wise to try to seek the child's permission for a discussion with the parent to confirm their agreement. If a parent is not available when children under 16 years of age are examined, then extreme caution is advised. In 1991, the Court of Appeal in England, in the case Re-R, decided that where a child under 16 refuses consent to treatment, that consent could be obtained from a parent. Whilst a child of 16 or 17 can consent to treatment in accordance with the Family Law Reform Act 1969, a person with parental responsibility can also consent to the treatment of a child aged 16 or 17. If a child of 16 or 17 consents to treatment, consent cannot be withdrawn by the person with parental responsibility.

The Consent Communication Process

As part of the communication process, practitioners should concentrate their focus not only on ensuring that the patient thoroughly understands the information being provided to them but that they are provided with

an impartial and precise overview of the advantages and disadvantages of the proposed treatment. Thus, patients should be comfortable in the fact that they comprehend the important issues relating to what is going to happen to them and which in turn will affect their decisions in whether to agree to embark on the recommended procedure or course of treatment.

In accordance with the GDC *Standards for the Dental Team* (2013), information which should be provided to the patient regarding procedures includes:

- Options for treatment, the risks and the potential benefits.
- Why, in the opinion of the clinician, a particular treatment is necessary and appropriate for them.
- The recommended treatment options.
- The consequences, risks and benefits of the proposed treatment.
- The likely prognosis of treatment.
- If applicable, the cost of the proposed treatment.
- What might happen if the proposed treatment is not carried out.
- Whether the treatment is guaranteed, how long it is guaranteed for and any exclusions that apply.

Additional information that is good practice and should be provided to patients includes:

- Potential follow-up treatments.
- If applicable, the materials and their constituents used during treatment.
- The clinicians involved in the treatment.

The emphasis therefore lies in maintaining an ongoing effective channel of communication between practitioner and patient for both parties to be satisfied that consent is not only informed but also valid.

If the need arises to change a patient's agreed treatment or the estimated cost, you must obtain your patient's consent to the changes and document that you have done so.

When obtaining consent, you should encourage patients who have communication difficulties to have a friend, relative or carer with them to help them ask questions or understand your answers.

Department of Health Guidance

In July 2009, the Department of Health England produced the *Reference guide to consent for examination or treatment* (second edition). This booklet provides guidance as to the legal framework which all health professionals, not just dentists and other dental care professionals, should bear in mind when obtaining valid consent from patients.

The definition of valid consent offered by the guidance is that 'it must be given voluntarily by an appropriately informed person who has the capacity to consent to the intervention in question (this will be the patient or someone with parental responsibility for a patient under the age of 18, someone authorised to do so under a Lasting Power of Attorney (LPA) or someone who has the authority to make treatment decisions as a court appointed deputy). However, the guidance also states that 'people aged 16 or 17 are presumed to be capable of consenting to their own medical treatment'. Acquiescence where the person does not know what the intervention entails is not 'consent'.

In accordance with the Mental Capacity Act 2005, it must be presumed that:

- A person must be assumed to have capacity unless it is established that he lacks capacity.
- A patient who is considered lacking capacity is not able to make independent decisions due to a deficiency in the way their brain or mind functions.
- The deficiency may be deemed long-lasting, temporary or short-term, however should it affect decision-making the patient may be considered to be lacking capacity.
- Professionals should assess the capacity of a patient based not on their competence in making normal, everyday decisions, but on their ability to make a specific decision at a particular time.
- Some signs that a patient may be incapable of independent decision-making could be an inability to consider, comprehend or remember the applicable information.
- In addition, if a patient is unable, either through verbal or non-verbal means, to convey their decision, they are deemed to lack capacity.
- Always ensure that any information provided is appropriately presented in an unbiased manner and is suitable to the patient and any companion's level of understanding.

The Mental Capacity Act (2005) Code of Practice (2016), available at http://www.legislation.gov.uk/nia/2016/18/part/1/crossheading/establishing-whether-a-person-has-capacity, gives further guidance on understanding, evaluating and recording an individual's capacity.

1) Has the patient given their consent voluntarily?
   - To be considered valid, consent should be given willingly by a patient, without pressure or unwarranted influence or unjustifiable coercion.
   - This means that they should not feel that they are being compelled by others to make a decision.
   - This can include not only members of the healthcare team, but also relatives or friends or other individuals in authority.

2) Has the information provided been clear and sufficient for the patient, or patient's carer, to understand?
   - To ensure that the consent given is considered valid, the patient, or patient's carer, needs to be aware of the full extent and intention of the treatment being proposed.
   - Ensure that the patient, or carer, is fully aware of all alternative courses of treatment, as well as all risks and benefits.
   - Ideally, a patient should be given time to think about the options before giving their consent.
   - When talking to the patient, or carer, about their options, healthcare professionals should take the time to discuss the patient's concerns and specific needs, taking into account that some patients may need more support to make a decision than others.
   - Very occasionally a patient may express a wish to be told the minimum information about a procedure or treatment. In these instances, healthcare professionals should ensure that the patient is provided with enough information upon which to make a decision whether to consent.
   - Any discussions with a patient, or patient's carer, surrounding consent should be recorded.
3) Which team members should seek consent?
   - Ultimately, the member of the team responsible for providing the treatment should make sure that, prior to carrying out any procedure, valid consent has been obtained.
   - If the taking of consent is delegated to another member of the team, they must be appropriately qualified and have adequate knowledge about the proposed treatment or procedure.
   - Not only this, they should also hold sufficient knowledge about the patient's history to support their decisions.
   - Team members should also demonstrate respect to all patients when discussing treatment, considering any ethnic or social values or personal principles and beliefs.
   - If the team member is not appropriately qualified and does not have adequate knowledge about the proposed treatment or procedure, the consent may be considered invalid.
4) When should consent be taken?
   - The activity of gaining consent should be seen as an ongoing process.
   - Consent should be discussed at the point of initial consultation and, if applicable, again later at the time of carrying out the procedure or treatment.
   - Unless it is withdrawn by the patient, valid consent is considered to be applicable indefinitely.
   - Changes in the patient's condition may necessitate additional consent to be taken.
   - Further, should additional information become available which would affect the treatment plans or procedures, further consent may need to be discussed and obtained.
5) What format should the consent take?
   - Ideally, consent taken in writing to document discussions and dialogue represents the necessary confirmation and evidence that the patient, or the patient's carer, has been consulted.
   - However, consent can be gained, agreed and documented in a variety of ways.
   - Any additional notes regarding capacity assessment should be entered into the patient's notes.
   - A signature on its own does not constitute valid consent.
   - Remember to be mindful of an individual patient's ability to read and write when asking them to sign a consent form.
   - A mark by the patient indicating their understanding is adequate as evidence.
   - Others may be unable to express consent verbally, or physically make a mark on a form and therefore care must be taken to ensure that the method of giving valid consent has been recorded and documented carefully.
   - Implied consent is that which is concluded as a result of a patient's non-verbal indications.
6) Refusal and withdrawal of consent.
   - Despite full and informative discussions surrounding treatment and engagement with a patient's situation and concerns, a patient with capacity may still refuse to give consent.
   - Patients should be reassured at the time of taking consent that they are able to change their mind or ask for reassurance at any time.
   - This refusal should be respected as the patient has the right to decide what is the right course of action for them.
   - Equally, a patient considered capable is within their rights to withdraw their consent to a procedure or treatment whenever they like.
   - A patient may be happy to continue if concerns are addressed, but if not, they hold the right to halt a procedure and withdraw their consent. In this case, healthcare professionals must act in accordance with the patient's wishes.

General Dental Council Principles

The GDC has produced nine clear standards specifically for use by all members of the dental team. Effective from 30th September, 2013, these standards are intended to lay out clearly the 'standards of conduct, performance

and ethics' which all dental care professionals should adhere to as part of their registration. The document lists not only 'the principles, standards and guidance which apply to all members of the dental team. It also sets out what patients can expect from their dental professionals' (GDC, 2013).

There are nine principles registered dental professionals must keep to at all times. GDC registrants are expected to:

1) Put patients' interests first.
2) Communicate effectively with patients.
3) Obtain valid consent.
4) Maintain and protect patients' information.
5) Have a clear and effective complaints procedure.
6) Work with colleagues in a way that is in patients' best interests.
7) Maintain, develop and work within your professional knowledge and skills.
8) Raise concerns if patients are at risk.
9) Make sure your personal behaviour maintains patients' confidence in you and the dental profession.

Therefore, it is indisputable that every member of the dental team, dentist, hygienist or therapist, should not only maintain a comprehensive knowledge of the principles surrounding consent, but uphold an awareness of how the full range of principles relate to the broad variety of situations and interactions encountered in everyday practice to ensure that patients receive the best possible care.

In terms of specific guidance relating to valid consent, the GDC has taken the broad recommendations from the Department of Health England and made them specific and relevant to the dental community.

The guidance first points out that 'patients expect to be asked for their consent to treatment before it starts'. Showing respect and sharing knowledge with patients provides them with the ability to make informed decisions about their bodies and the treatment they receive. As previously stated, before starting any treatment, it is a universal legal and ethical expectation that valid consent be sought.

As the responsible individual with a comprehensive understanding of the provision of the treatment, it is your obligation to discuss the details with the patient, allow them time to decide and, finally, obtain their consent. You may delegate this task; however, it is imperative that whoever obtains consent understands the full extent of the intended treatment as well as being a competent individual who is appropriately qualified to carry out the procedure. You will ultimately remain responsible for ensuring that valid consent has been given before commencing any treatment.

The section which is particularly significant for the preservation of good clinical practice is 'Principle 3 – Obtain Valid Consent', which is designed to complement and endorse the legal obligations and is broken down into three specific standards:

3.1 Obtain valid consent before starting treatment, explaining all the relevant options and the possible costs.
3.2 Make sure that patients (or their representatives) understand the decisions they are being asked to make.
3.3 Make sure that the patient's consent remains valid at each stage of investigation or treatment.

Care Quality Commission

The Care Quality Commission (CQC) is the independent regulator of health and social care in England. It describes its job as ensuring that hospitals, GP and dental practices and all other care services in England are providing patients with high quality care in a safe, effective and compassionate environment. It also protects the interest of people whose rights are restricted under the Mental Health Act (1983). In the amended 2015 CQC document *Essential standards of quality and safety*, Section E6 entitled 'Consent to care and treatment' explains that service users should have the right to give consent where they can, understand and know how to change their decision if indicated and feel confident that their human rights have been respected.

The CQC lists prompts useful to healthcare providers when setting up and using effective systems for gaining valid consent from patients. The points detail additional areas of note which complement the guidance provided by both the Department of Health and the GDC. Most notably, they summarise simply and clearly the consent procedural requirements in terms of treating children.

1) Where a child is judged as capable to make decisions independently, the healthcare team should treat their discussions with respect and maintain confidentiality if requested.
2) In the case of a child who is unable to consent, it is imperative to gain consent from the child's parent, or identify the individual who holds parental responsibility
3) Providers should ensure that they have set out provisions for gaining consent for children.

Practical Tips

1) The term 'care plan' is a better term to use than 'treatment plan'. To the patient, it is reassuring to hear they are being cared for, and the plan does not always

involve treatment. It could consist of preventive advice and/or procedures.

2) Before you do anything, ensure that you understand the care plan yourself and that you have considered all the pros and cons of various and alternative treatment options and you are happy with the proposed plan.
3) If the plan was made by another clinician, you should discuss the plan and make sure you are happy to offer the suggested care to the patient. If there are any doubts, you should discuss them with your colleague and agree a plan that you are both happy with.
4) Consider the patient's state of mind and feelings. Unfortunately, some patients may be apprehensive about receiving dental treatment and therefore may not be able to take in the information just prior to a procedure being carried out. It may be helpful to discuss the procedure at a separate time, or in an area away from the dental chair (assuming the discussion can be kept confidential) to try and put them at ease.
5) Similarly, a patient who is in severe pain may not be taking in any information, or may ask to have a tooth removed just to get out of pain and regret it afterwards. In some cases, it may be an idea to explain the circumstances and obtain valid consent for local anaesthesia to relieve the patient's pain before continuing with providing the patient with information about options and asking them to provide you with valid consent.
6) The information can be given to the patient in various ways: verbal discussion, visual aids, written format, etc. The nature of the consent being sought can determine which format is better, although there are no clear-cut rules. The method also needs to be tailored to the patient's needs. For example, if the appointment is for an emergency treatment then clear verbal discussion may be appropriate. On the other hand, for a complex restorative or orthodontic treatment, it may be better to explain things and then follow up that explanation by sending a letter detailing what was discussed. If the care plan is complex it may be difficult for patients to absorb all the information verbally and fully understand it in one appointment.
7) Small things can make a big difference:
   - Sit down and talk to the patient, making eye contact at the same level. Do not stand over the patient and try to explain the procedure.
   - Try to put them at ease and show them you are approachable and compassionate.
   - Keep eye contact with the patient if possible and show them you care and that they have your full attention.
   - Speak softly, clearly and slowly when you are explaining the treatment.
   - Let them know that they can ask you any questions they may have and more than once if necessary!
8) Do not use dental 'jargon' and make treatment items specific. Explain things in terminology that is easy for the patient to understand. For example:
   - Instead of 'You have periodontal disease', you can say 'You have gum disease'.
   - Instead of 'You need two restorations on the upper right 6 and upper right 7 due to caries', you can say 'You need to have two fillings on two of your molar teeth on the top right-hand side. These are the last two teeth in that area. These teeth have already been filled in the past but I can see there is some decay underneath the fillings and it would be best to remove them and clean out the decay and put new fillings in'.
   - 'You need to have endodontic treatment on your upper incisor because the pulp has died'. This is not only unclear, but also non-specific. To make it clearer exactly what the treatment involves and exactly which tooth is affected, you can say 'You need to have a root treatment on your front tooth on the top right side' and point to the tooth and let the patient see it in the mirror. 'This is due to the fact that the nerve inside the tooth has unfortunately died and if left as it is the tooth may get infected'. You must emphasise that it is the nerve inside the tooth and not the tooth itself that has died. 'The treatment would involve removal of the remainder of the nerve and cleaning out of the canal inside the tooth. This is then filled'. The patient will of course need further information about what the process entails and the need for the use of a rubber dam, etc.
   - Once you have finished explaining the procedure, you should ask the patient if they have any questions. In addition, check if they need some time to consider the options and ask any questions at a later date.
9) How do you know if the patient has understood the care plan? It is not always easy to know. You could ask the patient questions regarding the treatment and assess their answers. Sometimes that gives you a clue as to the depth of the patient's understanding.
10) Ensure the patient can understand English. If in doubt, make sure there is an appropriate interpreter who can help. If you do have doubts, you may have to delay the treatment until there is an interpreter present at the next visit.
11) What if you feel the patient is making the wrong choice? Different people have different opinions, values and priorities. The most important thing is to ensure you have explained everything clearly and that the patient is making the choice knowing all the

pros and cons. Ultimately it is the patient's choice and decision; their decision, even if it is not to give consent (as long as they have the capacity to consent), must be respected.

12) Ensure consent is documented. This does not simply mean writing in the notes 'consent obtained'. It is important that details of the conversation carried out with the patient are documented as well as benefits, risks, pros and cons, side effects and other relevant details. If anything changes, the patient needs to be informed and consent re-obtained and again documented with details of why the change was necessary, as well as all other information mentioned previously.
13) Ensure there is a clear and written procedure in place for consent taking. This will ensure everyone in the team is clear about what they need to do, especially less experienced and new members of staff.
14) It is important to ensure the patient has the correct expectations of what the treatment involves. This is particularly relevant when carrying out any aesthetic procedures. The patient may be very realistic about the outcome of treatment and therefore once the treatment is explained and consent obtained no problems result. On the other hand, some patients have unrealistic expectations of the appearance of their teeth and the effect on their facial appearance. Once the treatment is completed they will be unhappy with the result and therefore may feel they had not given consent for what the outcome is. One way to avoid problems is to ensure that thorough diagnostic procedures (e.g. diagnostic wax-ups, occlusal analysis, trial set-ups and provisional restorations) are used to assess the final outcome. In this way, the patient can give consent to a realistic outcome and not be disappointed.
15) Be mindful of risk management and ensuring you have done all you possibly can. Ensure that any issue that could potentially be a cause for concern for the patient, and hence result in a complaint, is discussed and documented. Some examples are:
    - Prognosis of a tooth and possible need for extraction if proposed treatment is not successful.
    - Risks associated with a dental extraction.
    - Long-term impact of the treatment or no treatment.
    - Maintenance requirement and the costs in terms of time and money required.
    - Risk of failure of treatment; for example, in a patient who is a bruxist.
    - Risk of resorption in orthodontic treatment of teeth involved in trauma.
16) Most importantly, remember to treat the patient as you would like to be treated, and explain things the way you would like them explained to you if you were having a procedure done that you were not familiar with and perhaps were nervous about.

Consent in Research

At some point in your career, you may be interested in taking part in research involving your patients, either to evaluate and improve service, or to test products or assess new procedures. Not surprisingly, obtaining consent is also a crucial part of this process and should be followed when inviting patients, as well as healthy volunteers, to participate in research.

Study specific documents, including patient information sheets and consent forms, are carefully conceived and written and subsequently approved by ethics committees to ensure that research is conducted in accordance with regulations, as well as offering reassurance to participants that their welfare has been assessed and prioritised. The same considerations discussed previously should be afforded to the research participant in respect of explaining potential benefits, suspected risks and possible adverse events. It is imperative that participants are provided with the approved study information and given the opportunity, usually 24 hours, to consider its content before being asked to consent to taking part. Consent should then only be taken by individuals with a comprehensive insight of the trial and the activities involved.

From a regulatory and compliance point of view, research investigators should always endeavour to achieve best practice by following guidelines developed by regulatory bodies, such as the principles detailed in the Research Governance Framework (Department of Health, 2005) and the World Medical Association Declaration of Helsinki (2013), as well as ensuring that all necessary approvals are in place before starting research activity.

Researchers are also expected to maintain an awareness of the requirements set out in the Human Tissue Act (2004), which details the requirements relating to the use and storage of human tissue and International Conference on Harmonisation E6 (Good Clinical Practice) and which studies they are legally applicable to.

Good Clinical Practice (GCP; International Conference on Harmonisation, 1996) is an internationally recognised standard which ensures that research involving humans is designed and conducted in an ethical manner. Developed by the regulatory authorities of the European Union, the United States of America and Japan, GCP offers reassurance that participants' confidentiality is

respected and that their rights and safety are protected. In addition, it offers assurance that results and data are reported credibly and accurately.

GCP is made up of a core of 13 principles and is applicable to clinical research which could influence the wellbeing or safety of the participants involved. This is particularly relevant to studies which involve clinical trials of medicinal products (CTIMPs) for which, as with the implementation of the GCP EU Clinical Trials Directive (2001) and the 2004 Medicines for Human Use (Clinical Trials) Regulations, GCP is a legal requirement. However, in terms of achieving continuous excellent practice, researchers should aim to apply their concepts to all types of studies.

References

Adults with Incapacity (Scotland) Act 2000, asp 4, (2000). http://www.legislation.gov.uk/asp/2000/4/pdfs/asp_20000004_en.pdf (accessed 21st July, 2017).

Bolam v. Friern Barnet Hospital Management Committee, 1WLR 5821990 SLT 444, (1957).

Care Quality Commission. (CQC). The Care Quality Commission (Amendment) Regulations 2015. E6: Consent to care and treatment. Available from: https://www.cqc.org.uk/guidance-providers/nhs-trusts/consent-care-treatment (accessed 17th July, 2017).

Children Act 1989, Chapter 41, (1989). https://www.education.gov.uk/consultations/downloadableDocs/Children%20Act%201989%20Part%201%20s1.pdf (accessed 21st July, 2017).

D'Cruz, L., Kaney, H. (2015) Consent – a new era begins. British Dental Journal 219:57–59.

Dental Protection. (2015) Dental Advice Series. Consent UK excluding Scotland: Consent to Dental Treatment. The Principles and their Application. https://www.dentalprotection.org/docs/librariesprovider4/dental-advice-booklets/dental-advice-booklet-consent-uk-excl-scot.pdf?sfvrsn=36 (accessed 17th July, 2017).

Department of Health. (2005) Research Governance Framework. Health Research Framework. Research Governance Framework for Health and Social Care. 2nd edn. Available from: https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/139565/dh_4122427.pdf (accessed 5th July, 2017).

Department of Health. (2009) Reference guide to consent for examination or treatment. 2nd edn. Available from: https://www.gov.uk/government/publications/reference-guide-to-consent-for-examination-or-treatment-second-edition (accessed 18th July, 2017).

EU Clinical Trials Directive. (2001) Available from: http://ec.europa.eu/health/human-use/clinical-trials/index_en (accessed 5th July, 2017).

Family Law Reform Act 1969, Chapter 46, (1989). http://www.legislation.gov.uk/ukpga/1969/46/pdfs/ukpga_19690046_en.pdf (accessed 21st July, 2017).

General Dental Council (2013) Standards for the Dental Team. https://www.gdc-uk.org/api/files/Standards%20for%20the%20Dental%20Team.pdf (accessed 18th July, 2017).

General Medical Council (GMC). (2008) Consent: Patients and Doctors Making Decisions Together. Available from: www.gmc-uk.org/guidance (accessed 17th July, 2017).

Gillick v. West Norfolk and Wisbech Area Health Authority, AC 112, (1986).

Human Tissue Act 2004, Chapter 30. Available from: http://www.legislation.gov.uk/ukpga/2004/30/contents (accessed 5th July, 2017).

International Conference on Harmonisation. (1996) Efficacy Guidelines. Good Clinical Practice E6. Available from: http://www.ich.org/products/guidelines/efficacy/article/efficacy-guidelines.html (accessed 5th July, 2017).

Mental Capacity Act (2005) http://www.legislation.gov.uk/ukpga/2005/9/pdfs/ukpga_20050009_en.pdf (accessed 17th July, 2017).

Mental Capacity Act Code of Practice. (2016) http://www.legislation.gov.uk/nia/2016/18/part/1/crossheading/establishing-whether-a-person-has-capacity (accessed 12th September, 2017).

Mills, I., Frist, J., Cooper, C., et al. (2014) Patient-centred care in general dental practice - a systematic review of the literature. BMC Oral Health 14:64. Available from: https://bmcoralhealth.biomedcentral.com/articles/10.1186/1472-6831-14-64 (accessed 20th July, 2017).

Montgomery (Appellant) v. Lanarkshire Health Board (Respondent) (Scotland), UKSC 104, (2015).

Re-R (A Minor), 4 ALL ER, (1991).

The Medicines for Human Use (Clinical Trials) Regulations 2004. No. 1031. Available from: http://www.legislation.gov.uk/uksi/2004/1031/contents/made (accessed 5th July, 2017).

The Royal College of Surgeons of England. (2016) Consent: Supported Decision-Making – a good practice guide. Domain 3: Communication, partnership and teamwork. Available from: https://www.rcseng.ac.uk/library-and-publications/college-publications/docs/consent-good-practice-guide/ (accessed 17th July, 2017).

World Medical Association. (2013) WMA Declaration of Helsinki – Ethical Principles for Medical Research Involving Human Subjects. Available from: https://www.wma.net/policies-post/wma-declaration-of-helsinki-ethical-principles-for-medical-research-involving-human-subjects/ (accessed 18th July, 2017).

6

Procedures in the Assessment and Examination of Patients

Stephen Dunne and Warren Birnbaum

Introduction

Oral diagnosis, like diagnosis of disease in other parts of the body, is complicated by many factors:

• Symptoms of quite different diseases may be similar; in some cases exactly similar, for example, pulpitis and atypical odontalgia.	A symptom is defined as any bodily change perceptible to the patient.
• Signs of different diseases may be similar. An ulcer, for example, may be caused by minor trauma from a sharp tooth or may potentially be a squamous cell carcinoma.	A sign is defined as any bodily change which is perceptible to a trained observer.
• Signs and symptoms of the same disease, suffered by different patients, may be very different.	For example, an excruciating pain described by one may be perceived as discomfort by another. Signs and symptoms may be hidden.
• It is the dentist's task, by careful questioning and observation to render these 'visible'. Preconceived ideas may cloud the perspective of the patient, who may have decided that the problem is 'dental' and has, therefore, sought the advice of a dentist.	In this way the patient may fail to reveal appropriate details to the dentist and non-dental causes of oral problems may be missed, despite repeated and adequate questions.
• Common disease (e.g. pulpitis) occurs frequently and must be excluded before the rarity is considered.	However, the rarity will occasionally present, and hence the dentist must learn to expect the unexpected.
• Some patients may provide the history that they believe the dentist wants to hear, and which is socially acceptable.	For example, patients may underestimate their alcohol, tobacco and sugar consumption, whereas time spent on tooth cleaning may be overestimated. In addition, a history of misuse of drugs, sexually transmitted diseases, eating disorders or child abuse may not readily be admitted to a dentist.
• Relevant but non-dental matters may erroneously be considered, by some patients, to be none of the dentist's business!	For example, the medical history.
• While the process of diagnosis, quite rightly, begins as soon as a patient enters the surgery, appearances can be deceptive.	A smart suit, for example, does not confer immunity to high alcohol and tobacco use, or dental neglect.
The system of diagnosis of disease involves three main elements: 1) History. 2) Examination. 3) Diagnostic tests.	General considerations: • Patients should be respectfully treated as an individual, not as a disease requiring treatment. • Always use a methodical approach, avoiding 'spot' diagnosis.
While the experienced clinician will appear to diagnose a problem with minimal attention to peripheral details, this technique may lead the inexperienced clinician to guesswork. Experience is gained by practice in the consideration of all details. Only with experience is it possible to reject those enquiries and investigations irrelevant to the particular patient under consideration.	

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

• During a clinical consultation a third person, such as the dental nurse, should be present at all times.	This chaperone should not be a lay person since emergency procedures may need to be followed and equipment operated.
• The consent of a parent/legal guardian is required for patients who have not shown the mental capacity to give consent.	See Chapter 5.
• Children are often more cooperative and communicative if, after the initial introduction, the accompanying parent is asked to return to the waiting area.	
• Establishing rapport with the patient is an essential prerequisite for obtaining a adequate history.	
Record keeping	
• The dental record contains important facts.	Neither hide such facts amongst irrelevant details nor omit them.
• The dental record should be dated, complete, legible and indelible and signed by the clinician. The record should be contemporary.	Contemporary – written at the time of the appointment.
• The record may be required by other clinicians and occasionally by members of the legal profession.	
• Do not write anything that you would not wish to be read in court.	
• Avoid abbreviations unless universally recognised.	
• Delete errors with a single line and sign and date the correction.	The error must remain readable.
• Accurate sketches are useful to indicate position, size and shape of lesions.	
• Use headings, where appropriate.	e.g. 'Medical history'.
• Where standard layouts/formats exist, use them.	
• Where notes carry on over the page, each page should be dated and the abbreviation 'Cont'd' (continued) should follow the date.	
• Records must be safely stored in accordance with the Data Protection Act (or other relevant legislation).	
• Accurate and complete dental records are an essential element of patient care and make a major contribution to diagnosis and planning of treatment.	
• The patient has a legal right to access their dental record.	Do not enter any disparaging remarks.
Establishing rapport	
The initial patient interview consists of an exchange of both verbal and non-verbal information. The dentist's posture and demeanour can do much to enhance or ruin rapport:	
• The patient should be at the same eye level as the clinician.	Not lying flat.
• Make eye contact, but do not stare.	This may be intimidating.
• The patient should be reasonably close to the clinician, approximately one metre away.	Proximity denotes intimacy, whereas excess distance suggests inattentiveness.
• Likewise, facing the patient indicates attentiveness, while turning away suggests rejection.	
• A smile or confirmative nod of the head shows warmth and concern.	
• Record details of the patient's close family and any forthcoming social events (e.g. marriages, births) that may be volunteered.	Reference to these, subsequently, establishes personal rapport.
• The initial interview should be conducted free of any protective eyewear and mask.	Otherwise, facial expressions are concealed and speech is muffled. Protective eyewear should be placed on the patient only when the physical examination begins.
• Before any investigation or procedure, tell the patient what you will be doing and when and why you will be doing it.	A patient surprised by any action may become frightened, leading to a possible loss of trust.

Conclusion

A relaxed patient and an attentive, thorough and methodical dentist, in a friendly but professional environment, are the foundations of oral diagnosis.

The History

'Listen to your patient, he is telling you the diagnosis!' (*dia-gnosis*: Greek, 'through knowledge').

Objectives: • To establish rapport between patient and dentist. • To gather sufficient information to arrive at a provisional diagnosis. • To gain an understanding of the patient's wishes and expectations.	
The history: • Is a personal account of the patient's problem. • Is often the most important component of clinical diagnosis. • May occasionally be the only diagnostic factor. • Some patients (e.g. young children or those with special needs) may be unable to provide an accurate history. • With extreme language difficulties, encourage the patient to bring an interpreter.	In extreme circumstances, questions may be addressed to a parent/guardian/carer. However, it is usually better to persevere with the patient, even if this means asking leading questions, since it is they who are suffering the problem. A third party may apply yet another interpretation of the problem. Here again, it is better to persist with the patient wherever possible, although this is clearly often difficult.
The history includes three main stages: 1) A brief introductory phase. 2) Listening to the patient's account. 3) Structured questioning.	
Stage 1. The introductory phase. • Greet the patient by name. • Introduce yourself by name and describe your role in helping the patient.	
• 'Break the ice'.	By greeting with an introductory comment about the weather, the patient's journey or occupation, or a compliment (but avoid excessive flattery).
• Most patients do not understand medical/dental terminology.	Use plain speech but do not 'talk down'. A useful 'rule of thumb' is to employ only vocabulary that might be found in a popular newspaper.
• Record the patient's initial statement.	This may, or may not, relate to their reason for attendance but may often provide important information. The statement, 'I'm terrified of dentists but the pain forced me here' has obvious implications for the patient's management.
• Record or check biographical data, including: – Patient's name. – Gender.	
– Date of birth.	cf. age-related diseases: most patients with oral cancer are over 40 years old.
– Address.	Difficulty in attendance, fluoridation of local water supply.
– Telephone number.	Mobile, daytime and residential.
– Occupation.	Education; socio-economic status; exposure to sunlight – skin and lip cancer; chef – caries.
– Names and addresses of general medical practitioner and general dental practitioner.	

Stage 2. Listening to the patient's account	**Notes:**
The present complaint (CO, Complains Of). This is the reason the patient is seeking care. • Use an opening question, such as 'How can I help you?' • If a list of problems is forthcoming, ask 'What is your main concern?'	Encourage the patient to describe their problem. In general, do not interrupt the patient. Encourage the inarticulate by simple questioning. Direct the 'talkative' to more relevant matters.
Record the complaint in the patient's own words.	Particularly in medicolegal cases, the patient's words may be set in inverted commas.
• In describing the present complaint, the patient is listing symptoms.	
• Record symptoms in order of severity.	
• If you cannot interpret an adjective describing a symptom it is often useful to ask the patient for a word that describes the opposite to it.	
• Relate the present complaint to the initial statement made by the patient.	
Stage 3. Structured questioning This is subdivided into five headings: 1) History of the present complaint. 2) Medical history. 3) Previous dental history. 4) Family history. 5) Social history.	
Open-ended questions, which do not have simple yes or no answers, allow patients more latitude to express themselves.	
History of the present complaint (HPC)	
• Is a chronological account of the development of the problem.	
• Include the following questions: – When did you first notice the problem?	
– How has it changed since?	Is it getting worse, better, or staying the same?
– Did (or does) anything cause the problem or make it worse?	e.g. heat, cold or eating may aggravate toothache.
– Does anything relieve the problem?	e.g. non-prescription analgesics might relieve mild to moderately severe dental pain.
• Proceed through questions relating to any additional symptoms and the effectiveness, or otherwise, of any previous treatments.	
• Symptoms may require further clarification.	Pain is a subjective symptom and unlike an ulcer, there may be nothing to assess visually. The history is, therefore, of paramount importance.
• Avoid 'leading' questions.	Suggestible patients may agree to symptoms they did not know they had! Thus, do not ask 'Do you experience pain with hot and cold foods?' Instead, ask 'What causes the pain to start?'
• If 'leading' questions are unavoidable, allow a range of possibilities from which the patient may select.	
Medical history (abbreviated MH)	
• May provide important clues to the diagnosis.	
• May greatly modify any treatment plan.	
• An inadequate medical history may put the health of the patient, the dentist and support staff at risk.	

• Is mandatory for medicolegal reasons.	
• If a self-administered medical history questionnaire is used, answers must be followed up by the dentist.	
• The following questions should be asked:	
– Have you ever had a serious illness or been in hospital?	Hospitalisation often indicates a serious problem.
– Have you ever had an operation?	May indicate a serious problem or detail information of the patient's tolerance of an anaesthetic.
– If so, did you have any problems?	Excessive bleeding, drug reactions etc.
– Are you presently under the care of a doctor?	May indicate a serious problem.
– Are you taking any tablets, medicines, pills, drugs or creams?	May suggest the underlying problem. Also, drugs prescribed for dental problems may interact with existing medication. Broad-spectrum antibiotics may reduce the effectiveness of oral contraceptives, for example, and a barrier method of contraception should be advised.
– Have you ever had excessive bleeding after cuts or tooth extraction?	May indicate bleeding tendency.
– Have you ever been turned down as a blood donor?	Blood-borne viruses, etc.
– Have you ever had jaundice, hepatitis or any liver problem?	Risk of delayed drug metabolism, bleeding problem.
– Do you have any heart problems?	Risk of angina/heart attack, general anaesthetic risk.
– Have you ever had rheumatic fever, a heart murmur, or heart valve problems?	
– Have you ever had high blood pressure?	Risk of stroke or cardiac arrest.
– Do you have asthma or any chest or breathing problems?	General anaesthetic risk.
– Have you ever had tuberculosis?	Risk of cross-infection.
– Have you ever had any other infectious diseases?	
– Are you a diabetic?	More susceptible to infection, periodontal disease, risk of collapse if blood sugar falls, general anaesthetic risk.
– Have you ever had epilepsy?	Risk of seizure
– Are you pregnant or a nursing mother?	Females only!
– Do you have any allergies, e.g. hay fever, asthma, eczema or to Elastoplast or latex?	Adverse reaction to drugs, general anaesthetic risk.
– Have you had any problems with antibiotics, particularly penicillin?	Risk of allergic reaction including anaphylactic shock.
– Have you had any problems with any tablets or medicines, e.g. aspirin?	Adverse drug reaction.
– Have you had any problems with dental or general anaesthetics?	Adverse drug reaction.
– Is there any other medical information that I should know?	General 'catch all'.
• Check the medical history at each recall appointment; it may have altered significantly in the interim.	e.g. anticoagulants, heart attack, etc.
• Contact the patient's doctor/attending physician or surgeon if in doubt.	
• If the patient is uncertain of the name or type of any medication, ask them to bring the medication to the next appointment.	
A medical examination may be required for patients undergoing general anaesthesia or sedation and patients with a positive history about to undergo extensive treatment under local anaesthesia.	

Previous dental history (DH)	
Ask the following questions:	
• How often did you visit your previous dentist?	Motivation, likely future attendance.
• When did you last see your dentist and what did your dentist do?	May hint at the present problem.
• Have you ever had orthodontic treatment?	May indicate good motivation.
• Have you ever had any problems with previous treatment/anaesthesia?	Anxiety, health problem.
• How often do you brush your teeth and for how long? Do you use dental floss, or fluoride?	Motivation, knowledge of prevention.
Family history (FH)	
• If a diagnosis involving a hereditary condition is suspected, include details of the health, age and medical history of parents, grandparents, siblings and children.	
• Some diseases such as haemophilia are notably hereditary, while in others a hereditary disposition may be present, including: – Non-insulin dependent diabetes mellitus. – Hypertension. – Some types of epilepsy. – Heart disease. – Some psychiatric conditions. – Breast cancer. – Some other malignancies.	
Social history (SH)	
The object is to obtain a profile of the patient's lifestyle, which may exert a major influence on the patient's dental and general health. Include details of:	
• Diet.	Vegetarian, high acid content, cariogenicity, etc.
• Exercise.	Anaesthetic risk if sedentary.
• Alcohol consumption.	Periodontal disease, acute necrotising ulcerative gingivitis (ANUG), oral cancer, liver cirrhosis, bleeding risk.
• Body weight relative to height.	Eating disorders.
• Tobacco smoking.	Periodontal disease, anaesthetic risk, ANUG, oral cancer. Alcohol and tobacco use together greatly increase the risk of oral cancer.
• Tobacco and betel quid chewing.	Oral cancer.
• Home conditions/partner.	Neglect, stress.
• Residence abroad.	Tropical diseases.
• Work.	Physical/psychological stress.
• Stress.	Psychosomatic disorders.
• Use of non-prescription ('recreational') drugs	Cross-infection risk, dental neglect, cardiac risks with cocaine, caries risk with methadone.
Conclusions	
The history will often suggest a provisional diagnosis or at the least, the history will allow a different diagnosis. The provisional or differential diagnosis will be confirmed or rejected by clinical examination and diagnostic tests.	*Note*: As a 'rule of thumb', a patient's report of alcohol, tobacco, sugar or non-prescriptive drug use should be doubled for accuracy, while a patient's estimate of time spent on oral care should be halved!

The Examination

Clinical examination consists of three main stages:

1) Observation of the patient's general health and appearance. 2) Extraoral examination of the head and neck. 3) Examination of the intraoral tissues.	*Note:* • Observation begins as soon as the patient enters the surgery. • During the examination the clinician elicits signs. • Like the history, the examination must be thorough and methodical.

Stage 1. General Observation

Note problems such as:	
• Body weight, fit of clothes.	Recent weight loss may indicate serious underlying pathology, e.g. cancer.
• Very low body weight may suggest an eating disorder. Excessive weight may suggest risk of heart attack or stroke.	Particularly with a general anaesthetic.
• Breathlessness after minor exertion.	May indicate heart or lung disorder.
• Physical disability.	
• Obvious illness.	
• Apparent age, relative to chronological age.	
• Complexion.	Pallor with anaemia, yellow with jaundice.
• Exposed skin areas, including head, neck, hands and nails	Any obvious lesion which may be visible, e.g. finger clubbing.
• Facial scarring.	Previous surgery or trauma.

Stage 2. Extraoral Examination (EO)

- Head, face and neck
- Eyes
- Lips
- Lymph nodes
- Salivary glands
- Temporomandibular joint
- Masticatory muscles

1. Head, face and neck	
Visually examine the face and neck from the front. Look for obvious lumps, defects, skin blemishes, moles, gross facial asymmetry or facial palsy.	Most faces are slightly asymmetric.
To visually examine the neck, ask the patient to tilt the head back slightly to extend the neck.	Any swelling or other abnormality is clearly seen in this position. Watch the patient swallow; thyroid swellings move on swallowing.
The patient should then turn the head, still with the neck extended, first to the left and then to the right, to allow visual examination of the submandibular region on each side.	Except in the most obese, swellings of the sublingual glands, the lymph nodes and the submandibular glands will be seen.
The neck should then be relaxed to allow bilateral examination of the region of the parotid glands.	*Note:* Unilateral swelling of the parotid salivary glands suggests: • Obstruction of the duct. • Tumour. • Abscess. • Retrograde infection of the gland. Bilateral swelling of the parotid salivary gland suggests: • Viral infection, e.g. mumps. • Degenerative changes, e.g. sialosis.

2. Eyes (if history suggests)	
Look for: • Blinking rate	Low frequency staring might indicate a psychological problem, or possibly Parkinson's disease. High frequency may indicate anxiety or dryness of the eyes, e.g. Sjögren's syndrome.
• Limitation of ocular movement or strabismus.	Fractured zygoma.
• Exophthalmos.	Tumour of orbit or cavernous sinus thrombosis.
• Bilateral exophthalmos.	Hyperthyroidism – Graves' disease.
• Subconjunctival haemorrhage.	Fractured zygoma or nasal arch.
• Ulceration of conjunctiva.	Behçet's disease, mucous membrane pemphigoid.
• Conjunctival pallor.	Anaemia.
• Blue sclera.	Rarely osteogenesis imperfecta.
• Yellow sclera.	Jaundice.
• Corneal scarring.	Mucous membrane pemphigoid.
• Dry eyes, conjunctivitis.	Sjögren's syndrome.
3. Lips	
Visual examination: note muscle tone.	e.g. drooping of the commissure and inability to purse the lips with Bell's palsy.
Any changes in colour or texture, ulceration, patches, herpetic lesions, angular cheilitis. Note also lip competency/ incompetency. Bimanual palpation: Palpate for lumps, using thumb and forefinger, one intraoral and the other extraoral.	
4. Lymph nodes	
Important: a normal lymph node cannot be felt. If a node is palpable it must be abnormal.	
Lymph node anatomy (Figure 6.1) The lymph nodes of the head and neck are divided into two main groups: A. Circular groups. B. Cervical groups.	

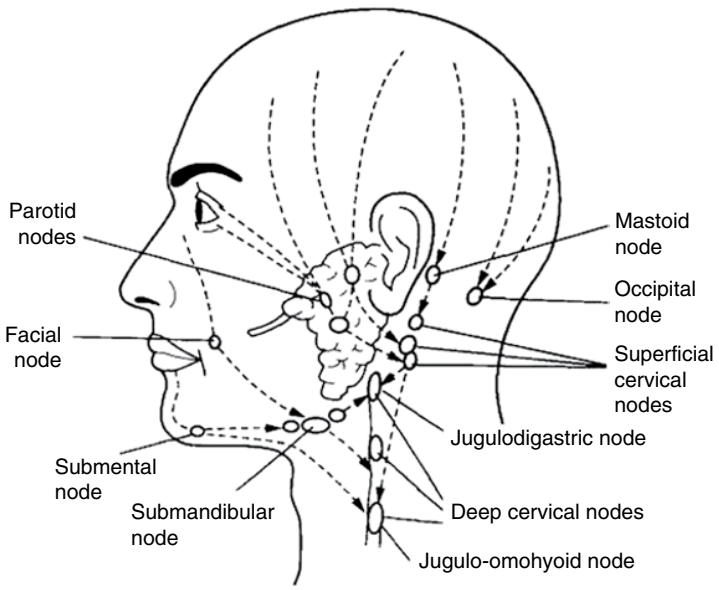


Figure 6.1 Lymphatic drainage of the head.

Circular groups (arranged around base of skull) These are subdivided into outer and inner circular groups:	
• Outer circle:	
– Submental.	Behind the chin, lying on the mylohyoid muscle.
– Submandibular.	Between the mandible and the submandibular salivary gland.
– Facial (buccal).	On the buccinator muscle, anterior to the insertion of the masseter muscle.
– Mastoid (post-auricular).	On the mastoid process.
– Parotid (pre-auricular).	In front of the tragus of the ear.
– Occipital.	Around the occipital artery.
• Inner circle (not illustrated in Figure 6.1). Named nodes include: – Retropharyngeal. – Pre-tracheal. – Para-tracheal.	The circular groups drain into the deep cervical chain.
Cervical groups	
Superficial cervical nodes.	Distributed around the external and anterior jugular veins. These drain into the deep cervical chain.
Deep cervical chain.	Distributed along the internal jugular vein.
Important named nodes include:	
• Jugulodigastric.	Between the angle of the mandible and the anterior border of the sternomastoid muscle.
• Jugulo-omohyoid.	Just behind the internal jugular vein, above the inferior belly of omohyoid, under cover of the posterior border of sternomastoid).
Drainage (see Figure 6.1)	
Submandibular nodes (unilateral drainage).	These drain the centre of the forehead, frontal and maxillary sinuses, upper lip, external nose, related cheek, upper and lower teeth and gums, anterior two thirds of the tongue (except the tip) and floor of the mouth. The submandibular node, in turn, drains into the jugulo-omohyoid and jugulodigastric nodes.
Facial (buccal) nodes.	Drain part of the cheek and lower eyelid. The facial node drains into the deep cervical chain.
Parotid (pre-auricular) nodes.	Drain the forehead, temple, vertex, eyelids and orbit. The parotid nodes drain into the superficial cervical and deep cervical chain
Occipital and mastoid (post-auricular).	Drain the scalp.
Retropharyngeal nodes.	Drain the soft palate and drain into the deep cervical chain.
Submental nodes (drain bilaterally).	Drain the tip of the tongue, lower lip, chin and incisor teeth and gum area. The submental nodes drain to the submandibular nodes or directly into the jugulo-omohyoid node.
Jugulo-omohyoid nodes.	Drain the posterior third of the tongue.
Clinical examination of the lymph nodes	
Most lymph nodes should be examined by extraoral, bimanual palpation from behind the patient.	Expose the neck by asking the patient to loosen relevant clothing. Do not extend the neck because sternomastoid must be relaxed. Use the pulp of the finger tips and try to roll the gland against adjacent harder structures.
Submental.	Tip the head forward and try to roll the node against the inner aspect of the mandible.
Submandibular.	Same as above but with the patient's head tipped to the side being examined (Figure 6.2).
Jugulodigastric.	Move the anterior border of sternomastoid back.

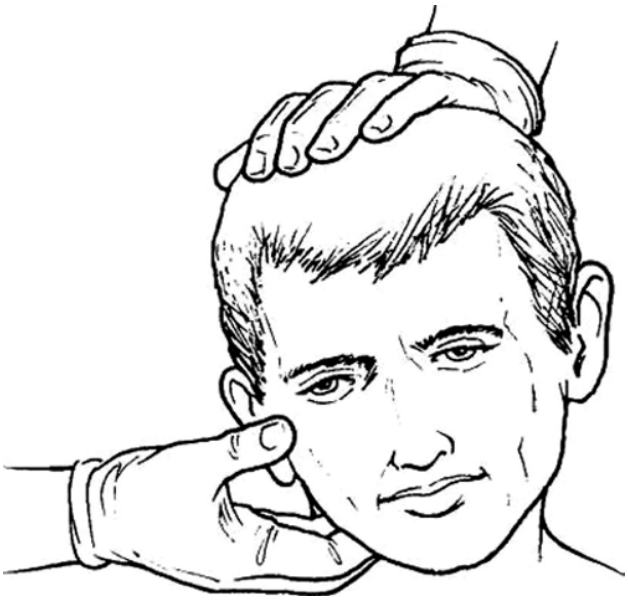


Figure 6.2 Palpation of submandibular lymph nodes.

Jugulo-omohyoid.	Move the posterior border of sternomastoid forward.
If a node is palpable, record the: • Site	
• Size	Measure using vernier callipers.
• Texture	Soft (infective), rubbery hard (possible Hodgkin's), stony hard (secondary carcinoma).
• Tenderness to palpation	Infection.
• Fixation to surrounding tissues	May suggest metastatic cancer.
• Coalescence	e.g. tuberculosis.
• Number of nodes	Multiple – glandular fever, leukaemia, etc.
If more than one node is found, refer for examination of the rest of the body for generalised lymphadenopathy and blood tests.	
Palpable node characteristics Acute infection.	Large, soft, painful, mobile, discrete, rapid onset.
Chronic infection.	Large, firm, less tender, mobile.
Lymphoma.	Rubbery hard, matted, painless, multiple.
Metastatic cancer.	Stony hard, fixed to underlying tissues, painless.
If a non-dental cause is suspected, refer urgently for medical assessment.	Suspect metastatic cancer or lymphoma until proven otherwise.
5. Salivary glands	
Parotid salivary gland View from the front. The lower part of the ear lobe may be turned outwards if the gland is swollen. Palpate the glands for enlargement or tenderness.	The gland is located mainly distal to the ascending ramus of the mandible. Occasionally a better view of the parotid gland may be obtained from the back of the patient.
Submandibular salivary gland Bimanual palpation (Figure 6.3). Use index and middle finger of one hand intraorally and the same fingers of the other hand extraorally.	Palpate the gland above and below mylohyoid and do not neglect to examine the ducts of the glands for calculi.

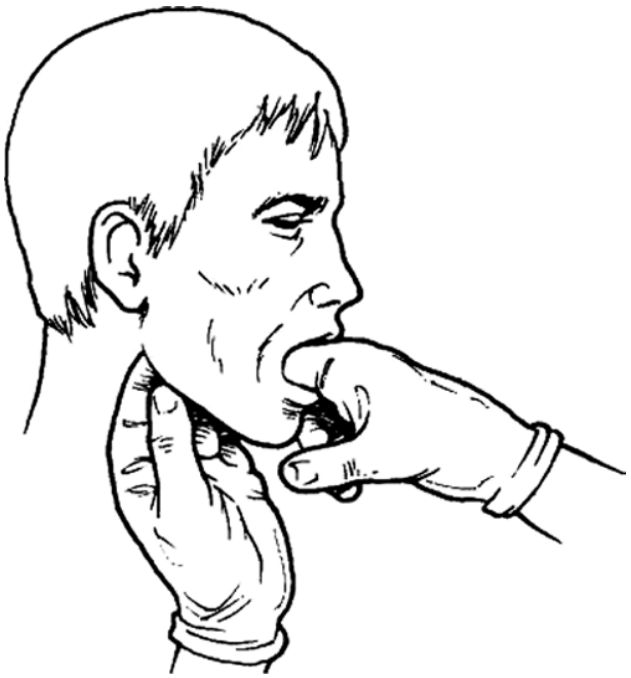


Figure 6.3 Bimanual palpation of the submandibular gland.

6. Examination of articulatory system (if history indicates)

Temporomandibular joints (TMJ)

Investigate the following:

- Range of movement.
- Tenderness.
- Sounds.
- Locking.
- Muscle tenderness.
- Bruxism
- Head/neck ache.
- Occlusion.

Range of movement

Measure the maximum pain-free jaw opening, then measure the maximum opening possible, at the central incisor tips.

Notes:

- Any lateral deviation on opening is usually towards the affected (i.e. painful) side.
- The lower limit for normal maximum inter-incisal opening is 35 mm (female), 40 mm (male) (approximately 2 patient finger-widths).
- Measurement in millimetres, using a rule or calliper, is preferable to measurement of mouth opening in terms of the number of the patient's fingers that can be inserted.
- Trismus is the inability to open the mouth (see later in this section).

Next, measure the extent of lateral excursion, both pain-free and forced. Measure from the centre lines.

Identify whether limitation is caused by pain or physical obstruction. Observe any lateral deviation.

Notes: • The lower limit for normal lateral excursion is 8 mm, in either direction. • If the left TMJ is painful, the right lateral excursion is usually reduced.	Mandibular movement may be limited by: • Trauma, e.g. third molar surgery, local anaesthetic injection, fracture of mandible, middle third of face or zygomatic arch, laceration of masticatory muscles. • Infection, e.g. pericoronitis, submasseteric, pterygomandibular, infratemporal or parapharyngeal space infections, tonsillitis, mumps, osteomyelitis. • Scar tissue formation, e.g. post irradiation, burns, submucous fibrosis, scleroderma. • Temporomandibular joint disorders. • Central nervous system disorders, e.g. tetanus, meningitis, Parkinson's disease. • Medication/poisons, e.g. phenothiazine group of drugs, strychnine. • Neoplasm, e.g. nasopharyngeal, carcinoma, coronoid hyperplasia. • Psychological factors, e.g. hysteria.
TMJ tenderness • Use bimanual palpation by pressing over the lateral aspect of the joint. Follow this by intra-auricular palpation by placing the little fingers into the external auditory meatus and gently pressing forwards (Figure 6.4).	
TMJ sounds • Clicks are caused by sudden movement of the disc relative to the condyle.	Clicks may be early (i.e. in the early part of jaw opening), late (may indicate greater disc displacement and are often louder), reciprocal (on opening and closing), single (usual), multiple (unstable or perforated disc), loud, quiet, painful or not, and may occur with crepitus.

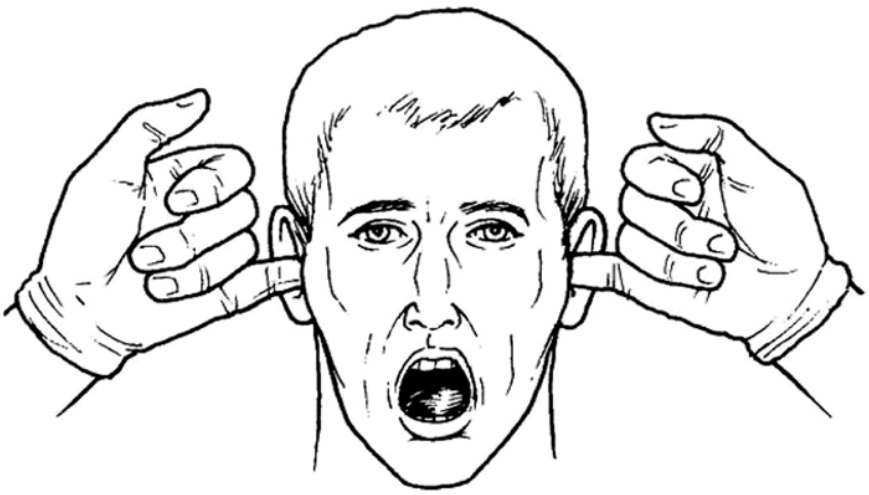


Figure 6.4 Intra-auricular palpation of the temporomandibular joint.

Fifty per cent of the population experience clicking during their life. It is usually of limited duration and if not causing problems should remain untreated.	
Crepitus is a prolonged, continuous, grating or crackling noise.	Crepitus occurs with degenerative diseases and acute inflammation (e.g. after trauma).
TMJ locking Locking is due to malposition, distortion or perforation of the disc, which allows the condyle to rotate but not translate.	The jaw may open up to 20 mm and then 'stick'. Rarely, the jaw may open but fail to close easily.
Dislocation The condyle is displaced over the articular eminence.	This may be caused by trauma (e.g. following a difficult tooth extraction) or, very rarely, on yawning. Bilateral dislocation will cause anterior open bite where none existed previously. Unilateral dislocation will lead to cross bite where none existed previously.

Muscles of mastication Examine for tenderness: • Muscles should be tested where they attach to bone. The body of a muscle is not usually tender.	
• *Masseter:* Originates from the anterior two thirds of the zygomatic arch and inserts into the outer aspect of the angle of the mandible.	Use bimanual palpation, with the finger of one hand intraoral, index and mid finger of the other hand on the cheek. Palpate the origin and insertion.
• *Temporalis:* Originates from the superior and inferior temporal lines above the ear and inserts into the coronoid process and anterior border of the ascending ramus.	Palpate the origin extraorally and insertion intraorally.
• *Lateral pterygoid:* Originates from the lateral surface of the lateral pterygoid plate and inserts into the anterior border of the condyle and disc. It is inaccessible to palpation	Attempts to palpate behind the maxillary tuberosity are unreliable. Resistance provided by the operator's hand to attempted lateral excursion by the patient may elicit lateral pterygoid pain, and is a more reliable guide.
• *Medial pterygoid:* Originates between the medial and lateral pterygoid plates and inserts into the medial surface of the angle of the mandible.	It is not accessible to comfortable palpation.
Occasionally, a more extensive examination may include the sternomastoid, trapezius, and digastric muscles.	

Stage 3. Intraoral Examination (IO)

A systematic approach must be adopted to ensure that all areas are examined. Few patients have died as a result of dental caries but many have died as a result of the late diagnosis of oral cancer.	Dentists have a duty to detect both potentially malignant and malignant oral lesions.
Examine: • Lining mucosa. • Tongue. • Floor of mouth and ventral surface of tongue. • Hard and soft palate. • Throat. • Salivary glands. • Salivary flow. • Periodontium. • Teeth.	
Method • Remove any dentures. • Use gloved fingers or, when access is very limited, two mouth mirrors, to retract the tissues. • Use visual inspection supplemented by palpation of any suspicious lesions.	
Lining mucosa	
Terminology used to describe mucosal lesions: Erosion.	Partial loss of surface epithelium without exposure of underlying connective tissue.
Ulcer.	Full thickness loss of surface epithelium with exposure of underlying connective tissue.
Vesicle.	Circumscribed accumulation of fluid within or below epithelium, less than 5 mm in diameter.
Bulla.	Circumscribed accumulation of fluid within or below epithelium, larger than 5 mm in diameter.
(Note: Intraorally, vesicles and bullae are often found in a burst condition, appearing as ulcers).	
Plaque.	Large circumscribed elevated area.
Papule.	Small circumscribed elevated area.

Macule.	Circumscribed, non-elevated area of discoloration.
Pustule.	Elevated area containing pus.
Sinus.	A blind ended, usually epithelial lined, track. An attempt should be made to express pus from any sinus. The patency of a sinus should be tested using a probe or gutta percha cone.
Fistula.	An epithelial lined tract running between two epithelial surfaces, e.g. mouth to maxillary antrum (oro-antral fistula).

- Record the site, shape, size and quality of the surface of any lesion.
- Draw the lesion and its site in the patient's notes. Record the lesion photographically, if possible.
- Palpate the lesion to determine whether it is soft, firm or hard, whether its edges are well defined or diffuse and whether the lesion is mobile or fixed.
- Develop an order for examining the entire oral mucosa and use this routinely.

A suggested order for examination of the oral mucosa is:

1) Upper and lower labial sulci. Retract the lips, with the mouth half open (Figure 6.5).
2) Cheek mucosa. With the mouth wide open, retract the cheek (Figure 6.6).
3) Upper and lower buccal sulci. Retract the cheek, with the mouth half open.

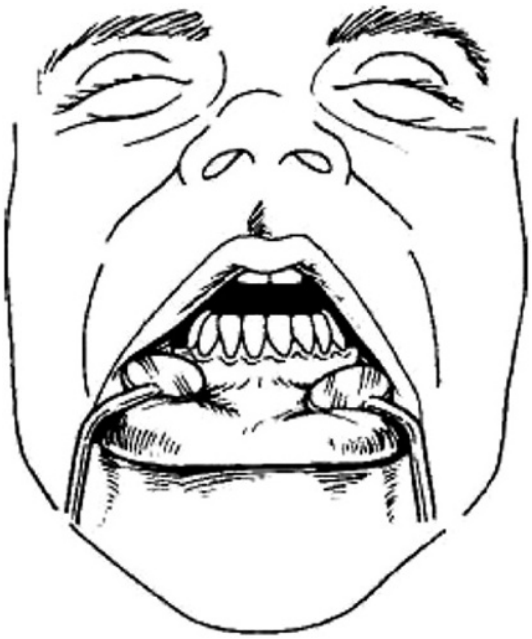


Figure 6.5 Retract the lips and examine the labial mucosa and sulcus with the mouth half open.

Figure 6.6 With the mouth open wide, retract the cheek and examine the buccal mucosa. Then with the mouth half open, examine the maxillary and mandibular sulci. Repeat for the other side of the mouth.

4) Repeat 2 and 3 for the other side of the mouth. 5) Dorsum of the tongue. Inspect at rest and protruded (Figure 6.7). 6) Lateral border. Use gauze to hold the tip of the tongue and move it to one side (Figure 6.8). Retract the cheek and view the lateral border of the tongue. Repeat for the other side.	Note any reduced mobility.
7) Floor of the mouth and ventral surface of tongue (the commonest site for oral cancer).	The floor should be viewed with the tip of the tongue raised to touch the palate (Figure 6.9).

Figure 6.7 Inspect the tongue at rest and protruded.

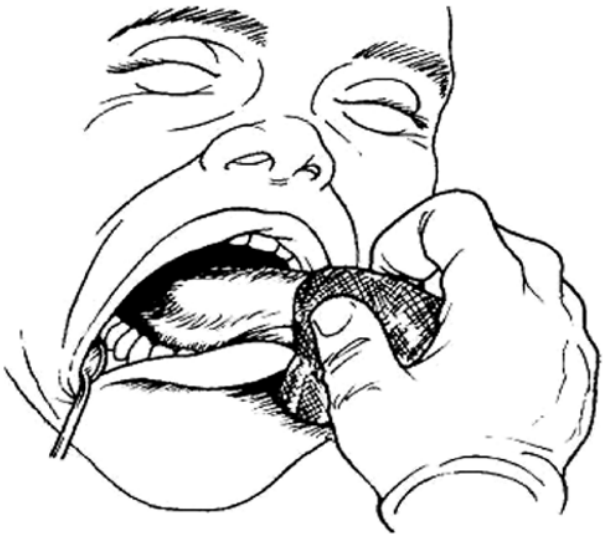
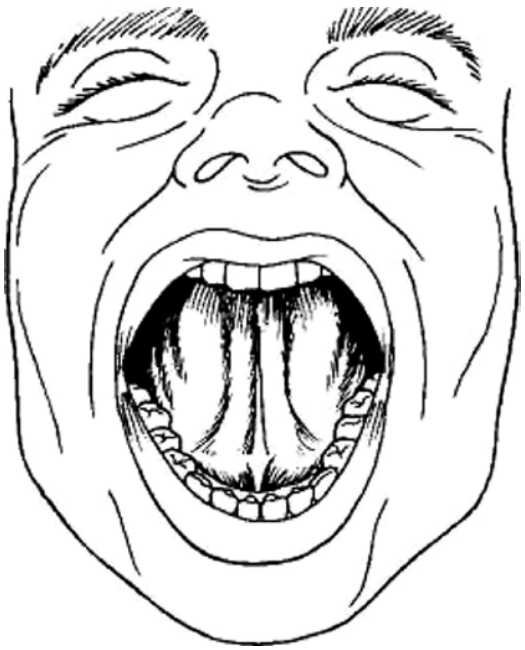


Figure 6.8 To inspect the lateral borders, hold the tip of the tongue with gauze and move it to one side, whilst also retracting the cheek. Repeat for the other side.

Figure 6.9 Examine the floor of the mouth and ventral surface of the tongue with the tip of the tongue touching the palate.



8) Palate (hard and soft). Depress the tongue using a tongue spatula (Figure 6.10).	Visually examine and palpate the hard palate. Visual examination of the soft palate includes its mobility. Request the patient to say 'Ah.'
9) Throat. Depress the tongue, again using a tongue spatula.	Repeat the request to say 'Ah' and view the pillars of the fauces, tonsils, uvula and oropharynx.

Figure 6.10 Tongue depressed, showing hard and soft palate.

Salivary glands	
Use bimanual palpation of the submandibular glands and ducts to detect enlargement, tenderness or calculi.	
Quality and consistency of saliva	
Note the quantity of saliva expressed.	Adhesion of the mirror to the buccal mucosa may indicate reduced salivary production. Bubbles of air in saliva are also suggestive of poor salivary production. Massage of normal major glands will produce a flow of saliva from the duct orifice.
Note the quality and viscosity.	(e.g. sticky, tenacious) of saliva, including any purulent discharge.
Periodontal examination	
Note gingival colour and texture.	Healthy gingivae are light pink, firm, knife-edged and stippled. Unhealthy gingivae are red, soft, swollen, glazed, smooth and may be ulcerated. Unhealthy gingivae will bleed following gentle probing or even spontaneously.
Use a periodontal pocket measuring probe to determine the distribution and severity of any pocketing.	If indicated by BPE score (for basic periodontal examination (BPE), please see Chapter 18).

Teeth	
Tooth mobility (Miller's classification).	
Place the tips of the handles of two dental mouth mirrors onto the buccal and lingual surfaces of the tooth to measure mobility (Figure 6.11).	
• Class 1 – Physiological mobility. • Class 2 – Up to 1 mm transverse movement. • Class 3 – More than 1 mm in any transverse direction or any non-physiological mobility on depression or rotation of the tooth.	*Notes:* • Fremitus is the term given to non-physiological movement of a tooth during function. • Teeth may be mobile as a result of periodontal disease, apical abscess, acute or chronic trauma, or other pathology of the soft or hard tissues.
Dental charting.	The dental chart: • Is a record of current status.

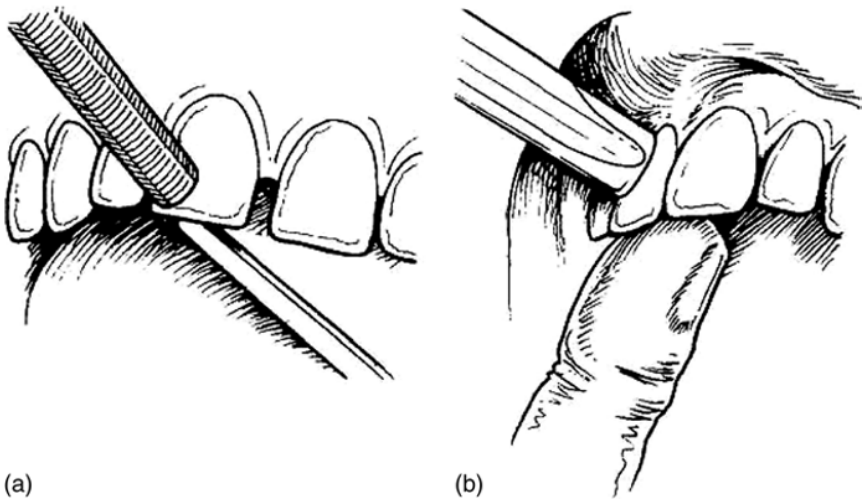


Figure 6.11 Tooth mobility may be assessed using two instrument handles (a) or an instrument handle and a gloved finger (b).

	• Aids treatment planning (if the chart accurately represents oral condition, e.g. size of lesion, priority, etc.).
	• Facilitates third party communication.
	• May be used for forensic purposes. • Is a medicolegal requirement.
A routine must be established when examining the teeth, always starting in the same place and following the same sequence. Absent teeth should be accounted for (i.e. extraction sites, unerupted teeth, teeth not developed).	
Prior to examination, the teeth must be clean.	This may entail scaling, flossing and polishing, if necessary.
Saliva should be controlled by placement of cotton rolls in the sulci. Floss may also prove useful to detect overhangs, caries and open contacts between teeth.	
Diagnosis of dental caries	
Teeth must be cleaned, isolated and dried, as above.	Good lighting is essential and can be augmented by transillumination (especially for suspected anterior approximal lesions), magnification and orthodontic tooth separators. The probe should be used mainly to remove debris and check for surface continuity. The probe must not be thrust into a suspected lesion (a cavity may be made where none existed). 'Stickiness' of a fissure to probing tells more about the sharpness and shape of the probe than the caries status of the fissure!

Look for cavitation, chalkiness, brown/blue/grey discoloration radiating peripherally under enamel from a pit or fissure or under a marginal ridge.	
Examination of existing restorations	
Look for approximal overhangs, marginal ditching, marginal gaps, fracture, wear, voids, contact relationship, marginal ridge height, recurrent caries and aesthetics.	The chart should precisely reflect the size and shape of the restoration and the position and type of any problem identified.
Examination for cracked cusps.	see 'Diagnostic Tests'.
Tooth surface loss (tooth wear) resulting from attrition, abrasion or erosion	
Occlusion (static/functional).	Includes examination for wear facets, fractured restorations or teeth, mobility, malpositioned, tilted teeth.
Static: Intercuspal position. Angle's classification:	
Class I	Mesiobuccal cusp of maxillary first molar lies in the buccal groove of the mandibular first molar.
Class II	Mesiobuccal cusp of the maxillary first molar occludes mesial to the buccal groove of the mandibular first molar.
Division I	Anterior teeth proclined.
Division II	Anterior teeth retroclined.
Class III	Mesiobuccal cusp of the maxillary first molar occludes distal to the buccal groove of the mandibular first molar.
Also note coincidence/non-coincidence of centre lines, overbite (normally, the upper incisors should overlap the lower incisors by one third of their clinical crown), overjet (normal range 2–3 mm), relationship of midlines, occlusal plane orientation, unopposed teeth, over-erupted teeth, submerged teeth and plunger cusps.	
Incisor relationship:	
Class 1	Lower incisor occludes with middle third of palatal surface of upper incisor.
Class II	Lower incisor occludes with cervical third of palatal surface of upper incisor.
Class III	Lower incisor occludes with incisal third of palatal surface of upper incisor or its incisal edge or labial surface.
Dynamic occlusion:	Intercuspal position (ICP), retruded contact position (RCP) and the difference and direction between these.
	Anterior guidance, canine guidance, group function, non-functional contacts, e.g. non-working side interferences.
Parafunction:	Crenations (scalloped areas) on tongue/cheek, tooth wear/tooth restoration fractures, masticatory muscle hypertrophy.
Edentulous ridge	Note degree of resorption, any excess mobility of mucosa ('flabby ridge') and presence of any retained roots.
Dentures:	Kennedy classification, design, age, fit, retention, occlusion.

The Pathological (Diagnostic/Surgical) Sieve

When you have systematically considered the symptoms and signs, the available data may be passed through a diagnostic sieve such as the following:	
Is the condition congenital or acquired?	

Congenital:	
• Congenital lesions are often bilateral	e.g. torus mandibularis.
• Acquired lesions are usually unilateral.	Lichen planus, however, typically presents bilaterally.
Acquired:	
Is the condition: • Infective? • Bacterial, fungal, viral, other? • Acute or chronic? • Neoplastic? Benign, malignant? • Primary, secondary? • Traumatic? Physical, chemical, electrical, thermal, electromagnetic? • Metabolic? • Nutritional? • Drug-related? • Allergic? • Iatrogenic? • Psychological? • Degenerative? • Idiopathic?	Remember – common diseases occur commonly; exclude the most likely (e.g. pulpal pathology) before considering the rarity.

Conclusions

• Following the history and examination it is usually possible to form a provisional diagnosis. • This will be confirmed or rejected by further diagnostic tests.	*Notes:* • Never order tests that you cannot interpret. Always interpret tests that you have ordered. • Any ulcer, lump, red or white patch that does not heal within 2 weeks requires immediate specialist referral.
Referral to a specialist (usually by letter):	Supplementary verbal communication is usually very useful, e.g. with a local specialist or their registrar. In an emergency, refer by telephone.
The referral letter should include: • Name, address and telephone number of referrer.	
• Name, address, telephone number, age and gender of patient.	
• Date of referral. • Reason for referral, including case history, signs, symptoms and provisional diagnosis. • Suggested urgency of referral. • Medical, dental and social history. • Results of any special tests (including radiographs). • Request for opinion only or opinion and treatment.	
Referrals can be made by facsimile.	However, care should be taken to ensure a copy is also sent by post. Referrals should not be made by email, unless an encrypted system is being used.
Patients should never be simply given a letter of referral and dispatched to the local specialist.	This is discourteous to the specialist and to his/her other patients.

Example referral letter:

Professor…
Oral and Maxillofacial Surgery
King's College London Dental Institute
Denmark Hill Campus
London SE5 9RS

Dr S Brown
The Dental Surgery
35 Dane End
London N1 3LP
Tel: 020 8773 2433

22nd February, 2011
Dear Professor…
Re: Mr Charles White. D.O.B 17/2/20. 23 Elgin Court, London, N1 2JK Tel: 0207 233 4455.
URGENT

Mr White attended my surgery 10th February, 2011 for a routine checkup and did not complain of any dental problems. On examination of the left floor of the mouth I found a 5 mm diameter ulcer, with raised edges and a bleeding base. The ulcer was not particularly painful when touched but pressure on the lower denture in the area caused minor discomfort. I could detect no lymph node enlargement.

I relieved the lower denture and arranged to review the problem a week later.

At the review, the ulcer appeared unchanged. However, pressure on the lower denture still caused discomfort in the region of the ulcer. This time I cut the denture completely away from the ulcer site and arranged a second review.

At this second review, the ulcer shows no signs of healing and I am confident that the denture is not implicated. I am concerned that the ulcer may be malignant.

The medical history includes mild angina and chronic bronchitis only. Mr White takes no medication other than aspirin 75 mg and occasional use of glyceryl trinitrate.

Mr White has been edentulous for many years and wears complete upper and lower dentures. He smokes 20 cigarettes per day and drinks 4 or 5 glasses of whisky per week.

I should be grateful if you would examine Mr White urgently and provide any relevant treatment.

Yours sincerely,

Steven Brown

Diagnostic Tests

The list of diagnostic tests included in this section is as follows:

1) Routine 'dental' tests
   - Vitality:
     - Thermal.
     - Electrical.
     - Diagnostic access cavity.
   - Percussion:
     - Tenderness.
     - Percussion note.
   - Mobility.
   - Transillumination.
   - Magnification.
   - Photography.
   - Biting.
   - Auscultation.
   - Diagnostic local anaesthesia.
   - Temperature.
   - Radiography.
   - Simple techniques using radiopaque materials:
     - Soft probes.
     - Removable appliances.
2) Routine 'medical' tests
   - Temperature.
   - Blood pressure.
   - Pulse.
   - Respiratory rate.
   - Body weight.
3) Additional tests
   - Biopsy:
     - Excisional.
     - Incisional.
     - Scalpel.
     - Punch.
     - Needle/trephine/drill.
     - Aspiration.
   - Microbiology (including virology).
   - Cytology.
   - Blood:
     - Biochemistry.
     - Immunology.
   - Cranial nerve tests.
   - Advanced imaging techniques:
     - Computed tomography.
     - Magnetic resonance imaging.
     - Ultrasound.
   - Advanced techniques using radiopaque materials:
     - Arthrography.
     - Sialography.
     - Angiography.
     - Sinus/fistula investigation.
   - Patch test.
   - Urinalysis.

Introduction

- Diagnostic tests should only be conducted after thorough history taking and examination (see earlier sections).
- Tests are used to confirm or deny the provisional diagnosis in an attempt to arrive at a definitive diagnosis.

Do not order a test if you will be unable to interpret the result!

Diagnostic tests are considered under the following four headings:

1) Routine 'dental' tests.
   - These are part of the routine of the general dental practitioner.
2) Routine 'medical' tests.
   - Simple examinations that may be conducted by a nurse or dentist trained in the techniques and able to interpret the results.
3) Additional tests.
   - These may be undertaken in the dental surgery if the necessary equipment is available and personnel are suitably trained. If this is not the case, the patient should be referred to the appropriate centre. Again, the dentist must be able to interpret the results of any tests requested.
4) Referral.
   - For tests which are not usually conducted in the general dental practice.

1. Routine 'dental' tests	
Vitality tests	• These are used to attempt to determine the vitality (or non-vitality) of the dental pulp. • When interpreted with the history and results of the examination, vitality tests may also provide a rough guide to status of inflammatory change of the pulp (pulpitis). • However, results of pulp testing must be interpreted with caution; it only tests the integrity of the nerve supply in the pulp, whereas it is the blood supply that maintains pulpal health. Moreover, false positive and false negative results are common. • Vitality test results do not correlate well with histological changes occurring within the pulp. • Testing should never be limited only to the tooth in question. Surrounding (supposedly healthy) and contralateral teeth should also be tested and the results compared. • Testing should begin on a normal, healthy tooth, rather than a painful tooth or a tooth likely to provide an exaggerated response, to allay the patient's fears. • Testing stimuli should be applied to normal enamel of the crown of the tooth, avoiding any restorations and soft tissues; some restoratives are thermal conductors and may conduct to the soft tissues, whereas others are thermal insulators. More reliable conclusions can be drawn if the results of two different tests are combined (e.g. heat and cold, or cold and electrical tests).
The following vitality tests are described: • Thermal • Electrical • Diagnostic access cavity, without anaesthesia	
Thermal vitality tests	• A healthy tooth with a vital, non-inflamed pulp can usually be stimulated within a temperature range of some 20–50 °C without pain. • Teeth with inflamed pulps (pulpitis) may react with severe pain on temperature stimulation even within the above range. • Extremes of temperature are employed in thermal vitality tests: **Cold** A pledget of cotton wool, held in college tweezers, is soaked in ethyl chloride. As the ethyl chloride evaporates, ice crystals form on the pledget. This process can be speeded up by application of an air blast to the pledget, or waving the pledget in the air. The icy pledget is then applied to the tooth. **Heat** A gutta percha stick is heated in a flame until the tip softens. The hot tip is then applied to the tooth. If the tooth is previously lightly vaselined, the softened gutta percha will not adhere to the tooth.

Electrical vitality tests These offer the advantage of a more controlled, graded stimulus in comparison with thermal tests, as most machines offer a digital display of the stimulus level. However, while this appears more accurate, variations occur, e.g. as the battery discharges.	The teeth to be tested must be isolated with cotton wool rolls and dried. Any moisture on the tooth may conduct electricity into the soft tissues. The electrode in contact with a tooth should not be placed on a restoration; plastic restoratives are electrical insulators, while metals may conduct electricity to the gingival tissues or an adjacent tooth, for example. Likewise, the electrode must not contact soft tissues. For reliable results, good electrical contacts must be made. An electrolyte (e.g. KY® jelly) is usually required on the tip of the testing electrode and some machines require the operator to remove the latex glove from the hand holding the device, to provide a satisfactory earth. The voltage should be gradually increased until a response is elicited.
Results of vitality testing These may be: • Positive (normal). • Exaggerated, brief. • Exaggerated, prolonged. • Negative. • False positive. • False negative. • Inconclusive.	
Positive (normal).	• The test tooth responds in a similar way and to a similar level of stimulation to the other healthy teeth. This result suggests that the pulp is vital and not inflamed.
Exaggerated, brief.	• The test tooth responds more severely than other healthy teeth and/or to a lower level of stimulation. • However, the painful response lasts for less than some 15 seconds after removal of the stimulus. • The tooth may respond more to cold than heat stimulation. • This result suggests that the pulp is vital but inflamed (hyperaemia). • The pulpitis may be reversible if the cause is eliminated. Alternatively, dentine may simply be exposed as a result of a crack, caries, leaking restoration or exposed and sensitive root dentine.
Exaggerated, prolonged.	• The test tooth responds more severely than other healthy teeth and/or to a lower level of stimulation. • The painful response lasts for more than some 15 seconds (and occasionally minutes or even hours) after removal of the stimulus. • The response to heat and electrical stimulation may be greater than to cold. Indeed, cold may reduce the pain. • This result suggests that the pulp is vital but inflamed (acute pulpitis). The pulpitis is likely to be irreversible. *Note:* A very gradual reaction to heat, but not to cold or electrical stimulation, leading ultimately to an exaggerated response, may indicate chronic pulpitis.
Negative.	• The test tooth does not respond to stimulation but healthy teeth do. • This result suggests that the pulp is non-vital and may be necrotic, or that the root canals are sclerosed.
False positive.	• The test tooth responds normally but subsequent events prove the pulpal condition to be abnormal. In multi-rooted teeth: vital tissue remains in one root but the remaining pulp is necrotic. In a root canal filled with pus: conducts stimuli. In a root canal filled with gas: heat causes expansion.
	A frightened patient or a patient with a low pain threshold may report a painful response even before the stimulus is applied to the tooth!
False negative.	• The test tooth does not respond to stimulation but subsequent events prove the pulp to be vital. • This may occur: – If the pulp is well insulated from thermal and electrical stimuli, e.g. plastic restoration, secondary dentine. The latter partly explains the common occurrence of false negative responses from elderly teeth. – If the nerve supply to the pulp is damaged, e.g. following trauma. – In patients with a high pain threshold. – With faulty technique or equipment.

Inconclusive.	• All teeth give exaggerated responses or, conversely, no teeth respond! • Alternatively, different tests give conflicting results or the same test repeated subsequently gives conflicting results. • If the results of two tests (e.g. heat and cold) are inconclusive, add a third test (e.g. electrical). If doubt still exists, consider cutting a diagnostic access cavity, without local anaesthesia, as follows.
Diagnostic access cavity without local anaesthesia	• Cutting a small cavity in the suspect tooth without anaesthesia is probably the most reliable vitality test. • If the pulp is vital, a response is usually elicited as the dentine is entered. • Since this test is destructive, it should be considered only as a last resort.
Percussion tests	• These are conducted by gently tapping a tooth with the tip of a dental mirror handle. • Two characteristics are noted: tenderness to percussion and a dull percussion note. • Both characteristics denote inflammation of (and accumulation of fluid in) the periodontal ligament. • Greater tenderness to percussion in an apical direction suggests apical periodontitis. • Greater tenderness to percussion in a lateral direction suggests acute periodontitis of gingival origin (lateral periodontitis). • As in vitality testing, a number of teeth should be tested in addition to the suspect tooth, and testing should begin on a healthy tooth. • Percussion testing must be conducted with *great* care because teeth with periodontitis may be exquisitely tender.
Mobility	• Tooth mobility is assessed by use of two instrument handles, one placed buccal and the other lingual on the tooth. • Alternatively, a finger may substitute for one of the instruments. • Increased mobility is caused by:
Reduced bone support:	• Periodontal disease. • Bony cyst. • Neoplasm.
Abscess or inflammation of the periodontal ligament:	• Apical periodontitis. • Periodontitis of gingival margin. • Occlusal trauma. • Acute trauma. • Crown or root fracture. • Fracture of supporting bone.
Transillumination	• A dedicated light source may be purchased. • Alternatively, a composite curing light can be employed. • Less satisfactory is reflection of light from the operating lamp by a dental mirror. Transillumination is useful in the diagnosis of: • Tooth cracks. • Interproximal caries in anterior teeth. • Interproximal caries in posterior teeth, where there is sufficient access. Intraoral transillumination in a darkened room has been employed in the diagnosis of maxillary sinusitis.
Magnification	• Magnification (2×–4×) by lenses, loupes or video camera is generally useful to supplement naked eye examination of the oral cavity. • It is particularly useful in the diagnosis of caries, tooth and restoration cracks, examination of restoration margins and identification of root canals during endodontic therapy.
Photography	• May magnify a lesion, facilitating diagnosis. • Maintains a record of a lesion over time, enabling a more accurate judgement of healing or sinister change. • May be helpful in medicolegal matters.
Biting	• Biting on a roll of rubber dam material, a rubber or wood point or dedicated, pyramidal shaped, plastic instrument may assist in the diagnosis of a cracked tooth.
Auscultation	A stethoscope placed over the temporomandibular joint may occasionally assist in the diagnosis of joint clicks or crepitus.

Diagnostic local anaesthesia	• Dental pain, particularly that of pulpitis, is often very difficult to localise to the offending tooth. • Indeed, the patient may not even be certain from which jaw the pain arises. • Elimination of pain, e.g. following a mandibular nerve block, or persistence of pain localises the cause to the correct jaw and may help to confirm a dental aetiology. • Infiltration anaesthesia may be used to localise a causative tooth.
Temperature	• Should usually be measured using a clinical thermometer. • However, raised body temperature can be roughly gauged by placement of the back of the operator's ungloved hand on the patient's forehead. • The temperature of an accessible facial swelling can be gauged by placing the backs of the operator's ungloved fingers on the swelling (Figure 6.12).

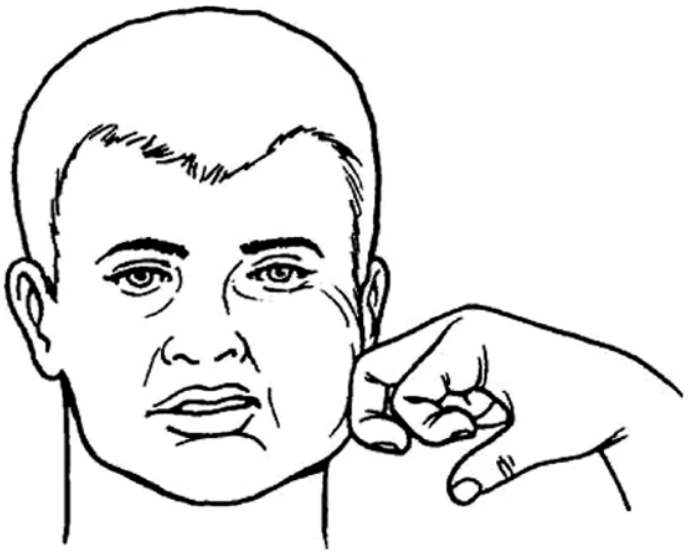


Figure 6.12 The temperature of an accessible facial swelling can be gauged by placing the backs of the operator's ungloved fingers on the swelling.

Radiography	
The following techniques are suitable for use in general dental practice where appropriate facilities exist:	
Bitewing	Crowns of teeth, caries (particularly interproximal lesions), restorations, alveolar bone height (if bone loss is only modest). Extension of fissure caries into dentine will only be visible if the lesion is large.
Periapical	Root and surrounding bone.
Parallax technique (Figure 6.13)	• Two periapical films, exposed at slightly different anteroposterior angulation, assist in the assessment of the buccolingual position of unerupted teeth, particularly maxillary canines. • The most *palatal* tooth appears to move in the *same* direction as the tube is moved. • The most *buccal* tooth appears to move in the *opposite* direction to the tube.
Panoral	General view of teeth, jaws, temporomandibular joints, maxillary sinuses, etc. Detail in the midline is obscured by superimposition of the cervical spine.
Lateral oblique	General view, as above. May be used where panoral facilities are not available.

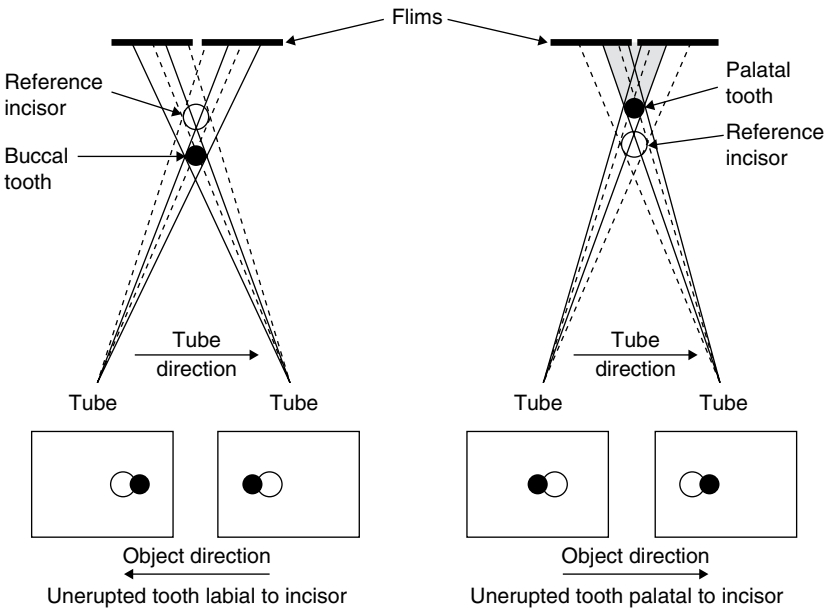


Figure 6.13 Localisation by parallax: the more palatal object moves in the same direction as the tube; the more buccal object moves in a direction opposite to the tube.

Maxillary anterior occlusal	Roots of maxillary anterior teeth.
Mandibular occlusal	Calcification in the floor of the mouth, including submandibular gland and duct, buccolingual displacement of mandibular fractures.
Transpharyngeal	Temporomandibular joint.
Occipitomental	Maxillary sinuses, facial and skull bones.
Postero-anterior and lateral skull	Skull and facial bones. Useful in orthodontic assessment.
Stereoscopic radiography	• Two radiographs of the same area are taken but at a slightly different angle to each other. • These are placed in a stereoscope and the mirrors adjusted until the two images come into focus, producing a 3D effect. The technique is particularly useful for detailed examination of fractures.
Simple techniques using radiopaque materials	
Soft probes	• Soft probes (including endodontic silver or gutta percha points) may be inserted along sinuses, e.g. dental sinuses, to lead to the offending tooth apex and viewed radiographically. • In a similar way, one or more needles may be inserted into tissue to localise a foreign body.
Removable appliances	• Wax base plates containing identifiable metal markers can be placed over the alveolus prior to recording a radiograph. • This may be useful, e.g. in localising a retained root at surgery.
2. Routine medical tests The following tests may be undertaken in the dental surgery if the necessary equipment is available and personnel are suitably trained:	

Temperature	• Body temperature, measured by sublingual placement (minimum 3 minutes) of a clinical thermometer, should be within the range 36.2–37.8 °C. • Axillary temperature is slightly lower (and rectal temperature slightly higher) than sublingual temperature. • Body temperature varies slightly during the day, being higher during the evening than in the morning. • Body temperature may be raised due to: – Infection. – Surgery. • Body temperature may be lowered due to: – Hypothermia. – Severe shock.
Blood pressure	• Is measured using a sphygmomanometer. • Is subject to wide variation within groups. • Increases with increasing age. • Is normally within the range 120–140 mmHg (systolic), 60–90 mmHg (diastolic). • Raised diastolic pressure is more significant than raised systolic pressure. • Raised blood pressure (hypertension, hyperpiesis) may be due to: – Essential (idiopathic) hypertension (80%). – Kidney disease (19%). – Rare disorders (1%): ○ Conn's disease. ○ Cushing's syndrome. ○ Phaeochromocytoma. ○ Coarctation of the aorta. ○ Raised intracranial pressure. – A patient with raised blood pressure should be referred for full medical examination. – Lowered blood pressure (hypotension) may be due to: ○ Shock. ○ Haemorrhage. ○ Cerebrovascular accident. ○ Myocardial infarction.
Pulse	Should be measured at both wrists because there may be variations between the sides.
Pulse rate	• In adults is normally 60–80 beats per minute. • Is higher in infants (up to 140 beats per minute). • May be lowered (bradycardia) in: – Athletes. – Old age. – Hypothyroidism. – Heart block. – Vasovagal attack. • May be raised (tachycardia) in: – Thyrotoxicosis. – Infection. – Paroxysmal tachycardia. – Exercise. – Emotional upset.
Pulse rhythm	• The pulse should be regular. • However, it tends to increase with inspiration and decrease with expiration. • If this variation is marked, it is called 'sinus arrhythmia'. • Common irregularities are extrasystoles which disappear on exercise. They are of no clinical significance. • Atrial fibrillation is described as 'irregular irregularity' and is associated with serious problems including: – Thyrotoxicosis. – Mitral stenosis. – Cardiac ischaemia.

Respiratory rate	• Normal adult respiratory rate is within 12-20 breaths per minute. • Is faster in infants and slower in old age. • Is increased by: – Thyrotoxicosis. – Infections, particularly chest infections. – Pulmonary oedema. – Shock. – Exercise. – Emotional upset. • May be decreased by: – Rest and during sleep. – Narcotic drugs.
Cheyne –Stokes respiration	• Characterised by a repeating cycle of greatly reduced respiration (apnoea) followed by a gradually increasing rate to a maximum only to be followed by a gradual reduction to apnoea again. • Cheyne–Stokes respiration is seen in the gravely ill: – Cerebrovascular accident. – Meningitis. – Severe kidney disease.
Body weight	• A patient may be above or below the 'normal' weight. • Sudden increase or loss of weight demands referral for full medical examination. • Average body weight of populations in industrialised countries is increasing. • Increase in body weight may be due to: – Overeating. – Lack of exercise. – Pregnancy. – Any condition causing fluid retention. – Adverse reaction to drugs. – Loss of weight may be due to: – Anorexia nervosa. – Bulimia. – Diabetes mellitus. – Tuberculosis. – Thyrotoxicosis. – Malignancy. – Dieting.
3. Additional tests The collection of specimens and conduct of some of the following tests may be undertaken in the dental surgery if the necessary equipment is available and personnel are suitably trained. If this is not the case, the patient should be referred to the appropriate centre. However, a referring practitioner still maintains a responsibility for the patient.	
Biopsy	• Is the removal of tissue for further (usually histological) examination. • Should be carried out whenever a suspicious lesion is encountered or a diagnosis cannot be made with any certainty. • All intraoral red lesions and non-removable white lesions should be biopsied (unless the diagnosis is certain and innocuous, e.g. aspirin burn). • Any tissue that is excised should be sent for histological examination, even if the clinical diagnosis seems reasonably certain. • If the dentist is suspicious that a lesion may be malignant, the patient should be referred (urgently) for biopsy. In all other cases a specimen should be sent for examination. • Biopsy specimens must be large enough for adequate histological examination; they should not be smaller than 1.0 cm × 0.5 cm. • Avoid crushing, tearing or burning the specimen (electrosurgery may make histological examination difficult).

Biopsy methods

- Excisional
- Incisional:
  - Scalpel
  - Punch
  - Needle/trephine/drill
  - Aspiration

Excisional biopsy

- Usually applicable to discrete lesions, smaller than 1 cm diameter.
- Used only when the clinician is fairly certain that the lesion is benign.
- May risk shedding malignant cells if the provisional diagnosis of benign lesion is incorrect. However, the clinical value of biopsy far outweighs this risk.
- Constitutes the definitive treatment if the diagnosis of benign lesion proves correct.

- **Method** Administer local anaesthetic, by regional block where possible. In any event, local anaesthetic should not be closer than 2 cm from the site, to avoid 'waterlogging' of the specimen with anaesthetic solution. Stabilise the lesion by transfixing it with a suture (Figure 6.14). (Many specimens are ruined by crushing with tissue forceps.)

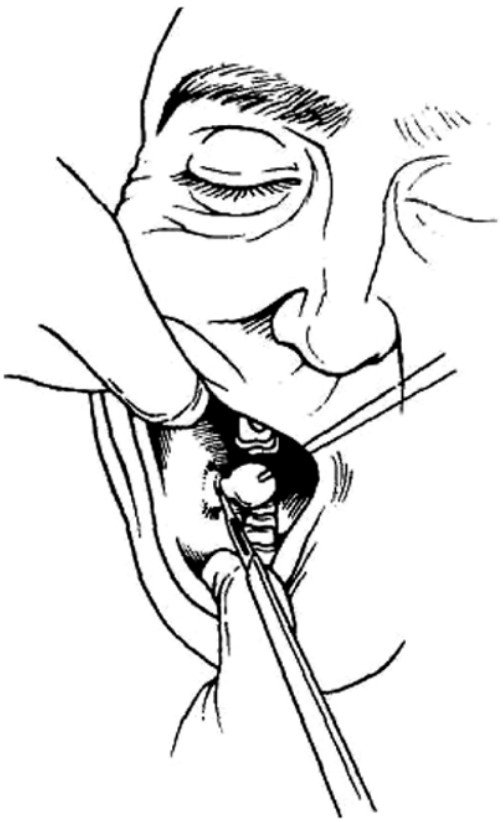


Figure 6.14 Excisional biopsy: stabilise the lesion by transfixing it with a suture. Stabilisation by tissue forceps may damage the specimen.

• Apply traction to the lesion via the suture. • Incise the mucosa around the base of the lesion in an elliptical shape. • Use a combination of blunt and sharp dissection to detach the lesion. • Place the specimen immediately in an appropriate, labelled, screw-top specimen bottle containing fixative (usually 10 times the specimen's volume of 10% formalin/formol saline). • Close the wound using sutures.	
Incisional biopsy	• Applicable if the lesion is large or there is a suspicion of malignancy. • May risk shedding malignant cells. • Incisional biopsy should *not* be performed on pigmented or vascular lesions. (Melanoma is highly metastatic and a vascular lesion may bleed excessively.) • Record the position, size and shape of the lesion in the patient's record.
Method • Administer local anaesthesia, as described above. • Identify the apparent junction between normal tissue and the lesion. Select the specimen across this region. • Stabilise the specimen with a suture (tissue forceps may crush the specimen). • Dissect the specimen from the edge of the lesion and include a margin of apparently normal tissue. • The specimen should include a representative area of the lesion. Avoid necrotic areas of the lesion. • If the lesion is close to bone, avoid perforating the periosteum (this is to maintain the tissue boundary, in case the provisional diagnosis of benign lesion is incorrect). • Place the specimen immediately in a prescribed specimen bottle containing (usually) 10 times the specimen's volume of fixative (e.g. 10% formalin/formol saline). • *Note:* If specimens are to be subjected to immunofluorescent investigations, they should not be fixed. Instead they should be sent for immediate freezing at −70 °C in liquid nitrogen. • Close the surgical site by sutures.	
Punch biopsy	• A surgical instrument is used to punch out a representative portion of tissue. • Because the resulting specimen is often damaged by the procedure, biopsy by scalpel is preferred.
Needle/trephine/drill biopsy	• These techniques have been employed to biopsy deep-seated fibro-osseous lesions. The resulting specimen is small, may be non-representative and is often damaged by the procedures; they are not often used.
Aspiration biopsy (see below for details of method)	• Is applicable to many cystic and fluctuant (i.e. fluid-containing) lesions. • Failure to aspirate from a lesion suggests that it is solid. • Is preferable to incisional biopsy of vascular lesions (e.g. haemangioma) due to the risk of excessive bleeding. • Aspiration of air from the molar region of the maxilla suggests that the needle is in the maxillary sinus. This may help to differentiate the sinus from a possible cyst. • Aspiration of air from a cystic mandibular lesion suggests a solitary (haemorrhagic) bone cyst. • Aspiration of blood suggests a haematoma, haemangioma or blood vessel. • Aspiration of pus indicates an abscess or infected cyst. • Aspiration of keratin, which looks like pus but has no unpleasant smell, indicates an odontogenic keratocyst. • Aspiration of a straw-coloured fluid containing crystals (of cholesterol) indicates a periodontal or dentigerous cyst.The presence of keratin squames on microscopic examination of the aspirate from a cyst suggests odontogenic keratocyst.

Microbiology	• Liaise with the testing laboratory to obtain swabs, specimen bottles, request forms, etc., and details of preferred method of delivery and protective packaging. • Ideally specimens should be taken before antimicrobial treatment is commenced. • Allows the identification of organisms causing infections of dental origin. • Organisms' sensitivity to various antibiotics can be determined, to facilitate the most effective treatment. • *Note:* Treatment of acute dental infections must be instituted before microbiological and antibiotic sensitivity test results are available. • Where possible, samples of pus should be obtained by aspiration. • If insufficient pus is available for aspiration, a swab should be used. • Swab specimens should be taken at the time of surgical drainage.
Method for aspiration biopsy • Clean the tissue over the proposed aspiration site, using a mild antiseptic. • Inject local anaesthetic solution over (not into) the lesion. Select a wide-bore needle and 10 ml syringe. Penetrate the tissue and aspirate fluid. • Transfer the aspirate into a screw-top specimen bottle. (Do not fill the bottle more than two thirds full.)	
Method for obtaining a swab specimen at the time of drainage • Administer local anaesthetic if injection into inflamed tissues can be avoided. Otherwise use refrigeration anaesthesia by spraying ethyl chloride over the surface of the abscess. Alternatively, surface local anaesthesia or relative analgesia may be employed. • Make a drainage incision by cutting upwards with a No.11 blade (Figure 6.15). (Cutting downwards with a No.15 blade will cause pressure in the abscess and pain, when refrigeration anaesthesia is used.) • Open the walls of the drainage incision for access for the swab by inserting the blades of sterile sinus forceps (Figure 6.16). • An assistant should then insert the swab, take a sample of pus, then remove it without touching any other tissue. • Seal the swab in its container, ensuring no contact of the swab with the external surface of the container or hand during insertion.	

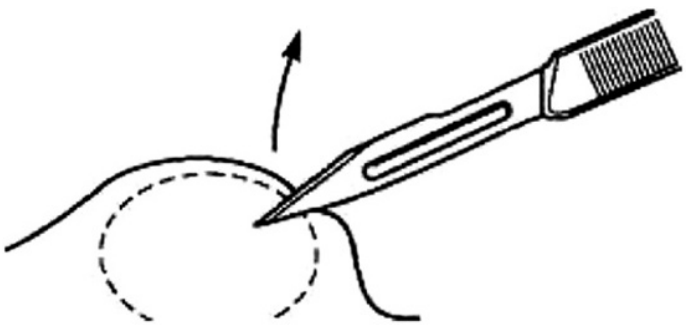


Figure 6.15 When using refrigeration anaesthesia (ethyl chloride spray) make the drainage incision by cutting upwards with a No. 11 blade.

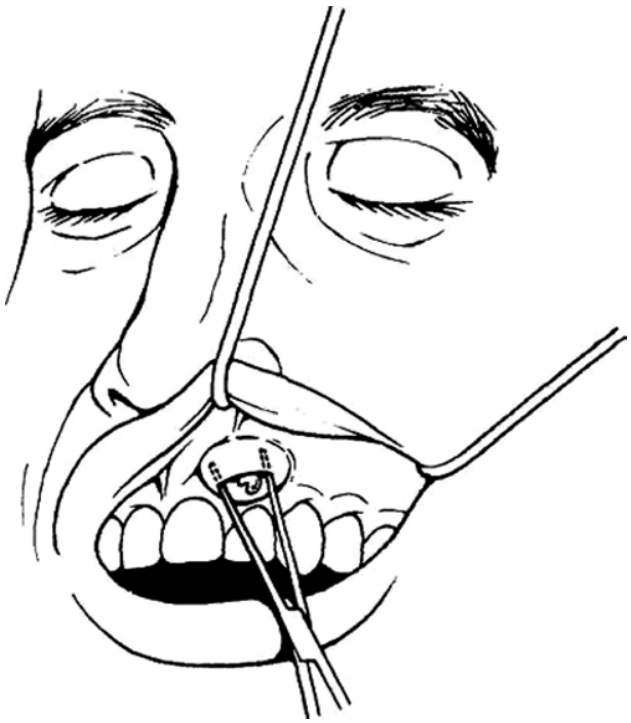


Figure 6.16 Method for obtaining a swab specimen at the time of surgical drainage: open the drainage incision for access for the swab by inserting sinus forceps blades.

Note: In suspected candidosis, the surface of the lesion or the related fitting surface of a denture may be swabbed.	
Viral infections	• Swabs must be sent in a dedicated viral transport medium for culture or electron microscopy. Dry swabs are of no diagnostic value. • A blood specimen (10 ml in a plain container) should also be taken for serology. • Particular care must be taken when obtaining and transporting especially hazardous specimens, e.g. viral hepatitis, HIV. Contamination of the external surfaces of the specimen tube and needlestick injury must obviously be avoided.
Exfoliative cytology	• Is the microscopic study of cells exfoliated or scraped from the surface of a lesion. • Is an adjunct to biopsy, not a substitute. • Is indicated when biopsy cannot be undertaken, is refused by the patient, where multiple lesions need investigation, or where serial specimens need to be taken frequently over long periods. • If interpretation of a cytological specimen is in doubt, a biopsy is indicated. *Notes:* 1) In suspected syphilis, oral lesions should be cleaned with saline before a smear is made for dark ground examination. A blood specimen (10 ml in a plain container) should also be sent for rapid plasma reagin (RPR) and *Treponema pallidum* haemagglutination (TPHA) testing. 2) If tuberculosis is suspected, this must be stated on the request form.

Method

- Do not wipe the surface of the lesion except to remove necrotic material.
- Ensure the surface of the lesion is moist. (Do not dry the surface.)
- Scrape the surface of the lesion with the edge of a sterile flat plastic instrument or moistened wooden tongue spatula.
- The scraping action should be repeated several times in the same direction.
- The scrapings obtained should be transferred to a previously labelled microscope slide and spread over the slide surface using the edge of another slide.
- Immediately fix the specimen using an appropriate fixative (e.g. 10% formalin/formol saline).

Labelling of specimen bottles and completion of request forms:

- All specimen bottles must be labelled with the patient's details.
- Specimens must be accompanied by a completed request form.
- The request form should include details of the provisional diagnosis, history of any antimicrobial therapy and any drug allergies.
- The request form must also include adequate clinical information to allow accurate interpretation of the test results.
- This may include:
  - A diagram of the specimen.
  - Clinical features (size, site, colour, consistency, mobility, associated lymphadenopathy, etc.).

Transportation of clinical/pathological specimens

A triple packaging system should be used (primary container, secondary container, outer packaging).

- Specimens must be collected into the appropriate primary container.
- The primary container must be leak proof.
- Liquid specimens must not fill the primary container at 55 °C.
- The primary container must be labelled appropriately.
- The primary container must be placed into a watertight secondary container.
- For liquid specimens, sufficient absorbent material to absorb the entire contents of the primary container must be placed between the primary and secondary container.
- The primary and secondary containers must be placed into an outer package.
- The request form must be properly filled in.
- Between the secondary container and the outer package, the following are required:
  - An itemised list of contents.
  - The request form.
  - Name and address of the recipient.
  - Name and address of the sender.
  - Contact telephone number.
- On the outer packaging include:
  - Name and address of the recipient.
  - Name and address of the sender.
  - A contact name with an emergency contact number.
  - An 'Infectious Substance' sticker.
- When possible, specimens should be delivered to the laboratory by hand. Specimens transported through the post may be damaged, delayed or lost.
- Specimens sent by post are subject to specific regulations, which are subject to change.

Blood	
Venepuncture	• Liaise with the haematological laboratory to obtain report sheets, blood specimen bottles and information relating to the quantity of blood required for the tests. • Blood for film, red cell indices, white cell and platelet counts is usually collected in an ethylenediaminetetraacetic acid (EDTA) tube. (The EDTA prevents the specimen clotting.) • Blood for Paul–Bunnell test, serum iron and blood grouping is usually collected in a plain tube. • Blood for erythrocyte sedimentation rate (ESR) and prothrombin time is usually collected in a citrated tube.

Method

- The site for venepuncture is usually at the level of the elbow of the arm, the antecubital fossa.
- The preferred site is the lateral aspect of the antecubital fossa.
- The medial aspect of the antecubital fossa may also show prominent veins but a superficial branch of the brachial artery may also be present and is to be avoided.
- The basilic and cephalic veins (Figure 6.17) are joined by the median cubital vein. If the median cubital vein is V-shaped, the two arms of the V are the median basilic and median cephalic veins.
- The median basilic vein is the usual site for venepuncture. However, select a vein that can be felt as well as seen.
- Palpate the vein to confirm that it is indeed a vein and not an artery. Arteries pulsate; veins do not.
- Support the patient's arm on a table or the arm of the dental chair and extend the elbow.
- Apply a tourniquet or sphygmomanometer cuff (inflated to 80 mmHg) to the upper arm.
- Distend the veins by asking the patient to clench the fist several times. Further distension can be achieved by lightly tapping the skin over the veins.
- Clean the proposed puncture site with an antiseptic swab.
- Steady the vein by stretching the skin over the vein with the fingers of one hand.
- Puncture the skin 1 cm distal to the site at which the lumen is to be entered.
- The needle should be bevel uppermost, should lie parallel to the vein, and be held at an angle of 30 degrees to the skin.
- The fact that the lumen has been entered is confirmed by withdrawal of blood when the plunger of the syringe is withdrawn.
- Aspirate the required quantity of blood.
- Hold an antiseptic swab over the puncture site and withdraw the needle.
- Exert pressure over the site when the needle has been withdrawn, to prevent haematoma formation. The patient can maintain this pressure for a few minutes simply by flexing the forearm.

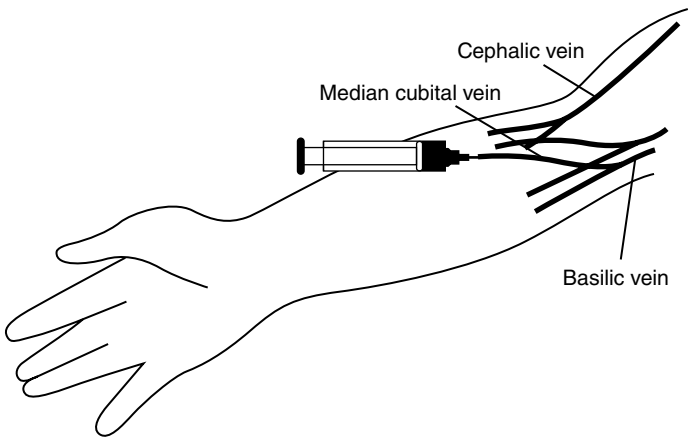


Figure 6.17 The site for venepuncture is usually the antecubital fossa.

A **full blood count measures:**
- Red cell count.
- Haemoglobin.
- Packed cell volume (haematocrit).
- Mean cell volume.
- Mean cell haemoglobin.
- Mean cell haemoglobin concentration.
- White cell count.
- Platelet count.

Data	
Red cell count (RBC): males $4.5–5.8 \times 10^{12}$/l, females $3.8–5.8 \times 10^{12}$/l.	Raised in polycythaemia, lowered in anaemia.
Haemoglobin (Hb): males 13.0–16.5 g/dl, females 11.5–15.5 g/dl.	Raised in polycythaemia, lowered in anaemia and after haemorrhage.
Packed cell volume (PCV) (haematocrit, HCT): males 0.4–5.4 l/l, females 0.37–0.47 l/l.	Raised in polycythaemia, lowered in anaemia.
Mean cell volume (MCV): 77–95 fl.	Raised (macrocytosis) in vitamin B_{12} and folate deficiency and alcoholism, lowered (microcytosis) in iron deficiency anaemia.
Mean cell haemoglobin (MCH): 25–34 pg. Determined by dividing haemoglobin (Hb) by the red cell count (RBC).	Raised in pernicious anaemia, lowered in iron deficiency anaemia.
Mean cell haemoglobin concentration (MCHC): 32–37 g/dl. Determined by dividing haemoglobin (Hb) by the packed cell volume (PCV).	Lowered in iron deficiency anaemia (for which it is the most reliable test).
White cell count (WBC/WCC): $4–11 \times 10^9$/l.	Raised in leukaemia and infection, lowered (leucopenia) in immunosuppression, aleukaemic leukaemia, aplastic anaemia and some viral infections.
Neutrophils: $2.2–6.3 \times 10^9$/l.	Raised with infection, trauma and malignancy. Lowered by some drugs and bone marrow disease.
Lymphocytes: $1.3–4.0 \times 10^9$/l.	Raised in leukaemia and glandular fever. Lowered by immune defects (e.g. HIV, AIDS).
Monocytes: $0.2–1.0 \times 10^9$/l.	Raised in monocytic leukaemia and glandular fever. Lowered by immune defects.
Eosinophils: approx. $0.0–0.4 \times 10^9$/l.	Raised with allergy and all parasitic diseases. Lowered by immune defects.
Platelets (PLT): $150–450 \times 10^9$/l.	Raised (thrombocytosis) in chronic inflammatory conditions and myeloproliferative disease, lowered (thrombocytopenia) in HIV, leukaemia and connective tissue diseases.
Erythrocyte sedimentation rate (ESR): male: 1–10 mm per hour; female: 1–15 mm per hour.	A raised ESR is an important non-specific indicator of disease, ranging from infection to malignancy.
Reticulocytes: constitute up to 6% of RBC (children), 0.2–2.0% RBC (adults).	Raised with increased marrow activity (e.g. after haemorrhage).
Coagulation screening Prothrombin international normalised ratio (INR): normal range 0.9–1.2. Prothrombin time (PT): normally 10.3–13.3 seconds. Activated partial thromboplastin time (APTT) ratio: normal range 0.85–1.15. Fibrinogen level: normal range 1.5–4.5 g/1. Factor VIII level: normal range 50–150 u/dl.	Haematology report may mark abnormal results low (L), high (H) or critical (C).
Blood film terminology A normal red cell is described as normocytic (normal size) and normochromic (normal colour).	
Abnormalities of size and shape	
Macrocyte	Red cell larger than normal (e.g. vitamin B_{12}, folate deficiency).
Megaloblast	Nucleated red cell larger than normal (e.g. megaloblastic anaemia).

Microcyte	Red cell smaller than normal (e.g. iron deficiency).
Anisocytosis	Red cells vary in size (e.g. iron deficiency).
Poikilocytosis	Red cells vary in shape (e.g. iron deficiency).
Sickle cell	Sickle-shaped red cell (e.g. sickle-cell anaemia).
Acanthocyte	Red cell with a spiky projection (e.g. haemolytic anaemia)
Spherocyte	Red cell spherical in shape (e.g. hereditary spherocytosis).
Abnormalities of colour	
Hypochromia	Pale red cells (reduced haemoglobin content) (e.g. iron deficiency).
Anisochromia	Irregular staining (e.g. severe anaemia).
Polychromasia	Red cells vary in staining (e.g. following blood loss).
Target cell	Pale red cell with aggregation of haemoglobin in the centre (like an archery target) (e.g. iron deficiency).
Abnormality of shape and colour	
Leptocyte	Red cell thin and pale (e.g. thalassaemia).
Immature red cells	
Blasts	Nucleated precursors are not normally present (except in the newborn infant). Their presence suggests severe anaemia, leukaemia, multiple myeloma.
Myelocytes	
Metamyelocytes	e.g. malignant bone marrow disease
Promyelocytes	
Normoblasts	
Reticulocytes	e.g. haemolysis
Blood biochemistry • Contact the laboratory to determine the quantity of blood required and the appropriate specimen tube. • Most biochemical tests can be carried out on serum. Thus, blood should be collected in a plain tube. • For analysis of electrolytes and proteins, plasma is required and blood should be collected in a lithium heparin tube. • For blood glucose analysis, blood should be collected in a fluoride bottle.	
Alkaline phosphatase (30–130 IU/1).	Lowered in hypothyroidism.
Calcium (2.2–2.6 mmol/1). Raised in hyperparathyroidism, bone malignancy and sarcoidosis.	Lowered in hyperparathyroidism and rickets.
Phosphate (0.8–1.7 mmol/1).	Raised in bone disease, lowered in hyperparathyroidism.
Ferritin (serum iron) (0–300 µg/l male, 0–200 µg/l female). Raised in leukaemia, lymphoma and other malignancies.	Lowered in iron deficiency anaemia.
Folate (3–13 µg/1).	Lowered in dietary deficiency, alcoholism, haemolytic anaemia and certain drugs, e.g. phenytoin.
Plasma glucose (3.0–7.0 mmol/l) (fasting).	Raised in diabetes mellitus.
Vitamin B_{12} (180–1100 ng/1).	Raised in leukaemia, lowered in pernicious anaemia, dietary deficiency.
Blood immunology • Most tests are carried out on serum and blood should usually be collected in a plain tube. • However, serum for some tests requires special handling. Details should be obtained from the laboratory. • Autoantibodies of interest to the dentist include:	
• Epithelial basement membrane.	Pemphigoid.

• Epithelial intercellular cement.	Pemphigus.
• Rheumatoid factor.	• Rheumatoid arthritis. • Systemic lupus erythematosus.
• Salivary duct antibody.	Sjögren's syndrome.
• Immunoglobulins.	IgG – raised in pemphigus, myelomatosis and connective tissue diseases. IgG, IgA and IgM – all lowered in immunodeficiency states.

Cranial nerve tests

I. Olfactory nerve

Responsible for the perception of smell.	• Loss of smell (anosmia) is more often due to nasal mucosal inflammation than olfactory nerve damage. • Thus, the patient should first be questioned about nasal discharge. • The patency of the nasal passages may be tested by asking the patient to sniff, as each nostril is closed in turn by finger pressure. • However, olfactory nerve damage may occur with fractures of the ethmoid bones or a tumour of the anterior cerebral fossa. **Test** The patient (with eyes closed or blindfold) is asked to identify various common substances by smell only. Substances may include lemon, peppermint, etc. Each nostril is tested separately, the other being occluded. • Altered perception of smell may also occur with: – Phenytoin. – Epilepsy. – Migraine. – Depression (and other psychological/psychiatric conditions).

II. Optic nerve

Responsible for vision.	
Visual acuity	
Visual acuity is assessed (usually following referral) using Snellan's chart placed at 6 m from the patient.	
Visual fields	
Visual fields are assessed by the 'confrontation' test, where the patient's field of vision is compared to that of the clinician (Figure 6.18).	
Method The clinician sits opposite the patient, approximately 1 m away with eyes at the same level. The patient covers the left eye and stares with the right eye into the clinician's left eye. At the same time, the clinician covers his right eye and stares into the patient's right eye. The clinician then places his left hand with a finger outstretched outside the periphery of his field of vision and between himself and the patient. The finger is then drawn into the clinician's field of vision and the patient asked to report when the clinician's finger becomes visible. Each eye is tested in this way to include the nasal, temporal, superior and inferior fields.	

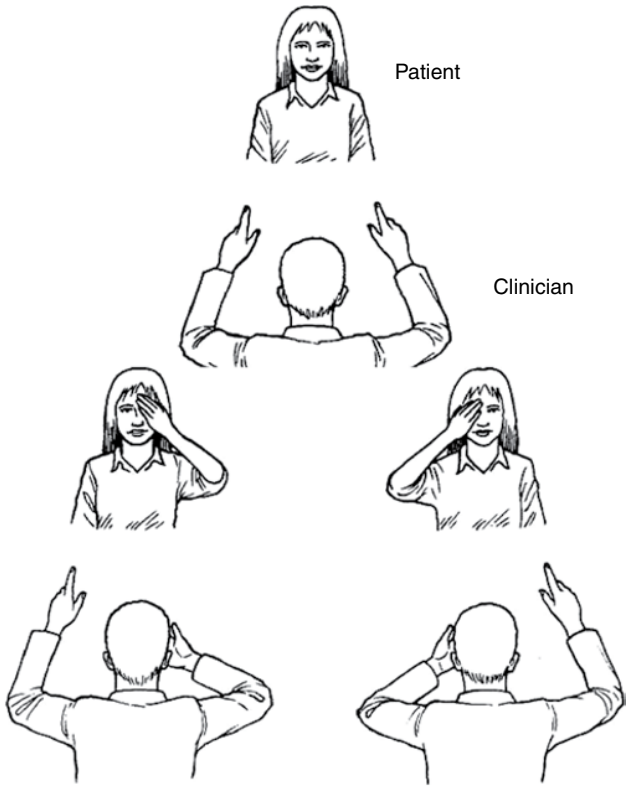


Figure 6.18 Testing the visual fields: 'confrontation' test.

Light reflex • The light reflex is tested by shining a light into the patient's eye.	• The pupil of the eye into which the light is shone should constrict (direct reflex), as should the pupil of the other eye, in which no light is shone (consensual reflex). – Failure of a pupil to constrict may be due to: – Failure to detect light (optic nerve damage). – Autonomic dysfunction. – Drugs. – Head injury. – Coma. – Death! • Pupils are normally round, regular in shape and equal in size. • Pupil size varies with ambient light but is usually within 3–5 mm. • Constriction of the pupil below 3 mm is termed miosis. • Dilatation above 5 mm is termed mydriasis.
III. Oculomotor nerve	
The motor supply to all the extraocular muscles except superior oblique and lateral rectus. The oculomotor nerve also contains motor fibres to levator palpebrae superioris (which elevates the upper eyelid) and parasympathetic fibres to sphincter pupillae (to constrict the pupil).	Thus, oculomotor nerve damage leads to: • Drooping of the upper eyelid (ptosis). • Poor up, down and inward eye movement leading to: – Double vision (diplopia). – Dilated pupil, non-reactive to light.
Test for eye movements	
The patient should face the clinician and be asked to follow the movements of the clinician's finger held approximately half a metre away, with the patient's head still. The clinician's hand should be moved medially and laterally, upwards and laterally, upwards and medially, downwards and medially, and downwards and laterally.	

IV. Trochlear nerve

Provides motor supply to superior oblique extraocular muscle.

The superior oblique muscle is a pure depressor of the eye when the eye is adducted (turned inwards).

Thus, damage to the trochlear nerve causes:
- Inability to look downwards and inwards.
- Diplopia.

V. Trigeminal nerve

The trigeminal nerve has three main divisions:
- Ophthalmic.
- Maxillary.
- Mandibular.

Each division contains sensory fibres to supply the orofacial tissues, including oral, nasal, conjunctival and sinus mucosa and part of the tympanic membrane.
The mandibular division also contains motor fibres to the muscles of mastication.

Testing of sensory function

Hold a pledget of cotton wool in college tweezers and tease out a few wisps to form a point.

With the patient's eyes closed, lightly touch the area of tissue under investigation with the cotton wool point and ask the patient if any sensation is felt.

Repeat the test on equivalent tissue on the other side of the face. If any loss of sensation is detected, map out the area affected.

Then confirm the results by repeating the test (gently) with a sharp point such as the tip of a dental probe.

Testing of motor function

Ask the patient to fully open and close the mouth, move the jaw to the left and right, then forward and back.

Weakness in movement can be assessed by the clinician providing resistance to movement by placing a hand on the patient's jaw.

Two reflexes should be demonstrated when testing the trigeminal nerve:

1) Corneal reflex.
2) Jaw jerk.

Corneal reflex

Ask the patient to look to the side.
Lightly touch the cornea with a wisp of cotton wool, without the patient being able to see the approach of the cotton wool.
In health, the eye lids of both eyes should blink. Repeat for the other eye.

Jaw jerk reflex (Figure 6.19)

The patient is asked to open the lips and relax the jaw. Place a thumb on the patient's chin, just below the lower lip.
Sharply tap the thumb with a tendon hammer (if available) or the fingers of the other hand.
The patient's jaw should close.

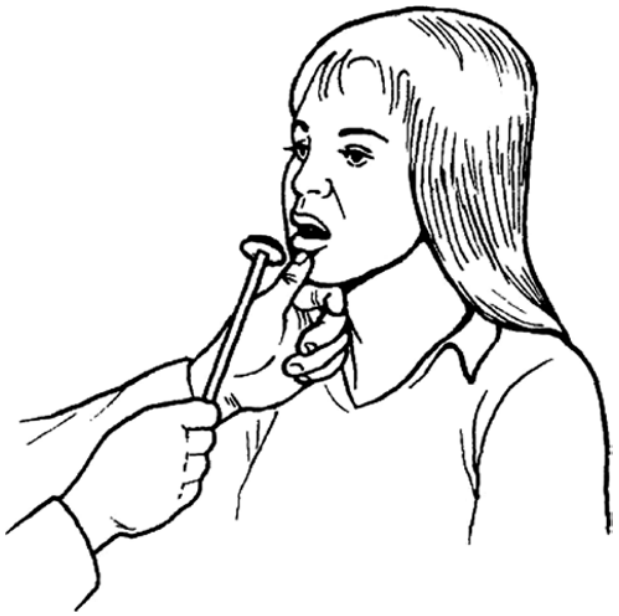
VI. Abducens nerve

Supplies motor fibres to the lateral rectus extraocular muscle.
The lateral rectus muscle moves the eye laterally.

Thus, damage to the abducens nerve causes paralysis of lateral eye movement (abduction).

Test
See test for eye movement (III. Oculomotor nerve).

Figure 6.19 Eliciting the jaw jerk reflex.



VII. Facial nerve	
Supplies: Motor fibres to the muscles of facial expression. Motor fibres to the stapedius muscle in the middle ear. Sensory taste fibres from the anterior two thirds of the tongue. Secretomotor fibres to the submandibular, sublingual and lacrimal glands.	• The lower facial muscles are unilaterally innervated, while the upper muscles are bilaterally innervated. • Signs of facial paralysis are often obvious on inspection and include: – Absence of wrinkles on the forehead. – Drooping of the corner of the mouth. – Flattening of the nasolabial fold.
Testing of facial nerve motor function	
Ask the patient to smile, frown, whistle, blow out the cheeks, close the eyes tightly and 'screw up' the face. Next, ask the patient to raise each eyebrow in turn.	• Damage to the facial nerve will lead to inability to perform this on one side of the face.
If the patient exhibits unilateral facial muscle paralysis, but is able to raise both eyebrows, damage is likely to be an upper motor neurone lesion.	Upper motor neurone lesions: • Cerebrovascular accident. • Neoplasm. • Demyelinating disease.
If the eyebrow on the affected side cannot be raised, damage is likely to be a lower motor neurone lesion.	Lower motor neurone lesion: • Bell's palsy.
Test for taste perception	
Prepare dilute solutions representing the four primary tastes (sweet, salt, sour, bitter). These may include solutions of: • Sugar. • Table salt. • Vinegar. • Quinine. Ask the patient to protrude the tongue and hold the tip of the tongue forward, using a gauze swab. Apply the test solution to the lateral borders of the anterior two thirds of the tongue. Ask the patient to identify the taste (i.e. 'sweet', 'salt', etc.). Allow the patient to rinse with water, then repeat with the next test solution.	

VIII. Vestibulocochlear nerve

Is made up of two parts:

1) Cochlear component – sensory for hearing.
2) Vestibular component – sensory for balance.

Definitive testing of the vestibulocochlear nerve is beyond the remit of the dentist.

However, a crude assessment of hearing may be made by asking the patient to repeat words whispered into the ear, while the other ear is covered.

A crude assessment of balance may be made by asking the patient to stand on one leg or walk along a fine line.

IX. Glossopharyngeal nerve

Supplies:
Sensory fibres to the posterior third of the tongue (including taste), pharynx, middle ear and eustachian tube.

Motor fibres to the stylopharyngeus muscle.

Secretomotor (parasympathetic) fibres to the parotid gland.

Test

Testing of the glossopharyngeal nerve is based on the gag reflex, which also involves the vagus nerve (efferent path).

Gag reflex
Ask the patient to open the mouth widely.

Touch the pharyngeal tissue lightly with the tip of a wooden spatula.

In health, this should result in bilateral elevation of the soft palate.

Needless to say, this is an unpleasant procedure and should only be conducted when glossopharyngeal nerve damage is suspected.

X. Vagus nerve

Supplies:
Motor fibres to the muscles of the palate, larynx and pharynx.

Sensory fibres from the viscera of the thorax and abdomen.

Autonomic fibres to the bronchi, heart and gastrointestinal tract.

Testing of the oropharyngeal component of the vagus nerve

Ask the patient to open the mouth widely and say a prolonged 'Ah'.	In health, this should result in equal bilateral elevation of the soft palate. If the nerve is unilaterally damaged, the soft palate deviates to the healthy side and elevation is unequal. If the voice is hoarse, the patient should be referred for laryngoscopy.

XI. Spinal accessory nerve

Supplies:
Motor fibres to the sternomastoid and trapezius muscles.

Test for sternomastoid function

First, ask the patient to press the chin downwards while the clinician provides resistance by placing a hand beneath the patient's chin. The definition and apparent size of the two sternomastoid muscles should be approximately equal. Then ask the patient to turn the head to one side while the clinician provides resistance against the movement by placing a hand against the patient's jaw.	In health, the contralateral sternomastoid muscle should contract and be clearly visible beneath the skin. Repeat for the other side.

Test for trapezius function	
Ask the patient to shrug the shoulders while the clinician provides resistance against the movement by placing a hand on each shoulder.	
XII. Hypoglossal nerve	
Supplies: Motor fibres to the extrinsic and intrinsic muscles of the tongue, except palatoglossus.	
Test	
Ask the patient to protrude the tongue.	In health, the tongue should protrude in the midline. If the hypoglossal nerve is damaged unilaterally, the tongue will deviate to the damaged side.
Muscular power of the tongue can be assessed by asking the patient to push the tip of the tongue into the cheek while the clinician provides resistance by placing a finger on the overlying cheek.	
4. Referral	
The conduct of the following tests is not usually undertaken in the dental surgery; instead, the patient is referred to the appropriate centre. As detailed previously, the referring practitioner still maintains a responsibility for the patient and must be able to interpret the results of any tests requested.	
Advanced imaging techniques	
Computed tomography (CT)	• Increasingly allows three-dimensional image reconstructions. • Allows exact visualisation of the shape and size of a lesion and proximity to important structures. • May be used to image the major salivary glands. • Is very useful in the planning of surgery, particularly prior to implant placement. • However, CT scans require a high radiation dose.
Magnetic resonance imaging (MRI)	• May be used to image the major salivary glands. • Less satisfactory than CT for imaging bones.
Ultrasound	• Particularly useful for examination of cysts and space-occupying lesions. • Can also be used to visualise the temporomandibular joints and major salivary glands.
Advanced techniques using radiopaque materials	
Arthrography	• Injection of contrast media into the upper and lower compartments of the temporomandibular joint. • May be combined with cineradiography to observe joint movements.
Sialography	• Injection of contrast medium into the ducts of the major salivary glands. • May be followed by conventional radiography or computed tomography. • Will demonstrate: • Glandular structure, e.g. glandular dilatation (sialectasis). • Intraglandular lesions. • Duct obstruction, e.g. calculi. • Duct restriction (stricture). • Duct dilatation. • Prior to sialography, the medical history must include questioning about allergy to iodine; some contrast media contain iodine.

Angiography	• Injection of radiopaque material into the blood stream. • Useful for demonstrating aneurysms and arteriovenous shunts. The latter may rarely cause radiolucent areas in the jaws.
Sinus/fistula investigation	• Contrast media can be injected into sinuses and fistulae to determine their path and extent.
Patch test	• Skin patch tests may be employed to test for allergy to substances that may be used in dentistry. • Increasingly, patients are concerned with possible allergy to dental amalgam. • True allergy to dental mercury and other components of amalgam (and other dental materials) is rare but does occur. • Patch testing and interpretation of the results should be undertaken by a competent dermatologist. • Test kits designed for use in the dental surgery, with the results interpreted by the dentist (or other untrained personnel), are unreliable.
Urinalysis	• Normal daily urine output in a healthy adult is approximately 1500 ml. • Water excretion is usually impaired after surgery or severe accident, and increased in diabetes insipidus and with use of diuretics. • The following substances are not usually found in the urine of the healthy subject; their presence may indicate disease: – Proteins. – Cells. – Glucose. – Pus. – Bilirubin.
Proteins (proteinuria)	• May be due to: – Infection of the urinary tract (cystitis, pyelitis). – Most kidney diseases. – Multiple myeloma (Bence Jones protein). *Note:* A trace of protein is a frequent contaminant of urine samples.
Cells	• If urine is examined microscopically, occasional cells will often be seen. • However, urine should not contain more than 1 red cell and 15 white cells per cubic millimetre. • Blood (haematuria): – May be caused by trauma or disease of the kidney or from the renal tract. – Should be tested for in all accident cases.
Glucose (glycosuria)	• May be found in diabetes mellitus (acetone also present).
Pus (pyuria)	• May be found in any infection of the urinary tract.
Bilirubin	• May be found with jaundice.

7

Procedures and Arrangements for the Prevention of Oral and Dental Diseases

Blánaid Daly and Koula Asimakopoulou

Introduction

The education of patients to maintain their oral and dental health and prevent disease is a core element of the care provided by the dental team. This chapter will examine the rationale for preventing oral and dental diseases and the relationship with the overall strategy of health promotion. Next the concepts of adherence, chairside dental health education and prevention will be described, followed by an overview of how to risk assess a patient, design a personal care plan, choose an appropriate recall interval and communicate risks effectively.

Rationale for Prevention of Oral and Dental Diseases

Oral and dental diseases are common and cause substantial impact to the individual and society in terms of pain, discomfort, and time off from school and work amongst other consequences. Dental treatment is costly and time consuming and can sometimes be considered unpleasant from the patient's perspective, no matter how adequate the pain control and skill of the clinical team. To optimise the outcomes of dental treatment and minimise failure, it is necessary to enable patients to adopt behaviours and habits to support long-term oral health. Thus, chairside dental health education and clinical prevention are core activities for the dental team. However, these activities must be seen and set within an overall understanding of the determinants of health and the strategy of health promotion. This is because many of the determinants of oral and dental disease are social and economic in origin, and cannot be addressed by changes in a person's habits and lifestyle alone.

The determinants of health are constructs which include personal, social, economic and environmental factors and 'determine' the health status of an individual or population. How these determinants operate is illustrated in Figure 7.1. At the individual or personal level, health is determined by behaviours and lifestyle factors such as choosing not to smoke, maintaining a healthy weight and eating a healthy diet. At the social and community level, social networks and support increase community resistance to disease. At the socio-economic, cultural and environmental level, health is affected by a range of living and working conditions. These include quality of housing and security of employment. Health determinants can be multiple and often interact with each other.

Behaviours are shaped by the relevant socio-economic, cultural and environmental factors, though these factors can also influence health in ways which are not mediated solely through behaviour; for example, stress. Thus, differences in people's health cannot simply be explained away by differences in personal health behaviours and lifestyle. In simple terms, social structure and social conditions are the true causes of most chronic non-communicable diseases, including oral and dental diseases.

The importance of chairside dental health education and clinical prevention with individual patients cannot be overestimated, but as the focus of these activities is at the personal and lifestyle level of health determinants, they will only deliver restricted improvements in oral health. Contemporary approaches to health promotion suggest a need to tackle health determinants at all levels, if those who are most in need are to benefit. As the wider determinants of health are deemed to be social in origin, a strategy for health promotion must be embedded in social policy, which enables the healthy choice to be the easier choice.

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

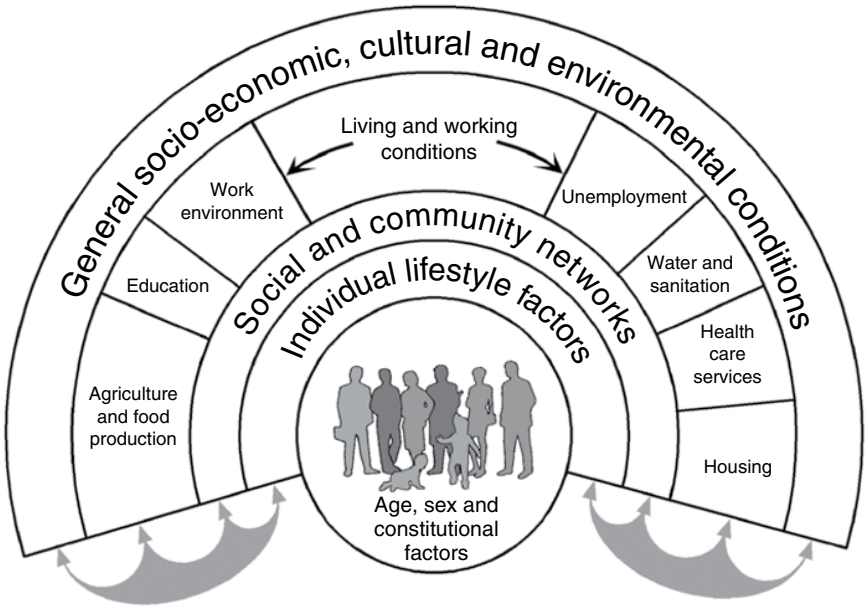


Figure 7.1 The main determinants of heath. *Source:* Dahlgren, G., Whitehead, M. (1993). Tackling inequalities in health: what can we learn from what has been tried? Working paper prepared for the King's Fund International Seminar on Tackling Inequalities in Health, September 1993, Ditchley Park, Oxfordshire. London, King's Fund, accessible in: Dahlgren, G., Whitehead, M. (2007) European strategies for tackling social inequities in health: Levelling up Part 2. Copenhagen: WHO Regional office for Europe: http://www.euro.who.int/__data/assets/pdf_file/0018/103824/E89384.pdf.

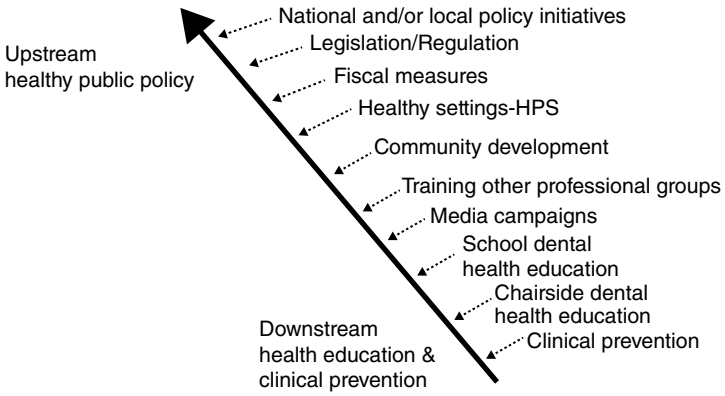


Figure 7.2 Upstream/downstream: options for oral disease prevention. HPS, health promotion specialist. *Source:* Watt, R.G. (2007) From victim blaming to upstream action: tackling the social determinants of oral health inequalities. Community Dentistry and Oral Epidemiology 35: 1–11. Reproduced with permission of W. Murray Thomson.

Health Promotion

Health promotion aims to create favourable socio-economic conditions for health and enable people to take control of factors which determine their health; it also involves coordinated action by all health and non health sectors to create the conditions for health (WHO, 1986).

The (WHO) Strategy of Health Promotion suggests five focused areas of action:

1) Building healthy public policy through legislation, fiscal measures, taxation and organisational change.
2) Creating supportive environments to enable the healthy choice to be the easier choice.
3) Strengthening community action to enable individuals and communities to take control and ownership of the actions needed to improve their health.
4) Re-orientating health services to a preventive rather than restorative and reparative philosophy.
5) Developing personal skills in communities through education and information-giving to enable selection of healthy choices and development of coping skills to manage the stresses and strains of life.

Health promotion, therefore, focuses on the social and environmental determinants *in addition* to the actions that the individual can undertake themselves in terms of modifying their behaviours and lifestyle. The strategy focuses on both upstream and downstream activities, as illustrated in Figure 7.2.

Upstream activities are largely focused on preventing the causes of disease, whereas downstream activities are largely focused on managing the early consequences of disease, or modifying risk factors, habits and behaviours associated with diseases. Chairside dental health education and clinical prevention are considered downstream activities, because they focus on unhealthy behaviours, habits and risk factors, or they manage the

Box 7.1 Risk factors.

- Risk factors can be environmental, behavioural or biological. Typically they are identified in longitudinal studies, with the presence of the risk factor increasing the probability of disease occurring, and the absence of the risk factor reducing the probability
- Risk factors can either be part of the causal chain, or bring a person into contact with the causal chain
- A risk factor may be modified and controlled, but if the disease occurs, removal of the risk factor may not result in a cure

Adapted from Burt & Eklund 2005 Research Designs in Oral Epidemiology. In Dentistry, Dental Practice and the Community USA and Elsevier Saunders p173–202. Beck J 1998 Risk Revisited, Community Dentistry Oral.

early consequences of oral and dental diseases. Risk factors are defined in Box 7.1.

A Common Risk Factor Approach

Specific oral health determinants for oral and dental diseases may be summarised as:

- Frequent consumption of fermentable carbohydrates, also termed non-milk extrinsic sugars (NMES).
- Plaque control.
- Exposure to fluorides.
- Smoking.
- Alcohol consumption.
- Appropriate use of high-quality dental care.

Many chronic non-communicable diseases share common risk factors with oral and dental diseases. For example, tobacco smoking is a risk factor for heart disease and cancers, including oral cancer, and is also a risk factor for periodontal disease. It seems sensible, therefore, to adopt a common risk factor approach – CRFA (Sheiham and Watt, 2000) – in health promotion as it offers the potential to tackle more than one health problem at a time. This approach allows for consistent and accurate general and oral health messages to be given to the public, which are also relevant for the prevention of a range of chronic non-communicable diseases. Thus the dental team can become involved in preventing chronic non-communicable diseases, including oral and dental diseases. There is also the potential for wider dissemination of oral health messages by other health personnel such as doctors, nurse practitioners, health visitors and carers, who have contact with patients in other health and social care settings.

Supporting Behaviour Change and Adherence

To support the minimisation and control of risk factors for disease, it is vitally important that the dental team has a clear understanding of the processes involved in behaviour change and how they can enable patients to change and maintain new health behaviours. In this section the concept of adherence will be described, and some theories about how behaviour change occurs will be outlined, along with their implications for everyday practice.

Adherence

There has been an exponential rise in the evidence base underpinning clinical dental prevention, for example, *Delivering Better Oral Health* (Department of Health/ British Association for the Study of Community Dentistry, 2009). This 'toolkit' gives clear, evidence based guidelines on the clinical prevention of oral and dental conditions. What has proved more challenging, however, is supporting patients to change their behaviours. The difficulties are primarily, but not exclusively, related to the dental team not always being sure about the best way to work with patients to support behaviour change. Effectiveness reviews of dental health education, including chairside dental health education, indicate that interventions fail because of the lack of psychological theory underpinning the interventions. It is important for the dental team to understand these psychological processes in order to *encourage* patients to engage with behaviour and lifestyle change.

Patient adherence has been defined as 'the extent to which a person's behaviour – taking medication, following a diet, and/or executing lifestyle changes, corresponds with agreed recommendations from a health care provider' (WHO, 2003). This concept is important because, if patients do not follow advice from the healthcare professionals, it is possible that their condition may not resolve or may indeed get worse, resulting in treatment failure and disability. The issue is a problem throughout healthcare. The consequence of non-adherence with treatment and preventive regimens is a waste of scarce health resources, which denies others the opportunity to access and benefit from healthcare.

The dental team is concerned and interested with a number of behaviours, which require long- and short-term behaviour change. The core oral and dental health messages are summarised in Box 7.2 but the nature of the behaviour change required in these messages is not the same in all cases.

Box 7.2 Core dental health messages.

- Sugar-containing foods and drinks should be limited to mealtimes and on no more than four occasions in the day
- Brush the teeth effectively twice per day, preferably last thing at night and on one other occasion. Use a small-headed brush and change when the bristles are splayed. Powered toothbrushes with an oscillating/rotating head are most effective. Use an interdental cleaning aid appropriate to the size of the interdental space
- Use a family strength fluoridated toothpaste with 1350 ppm fluoride or above (for children under 3 years of age use fluoridated toothpastes containing 1000 ppm fluoride)
- Spit, do not rinse, after brushing
- Toothpastes containing antimicrobial agents may improve plaque control
- Do not smoke
- Drink alcohol in moderation and be aware of your units of consumption
- Visit the dentist regularly

Adapted from *Delivering Better Oral Health* (Department of Health, England, 2009).

Plaque Control and the Use of Fluoridated Toothpastes

Brushing, flossing and the use of other oral hygiene aids, supplemented by the use of fluoridated toothpastes, are important behaviours to establish to help control plaque and prevent periodontal diseases and dental caries. Central to these behaviours will be modification of existing brushing and related oral hygiene techniques, learning new techniques and raising awareness of the need to check that the chosen toothpaste contains fluoride at appropriate dosage to prevent dental caries. Most people may well have learnt how to brush their teeth at an early age, but will need support to check and ensure their technique is effective.

Flossing and the use of other oral hygiene aids such as interdental brushes are not common oral hygiene measures and many people find them fiddly and difficult. So, while patients may be motivated and willing to learn how to modify how they brush and otherwise clean their teeth, they may lack the manual dexterity to undertake the techniques effectively. By way of contrast, raising the awareness of the fluoride content of toothpastes can be readily effected by checking the fluoride content of the patient's preferred brand of toothpaste and recommending an alternative easily remembered brand should the fluoride content of the preferred toothpaste be too low. Most well-known brands, including supermarket brands, have sufficient fluoride content to prevent dental caries. These behaviours, which are very much centred around the mouth, require only a short-term modification until they become habitual. The patient will no longer actively have to remember to check their behaviour and reinforce change.

Dietary Change

A behaviour such as dietary change, for example reducing sugar consumption, is complex and typically needs high levels of support if the patient is to effect the desired change in behaviour and maintain it in the long term. Reducing sugar consumption is an immense challenge, given that most sugars are added to food before it arrives in the kitchen. People can often find food labels difficult and confusing to read. Diet modification involves time, motivation and ability to engage in the constant checking of food and drinks packaging, together with motivation and desire to avoid sugar-containing foods and drinks and the resources to buy healthy alternatives. Changing diet, therefore, requires a sustained and long-term lifestyle change. The patient has to constantly monitor their behaviour and reinforce change. The dental team needs to remember also that this type of change takes place within the context of the patient's socio-economic circumstances, education and body image. As such, adherence to dietary change instructions may well be challenging.

Tobacco and Alcohol

Part of the detailed oral health assessment described in Chapter 6 will involve asking about and recording patients' smoking behaviour and alcohol consumption. Patients may be surprised that the dental team is interested in their smoking and alcohol consumption, so it may be necessary to explain the impact of tobacco and alcohol on oral and general health. Current best practice is that the dental team should act as a point of referral for patients who wish to stop smoking or seek advice about alcohol problems.

Dental Attendance

Regular visits to a dental practice are important to enable patients to receive and benefit from dental health education and clinical prevention. The time frame for re-attendance should be based on an assessment and

discussion with the patient of their risk of oral and dental diseases, values and expectations around oral health and the need for support and reinforcement of healthy behaviours (NICE, 2004; SDCEP, 2011). The dental team must recognise that there are many barriers to dental care which include cost and dental fear and anxiety.

The nature of dental practice can mean that there are few opportunities for the dental team to work with patients on behaviour change. Also, apart from a scale and polish, patients may have little sense of what might be involved in prevention. The majority may arguably expect their dentists to be treating them rather than talking to them.

What Might Predict Adherence to Healthcare Advice?

The factors which predict patient adherence to healthcare advice could be said to relate to three themes:

1) Patient characteristics, including age, gender, beliefs, personality, mood, and socio-economic status.
2) Health professional characteristics, including age, gender and communication skills, in particular the ability to develop a rapport with patients.
3) The nature of the behaviour the patient is asked to perform, in particular its complexity and pleasantness.

Adherence to healthcare advice is a complex interplay between all three of these factors. Three psychological models of behaviour change give insight into how the dental team might help patients adhere to dental advice:

1) The Health Belief Model.
2) The Stages of Change Model.
3) The Theory of Planned Behaviour.

The Health Belief Model

The Health Belief Model – HBM (Rosenstock, 1990) – is a widely used model. It is illustrated in Figure 7.3.

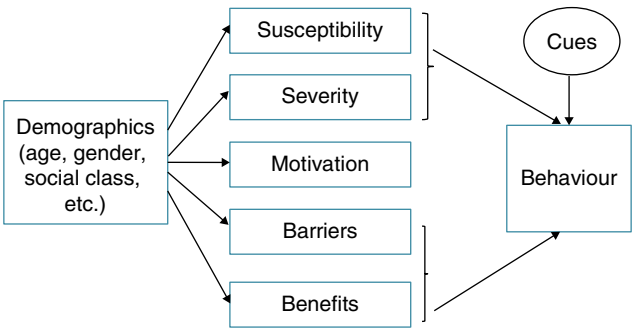


Figure 7.3 The Health Belief Model. Adapted from Rosenstock, M. (1990).

The HBM suggests that adherence depends on whether a patient perceives a health threat and believes that the treatment or option suggested will solve the problem. To illustrate the key points, consider the adoption of flossing as an example. If a patient were to adopt flossing their teeth for the first time, they would need to believe they could develop gum disease (susceptibility), consider gum disease to be a serious problem (severity) and be concerned about getting gum disease (motivation). They would need then to think that, although flossing teeth is time consuming and fiddly (barriers), it would help them have fresh breath and avoid gum disease (benefits). Should cues supplement their thoughts – external cues such as people telling them they have bad breath and/or internal cues such as noticing that their breath smells – then the HBM model suggests that this patient is more likely to begin flossing than someone who was not troubled by whether they were likely to have gum disease, thought flossing took too long (barriers) and could not see any benefit in flossing. Studies which have used the HBM model to predict adherence to oral hygiene instruction have shown that only the model's components of seriousness, susceptibility and benefits successfully predict adherence (Kuhner & Raetzke, 1989; Barker, 1994). Critics of the model suggest that it has limitations because it assumes that, even for a simple behaviour such as picking up a packet of floss, people process issues such as seriousness and susceptibility. An additional significant problem with the model is that it does not account for emotional and environmental factors, or for the fact that patient beliefs might change as a result of experience.

The Stages of Change Model

The Stages of Change Model presents the idea that differences in adherence to healthcare advice might be attributed to differences in how prepared people are to take on board the advice. This model is illustrated in Figure 7.4.

The model suggests that health professionals should assess patients' readiness to change their health behaviours. The model proposes five stages:

1) A pre-contemplation stage where people have not yet considered changing their behaviour.
2) A contemplation stage where people are thinking about changing their behaviour.
3) A preparation stage where people are making definitive plans to change behaviour.
4) An action stage where people are actively performing the new behaviour.
5) A maintenance phase where people have been performing the behaviour for some time.

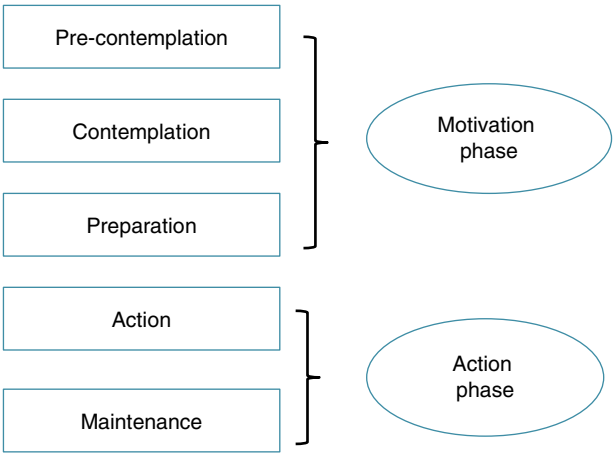


Figure 7.4 The Stages of Change Model. Adapted from Prochaska, J. and Di Clemente, C. (1984).

The first three stages are described as the motivation phase. The role of the health professional is to provide suitable advice and support to move people from an early stage to a later stage in the process of change (Prochaska & DiClemente, 1984).

The Theory of Planned Behaviour

The Theory of Planned Behaviour (TPB) is illustrated in Figure 7.5.

The underpinning theory is that behaviour change will occur through the proposed transition phases of the model. Intentions are a key concept in that people are unlikely to change their behaviour unless they have contemplated change and moved on to form intentions to change. In the TPB model, intentions are central to whether health behaviour may be adopted and undertaken. In other words, people's intentions will determine whether they perform the behaviour. Intentions are determined by attitudes, subjective norms and perceived behavioural control. Attitudes are formed by people evaluating how pleasant the behaviour is, and beliefs about the behaviour, for example believing that going to the dentist is a pleasant experience and checking teeth will improve oral health. Subjective norms relate to others' attitudes to the behaviour and the person's motivation to comply with others. For example, a person may think that their peer group think going to the dentist is important and they want to please their peer group. Perceived behavioural control refers to a person's belief that they can perform the behaviour. The person makes a judgement on the basis of internal factors (they know where and how to get to the dentist), weighed against external factors (dentistry is expensive and takes up valuable time).

According to the TPB model, these variables are, in turn, influenced by a person's behavioural beliefs (going to the dentist will improve oral health), normative beliefs (it is a generally held view that going to the dentist is a behaviour to be encouraged) and control beliefs (held beliefs that act as a barrier to performing the behaviour). In turn, these variables are influenced by demographics, personality and environmental variables. The TPB model is attractive, but the role of intention is problematic. People can form intentions to change behaviour without ever acting on the intention. This is known in the field as the 'attitude–behaviour gap'.

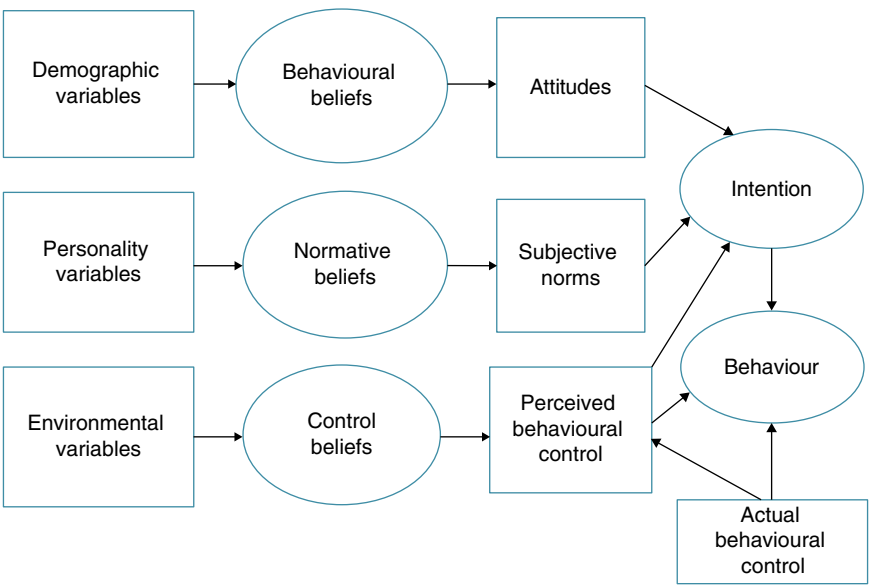


Figure 7.5 The Theory of Planned Behaviour. Adapted from Ajzen, I. (1985).

Implementation Intentions

Gollwitzer (1993) suggests that the way to bridge the attitude–behaviour gap is through 'implementation intentions'. He suggests that people need to be supported in translating their good intentions into behaviour by helping them identify the situation when the new behaviour will happen, where it will happen, and how it will be performed. He also suggests that implementation plans need to consider the likely barriers that people will come up against in trying to perform the behaviour change, and to make arrangements for tackling these likely barriers when designing the behaviour change plan. So, for example, in supporting a patient to adopt flossing as part of their oral hygiene regimen, it would be important to agree *when* they would floss, maybe suggesting last thing at night rather than the morning when they are rushing to work or school, thus avoiding the barrier of not having enough time. It could be agreed with the patient that after their morning oral hygiene routine, they place the floss packet beside their toothbrush ready to use in their night routine. This could act as a prompt to help the patient remember to include flossing in their night time oral hygiene routine. It would be good to identify *where* flossing might happen. The bathroom is the room in the home most likely to have a mirror, and people associate flossing and tooth brushing with personal hygiene carried out in the bathroom. People might also value the privacy of the bathroom as they develop their flossing skills. Flossing for some people is a fiddly procedure, and many find standing in front of a mirror helpful. It would be good practice to help the patient identify the steps (*the how*) of flossing and get them to go through each step in their mind: choose and cut an appropriate length of floss, hold floss between fingers, select correct tension, identify where to start in the mouth, where to go next, where and when to stop. This helps the patient develop a systematic approach to flossing and reinforces the '*how*' element of the behaviour.

What Works?

Although these models are theoretically sound when tested in practice, they are only partially useful at explaining adherence. This is because (Asimakopoulou and Daly, 2009):

- The models take a one size fits all approach, which is inappropriate for different types of behaviour.
- The models focus on social cognitive processes, which play a role but do not explain all aspects of the process of behaviour change.
- The models do not distinguish behaviours that are old and habitual, and behaviours that may be new.

Box 7.3 Factors to consider in promoting adherence.

- Assess how ready and prepared the patient is to change or adopt new behaviour(s)
- Discuss the behaviour(s) with the patient and emphasise the consequences (positive) and advantages of the behaviour
- Explore the patient's beliefs about the factors for and against adopting the behaviour, the relevance of the behaviour to them, their confidence and belief that they can perform the behaviour, the likelihood of a positive outcome and norms
- Discuss and negotiate with the patient where, when and how the new behaviour will be adopted; support them to turn intentions into action by making concrete plans and behavioural contracts

Data from Asimakoupolou and Daly (2009).

However, the models do identify some aspects that are important in promoting adherence. These are summarised in Box 7.3.

Drawing from these theoretical models, it is clearly important to assess where the patient is in their thinking about the behaviour, and how prepared they are for undertaking the behaviour. If we assume that the patient is at the contemplation stage (thinking about changing their behaviour) then it is important for a member of the dental team to discuss the importance and consequences of undertaking the suggested behaviour. There should also be some discussion of barriers and facilitative factors to behaviour change so that the patient can start planning how this new behaviour might be made to fit into their normal routines. Finally, should patients appear to be ready and prepared to perform the new behaviour, their adherence could be further supported by planning with them where, when and how the behaviour will be performed.

Central to success are the skills of the dental team in terms of communication and building rapport. Encouraging patients, through imparting knowledge, offering choice and assigning control over the health behaviours they adopt, enables them to make informed decisions about their health and take responsibilities for the choices they make. In the end, it may be a better use of the dental professional's time to work with those who are prepared and ready for change, rather than trying to convince those who are not yet ready. It is only those people who are consciously signing up to a health behaviour that are likely to adopt it.

Implications for Chairside Dental Health Education

Evidence from NICE (2007) suggests that no one behaviour change model is more effective than another.

Nevertheless, an understanding of the psychological principles underpinning behaviour change could help the dental team support their patients adopt or modify behaviours more effectively. Making people feel guilty because they have not changed their behaviour is an ineffective approach, and may further deter those most in need of change. Rather, the approach should be to give patients the knowledge and tools necessary for change, negotiate with them and identify the most appropriate behavioural goals. Behaviour change is difficult, especially when it is to be sustained over a long time. It is important, therefore, to be empathic, positive, encouraging and non-judgemental when engaging in collaborative work with patients seeking to change their oral health behaviours.

Chairside Dental Health Education

Health education is 'any planned combination of learning experiences designed to predispose, enable and reinforce voluntary behaviour conducive to health in individuals, groups or communities' (Frazier, 1992). Chairside dental health education refers to dental health education provided to a patient when they attend for an oral health assessment or treatment (Sheiham and Croucher, 1994). It may be undertaken by any member of the dental team. In general it is delivered on a one to one basis, and may impact in a number of ways including (Tones and Tilford, 1994; Adair and Ashcroft, 2007):

- Changing knowledge and understanding in relation to health issues.
- Exploring, challenging and refining values in relation to health issues.
- Influencing beliefs or attitudes held with respect to health issues.
- Enabling the development of new skills or modification of existing skills that enhance health.
- Bringing about a discernible change in lifestyle or individual health behaviours.

During chairside dental health education, the dental professional focuses on enabling the patient to change their health behaviour, in addition to providing training in key skills such as brushing and flossing techniques or reading and interpreting food labels. Steptoe et al. (1994) defined health behaviour as 'any activity undertaken by people in order to protect, promote or maintain health, and prevent disease'. Adair and Ashcroft (2007) make an important distinction between health-related behaviour and health-directed behaviour. *Health-related behaviour* occurs when a person will adopt health behaviour for non-health reasons, for example reducing sugar in their diet to improve body image. *Health-directed behaviour* occurs when an individual adopts behaviour in the belief that it will improve some aspect of their health, for example taking up flossing to prevent gum disease. In addition to chairside dental health education, patients may also be directed towards patient information leaflets, which can provide useful information to reinforce and remind patients about the material covered in the dental health education session.

Learning can take place in three domains (Jacob and Plamping, 1989):

- A cognitive domain which refers to types of knowledge such as facts, information and ideas. For example teaching a patient to look for a small-headed brush with round-ended filaments when choosing a toothbrush, and why this might be so.
- An affective domain which refers to attitudes, values and beliefs. For example changing a patient's belief that they have 'weak teeth', which influence their oral health, to a belief that, while they may be at greater risk of caries and may have more tooth decay than others, they can still take steps to influence the progression and severity of the disease.
- A behavioural domain which refers to skills, behaviours and habits. For example, teaching a patient how to clean their dentures.

Much chairside dental health education has tended to focus on the cognitive domain, assuming that a linear transfer of knowledge will lead to changes in attitudes and the development of new behaviours. Unfortunately, this approach rarely works. For example, most smokers are aware of the dangers of smoking to their health, but having this information alone does not change their attitudes and convince them to stop smoking. The relationship between the domains of knowledge, attitudes and behaviour is complex and rarely linear. New knowledge does not come in to a blank canvas; it gets assimilated with pre-existing knowledge, thoughts and beliefs, as well as human need – one of these being the need to feel good about oneself. Where new knowledge threatens people's 'feel good' state, such knowledge will either be expediently dismissed, or accommodated to support behaviour change, through the formation of new attitudes and the uptake of new habits. Additionally, acquiring new knowledge, developing and forming new attitudes and learning new skills are learnt in different ways. It is important to use a range of teaching approaches, which promote learning in all three domains. Health professionals tend to focus on the knowledge domain and 'talk at their patients', then seem surprised that patients fail to be motivated, or act on the advice given.

Box 7.4 Planning chairside dental health education.

- Ensure the evidence base of the dental health education
- Assess how ready and prepared the patient is to change or adopt new behaviour. Emphasise advantages of behaviour change and consequences of not changing behaviour
- Discuss and assess the patient's current knowledge, attitudes and beliefs about oral health behaviours and any barriers to change
- Identify needs and priorities with the patient:
  - Identify patient and their characteristics
  - Identify patient needs
- Negotiate and agree aims (overall aim of the session) and objectives (specify steps to achieving the desired outcomes) of the session:
  - What should the patient know?
  - What should the patient believe?
  - What should the patient be able to do?
- Appraise and decide the best way of achieving the aims; set and agree goals for change in the patient that are SMART and assess confidence:
  - *S*pecific
  - *M*easurable
  - *A*ppropriate
  - *R*ealistic
  - *T*ime related
- Identify resources
- Plan evaluation methods
- Set an action plan; agree when, where, what and how the behaviour will occur; boost patient's confidence
- Action – implement your plan, including evaluation
- Evaluate
- Review

Planning Chairside Dental Health Education

It is the duty of the dental team to provide preventive advice to their patients. The steps involved in planning chairside dental health education are set out in Box 7.4.

A prerequisite is to ensure that the dental health education given is up to date, has a sound evidence base and is consistent. Access to current evidence based information is now greatly facilitated by the plethora of consensus documents and guidelines produced by dental organisations and societies and government agencies. In England, for example, the Department of Health sponsored *Delivering Better Oral Health*, an evidence based toolkit for prevention (Department of Health and the British Association for the Study of Community Dentistry, 2009). It provides simple preventive advice supported by research evidence endorsed by a wide range of specialist organisations.

To promote adherence with dental health education advice, it is important to assess a patient's readiness and preparedness for change. Should the patient be in the contemplation phase, this is an opportune time to discuss the relevance of the behaviour to their oral health and to emphasise the benefits they can obtain from changing their behaviour.

The next phase is to discuss and assess the patient's educational needs and priorities for oral health. A person is more likely to engage with dental health education if they believe that they are susceptible to dental disease, the disease is serious and there is direct benefit to them in undertaking the behaviour. The assessment of need must take account of the individual patient and their particular characteristics. Dental health education must be tailored to reflect the patient's age, gender, cognitive ability, social background, ethnicity and cultural background and language. The assessment must also identify the particular needs of the patient; this should be a balance of need identified by the dental team and the needs or concerns expressed by the patient. For example, a clinical examination may determine that a patient has significant plaque accumulation associated with a new partial denture, although the patient might be more concerned by bad breath and the appearance of the new denture.

The aims and objectives of the dental health education session should be negotiated and agreed with the patient. An aim is the overall goal or intent of the oral health education session, while the objectives are the specific steps needed to achieve the aims. The outcomes that the intervention is aiming to achieve are also stated. It is good practice to state the outcomes within the three domains of learning (Jacob and Plamping, 1989): What does the patient need to know? What does the patient need to believe? What does the patient need to be able to do? An easily remembered acronym – SMART – will help identify the key characteristics of the objectives. Objectives need to be *specific* (S) and understood by the patient and the dental team. Objectives should be *measurable* (M) and easy to assess. Patients can be more involved if their goals are observable. Easily observable and measurable outcomes have the advantage of enabling the patient to make judgements about their performance, and take responsibility for monitoring and improving performance, without the need to wait for the next appointment. Objectives should be *appropriate* (A) to the patient's needs and address a specific problem or

concern. Objectives should also be *realistic* (R) and attainable. Setting perfection as an objective dooms the patient to failure. Objectives that are challenging and achievable help keep patients motivated to pursue the final outcome. Furthermore, objectives should be *time related* (T). Patients should be set a time scale in which to achieve the outcome and assess the changes made. It is important in the early stages of changing a behaviour that patients receive frequent feedback on how they are doing in order to keep motivated and interested.

It is important to assess not only patients' confidence in undertaking a task but also their competence and the importance they assign to the behaviour change (Miller and Rollnick, 2002). For instance, a patient may be confident at taking up flossing, but they might not be appropriately competent at it. Equally, a patient might have been assessed as competent to perform the behaviour the dental team has prescribed, but unless the behaviour is important to the patient, and they themselves feel confident about performing it, it is unlikely to take place.

If a patient indicates that they are confident, it is good practice to identify why that is, in addition to identifying the conditions and support mechanisms that are in place to enable them to change their behaviour. Remember to emphasise these support mechanisms. If a person does not feel confident, identify an occasion with them when they have changed a behaviour and encourage them to think about the processes and support mechanisms on that occasion which enabled them to change their behaviour. Encourage a patient to draw on that experience and consider what support they could put in place to help them be successful this time. If a patient continues to lack confidence, it may be appropriate to reconsider the objectives set and adjust them to suit the level of confidence the patient is currently feeling.

The next phase is to assess the necessary resources required. These do not have to be costly to be effective and can include posters, leaflets, CDs, demonstration and models. It is important to plan the content and method of the delivery of the dental health education in some detail. In trying to teach new skills, for example, allow the patient a chance to see and practise the new skills. It is important therefore to think about where and when the dental health education will take place. Plan when and where the patient will see the skill being demonstrated, plan opportunities for them to practise the skill themselves and then plan time to give them feedback on their performance of the new skill.

Evaluation is a critical appraisal of the intervention to see if the aims and objectives have been met and if not, why not. The methods will vary depending on the intervention, but could include plaque scores, gingival bleeding and self-reported behaviours such as tooth brushing or frequency of snacking. It is essential that the evaluation (and methods) of the intervention are integral to the overall planning of the dental health education intervention. This ensures that the methods for measuring outcomes are robust and valid.

The last three stages are action (implement the intervention), evaluate the intervention, and review and reflect on the outcomes. In preparation for the action phase, negotiate with the patient when, where, what and how the behaviour will take place. Boost the patient's confidence about their ability to undertake the new behaviour. Highlight and reinforce with them occasions when they have been successful in changing behaviour in the past. Build on this experience for the action phase.

It is vitally important to review the outcome of the intervention with the patient. Identify what went well and what were the challenges. How could the intervention be improved? It is important to reinforce and praise the change achieved at every visit, as this retains interest and reduces the likelihood of relapse.

The possible effects of dental health education are listed in Box 7.5.

Of course health education is not a neutral activity and it can raise some ethical dilemmas for the healthcare professional. Ethical requirements for clinical practice require that there is respect for a person's autonomy and that healthcare professionals do good, do no harm and are fair and equitable (Beauchamp and Childress, 2008). It can be difficult to stand back and respect a person's personal autonomy and right to determine their own lives when they persist in a behaviour that is clearly damaging to their health, or is likely to be so in the long term. Dental health education can increase inequalities in oral health because those in higher socio-economic groups have a greater capacity and opportunity to act on dental health education advice, compared to people from lower socio-economic groups with fewer resources (Watt, 2007). There is a potential ethical dilemma in raising people's consciousness about a health issue when there are no means available at a socio-economic level to support healthy living. There is also a potential ethical dilemma in relation to managing patients' expectations

Box 7.5 Impacts of dental health education.

- Raising health consciousness
- Giving health information
- Facilitating attitude change
- Helping behaviour change
- Supporting behaviour change
- Improving self-awareness
- Helping decision making
- Affecting social change

Data from Munday, B.P. (2003).

Box 7.6 Common communication problems in dental health education.

Social and cultural gaps. These gaps can be related to ethnic background, social class, cultural and religious beliefs, gender issues and personal values

Understanding and limited receptiveness. Understanding problems can be related to presence of a learning disability, mental health problems, confusion, poor memory or limited education. Receptiveness problems can be related to illness, tiredness or pain, being too busy, distracted or preoccupied, dental anxiety, use of technical words or dental jargon

Contradictory messages. Individual members of the dental team may give different advice, patients may receive contradictory messages from family, friends or neighbours. Patients may feel experts keep changing their minds as new knowledge and understanding update information and guidance

Attitudes of the health educator. A low priority is given to dental health education in some curricula and many dentists lack the confidence, knowledge and skills to undertake health education effectively. Some are too busy with clinical concerns, or are uncomfortable sharing control with patients

Negative attitudes to the health educator. Some patients lack trust in their dentist, or have had a previous 'bad' experience. Others may believe they know it all anyway, or feel they are going to be criticised and blamed for the state of their mouth. Some patients feel that the advice cannot be complied with because of financial and social constraints.

Data from Munday, B.P. (2003).

about their susceptibility to disease. Changing a behaviour may well reduce the severity and possibility of a patient developing disease, but it does not completely eliminate the likelihood. For example, a patient may improve their plaque control but still develop periodontal disease.

Some of the main communication problems that can arise during dental health education are summarised in Box 7.6. It is apparent, for effective dental health education, that the dental team needs to acquire listening and negotiating skills, adopt a non-judgemental approach, avoid inducing fear and victim blaming and plan their intervention carefully. Communication skills are essential for effective dental health education. These are covered in more detail in Chapter 4.

Written Materials for Dental Health Education

Written materials are an important adjunct to chairside dental health education and are a useful support; however, they rarely have a lasting impact on their own. Leaflets and advice sheets can provide information which repeats, reinforces and supplements the material covered in the dental health education session. Some of the characteristics of high-quality written materials are set out in Box 7.7.

It is important to check that information is current, evidence based, relevant to the patient's oral health, appropriate to the age group, gender and background and is culturally sensitive.

Health education materials should be clear and use simple messages. Materials should be readable and avoid the use of uncommon words and jargon. It is a good idea to use simple sentences and check grammar and wording. A long sentence can overload the reader. A range of tests can be used to assess readability. The usual approach is to assess sentence length in combination with the number of polysyllabic words in the sentence. Many computer programmes now incorporate a readability test, based on the Flesch approach (Flesch, 1948). These tests imply readability, but it is always essential to pilot test written materials to ensure they are understood by the target audience and are also culturally sensitive and inoffensive.

It is important that the format is attractive, with a clear logic to the layout. The text should be broken up with

Box 7.7 Quality assessment of written materials.

- Written materials should be evidence based, current and relevant to the oral health issue being discussed with the patient
- Written materials should be targeted appropriately, taking into consideration age, gender, background and cultural sensitivities
- Material should be readable. Use simple sentences and avoid jargon and technical terms
- The layout and format of the material should be logical, with large blocks of text broken up by visuals and titles used to emphasise key points
- Diagrams and visuals should be simple and appropriate to the text. Diagrams should enhance explanations rather than compete with the text
- Materials should be pilot tested before widespread use to ensure readability, and that messages are clear, appropriate, culturally sensitive and inoffensive

Data from Jacob and Plamping (1989), Newton (1995), Tones and Green (2004), Adair and Ashcroft (2007).

diagrams and visuals. Bullet points and titles can be used to emphasise important points. Diagrams should be simple, easily interpreted and supplement and reinforce the text rather than compete with it. It is good practice to have a built-in activity such as a quiz to reinforce and help people check their learning.

Prevention

In the UK, the National Health Service (NHS) spends £3.3 billion on dentistry and a further £2.4 billion is spent on private dentistry. Most of these costs are related to treating the consequences of disease. Treatment by itself will not address the causes of oral and dental diseases. Oral and dental diseases, although common, are readily prevented. Attempting to prevent a disease is only useful if there is a risk of that condition occurring. In any population, the risk of developing disease has a normal bell-shaped distribution. Those to the left of the distribution are at low risk, those under the bell-shaped curve are at moderate risk, and those to the right of the distribution are at high risk from the disease.

Although individuals at high risk are mostly likely to develop a disease and give rise to a case, those at low to moderate risk, because there are more of them, give rise to more cases. For example, whereas mothers over 30 are at high risk of giving birth to a baby with Down's syndrome, those mothers under 30 who are at lower risk generate more cases because there are so many more younger mothers giving birth. Rose (1985) identified two approaches to prevention: one based at the individual level (the high risk approach) and one based at the population level (the population approach). In the high risk approach, individuals are identified and given specific interventions to reduce their individual risk. Clinical dental prevention is an example of a high risk approach. For example, the placement of a fissure sealant or fluoride varnish confers an added protection to the individual from developing dental caries. A high risk approach is very appropriate to the individual who has many risk factors. It does not interfere with those at minimal risk and is a cost effective use of resources. The problem with the high risk approach is that there may not be a good screening test to identify disease in its early stage. Neither can we be absolutely confident that the individual at high risk will develop disease. A high risk approach will only prevent oral and dental disease in those who are in regular contact with the dental team and can access dental health education and clinical preventive procedures. The Adult Dental Health Survey (Steele and O'Sullivan, 2011) in England and Wales reported that 61% of adults said they attended the dentist regularly. However 39% of the population did not, so for this proportion of the population a high risk approach to preventing dental caries would be ineffective because people are not in contact with the dental team.

In contrast, the population approach seeks to decrease the incidence of the risk factors of disease across the population as a whole, which would benefit people who are not in contact with dental services. For example, by decreasing total sugar consumption, the risk of dental caries in the whole population is reduced and will benefit all, including those at high risk of developing dental caries. Fluoridation of the water supplies is another example of a population approach which can confer benefit on those at high and low risk of dental caries. The advantage of a population approach is that it is radical – it tackles the determinants of oral and dental disease – and also powerful. A small shift in the population distribution of risk factors such as sugar consumption may have a large impact on the people affected, giving rise to fewer cases of people with dental caries in all risk categories.

In preventing any disease, including oral and dental diseases, it is important to use a combined population and high risk approach and thereby reduce risk factors for disease at both the population and individual level.

Some older approaches have categorised prevention into three categories, although all three approaches are directed at the individual and are 'high risk approaches'. The three categories are:

1) *Primary prevention:* an intervention which prevents the start of the disease process, e.g. dietary control focusing on reducing frequent consumption of non-milk extrinsic sugars (NMES).
2) *Secondary prevention:* arresting the progression of a disease in the early stages, e.g. modification of risk factors such as plaque accumulation and fluoride applications in individuals with early carious lesions.
3) *Tertiary prevention (rehabilitation):* removal of caries, restoration of the tooth to restore form and function.

These are all high risk approaches and it can be difficult to work out when one phase begins and the other finishes. For this reason contemporary approaches to prevention favour a combined high risk and population approach to prevention of disease. The dental team need to be aware that while they work with individuals using a 'high risk' approach there also needs to be work done at a population/community level to prevent oral and dental diseases.

Risk Assessment

To plan appropriate individualised prevention, it is important to undertake a full oral health assessment (OHA) and an assessment of the risk the patient faces from future oral and dental diseases – the risk assessment.

The stages and procedures involved in the OHA and examination of patients are described in detail in Chapter 6. Risk assessment is a clinical judgement which weighs up a number of factors that determine an individual's risk of getting or developing new disease in the near future.

In the UK, the OHA is increasingly being used as a formalised process and was the first example of a dental clinical pathway (Hally and Pitts, 2004). Care pathways have become popular in many parts of the world in the belief that pathways ensure that patients receive a standard package of care for a given diagnosis in a specified timeframe (Harris and Bridgeman, 2010). Although there is some confusion in terminology and interpretation in the literature, two key elements may be identified: the sequencing and timing of care given by the healthcare team, and the patient journey through the care pathway (Harris and Bridgeman, 2010). In the UK, the OHA was seen as a clinical pathway which would act as a gateway to NHS dentistry. The key elements of OHAs are: the prevention of disease, lifestyle advice, discussion of treatment and prevention needs, and setting a recall interval (Scottish Dental Clinical Effectiveness Programme (SDCEP), 2011). How the oral health assessment acts as a clinical pathway is illustrated in Figure 7.6. The process integrates information from the patient and the clinical examination to produce a diagnosis and risk assessment. This informs a personal care plan, leading ideally to a continuing care relationship with the dental team (NICE, 2004; Steele, 2009; SDCEP, 2011). This continuing relationship is important, as longitudinal studies demonstrate that people who are regular attendees over the life course have better oral health compared to those who are irregular attenders. The rationale behind the oral health needs assessment and review has been described as facilitating 'the move from a restorative approach to patient care to a preventive and longer approach that is risk based and meets the specific needs of individual patients' (SDCEP, 2011). To achieve this reorientation from treatment to prevention, the dental team prepares an individualised care plan based on the principles of early detection of disease, prediction of future risk, planned personal prevention, a minimal interventionist approach to the management of oral and dental diseases and appropriate recall (Banerjee and Watson, 2011).

The oral health needs assessment involves an assessment of personal, dental, social and medical history, current habits, identification of modifying factors for disease and a detailed clinical assessment. Modifying factors may be protective, for example living in an area with water fluoridation, or act as risk factors for disease, for example diabetes. Within the assessment process the patient's adherence with previous preventive advice is assessed and future adherence is estimated. The personal care plan needs to be informed by an assessment of the patient's risk of developing further oral and dental diseases. The approach is detailed in Box 7.8.

Choosing a Recall Interval

The personal care plan should identify an appropriate personal individualised prevention plan, the need for treatment, together with an appropriate recall interval to review oral health. It is recommended that all adult patients should receive an OHA at a frequency of 24 months.

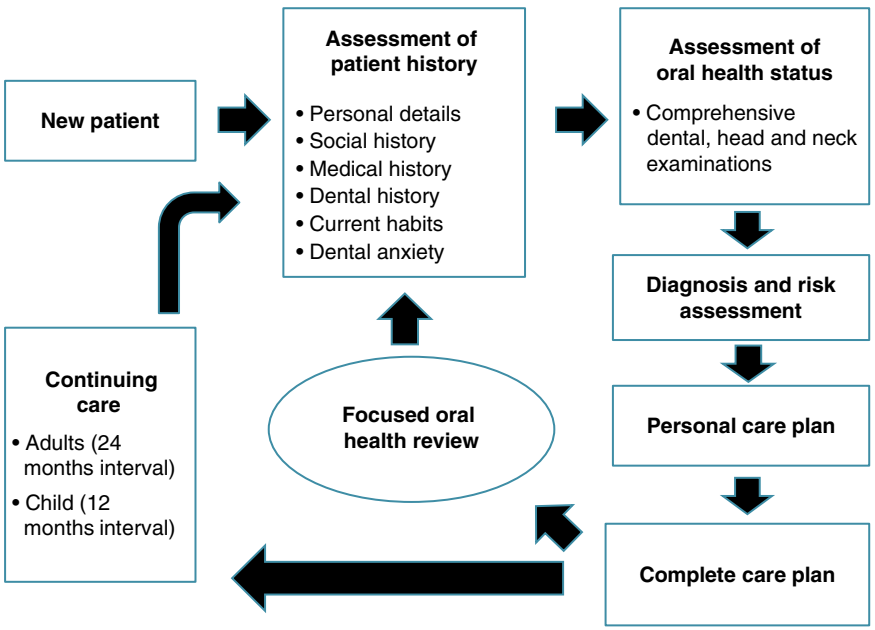


Figure 7.6 Integration of oral health assessment, risk assessment and recall interval. Adapted from NICE (2004), Scottish Dental Clinical Effectiveness Programme (SDCEP, 2011), Steele (2009).

Box 7.8 Steps in undertaking a risk assessment.

- Review modifying factors. Assess the modifying factors derived from the patient's history and clinical examination and review their impact on past experience of oral and dental disease and disease identified during the oral health assessment
- Predict the risk of future disease. Consider individual risk for dental caries, periodontal disease, tooth wear and oral cancer and other mucosal disease and assign risk level (high, medium and low). The risk assignment must be balanced by the following considerations:
  - The patient's self report of their habits and behaviours can be inaccurate
  - Modifying factors can change with time
  - Past disease experience does not reliably predict future disease
  - Patient adherence
- Risk assess other aspects of the patient's oral health, as this will need to be integrated into an overall care plan
- Give an overall risk rating (high, medium and low). Any disease in high risk category confers high risk as an overall rating
- Decide on an appropriate focused oral health review (FOHR) if needed within the recommended intervals for adults (24 months) and children (12 months). Base the interval on overall risk rating and individual needs. New patients unknown to the practice may initially need shorter recall intervals
- Inform and discuss the risk rating with the patient, explain prevention needs and the recall interval assigned. Explain that the risk rating and recall interval will be monitored and may be amended over time. Provide the patient with a written record summarising the main decisions made in relation to risk rating, prevention advice and recall interval
- Agree and set the interval for the next oral health assessment, typically 24 months for adults and 12 months for children.

Adapted from Scottish Dental Clinical Effectiveness Programme (SDCEP, 2011).

Children should receive one no later than 3 years of age and at a frequency of 12 months (NICE, 2004; SDCEP, 2011). For some patients, there may be a need to stabilise their oral environment, manage disease risk and establish a continuing relationship with the dental team before advanced care is provided (Steele, 2009). Focused oral health reviews (FOHR) are recommended to take place between the recommended recall time intervals, depending on the risk assessment and the need to re-assess the patient once their initial condition has been managed (SDCEP, 2011).

This approach is not, however, appropriate for patients who only attend for urgent care (Steele, 2009; SDCEP, 2011). In these cases a basic assessment is advised to inform the management of the immediate problem, although clinicians are advised to take a full medical history and complete an examination of the oral mucosa (SDCEP, 2011). Once pain relief and stabilisation are established the patient should be encouraged to attend for a detailed OHA.

Considerations in Undertaking a Risk Assessment

There are many approaches in the literature recommending how a risk assessment may be conducted and planned. One example comes from Scotland (SDCEP, 2011), where the patient's overall risk for a condition is assessed along a series of logical steps illustrated in Figure 7.7. This stylised view illustrates how the dental team might assign a risk level for the development of oral disease.

In the SDCEP (2011) example, the process involves first gathering all the information derived from the OHA and clinical examination.

Modifying factors identified as either protective or risk factors are used to assign patients to the risk category as illustrated in the sample algorithm (SDCEP, 2011). Those with no risk factors present are clinically assessed for the presence of disease. Should the patient be free from active disease and there is evidence that this has been the case for the preceding 2–3 years, the patient is assigned to a low risk category. Should disease be present, estimation is made of the severity of the disease and associated clinical concern. Should the condition give no rise to clinical concern, the patient would be assigned to a moderate risk category. However, should the same patient have a disease giving clinical concern, then they are assigned to a high risk category.

For those patients who have modifying factors an estimate is again made of their clinical concern and those with factors of clinical concern are assigned to a high risk group. Should the modifying factors not be of clinical concern, then the patient's clinical condition is reviewed. If there is no disease present, the patient is assigned to a medium risk category. If there is disease present and giving rise to clinical concern, then the patient is assigned to a high risk group. Should the disease not give cause for concern, the patient is assigned to a medium risk group.

The concept of risk assessing patients in terms of 'high risk, medium risk and low risk' is still an emerging field. Some have called it an intuitive process (NICE, 2004). However, there is currently no clear evidence base for the final determination of risk level. Indeed some authors

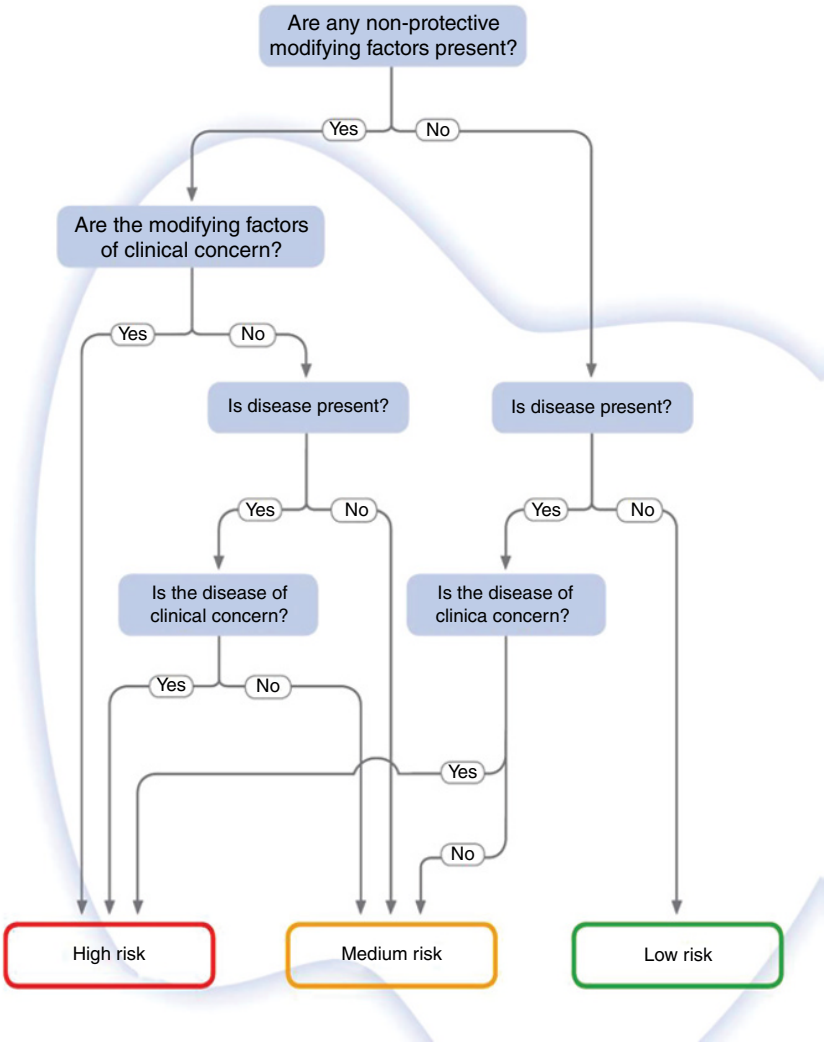


Figure 7.7 Assigning a risk level for the development of oral disease. *Source:* Scottish Dental Clinical Effectiveness Programme (SDCEP, 2011). Reproduced with permission of Scottish Dental Clinical Effectiveness Programme (SDCEP), Dundee.

suggest two risk levels are more appropriate: high risk and low risk. The fact that one person has one decayed tooth whereas another has four decayed teeth does not suggest that the carious process per se is happening faster in the person with four decayed teeth. The fact that there is decay present indicates that the conditions in the oral cavity favour the carious process and it is imperative that individual clinical prevention is instituted as soon as possible regardless of the number of teeth affected.

The aim of the risk assessment is to link the patient to a personal prevention plan which is relevant to their oral condition. Recommendations as to how a risk assessment should be linked to evidence based prevention protocols are set out in Figures 7.8 (dental caries) and 7.9 (periodontal disease).

Dental Caries – Personal Care Plans

Dental caries has been described as a diet-dependent, microbiological disease which is transmissible (Shulman and Capelli, 2008). It is a multifactorial disease requiring time, a susceptible host (tooth surface), micro-organisms and a suitable substrate (fermentable carbohydrates). Dental caries is a dynamic process with periods of de-mineralisation and re-mineralisation of the tooth, with these periods being dependent on the presence of protective and pathological factors. Featherstone (2006) describes the 'caries balance concept' which occurs when there is equilibrium between protective factors (salivary flow, optimal exposure to fluorides, favourable diet low in NMES) and pathological factors (reduced saliva, bacterial biofilm, high and frequent sugar consumption).

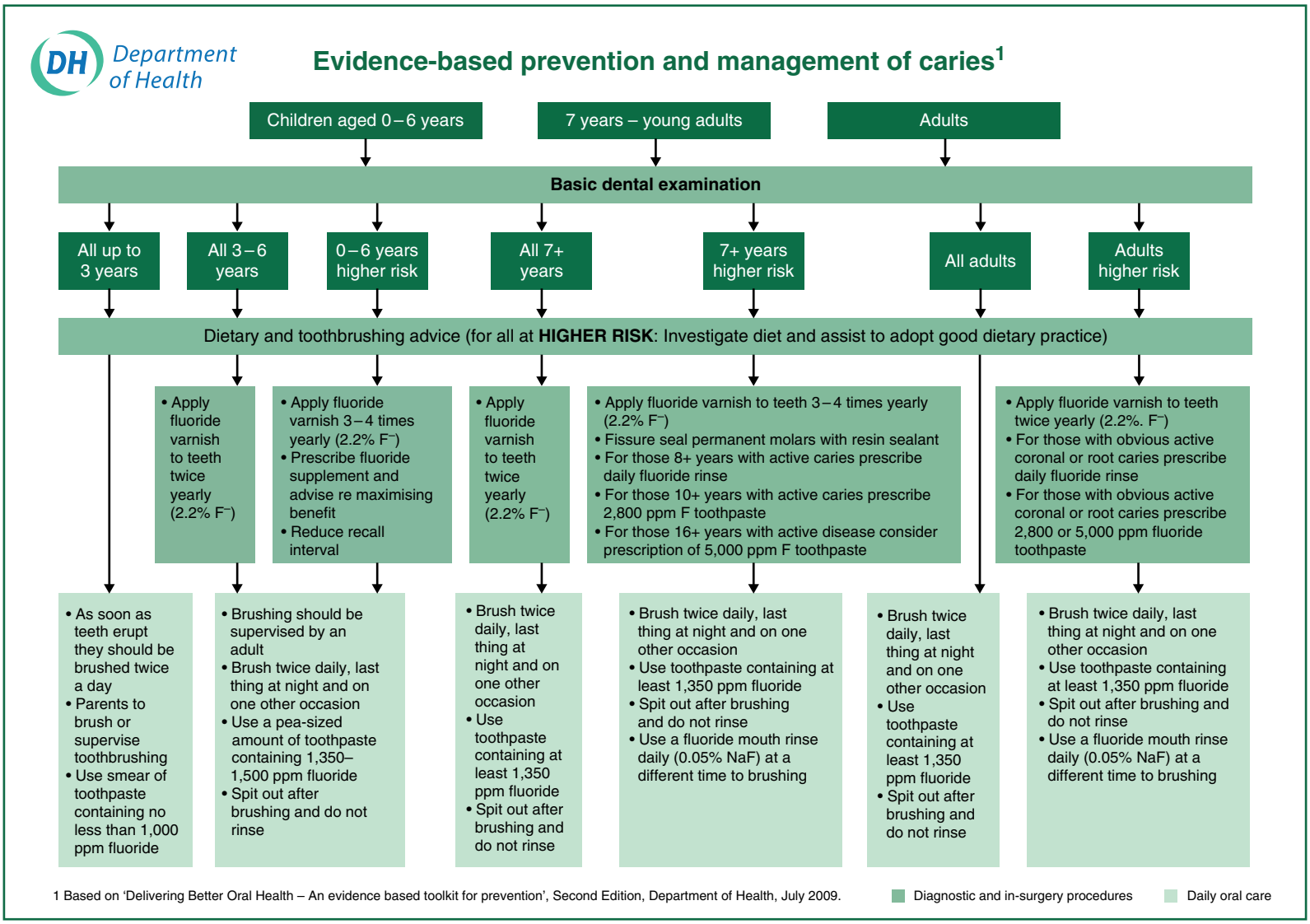


Figure 7.8 Evidence based prevention and management of dental caries. *Source:* Public Health England (2014). Delivering better oral health: an evidence-based toolkit for prevention 3rd edition. Reproduced with permission of Public Health England.

Over time, the de-mineralisation and re-mineralisation cycle can result in cavitation, reversal of the lesion or a static state (Shulman and Capelli, 2008). The carious process cannot be prevented because it is a function of the processes which occur at the ionic, metabolic and microscopic level of the tooth but are made pathological by other factors (Banerjee and Watson, 2011). Nevertheless it is possible to modify and control these factors and control the disease. In caries prevention the priority is to minimise surgical intervention and remove tooth tissue only to the extent required for caries removal, with cavity preparation and material selection being determined by the wish to preserve tooth structure (Pitts, 2011). A care plan for the prevention and management of caries is set out in Figure 7.8. A distinction is made between age groups and their caries prevention requirements. The three groups are: children (0–6 years), 7-year-old children and young adults, and adults. All patients first receive an OHA and their risk category is assigned based on their age and presence of risk factors. Current caries risk is included as one of the factors to be assessed. Various thresholds have been set for caries risk, known as 'RAG' ratings. In one example from the North of England, individuals with no active caries and no history of requiring restorative care in the last 2–3 years are classified as low risk (G, green rating) (Harris and Bridgeman, 2010). In the same example, individuals with one active caries lesion and no history of requiring restorative care in the last 2–3 years are rated as moderate risk (A, amber rating) and individuals with more than one active lesion, who have a history of requiring restorative treatment for active carious lesions in the last 2–3 years, are identified as high risk (R, red rating). The cut-off points and threshold for each group (low, moderate and high risk) are still under debate amongst cariologists. In the Department of Health care plan from England presented in Figure 7.8, dentists are encouraged to prescribe a prevention package based on the patient's risk rating. The prevention algorithm is evidence based, and although a clinician may deviate from the protocol they must provide a fully documented clinical reason for doing so. In the English example, while a patient's risk assignment is made, all patients must first enter an initial phase to receive advice on tooth brushing, dietary advice and plaque control regardless of their risk rating. Those at high risk to dental caries receive more focused help to adopt good dietary practices which may include an individual assessment of dietary intake. Patients are then prescribed fluoride supplementation based on their caries risk and the current evidence based guidelines. For example, adults determined as high risk to dental caries are advised to use fluoridated toothpaste containing between 2800 and 5000 ppm, rinse their teeth on a separate occasion with a daily fluoride rinse and attend for application of twice yearly 2.2% fluoride varnish applications.

Box 7.9 Application of fluoride varnish.

- Assess the patient's medical history. Varnishes are contraindicated in patients with ulcerative colitis and stomatitis and children with a history of allergy, including asthma
- Institute appropriate cross-infection control procedures
- Remove gross plaque deposits
- Dry the teeth with cotton rolls or triple syringe
- Dispense 0.25 ml of varnish and apply with a microbrush to pits, fissures and approximal surfaces of primary and permanent teeth
- Advise the patient to avoid eating and drinking for 30 minutes after the application and then only consume soft foods for the next 4 hours

Adapted from *Delivering Better Oral Health* (Department of Health, 2009).

Application of fluoride varnishes has become popular as one of the most effective methods of delivering topical fluorides. The key considerations in the application of fluoride varnishes are set out in Box 7.9.

It is likely that as the evidence base improves, the dental team will refine the protocols for the prevention and clinical management of dental caries for all age groups and categories of risk. The key oral health messages and clinical interventions by the dental team for prevention of dental caries are detailed in Table 7.1. Procedures for the clinical management of early caries and the clinical management of caries in children and adults are covered elsewhere in this manual.

Periodontal Disease – Personal Care Plans

Current concepts in relation to the aetiology and progression of gingivitis and periodontal diseases have changed dramatically in recent years. The traditional 'progressive' disease model has now been replaced by the 'burst theory' which suggests that periodontal diseases have 'short bursts' of activity followed by periods of quiescence. Gingivitis does not inevitably lead to periodontal disease and tooth loss. Periodontal diseases generally progress slowly. Gingivitis is a reversible disease, whereas periodontal diseases are not. At a population level, although gingivitis is widespread, a smaller proportion of the population experience severe destructive periodontal diseases. In the Adult Dental Health Survey in England, for example, approximately 8% of people were found to have severe destructive periodontal disease. Many risk factors and indicators are associated with the

Table 7.1 Prevention of dental caries based on *Delivering Better Oral Health* (Department of Health, 2009).

For children aged 0–3 years • Encourage the use of breast feeding as the best nutrition for baby • From 6 months onwards encourage babies to drink from a cup • At 1 year bottle feeding should be discouraged • Do not add sugar to weaning foods or to any drinks • Sugar-containing foods and drinks should be limited to no more than four occasions in the day • Use sugar-free medicines • Keep the number of sugar-containing foods and drinks to a minimum and consume at mealtimes • As soon as teeth erupt begin to brush and encourage parents to brush their babies' teeth and supervise brushing in older infants • Use a fluoridated toothpaste at no more than 1000 ppm. Use no more than a smear	**Clinical prevention**
For all children 3–6 years • Brush (supervise) the teeth last thing at night and on one other occasion • Use a fluoridated tooth paste using a pea-sized amount of 1350– 1500 fluoride • Do not rinse out after brushing, encourage child to SPIT • Sugar-containing foods and drinks should be limited to mealtimes and no more than four occasions in the day • Use sugar-free medicines	**Clinical prevention** • Recommend application of fluoride varnish on two occasions in the year using 2.2% fluoride
For all children identified as high risk, including children with special needs • Brush and supervise tooth brushing last thing at night and on one other occasion • Use a fluoridated tooth paste using a pea-sized or a smear amount of 1350–1500 fluoride • Do not rinse out after brushing, encourage child to SPIT • Sugar-containing foods and drinks should be limited to no more than four occasions in the day. • Should dietary supplements be required containing sugar and glucose polymers, give at mealtimes if possible unless clinically directed otherwise • Inform parents of cariogenic potential of supplements and risks associated • Use sugar-free medicines	**Clinical prevention** • Recommend application of fluoride varnish on three to four occasions in the year using 2.2% fluoride • Advise a fluoride supplement • Analyse the diet and support adoption of good dietary habits • Ensure use of sugar-free medicines and ensure they are given at times to minimise potential to cause caries • Reduce recall interval
For all children over 7 and young adults • Brush twice daily, last thing at night and on one other occasion • Use a fluoridated tooth paste containing 1350 or above • Do not rinse out after brushing, encourage child and young adult to SPIT • Sugar-containing foods and drinks should be limited to mealtimes and no more than four occasions in the day	**Clinical prevention** • Recommend application of fluoride varnish on two occasions in the year using 2.2% fluoride
For all children over 7 and young adults identified as high risk, including children with special needs • Brush twice daily, last thing at night and on one other occasion • Use a fluoridated tooth paste containing 1350 or above • Do not rinse out after brushing, encourage child and young adult to SPIT • Use a fluoride mouth rinse on a daily basis (NaF 0.05%), but on a separate occasion to brushing • Sugar-containing foods and drinks should be limited to mealtimes and no more than four occasions in the day	**Clinical prevention** • Recommend application of fluoride varnish on three to four occasions in the year using 2.2% fluoride • In children 8 years and above at high risk, prescribe a daily fluoride rinse • For children over 10 and identified at high risk prescribe a fluoridated toothpaste containing 2800 ppm • For those aged 16 and above considered at high risk, prescribe a fluoridated toothpaste containing 5000 ppm • Analyse the diet and support adoption of good dietary habits • Apply fissure sealants to permanent teeth with resin sealants

Table 7.1 (Continued)

For all adults • Brush twice daily, last thing at night and on one other occasion • Use a fluoridated tooth paste containing 1350 or above • Do not rinse out after brushing, SPIT • Sugar-containing foods and drinks should be limited to mealtimes and no more than four occasions in the day	**Clinical prevention**
For adults identified as high risk, including adults with special needs with dry mouth, active decay or other predisposing factors • Brush twice daily, last thing at night and on one other occasion • Use a fluoridated tooth paste containing 1350 or above • Do not rinse out after brushing, SPIT • Sugar-containing foods and drinks should be limited to mealtimes and no more than four occasions in the day • Use a fluoride mouth rinse on a daily basis (NaF 0.05%), but on a separate occasion to brushing	**Clinical prevention** • Recommend application of fluoride varnish on three to four occasions in the year using 2.2% fluoride • For those at high risk prescribe a daily fluoride rinse • For those considered at high risk prescribe a fluoridated toothpaste containing between 2800 and 5000 ppm • Analyse the diet and support adoption of good dietary habits

Data from Department of Health (2009).

development of periodontal diseases. Novak (2008) categorises these factors into four domains:

1) Individual factors: bacteria, host response, morphology of teeth and restorations/plaque-retaining factors.
2) Systemic factors: age, gender, immunodeficiency, hormonal, genotype.
3) Environmental factors: smoking, nutrition, obesity, stress.
4) Economic factors: access to dental care and socioeconomic circumstances.

Approaches to the prevention and management of gingivitis and periodontal diseases focus on the adoption of effective plaque control measures, modification of plaque-retentive factors and effective control and management of systemic factors. This should be supported at the population level by a focus on effective plaque control and smoking cessation interventions, together with a broader focus on the social determinants of health.

Patients attending a dental practice should be screened and monitored for the presence of periodontal diseases including any necessary radiographs to aid diagnosis and decide upon a care plan. A care plan enabling the dental team to prevent and manage gingivitis and periodontal diseases is reproduced in Figure 7.9. The criteria for the assessment of clinical status using the basic periodontal examination (BPE) are detailed in Box 7.10.

As for dental caries in the previous section, a risk assessment is assigned based on a RAG rating. Individuals who score 3 or more on the BPE, indicating pocketing of greater than 3.5 mm, are assigned a high risk rating (R, red). Individuals with poor plaque control or uncontrolled diabetes or who have bleeding on probing or have plaque-retentive factors present and pocketing in one sextant are assigned an amber rating (A, amber). Individuals with a score of 2 or lower on the BPE and adequate plaque control are assigned a green rating (G, green). All patients receive support to improve their plaque control. In those with an amber rating, plaque control is reinforced using plaque-disclosing agents and plaque-retentive factors are removed or modified. In those with a BPE of 3, root debridement is instituted. If the condition fails to resolve after the intervention, referral to specialist care may be indicated. Smokers are encouraged to seek smoking cessation advice. For those at high risk the focus is again on plaque control, modification of local plaque-retentive factors and minimisation of the impact of hormonal factors plus root debridement. Early monitoring and referral is indicated should the condition fail to resolve.

Key oral health messages and clinical interventions by the dental team for the prevention of periodontal diseases are detailed in Table 7.2. Procedures for the clinical management of gingivitis and periodontal diseases are considered in Chapter 18.

Oral Cancers and Other Mucosal Lesions

As with dental caries and periodontal diseases, oral cancers and other oral mucosal lesions have a multifactorial aetiology.

The key oral health messages and clinical interventions by the dental team for the prevention of oral cancers are detailed in Table 7.3. Procedures for the clinical management of oral mucosal lesions, including oral cancers, are considered in Chapter 13.

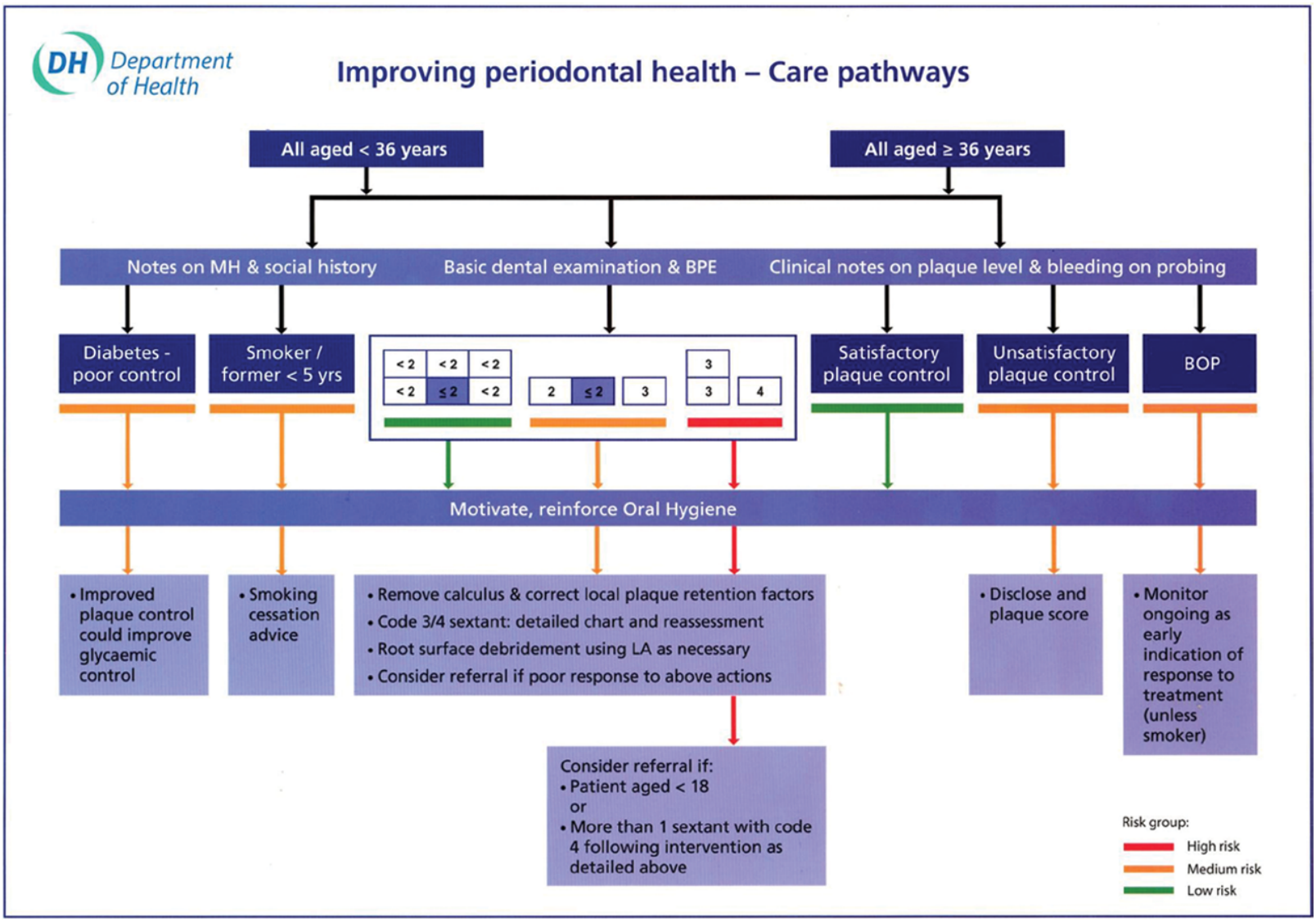


Figure 7.9 Evidence based prevention and management for periodontal health. *Source:* Public Health England (2014). Delivering better oral health: an evidence-based toolkit for prevention 3rd edition. Reproduced with permission of Public Health England.

Box 7.10 Basic periodontal examination (BPE).

The basic periodontal examination requires the use of a standardised probe. The periodontal tissues are examined with light pressure and assessed for bleeding, plaque-retentive factors and pocket depth. The following criteria are applied to five codes:

Code 0 No bleeding or pocketing present
Code 1 Bleeding on probing but no pocketing greater than 3.5 mm in depth
Code 2 Plaque-retentive factors are present but no pocketing greater than 3.5 mm in depth
Code 3 Pocketing present greater than 3.5 mm but less than 5.5 mm in depth
Code 4 Pocketing present and greater than 5.5 mm in depth

Data from British Society of Periodontology (2011).

Table 7.2 Prevention of periodontal diseases based on *Delivering Better Oral Health* (Department of Health, 2009).

All adults and adolescents	**Clinical prevention**
• Brush twice daily, last thing at night and on one other occasion • Use either a manual brush with a small head and round-ended filaments or a powered toothbrush with an oscillating or rotating head • Do not smoke • Some consideration should be given to using toothpastes with triclosan with copolymer or triclosan with zinc citrate for more effective plaque control • Toothpastes containing stannous fluoride may reduce gingivitis • Clean interdental spaces with appropriate sized brushes or floss • Adopt and maintain good dietary practices	• Show the patient plaque control methods and help the patient develop and adopt plaque control techniques • Explore the possibility of increasing or improving control over systemic factors • Investigate tobacco use and direct the patient to smoking cessation services • Analyse the diet and support adoption of good dietary habits
For children who have a relevant medical history, or are wearing orthodontic appliances or have a significant plaque accumulation	**Clinical prevention**
• Brush twice daily, last thing at night and on one other occasion • Use either a manual brush with a small head and round-ended filaments, a compact head with angled filaments easily held in the hand or a powered toothbrush with an oscillating or rotating head • Adopt and maintain good dietary practices	• Show the patient plaque control methods and help the patient develop and adopt plaque control techniques • Analyse the diet and support adoption of good dietary habits

Data from Department of Health (2009).

Table 7.3 Prevention of oral cancers based on *Delivering Better Oral Health* (Department of Health, 2009).

All adults and adolescents	**Clinical prevention**
• Do not use smokeless tobacco, e.g. paan • Do not smoke • Consume alcohol at recommended moderate intake levels • Adopt and maintain good dietary practices • Eat at least five portions of fruit and vegetables per day	• Take a smoking history and signpost to a smoking cessation service if the patient is a smoker • Take an alcohol history and signpost to an alcohol misuse service if the patient is showing signs of problem drinking

Data from Department of Health (2009).

Tooth Wear

The trends in relation to tooth wear are unclear. The aetiology is multifactorial and can include bruxism, tooth brushing habits and abfraction, tooth anatomy, saliva composition and flow, intrinsic sources of acid from gastrointestinal reflux or consumption of NMES and demineralising acidic foods and drinks. There are limited evidence based guidelines on the prevention of tooth wear. Current best practice advice suggests that erosive drinks should be taken at mealtimes and at one sitting. Patients should avoid the use of non-diluted fruit juices and concentrates. They should also avoid brushing the teeth for 30 minutes after consuming potentially erosive drinks.

Communicating Risk

Having carried out an OHA and risk assessment, the obvious questions that follow include: What and how much of that assessment should be communicated to the patient? What should be the purpose of the communication? and In what ways should the dental team communicate such information?

It is unethical to withhold information about risk of disease from patients, assuming that accurate, reliable and valid information about such risk exists. Patients have a right to information about oral health, and the results of an OHA and risk assessment are no different. If the purpose of the communication is to underpin behaviour change, it is important that risks are communicated to patients effectively.

Behavioural scientists have shown that, in general, patients have difficulty comprehending risk-related information and that some strategies for communicating risk are better than others. So personalised rather than general risk information is better, as is information that appears in several ways to include, for example, graphs and pictures.

Just as with the example of dental health education earlier, risk information does not reach people in a vacuum. Most people already have rigidly held personal beliefs about health risks. Unfortunately, such widely held beliefs are typically inaccurate. One such example is the phenomenon known as 'unrealistic optimism' where people believe that they are less likely than others to experience a variety of negative events, ranging from heart disease to divorce. The reasons behind this phenomenon include lack of experience of the relevant problems, the belief that if something has not happened yet, it is unlikely to happen in the future, and self-esteem enhancing, yet erroneous, beliefs relating to the person's ability to control events. At the other extreme, 'unrealistic pessimism' may exist in respect of diseases which are dreaded, poorly understood and not under the individual's personal control, for example, cancer. At the same time, erroneous beliefs influence people's estimates of their very own risk of disease. For example, women rate their chances of dying from breast cancer higher than heart disease, although the mortality rate for heart disease in women is nine times greater than that of breast cancer. Beliefs about health risks associated with less dreaded, better understood and more controllable causes, such as cardiovascular disease, are underestimated. People's understanding and assessment of health risks are primarily determined by emotions rather than facts. Emotional reactions to one's risk of illness development are important as they are hypothesised to be related to motivation to engage in illness-preventive behaviours. For example, whereas a justified concern about one's risk of disease may increase motivation to engage in health-protective behaviours, unjustified fear and anxiety will lead people to ignore or fail to recall risk information, and disengage from any attempts to tackle the risk.

It is very important, therefore, that individualised, reliable and accurate risk assessment information is clearly communicated to patients, having established the extent and accuracy of the patient's own beliefs about such risks.

Conclusion

There needs to be a strong coordinated public health system which recognises the common risk factors for oral health and provides support to the dental team and information to patients about how to minimise and mitigate risk factors for disease. It is essential therefore that prevention is individualised, appropriate to the patient's risk level, evidence based, carefully explained and understood by the patient and included in the patient's overall care plan. It must also be set within a context and understanding of the CRFA and the overall determinants of health.

References

Adair, P., Ashcroft, A. (2007) Theory-based approaches to the planning and evaluation of oral health education programmes. In: Pine, C., Harris, R., eds. Community Oral Health. 2nd edn. London: Quintessence Publishing Company Limited.

Ajzen, I. (1985) From Intentions to actions: a theory of planned behaviour. In: Kuhland, J., Beckman, J., eds. Action-control: From Cognition to Behavior. Heidelberg: Springer; pp. 11–39.

Asimakopoulou, K., Daly, B. (2009) Adherence in dental settings. Dental Update 36:626–630.

Banerjee, A., Watson, T. (2011) Pickard's Manual of Operative Dentistry. 9th edn. Oxford: Oxford University Press.

Barker, T. (1994) Role of health beliefs in patient compliance with preventive dental advice. Community Dentistry and Oral Epidemiology 22:327–330.

Beck, J. (1998) Risk revisited. Community Dentistry and Oral Epidemiology 26:220–225.

Beauchamp, T., Childress, J. (2008) Principles of Biomedical Ethics. 8th edn. New York: Oxford University Press.

British Society of Peridontology. (2011) Referral Policy and Parameters of Care. Available from: http://www.bsperio.org.uk/publications/downloads/28_143801_parameters_of_care.pdf (accessed 21st July, 2011).

Burt, B.A., Eklund, S.A. (2005) Research designs in oral epidemiology. In: Burt, B.A., Eklund, S.A., eds. Dentistry, Dental Practice and the Community. Philadelphia: Saunders; pp. 173–202.

Department of Health and the British Association for the Study of Community Dentistry. (2009) Delivering Better Oral Health: An Evidence based Toolkit for Prevention. 2nd edn. London: Public Health England.

Department of Health and the British Psychological Society. (2008) Improving Health: Changing Behaviour. NHS Health Trainer Handbook. London: Public Health England and Department of Health England.

Featherstone, J. (2006) Caries prevention and reversal based on caries balance. Paediatric Dentistry 28:128–132.

Flesch, R. 1948. A new readability yardstick. Journal of Applied Psychology 32:221–233.

Frazier, P.J. (1992) Research on oral health education and promotion and social epidemiology. Journal of Public Health Dentistry 52:18–22.
Gollwitzer, P.M. (1993) Goal achievement: the role of intentions. European Review of Social Psychology 4:141–185.
Hally, J.D., Pitts, N.B. (2004) Developing the first dental care pathway: the oral health assessment. Primary Dental Care 12:117–121.
Harris, R., Bridgman, C. (2010) Introducing care pathway commissioning to primary dental care: the concept. British Dental Journal 209:234–239.
Jacob, M.C., Plamping, D. (1989) The Practice of Primary Dental Care. London: Wright.
Jones, D., Rankin, K.V. (2008) Oral cancer and associated risk factors. In: Cappelli, D.P., Mobley, C.C., eds. Prevention in Clinical Oral Health Care. St Louis: Mosby; pp. 68–77.
Kuhner, M.K., Raetzke, P.B. (1989) The effect of health beliefs on the compliance of periodontal patients with oral hygiene instructions. Journal of Periodontology 60:51–56.
Miller, W.R., Rollnick, S. (2002) Motivational Interviewing: Preparing People for Change. London: The Guildford Press.
Munday, B.P. (2003) Dental health education in primary dental care. Department of Community Special Care Dentistry, King's College Hospital NHS Trust.
Newton, J.T. (1995) The readability and utility of general dental practice patient information leaflets: an evaluation. British Dental Journal 178:329–332.
NICE. (2004) Dental Recall: recall interval between routine dental examinations. Clinical Guideline 19, October 2004. London: National Institute for Clinical Excellence, Appendix D: NHS England clinical care pathways: overview of oral health assessment and oral health review; p. 22.
NICE. (2007) Behaviour change at population, community and individual levels. NICE public health guidance 6. October 2007, London: National Institute for Clinical Excellence.
Novak, K. (2008) Periodontal disease and associated risks. In: Cappelli, D.P., Mobley, C.C., eds. Prevention in Clinical Oral Health Care. St Louis: Mosby; pp. 56–65.
Pitts, N.B. (2011) Modern perspectives on caries activity and control. Journal of the Americal Dental Association 142(7):790–792.
Prochaska, J., Di Clemente, C. (1984) The Transtheoretical Approach: Crossing Traditional Boundaries of Therapy. Homewood, IL: Dow-Jones Irwin.
Rose, G. (1985) Sick individuals aand sick populations. International Journal Of Epidemiology 14:32–8.
Rosenstock, M. (1990). The health belief model: explaining behaviour through expectancies. In: Glanz, K., Lewis, F.M., Rimer, B.K., eds. Health Behavior and Health Education: Theory, Research and Practice. San Francisco: Jossey-Bass; pp. 39–62.
Scottish Dental Clinical Effectiveness Programme (2011) Oral Health Assessment and Review. Available from: http://www.sdcep.org.uk/published-guidance/oral-health-assessment/ (accessed 21st July, 2017).
Sheiham, A., Croucher, R. (1994) Perspectives on improving chair-side dental health education for adults. International Dental Journal 44:202–206.
Sheiham, A., Watt, R.G. (2000) The common risk factor approach – a rational basis for promoting oral health. Community Dentistry and Oral Epidemiology 28:399–406.
Shulman, J.D., Capelli, D.P. (2008) Epidemiology of dental caries. In: Cappelli, D.P., Mobley, C.C., eds. Prevention in Clinical Oral Health Care. St Louis: Mosby; pp. 1–13.
Steele, J. (2009) NHS dental services in England. An independent review led by Professor Jimmy Steele. Available from: http://dorsetldc.org/pdf/Independent%20Review%20of%20NHS%20Dentistry_Full%20Report.pdf (accessed 21st July, 2017).
Steele, J., O'Sullivan, I. (2011) Executive Summary: Dental Health Survey. London: The Health and Social Care Information Centre.
Steptoe, A., Wardle, J., Vinck, J., Tuomisto, M., Holte, A., Wichstrøm, L. (1994) Personality and attitudinal correlates of healthy and unhealthy lifestyles in young adults. Psychology and Health 9:331–343.
Tones, K., Green, J. (2004) Health Promotion: Planning and Strategies. London: Sage Publications.
Tones, K., Tilford, S. (1994) Health Education, Effectiveness, Efficiency and Equity. London: Chapman and Hall.
Watt, R.G. (2007) From victim blaming to upstream action: tackling the social determinants of oral health inequalities. Community Dentistry and Oral Epidemiology 35:1–11.
World Health Organization. (1986) The Ottawa charter for health promotion. Health Promotion 1. Geneva: World Health Organization; pp. i–v.
World Health Organization. (2003) Adherence to long-term therapies: Evidence for action. Available from: http://www.who.int/chp/knowledge/publications/adherence_report/en/ (accessed 21st July, 2017).

8

Procedures in Dental Imaging

Jackie Brown and Jonathan Davies

Introduction

Radiographs are an important diagnostic tool in dentistry. Unlike other diagnostic tools, radiography involves a risk of harm to the patient from radiation exposure and therefore the benefits of gaining valuable diagnostic information need to be balanced against the risk of harm from the radiation used to create the image. Radiation protection is therefore a central principle of radiography and is underpinned by a regimen of legislation, selection criteria, justification, quality assurance and audit.

Procedures in Radiation Protection for Dental Imaging

Exposure to x-rays, at levels used in diagnostic radiology, has the potential to cause harm to the exposed individual through damage to DNA and to cell structures which may lead to the induction of tumours. These are known as *somatic stochastic* effects, and it is understood that there is no threshold dose beneath which these effects do not occur. Therefore any dose of ionising radiation has the potential to induce a tumour, but the level of risk is proportional to the level of exposure and for this reason exposures are kept as low as possible. This principle of radiation protection is described by the ALARA (As Low As Reasonably Achievable) principle which advocates the lowest possible exposure to ionising radiation, consistent with producing a diagnostic radiograph, in order to reduce the risk of harm to its lowest possible level. The net detriment to the patient must be outweighed by the net benefit from the diagnostic information obtained from the radiograph.

Dental radiographs normally expose the individual patient to relatively low doses of ionising radiation, but unfortunately dental radiographs are used much more frequently than medical radiographs and tend to be used on a generally younger population of patients who are more at risk of harm from ionising radiation. It is therefore important to understand how to implement radiation protection measures during dental radiography in order to reduce the level of risk to the patient.

Justification and Selection Criteria

A fundamental principle of radiation protection is that radiographs should only be taken when clinically necessary, and when their benefit to the patient outweighs the harm from exposure to ionising radiation. The aims of the investigation, and any other imaging methods which may yield the information but avoid or reduce x-ray exposure, must always be considered. This process is known as 'justification' and is required under UK and European guidelines (Faculty of General Dental Practitioners, 2013; European Commission, 2004). The responsibility for undertaking this decision, through a weighing of the potential benefit against detriment, belongs normally to the dentist who requests the radiograph.

Selection criteria have been developed to assist this decision-making process. *Selection Criteria for Dental Radiography*, published by the Faculty of General Dental Practitioners (2013) and the European Commission Guidelines on radiation protection in dental radiology, *The Safe Use of Radiographs in Dental Practice* (2004), identify evidence-based indications for commonly taken dental radiographs in a range of clinical scenarios, such as in endodontics, periodontics, orthodontics, implantology and the heavily restored adult dentition. Specialist societies including the British Society of Orthodontics have also produced their own selection criteria in relation to orthodontic imaging (BOS, 2015), and the American Academy of Oral and Maxillofacial Radiology has implemented similar guidance in North America (Isaacson et al., 2008).

Levels of panoramic radiography have increased significantly in the past 20 years and concerns have been raised over its use as a 'screening' radiograph. Evidence shows that these concerns are unjustifiable (Rushton, Horner

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

and Worthington, 2002a, b). Indications for panoramic radiography include:

- Pathology extending outside the alveolus.
- Prior to dental surgery under general anesthetic (GA).
- Orthodontic assessment.
- Assessment of third molars.
- Mandibular fractures.
- Periodontal assessment if pocketing >5 mm in >1 quadrant and when other views are unavailable.
- Prior to dental clearance or multiple extractions.
- Prior to implant placement.

Selection criteria for orthodontic radiography are also available (Faculty of General Dental Practitioners, 2013) and include advice specific to the use of radiographs in orthodontic diagnosis and treatment, and flow charts for decision-making in prescribing lateral cephalometric radiographs.

Techniques for radiation protection of patients

Action	Rationale
Only take radiographs if clinically justified.	This is a fundamental principle of radiation protection and is the first principle of radiation protection laid down by the International Commission on Radiation Protection (ICRP).
Maintain x-ray equipment regularly; ideally service x-ray equipment every year.	To ensure correct working; to detect x-ray leakage from the tube head and to ensure accurate timing and x-ray output.
Tube output should be monitored regularly and doses compared with similar machines.	This allows the development of a 'dose reference level' (DRL), a dose which should not be exceeded for any particular radiographic examination.
Aluminium filtration, totalling 1.5 mm for dental x-ray tubes operating up to 70 kV, must be included to filter the x-ray beam as it leaves the x-ray set.	Filtration ensures that damaging, low energy x-ray photons are removed from the beam before it reaches the patient.
Use a modern dental intraoral x-ray set operating at between 60 and 70 kV and using, where possible, direct current (DC).	An operating kilovoltage in the region of 60–70 kV will deliver a reduced radiation dose compared with a machine operating at 50 kV, and direct current (DC) units also deliver a reduced radiation dose due to a shorter exposure time (National Radiological Protection Board/Department of Health, 2001).
Use a rectangular collimator for intraoral radiography.	This reduces the x-ray exposure field to match the size of the film, therefore reducing extraneous exposure. The dose to the patient may be reduced by 30–50%.
Use a 200 mm focus-to-skin distance.	This distance ensures a narrow, parallel beam and eliminates scatter arising at the tube port.
Apply ALARA.	This is the use of the lowest exposure which will achieve a diagnostic image.
Use paralleling technique for intraoral periapical radiography.	Advantages: • It is the most accurate technique and therefore avoids retakes. • The beam is directed across the dental arch and not normally down towards the trunk of the body. • It allows reproducible imaging, therefore allowing better comparison with previous films.
For intraoral radiography: • Use the fastest conventional film (F speed), *or* • Use a digital sensor which delivers a diagnostic image.	The most sensitive image receptors reduce exposure time. F-speed film gives a 20% reduction in exposure time in comparison with E-speed film. Digital intraoral sensors may potentially reduce exposure time (solid state sensors including CCD/CMOS slightly more than PSPs) but this effect is counter-balanced by a reported increase in re-takes and the smaller image area of CCD/CMOS sensors which requires more images to cover a region of interest (Wenzel and Møystad, 2010).
• Use film holders and beam-aiming devices for intraoral radiography.	These help to correctly centre the beam and stabilise the image receptor during exposure, ensuring a well-positioned radiograph. This also avoids the patient holding the film with their fingers.

(*Continued*)

Action	Rationale
For extraoral radiography:	
• Use suitably matched conventional film and intensifying screens.	Conventional extraoral film has a specified colour sensitivity spectrum and should be matched with intensifying screens of the same colour emission spectrum for proper exposure.
• Use a digital imaging system where the dose is optimised to match or improve on conventional extraoral film.	Extraoral digital radiographic systems may use direct exposure sensors – CCD/CMOS or PSPs. When using PSPs the intensifying screens are removed from a cassette and therefore the dose-saving advantage may be lost.
For panoramic radiography:	
• Use machines equipped with constant potential generators.	Constant potential (DC) x-ray machines deliver a lower radiation dose compared with conventional AC (alternating current) units.
• Use field limitation devices where possible.	If only the areas of interest can be exposed, this will significantly reduce radiation dose. Selecting a 'dentition only' mode can reduce the radiation exposure by up to 50% (Lecomber et al., 2000).
Ensure a quality assurance programme is in place.	This will monitor and help maintain good quality radiographs and reduce retakes.
Avoid radiography of the most vulnerable groups where possible; these include children and pregnant women. If a dental radiograph must be taken of a pregnant woman, a lead apron may provide psychological reassurance; a lead apron must be provided if the x-ray beam passes towards the abdomen.	The risk of harm to children is greater than for adults: **Age group (years) / Multiplication factor for risk of cancer** <10 ×3 10–20 ×2 20 –30 ×1.5 30 ×1 30 –50 ×0.5 50 –80 ×0.3 80+ Negligible risk (Faculty of General Dental Practitioners, 2013) The risk to the pregnant woman is in the potential for harm to the developing foetus. This is thought to be greatest in the first and third trimesters.
Ensure adequate training and regular updating for staff in radiographic techniques, processing, QA and radiation protection.	This ensures that quality is maintained and that staff use optimal radiographic techniques, avoiding unnecessary re-takes and applying sound radiation protection.

CCD/CMOS, charge-coupled device/complementary metal oxide semiconductor; PSPs, photo-stimulable phosphor plates; QA, quality assurance.

Techniques for radiation protection of staff

Action	Rationale
Ensure dental x-ray equipment is properly installed and within a suitable protected environment.	It is very important to protect both staff and patients. Staff outside the immediate x-ray cubicle should not receive more than 1 mSv per year additional exposure.
No person, other than the patient, should go within 1.5 m of the dental x-ray set, and nowhere within the primary beam, while it is in operation, unless this is essential (e.g. a mother reassuring a child). Any person admitted to the controlled area must be adequately protected, i.e. the comforter should wear lead protection. Record details of any persons assisting in radiography.	The area immediately around the dental x-ray tube head contains both primary and scattered radiation.
The operator should not, in any circumstances, hold the image receptor, spacer cone or x-ray tube head during an exposure.	This would expose the operator to unacceptable levels of scattered radiation.

(*Continued*)

Action	Rationale
The operator of the dental x-ray set should stand away from the primary beam and ideally behind a protective screen equivalent to at least 0.25 mm lead, where they may operate the equipment.	Exposure to primary and scattered radiation can be avoided by increasing the distance between yourself and the x-ray tube, because radiation obeys the inverse square law. A lead screen can be used where a suitable distance cannot be achieved.
Avoid aligning the beam so that it passes into adjacent rooms or into adjoining premises.	The walls may not prevent x-rays passing through to the neighbouring room, and therefore it is prudent to avoid irradiating adjacent areas. The Radiation Protection Adviser (RPA) should be consulted regarding protection afforded by walls of the dental surgery.
A warning sign should be placed at the entry point to an x-ray room.	This is to prevent people from entering the area when an x-ray exposure is being made.
If an additional person is needed to stand with the patient during a radiograph, to help or support the patient, then this person must be protected with a lead apron.	The helper is receiving no personal benefit from the radiographic exposure and must therefore be protected as much as possible from radiation exposure.
Personal monitoring, in the form of a film badge or thermo-luminescence dosemeter (TLD), may be worn by staff undertaking dental radiography.	This may be recommended if the radiographic workload is high, e.g. more than 100 periapicals per week, more than 40 panoramics per week or if cone beam CT examinations are undertaken in the practice.
Dose limits must be applied to staff who are occupationally exposed to radiation, e.g.: Total annual exposure limit = 20 mSv (Ionising Radiation (Medical Exposure) Regulations, 2018) By exercising good radiation protection practice in a dental surgery the operator should not exceed more than 1 mSv.	This will protect staff from excessive radiation exposure and identify cases where this may be a risk.
Ensure the x-ray set is switched off after use.	This will ensure that no accidental expose occurs.

Procedures in Dental Radiography

Long Cone Periapical Radiography

This radiographic technique is undertaken to image one or two teeth and their immediate supporting structures, and is designed, by optimising imaging geometry, to give as accurate and undistorted an image as possible. It is used to detect apical pathology, caries and periodontal bone loss.

A similar methodology is used in endodontic imaging where, by using a specialised film holder, the endodontic instrumentation within the tooth and rubber dam can be contained within a basket while an intraoral radiograph is undertaken.

Periapical radiography is achieved by placing the long axis of the image receptor and the tooth under investigation parallel with each other, with the x-ray beam aligned at right angles to the two objects.

Equipment

- Intraoral film (film size 0–2) or digital image receptor that is barrier wrapped using a manufacturer-recommended bag.
- Periapical film/sensor holder.
- Intraoral x-ray tube with a rectangular collimator.

Action	Rationale
Check identifying data for the patient such as their name, date of birth or address.	This ensures that you are about to irradiate the correct patient.
Prepare the patient by requesting removal of dentures and warning them of the need to keep still.	This prevents the degradation of the image by artefacts and patient movement.
Insert the image receptor into the film holder.	To support the image receptor during radiography and ensure it is in alignment with the x-ray beam. Check that the image receptor has not slipped during placement.
Insert the film holder into the patient's mouth, aligning it parallel with the palatal/lingual aspect of the tooth.	To ensure that the image receptor is adjacent to the object being imaged. In the maxilla the image receptor may be placed at the mid palate region, due to the curved shape of the palate. In the mandible, the image receptor may be placed against the tooth and into the lingual sulcus.

(*Continued*)

Action	Rationale
Ask the patient to gently close onto the bite block and support this with a cotton wool roll (Figure 8.1).	The cotton wool roll enables support of the bite block and may be used to fill any space where teeth may be missing.
Place the locating ring towards the patient's skin; this ring does not need to be in contact with the patient's face.	To enable the x-ray cone to be placed close to the object under imaging to reduce magnification of the image and to assist in correct alignment of the x-ray cone.
Bring the x-ray cone into close relationship to the locating ring, ensuring the rectangular collimator is correctly aligned with the positioning aid on the locating ring, that the end of the cone is parallel to the locating ring and that the arm of the film holder is parallel with the x-ray cone.	To assist in parallel alignment of the x-ray cone, to ensure the rectangular collimator is in the correct position in relation to the image receptor, and that the front edge of the cone is parallel to the image receptor to prevent any cone cuts or obliquely positioned images.
Select exposure factors and expose image.	The exposure factors are chosen to optimally display the tooth and apical bone tissues. A kilovoltage of 65–70 kV is normally selected with a short exposure time.
Remove the film holder and image receptor from the mouth and wipe the external barrier wrap, then dispose of the barrier wraps.	To prevent any contamination with saliva. There is a high risk of transmission of infection through salivary contamination of the film processor/image reading device.
Process the image receptor.	To enable display of the final image.
Assess the image for final image quality.	To ensure the image is of the correct density and contrast to enable differentiation of enamel, dentine, pulp and supporting bone; correctly positioned with no cone cuts, image faults, no obvious elongation orforeshortening of the image; that the whole image receptor has been exposed; and assess for any error of processing/handling.
Report the image in the clinical notes.	To comply with the IRMER – Ionising Radiation (Medical Exposure) Regulations in the UK (2018).

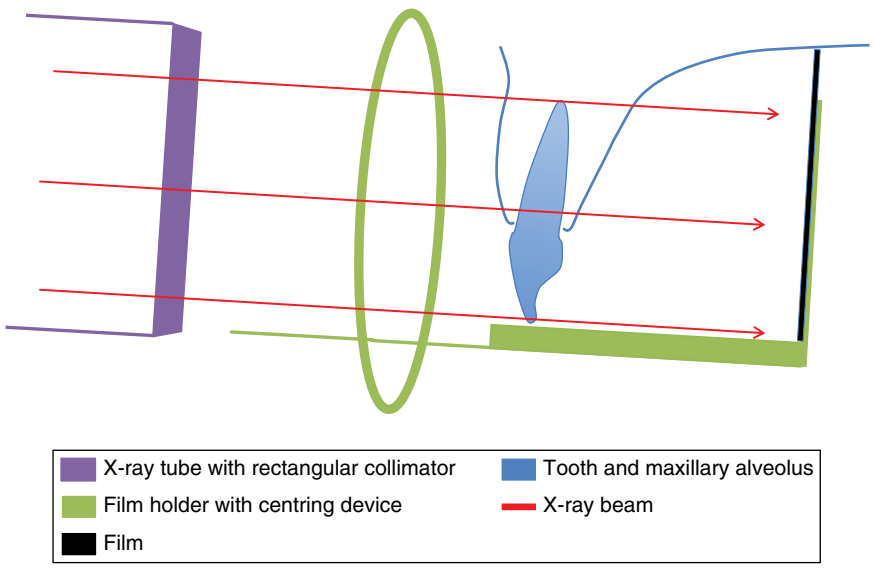


Figure 8.1 Paralleling technique periapical radiography.

Alternative Technique for Lower Third Molars

Tissue forceps may be used to insert the image receptor into the posterior lingual sulcus and to hold it in place. The x-ray beam is centred approximately 1 cm above the lower border of the mandible and on a vertical line dropped from the outer corner of the eye.

Digital image receptors such as photo-stimulable phosphor plates (PSPs) may be easily damaged when gripped by forceps. Clear tubing may be placed on forceps teeth, or additional protective covers used to protect the image receptor from damage.

Image Quality Criteria

- The tooth and surrounding periodontal tissues are clearly defined.
- At least 2 mm of bone is seen beyond the tooth apex, although ideally 4–5 mm should be demonstrated.
- There is no overlap of adjacent teeth. The margins of the interdental alveolar bone should be clearly visible.
- There is minimal elongation/foreshortening of the tooth.
- There should be no geometrical distortion of the image due to incorrect beam angulation or image receptor position or because of image receptor bending.
- The contrast and density should be such that the enamel, dentine and pulp can be readily differentiated from each other.

An alternative technique that may be undertaken in periapical radiography is the bisecting angle technique. Here, using the principle of similar triangles, the tooth is imaged by placing the image receptor as close to the tooth as possible but with an unavoidable angle between the long axis of receptor and of tooth. A line bisecting the angle between long axis of tooth and image receptor is envisaged, and the x-ray beam aimed perpendicular to this imagined bisecting plane. One inherent problem is that the roots may be foreshortened or elongated due to incorrect angulation of the x-ray beam to the bisecting plane and there may be lack of the detail required for periodontal and endodontics diagnosis, particularly a lack of definition of the alveolar crest.

Bitewing Radiography

This radiographic technique is undertaken to image the crowns, interproximal spaces and immediate supporting structures of the posterior maxillary and mandibular premolar and molar teeth. It is not intended to image the full root and apical tissues of any individual tooth. This technique is designed, by optimising imaging geometry, to give as accurate and undistorted an image as possible. It is used to detect coronal caries and interproximal caries and can be used to assess periodontal bone loss. The technique can be undertaken with the film in a portrait (vertical) position but is more commonly used in a landscape (horizontal) position. The vertical bitewing technique may have more precedence in periodontal diagnosis as it demonstrates fewer teeth but a greater depth of alveolar bone; however, the more prevalent technique is the horizontal bitewing.

This bitewing technique is achieved by placing image receptor parallel with the teeth of the dental arch, and with the x-ray beam aligned at right angles to these two objects. It is undertaken on both the patient's left and right sides.

Equipment

- Intraoral film (film size 0–2) or digital image receptor that is barrier wrapped using a manufacturer-recommended bag.
- Bitewing film/sensor holder.
- Intraoral x-ray tube using a rectangular collimator.

Action	Rationale
Check identifying data for the patient such as their name, date of birth or address.	This ensures that you are about to irradiate the correct patient.
Prepare the patient by requesting removal of dentures and warning them of the need to keep still.	This prevents the degradation of the image by artefacts and patient movement.
Insert the film/image receptor into the holder.	To support the image receptor during radiography and ensure it is in alignment with the x-ray beam. Check that the image receptor has not slipped during placement.
Insert the film into the patient's mouth, aligning it parallel with palatal and lingual aspect of the upper and lower posterior teeth and ask the patient to close tightly together.	To ensure adequate coverage, the image receptor should be placed so the front surface can be seen adjacent to the distal aspect of the canine tooth. Check this position when the patient bites together.
Align any locating ring towards the patient's skin, although this ring does not need to be in contact with the patient's face.	To enable the x-ray cone to be placed as close as possible to the object under investigation to reduce magnification of the image and to assist in correct alignment of the x-ray cone.
Bring the x-ray cone into close relationship with any locating ring or using the arm of the film holder, ensuring the rectangular collimator is correctly aligned with the orientation of the film and any positioning aids, and that the end of the cone is perpendicular to the image receptor.	To assist in parallel alignment of the x-ray cone and to ensure that the rectangular collimator is in the correct position in relation to the image receptor and that the front edge of the cone is parallel to the image receptor to prevent any cone cuts or obliquely positioned images.
Select exposure factors and expose image.	Appropriate choice of exposure factors is important; when imaging caries in a bitewing image a lower kV (such as 60 kV, as opposed to 70 kV) may be chosen for greater image contrast.

(*Continued*)

Action	Rationale
Remove the film holder and image receptor from the mouth and wipe the external barrier wrap, then dispose of the barrier wraps.	To prevent any contamination with saliva. There is a high risk of transmission of infection through salivary contamination of the film processor/image reading device.
Repeat the procedure for the opposite arch.	To enable imaging of the left and right sides.
Process the film or image receptor.	To enable display of the final image.
Assess the image for final image quality.	To ensure the image is of the correct density and contrast to enable differentiation of enamel, dentine, pulp and supporting bone; correctly positioned with no cone cuts, image faults, no obvious elongation or foreshortening of the image; that the whole image receptor has been exposed; and assess for any error of processing/handling.
Report the image in the clinical notes.	To comply with the IRMER – Ionising Radiation (Medical Exposure) Regulations in the UK (2018).

Image Quality Criteria

- The mesial edge of the first premolar and the distal edge of the second molar should be included. If the wisdom teeth are fully erupted then the 7/8 contact should be included.
- The alveolar crest of maxillary and mandibular bone should be shown.
- There should be no overlap of the approximal surfaces of the teeth.
- The desired density and contrast will depend on whether the radiograph is to be used to diagnose dental caries or periodontal disease; normally greater contrast is advantageous in detecting caries.
- For caries diagnosis the contrast and density should be such that the enamel, dentine and pulp can be readily differentiated from each other.
- For periodontal assessment the exposure factors may be decreased to avoid burnout of the alveolar crestal bone.

Upper Standard Occlusal Radiography

This radiographic technique is undertaken to image the area of the upper incisor teeth and their immediate supporting structures. This technique is a modification of the bisected angle technique and, using the principle of similar triangles, we can optimise geometry to obtain as undistorted an image as possible. This technique is useful to detect apical pathology, caries and periodontal bone loss, along with localisation of impacted canine teeth, identification of root fractures and localisation of any fractured teeth, and may be used in those who are unable to tolerate a periapical film of the anterior segment.

Equipment

- Intraoral film (film size 2–4) or digital image receptor, barrier wrapped in a manufacturer-supplied bag.
- Intraoral x-ray tube.

Action	Rationale
Check identifying data for the patient such as their name, date of birth or address.	This ensures that you are about to irradiate the correct patient.
Prepare the patient by requesting removal of dentures/removable orthodontic appliances and warning them of the need to keep still.	This prevents the degradation of the image by artefacts and patient movement.
Insert film/image receptor into the patient's mouth, with the receptive surface facing upwards, between the occlusal surfaces of the upper and lower teeth, then ask the patient to gently close together so that the film lies horizontally.	To support the image receptor during radiography. The image receptor is generally placed across the arch in the adult patient, and lengthways in children.
Bring the x-ray cone to approximately the bridge of the nose and angle the x-ray tube downwards by approximately 65 degrees to the horizontally positioned film. Align the tube so the external markers are centred through the nose and the cone is aimed at the approximate position of the canine teeth (Figure 8.2).	The upper teeth are approximately angled at 115 degrees to the hard palate. Aiming the tube downwards will ensure that there should be minimal elongation of the central incisors, maintaining the geometric principle of similar triangles.
Select exposure factors and expose image.	Always maintain contact with the exposure button throughout the exposure to prevent early termination of the exposure.

(*Continued*)

Action	Rationale
Remove the image receptor from the mouth and wipe the external surface of the barrier wrap, then dispose of the barrier wraps.	To prevent any contamination with saliva. There is a high risk of transmission of infection through salivary contamination of the film processor/image reading device.
Process the image receptor.	To enable display of the final image.
Assess the image for final image quality.	To ensure the image is of the correct density and contrast to enable differentiation of enamel, dentine, pulp and supporting bone; is correctly positioned with no cone cuts, image faults, no obvious elongation or foreshortening of the image; that the whole image receptor has been exposed; and assess for any error of processing/handling.
Report the image in the clinical notes.	To comply with the IRMER – Ionising Radiation (Medical Exposure) Regulations in the UK (2018).

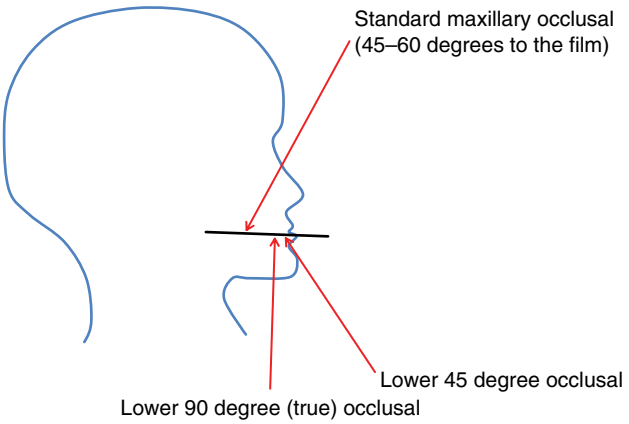


Figure 8.2 Positioning for occlusal radiographs.

Image Quality Criteria

- The apices of the maxillary incisor teeth are clearly defined.
- The maxillary first and second molar teeth are included on the image.
- There is minimal elongation/foreshortening of the maxillary incisor teeth.
- The apices of unerupted maxillary canines should ideally be included.
- There should be no geometrical distortion of the image due to incorrect beam angulation or because of image receptor bending.
- The contrast and density should be such that the enamel, dentine and pulp can be readily differentiated from each other.
- The appearance of premolars and molars on each side should be comparable.

Lower 90 Degree Occlusal Radiography

This radiographic technique is undertaken to image a section of the anterior mandible and floor of mouth, the view being aimed parallel with the long axes of the lower incisor teeth and perpendicular to the film or image receptor. This technique is useful to detect bucco-lingual expansion of the mandible caused by cysts and tumours, fractures of the mental symphysis, unerupted anterior mandibular teeth and any salivary calculi within the anterior submandibular duct.

Modifications can be made to undertake *lower 45 degree occlusal* (by angling the beam upwards and backwards by 45 degrees, centred through the mandibular symphysis) or *posterior oblique occlusal* radiographs (angled obliquely upwards and medially through the posterior mandible).

Equipment

- Intraoral film (film size 4) or digital image receptor barrier wrapped in a manufacturer-supplied bag.
- Intraoral x-ray tube.

Action	Rationale
Check identifying data for the patient such as their name, date of birth or address.	This ensures that you are about to irradiate the correct patient.
Prepare the patient by requesting removal of dentures and warning them of the need to keep still.	This prevents the degradation of the image by artefacts and patient movement.

(*Continued*)

Action	Rationale
Insert film/image receptor into the patient's mouth between the occlusal surfaces of the upper and lower teeth, with the receptive surface facing downwards, then ask the patient to gently close together.	To support the image receptor during radiography. The image receptor is generally placed transversely in the line of the arch in the adult patient.
Ask the patient to raise their chin, then centre the x-ray cone between the left and right body of the mandible with the end of the x-ray cone at 90 degrees to the image receptor. Align the tube so the external markers are centred through the midline of the floor of the mouth and the field includes the anterior mandible.	The lower teeth are angled at approximately 90 degrees in the anterior mandible. This view will undertake a survey of the floor of the mouth.
Select exposure factors and expose the image receptor.	The exposure should normally be selected to image the bony structures of the mandible. The exposure may be reduced to selectively image small calcifications in the soft tissues of the floor of the mouth.
Remove the image receptor from the mouth and wipe the external surface of the barrier wrap, and dispose of the barrier wraps.	To prevent any contamination with saliva. There is a high risk of transmission of infection through salivary contamination of the film processor/image reading device.
Process the image receptor.	To enable display of the final image.
Assess the image for final image quality.	To ensure the image is of the correct density and contrast to enable differentiation of supporting bone and any soft tissues; is correctly positioned with no cone cuts, image faults, no obvious elongation or foreshortening of the image; that the whole image receptor has been exposed; and assess for any error of processing/handling.
Report the image in the clinical notes.	To comply with the IRMER – Ionising Radiation (Medical Exposure) Regulations in the UK (2018).

Image Quality Criteria

- The image receptor should be far enough back to include the first molar teeth.
- There should be no geometrical distortion of the image due to incorrect beam angulation because of image receptor bending.
- The body of the mandible on each side should be equidistant from the midline and should appear symmetrical.
- The required contrast and density will depend on the clinical indications. To demonstrate salivary calculi a soft tissue exposure should be used.
- Great care should be exercised in mounting this film – ensure you have identified the true left and right sides on the image.

Panoramic Radiography

This radiographic technique is undertaken to image the mandibular and maxillary arches along with their immediate supporting structures. This view will also image part of the maxillary sinus, the condyle and articular eminence; part of the eye, cervical vertebrae and the hyoid bone may also be imaged. This image is an extraoral view, in which the image receptor rotates around *outside* the oral cavity and the x-ray source orbits in opposition around the patient's head. The image is undertaken using a slit beam technique which incrementally builds up the image of the mandible and maxilla. This image is subject to inherent magnification and superimposition of structures due to the way in which it is obtained.

A panoramic radiograph is useful for viewing the developing dentition, generalised and more extensive periodontal bone loss, larger areas of pathology and fractures related to the mandible or maxilla, giving a view of the temporo-mandibular joint and assessing wisdom teeth prior to removal. It is also used for assessment prior to implant placement. This view is not indicated for caries assessment and for screening of patients prior to any dental treatment.

Equipment

- Extraoral film (generally 15 × 30 cm) in a cassette with intensifying screen or a digital sensor, either a direct capture CCD/CMOS detector or a phosphor plate with a cassette not containing intensifying screens.
- Panoramic x-ray set and tube.

Action	Rationale
Check identifying data for the patient such as their name, date of birth or address.	This ensures that you are about to irradiate the correct patient.
If applicable, insert the cassette containing either a film or phosphor plate into the image receptor carriage.	To capture the image to be processed.
Prepare the patient by asking for removal of any dentures, earrings or necklaces. Warn them of the necessity to stand still while the x-ray gantry rotates around their head.	This prevents the degradation of the image by artefacts and patient movement (Figure 8.3).
Bring the patient towards the panoramic machine and ask them to stand straight and to bite onto the bite peg with their central incisor teeth.	The bite peg is used to obtain an approximate position of the central incisors into the focal trough of the panoramic machine.
Turn on beam aiming lights and correctly position the patient.	Generally the patient is aligned with the midsagittal line through the midline of the face and with the Frankfort plane (FFP) horizontal to the floor (the FFP can be drawn from the tragus of the ear to the lower border of the orbit). To position the patient within the focal trough please refer to the individual manufacturer's manual, although this is commonly undertaken by using canine guiding lights or head restst.
Ask the patient to close their lips onto the big peg and place the tongue to the roof of the mouth.	To ensure that the patient is biting together and to minimise any air shadows, between lips or between tongue and hard palate, that are inherent during panoramic radiography and which can be confused with pathology (ghost shadows).
Select exposure factors and expose the image.	The exposure should normally be selected to image the teeth and bony structures of the mandible and maxilla. The panoramic exposure panel allows adjustment of kV and mA. A large patient may require a small increase in kV and mA; however, follow the manufacturer's guidelines.
If necessary, process any image receptor or view the direct captured image on a computer screen.	To enable display of the final image.
Assess the image for final image quality.	To ensure the image is of the correct density and contrast to enable differentiation of enamel, dentine, pulp and supporting bone; the patient has been correctly positioned; there are not any no obvious image faults or movement artefacts; and assess for any error of processing/handling.
Report the image in the clinical notes.	To comply with the IRMER – Ionising Radiation (Medical Exposure) Regulations in the UK (2018).

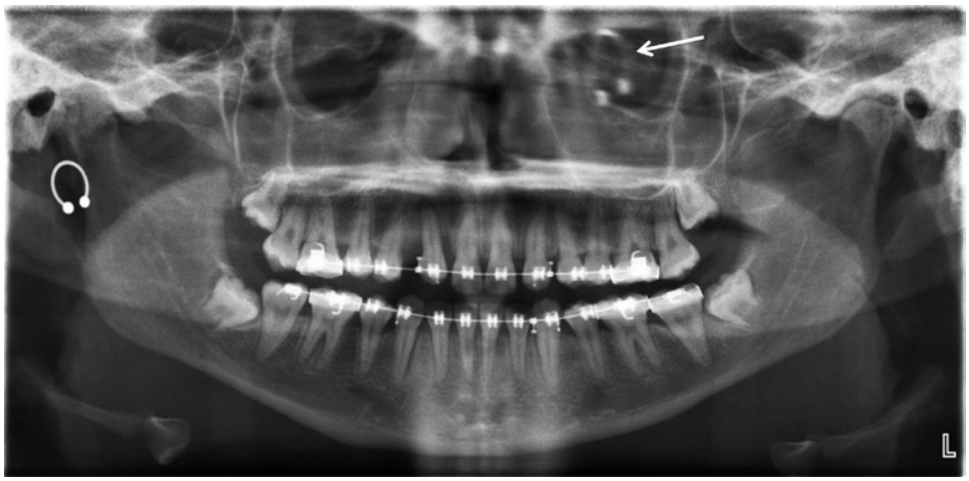


Figure 8.3 Earring causing artefact on a panoramic image. Note the earring in the right ear has caused a ghost shadow overlying the left antrum (arrowed).

Image Quality Criteria

- All the teeth and supporting bone are clearly demonstrated within the focal trough.
- The whole of the mandibular and maxillary teeth and supporting structures are included.
- Magnification in the vertical and horizontal planes should be equal – this is only achieved when the dental arches are located centrally in the focal trough.
- The right and left molar teeth should be equal in width.
- The density across the radiograph should be uniform with no air above the tongue causing overpenetration of the roots of the upper teeth.
- The image of the hard palate should appear horizontal and above the apices of the upper teeth.
- Ideally only the slightest ghost shadows of the contralateral angle of the mandible and the cervical spine should be perceptible.
- There should be no evidence of artefacts due to dentures, jewellery, etc.
- The image is clearly marked for 'Right' and 'Left'.
- The image is clearly marked with the patient's name and image date.

Lateral Cephalometric Radiography

This radiographic technique is undertaken to image the maxillofacial skeleton, including the skull base, hard palate, maxilla and mandible. The lateral cephalometric radiograph is taken to image the facial bones in a lateral perspective, and to measure distances in the maxillofacial skeleton. The tube is generally positioned approximately 180 cm from the patient, to minimise magnification and to ensure a straight x-ray beam. The image receptor is placed as close to the patient as possible to minimise magnification.

Equipment

- Extraoral film (generally 18 × 24 cm) in a cassette with intensifying screen or a digital sensor, either direct capture CCD/CMOS detector or phosphor plate with a cassette without intensifying screens.
- Panoramic x-ray set and tube with a cephalometric attachment.

Action	Rationale
Check identifying data for the patient such as their name, date of birth or address.	This ensures that you are about to irradiate the correct patient.
If applicable, insert the cassette containing a film or a phosphor plate into the image receptor carriage in the correct position for the view being undertaken.	To capture the image to be processed.
Prepare the patient by asking for removal of any removable orthodontic appliances, earrings or necklaces. Warn them of the necessity to stand still during the exposure.	This prevents the degradation of the image by artefacts and patient movement.
Ask the patient to stand straight. Position the head within the cephalostat so that the left side of the face is facing towards the x-ray tube. The x-ray beam is orientated at 90 degrees to the image receptor.	Standard imaging position requires that the midsagittal plane of the head is parallel with the image receptor. The x-ray beam will meet this plane at 90 degrees.
If available, turn on beam aiming lights and correctly position the patient; place the ear rods and any nasion marker into the patient's ears and nose to stabilise their head in a true lateral position.	Generally the patient is aligned with the midsagittal line through the midline of the face and the Frankfort plane horizontal to the floor (the FFP can be drawn from the tragus of the ear to the lower border of the orbit). In a 'natural head position' the patient is encouraged to look straight ahead to achieve a 'naturally' straight position.
Ask the patient to bite together naturally, and to close the soft tissues of the lips gently together.	To ensure that the patient is naturally biting together but not overclosed, clenched, or underclosed to mimic an open bite. The soft tissues are important in orthodontic camouflage therefore they should be in a relaxed position.
Select exposure factors and expose the image receptor.	The exposure should normally be selected to image the teeth and bony structures of the mandible and maxilla. An aluminium wedge may be introduced over the soft tissues of nose and lips in order to reduce the intensity of the beam and thus demonstrate these structures along with the denser maxillofacial skeleton in cassette based imaging devices. In units using direct digital capture this feature may be built into the imaging software.

(*Continued*)

Action	Rationale
If necessary, process any image receptor or view the direct captured image on screen.	To enable display of the final image.
Assess the image for final image quality.	To ensure the patient has been correctly positioned; there are not any obvious image faults or movement artefacts; and assess for any error of processing/handling.
Report the image in the clinical notes.	To comply with the IRMER – Ionising Radiation (Medical Exposure) Regulations in the UK (2018).

Image Quality Criteria

- The left ear rod should superimpose directly over the right ear rod.
- The head should be in a true lateral position.
- The image should extend from above the nasion to below the mandible, including the submandibular soft tissue outline. Horizontally it should include the soft tissue outline of the face anteriorly and the cervical spine posteriorly (the whole of C1 and C2 should be demonstrated).
- The density and contrast should be such that the anatomical features used for orthodontic tracing are clearly identifiable and the soft tissue profile should be visible.
- The teeth should be in centric occlusion.
- The lips should be at rest.

Cone Beam CT Imaging

Cone Beam CT (CBCT) is one of the latest imaging techniques to be introduced into dentistry and can be used in dental practice. The rationale for the use of CBCT is when the clinical question cannot be answered when using 2-dimensional (plain film) imaging alone, and when 3-dimensional imaging may be necessary to answer the clinical question.

The term 'cone beam' derives from the shape of the x-ray beam emitted from the x-ray tube head. The machine may look similar to a panoramic unit and normally makes a single rotation around the head of the seated patient. The size of the cone beam area may vary between CBCT units and, in some units, between different imaging programmes. The attenuated x-ray beam is captured on an image receptor and creates a series of projection images from multiple directions. These are collated into a 3-dimensional data set which may then be reformatted and viewed in any chosen plane, dependent on the software of the CBCT unit. The exposure factors for dental CBCT have been deliberately reduced to levels far lower than conventional CT in order to reduce patient dose; this still allows very good resolution of details of bone and teeth, but a consequence is that soft tissue structures cannot be shown.

Even though CBCT imaging can provide significantly greater information than a 2D image, CBCT imaging has much less resolution when compared to conventional planar images. 2D planar images have advantages and disadvantages; they are projection images which create superimposition of anatomical structures in the plane of the image. In dental panoramic radiography (a 2D tomographic technique), there will be superimposition of normal anatomy from the opposite side of the patient and from the soft tissues. Both panoramic and cephalometric radiographs are magnified images, and direct measurements are normally enlarged by a specific magnification factor. CBCT imaging, by contrast, can display true 'slice' images, is normally represented at its true size, and there is no superimposition of adjacent anatomy. The CBCT imaging technique, however, may suffer from inherent image artefacts (i.e. 'star' and beam-hardening from metallic restorations) due to the way the images are captured and reconstructed on screen.

CBCT can be described as small volume when undertaking imaging using a surface of less than 5 × 5 cm of either a single tooth or a group of adjacent teeth. Large volume scans may include the full mandible and maxilla, or the full maxillofacial complex may be imaged.

CBCT imaging has uses in complex implant cases for assessment of bone shape and volume where multiple dental implants are to be placed in the jaws, and CBCT will aid in the localisation of the dental implant in relation to important anatomy such as the floor of the maxillary sinus and superior aspect of the mandibular canal when implant placement should avoid these areas.

CBCT has a place in orthodontic imaging in localising displaced teeth, i.e. impacted canines, and when there may be resorption of the adjacent teeth by an

unerupted tooth, which cannot be assessed with a plain image alone.

Endodontic imaging may employ CBCT 3D imaging where complex root canal anatomy is not seen using a periapical and operating microscope, for example in the location of a second mesiobuccal root canal in an upper first permanent molar, and in identifying and quantifying external and internal root resorption.

In oral surgery, CBCT has been found helpful in planning surgical removal of wisdom teeth when the plain film suggests an intimate relationship to the mandibular canal, and for defining the extent of expansile and destructive bone lesions.

CBCT equipment is now available in combination with panoramic and cephalometric imaging systems, but is more commonly purchased as a standalone device and may incorporate different field sizes for image capture. The ICRP principle of radiation protection, ALARA, encourages the use of the smallest field size compatible with the diagnostic task, noting dose reduction as a legal requirement under IRMER (2018).

CBCT therefore should not replace traditional 2D imaging, but should be used to complement 2D imaging when the clinical question may require confirmation, or assistance in diagnosis.

The radiation effective dose to the patient is normally higher in CBCT imaging compared to 2D imaging, and thus those operating CBCT equipment should be able to adequately justify the additional dose and report all clinical findings within the whole image field. One of the problems of CBCT is that, especially in large volume scanning, anatomy outside of the dental arches is imaged and dentists may have little practical training in its interpretation. Care should be exercised in order not to miss certain important lesions which may be adequately seen in CBCT; these may include vascular malformations, base of skull lesions, lesions of the temporal bone, and sinus pathology.

Quality Assurance in Dental Radiography

Quality assurance (QA) for radiography is an important method of ensuring that radiographs are of consistent diagnostic quality. Repeat radiographs increase costs and reduce efficiency within the dental practice and expose the patient to unnecessary further radiation. A QA programme is required for every x-ray installation, and applies equally to conventional film-based and modern digital dental radiography (Ionising Radiation (Medical Exposure) Regulations 2018). It is recommended that the elements of the programme are written down, an individual nominated to be responsible for the programme, and a decision made on the type and frequency of quality control tests and audits.

Procedure Guidelines – Creating a Quality Assurance Programme for Dental Radiography

Equipment and Requirements

1) A ring binder divided into the following sections:
   - Personnel and training
   - Image quality
   - Patient dose and x-ray equipment
   - Films and digital receptors
   - Image processing
   - Audit.
2) Access to all practice records of staff and staff training, equipment, equipment maintenance and stock.
3) Access to x-ray equipment, films or image receptors, processing equipment.

Personnel and Training

Action	Rationale
Records of staff training.	Identify those 'adequately trained' to undertake duty-holder roles under IRMER in the UK. Dental radiography may be undertaken by dentists, and by professionals complimentary to dentistry (PCDs) with the Certificate in Dental Radiography.
Records of courses attended.	Shows compliance with continuing professional development (CPD) requirements – updating in radiation protection is required at least every 5 years (Ionising Radiation (Medical Exposure) Regulations, 2018; National Radiological Protection Board/ Department of Health, 2001).

Image Quality

Action	Rationale
Daily checks for image quality:	
• Keep a good quality reference film close to the image viewing area.	This ensures a ready and easy comparison of current image sharpness, contrast and brightness.
• If using digital imaging, ensure the monitor screen has been cleaned and the monitor calibrated against a standard test object.	Remove any 'screen' artefacts due to finger prints and ensures the full grey scale is shown.
Reject film analysis:	
• Regularly analyse rejected films.	This allows serious or frequent errors to be picked up and their causes identified. The error may then be rectified.
Formal image quality audit:	
• Perform prospectively for 1 month in at least every 6 months.	This allows a regular systematic review of all aspects of imaging to bring about an improvement in patient care.
• Make a log of *all* images taken within the audit period, detailing date, operator, area imaged, nature and cause of fault.	This process applies equally to film-based and digital imaging.
• Grade all images as either: – 1 = No errors of positioning, exposure or processing. – 2 = Some errors, but these do not detract from diagnostic utility. – 3 = Errors which render the image non-diagnostic.	Grading is helpful in identifying and categorising faults which may then be rectified. Particular attention is paid to Grade 3 errors because these will result in the image being retaken, unnecessarily increasing the radiation dose to the patient. Targets: Grade 1 > 70% Grade 2 < 20% Grade 3 < 10% (Royal College of Radiologists and National Radiological Protection Board, 1994)

Common Errors in Intraoral Dental Radiography

Errors	Corrective action
Patient preparation:	
• Radiopaque foreign bodies are visible on image.	Ask the patient to remove dentures, removable orthodontic appliances, earrings and hairgrips if these will be within the x-ray beam.
• Blurring of the whole image due to patient movement.	Ensure the patient is instructed to keep still.
Technique:	
• The tooth apex is missed from a periapical film.	Insert the film fully into the patient's mouth (passing the film fully down into the lingual sulcus, or fully up into the centre of the roof of the mouth) and ask the patient to bite fully together on the film holder.
• Contact points are overlapped, and therefore obscured, on a bitewing film.	Correct the horizontal angulation of the x-ray beam so that it is incident on the surface of the film/sensor at 90 degrees.
• The film or PSP plate is bent in the patient's mouth causing distortion (Figure 8.4).	Ensure the film/sensor is straight and does not distort as the patient bites together onto the film holder.
• The image shows white spot/line artefacts.	This is a common problem with PSP plates which become damaged during use; scratches on the receptor surface appear as white artefacts (Figure 8.5).

(*Continued*)

Errors	Corrective action
Pale image (Figure 8.6) The image may appear too pale due to:	
• Underexposure	Assess the patient's size; increase x-ray exposure factors slightly for very large or very swollen patients.
• Underdevelopment (conventional film imaging)	Film development is the first stage of film processing – it is a chemical process influenced by developing time, temperature, pH and concentration. If the film is underdeveloped the solution may be: too cold so must be brought to the required temperature; too acidic if contaminated by fixer so may need replacing; or too weak so may need replacing. Alternatively the immersion time may be too short so follow the manufacturer's instructions and possibly lengthen the immersion time.
• Poor image display adjustment (digital imaging)	Adjust the viewing software to optimise brightness and contrast. Consider calibration of the viewing monitor to ensure a reliable image.
• Light contamination of an exposed PSP plate (Figure 8.7).	After exposure to x-rays, PSP plates are sensitive to light contamination. Avoid opening the exposed PSP plate in bright light.
Dark image The image may appear too dark due to:	
• Overexposure (conventional imaging)	Assess the patient's size – reduced exposure factors may be needed if the patient is very small. In the case of Figure 8.8 the film has accidentally been exposed twice (a double image).
• Overexposure (digital imaging)	Overexposure of a digital sensor will cause saturation of the sensor leading to 'blooming', a phenomenon where adjacent pixels are also saturated and become totally black, creating a zone of erroneously dark image. Correct choice of exposure factors will prevent this (Figure 8.9).
• Fogging: exposure of film to light or excess background radiation	Avoid using old films and avoid any stray daylight into the processing area or into the processing machine.
• Overdevelopment (conventional film imaging)	Film development is, as stated above, the first stage of film processing – it is a chemical process influenced by developing time, temperature, pH and concentration. If overdeveloped the solution may be: too hot so must be brought to the required temperature; too alkaline (this is very rare); too strong so may need diluting. Alternatively the immersion time may be too long so follow the manufacturer's instructions and possibly shorten the immersion time.
• Poor image display adjustment (digital imaging).	Adjust the viewing software to optimise brightness and contrast. Consider calibration of the viewing monitor to ensure a reliable image.

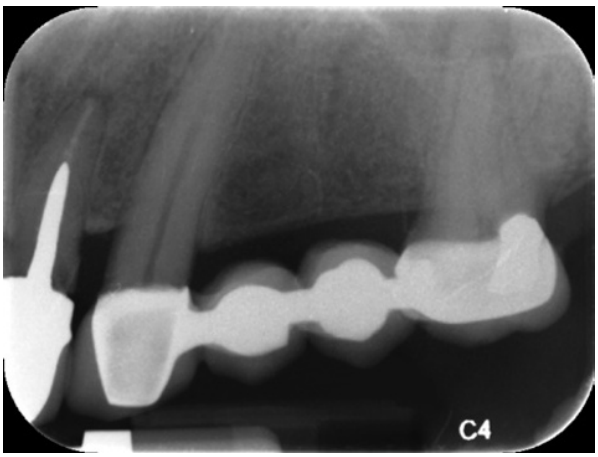


Figure 8.4 Bending of an image receptor causing image distortion.

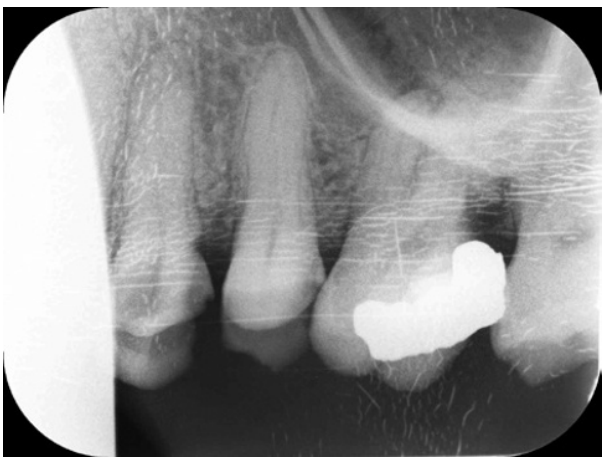


Figure 8.5 Scratch artefacts to surface of PSP plate.

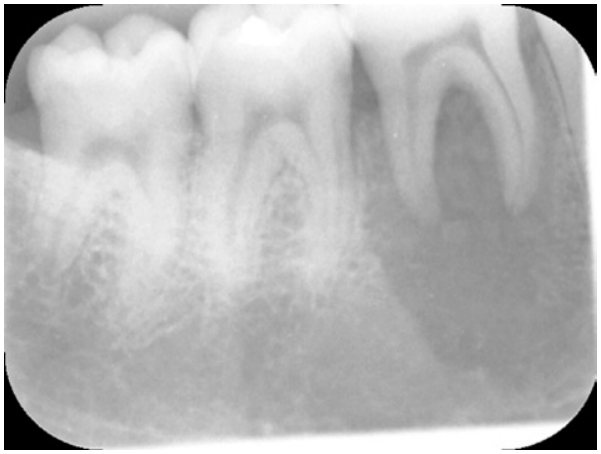


Figure 8.6 A pale image.

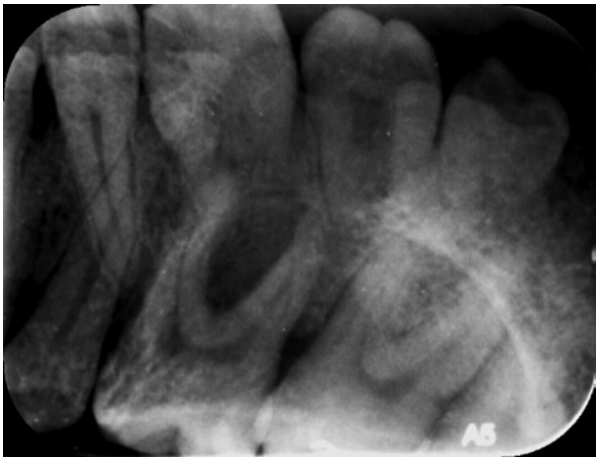


Figure 8.8 A dark image due to a double exposure of the film.

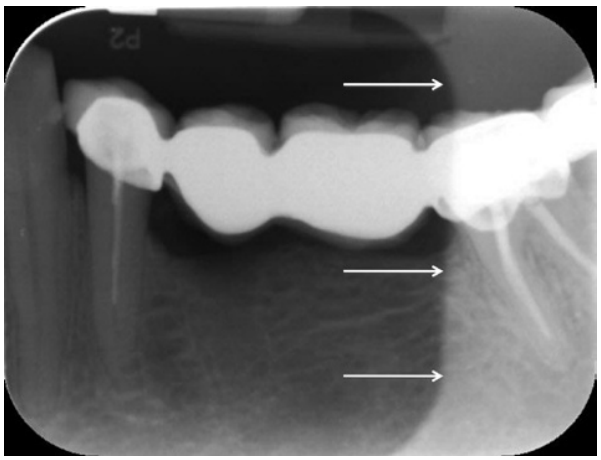


Figure 8.7 Light contamination of the phosphor plate. Note the pale area on the right of the film where light reaching the plate has 'bleached' the image before processing (arrowed).

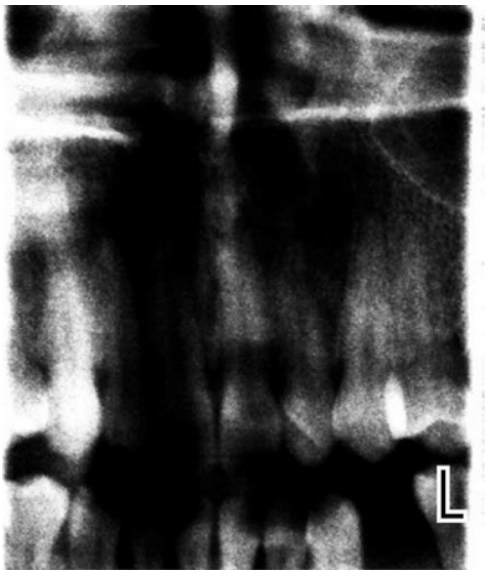


Figure 8.9 Blooming as a result of overexposure of a sectional digital panoramic image.

Common Errors in Panoramic Radiography

Action	Rationale
Panoramic image positioning errors (Figure 8.10):	Each of the errors of patient positioning listed creates *distortions* of the panoramic image. Typically distortions, when they occur, are most pronounced in the horizontal plane rather than in the vertical plane. Ideal patient positioning, centrally within the 'focal trough', results in equal magnification in both the horizontal and vertical dimensions.
• Head too far forward	If the patient is positioned too far forward then there will be reduction of the imaged object in the horizontal plane, i.e. the teeth (particularly the anterior teeth) will look too narrow but remain of approximately the correct length.

(*Continued*)

Action	Rationale
• Head too far back	If the patient is positioned too far back then there will be magnification of the imaged object in the horizontal plane. Here the anterior teeth may slip backwards out of the focal trough resulting in transverse magnification of the teeth, making them appear wider but again remaining of approximately the correct length.
• Head rotated	Head rotation will cause a combination of narrowing of teeth on one side of the patient (those moving closer to the film) and widening of teeth on the opposite side (those moving away from the film).
• Chin down	Tilting the chin down will heavily curve the occlusal plane and mandible downwards.
• Chin up.	Tilting the chin upwards will have the opposite effect. Both these positions distort the normal appearance and length of the teeth.
Patient movement:	
• A vertical zone of image blurring affecting one part of the image.	This will result in a single area of image distortion occurring at a specific location on the image correlated to the moment of movement. Advise the patient of what to expect during a panoramic image and ask them to remain stationary.
Air shadows:	
• Dark areas over the maxillary tooth roots and over the anterior teeth.	Air between the tongue and hard palate, and between the lips, will be seen as dark areas on the panoramic image overlying the teeth and maxillary tooth roots. The patient should be asked to keep lips together, and to keep the tongue against the roof of the mouth during the radiographic procedure.
Artefacts:	
• Patient foreign bodies	All earrings, necklaces, lip and tongue piercings, dentures and orthodontic appliances should be removed because each casts a real shadow onto the image and also a ghost shadow if the object lies between the x-ray source and the focal trough (Figure 8.3).
• Damage to film, cassette or imaging sensors.	Scratches and marks on the image receptor or on the cassette or intensifying screens (conventional film imaging) will result in artefacts on the image. Careful handling will prevent damage, and regular surface cleaning of intensifying screens will prevent marks (which appear white on films).

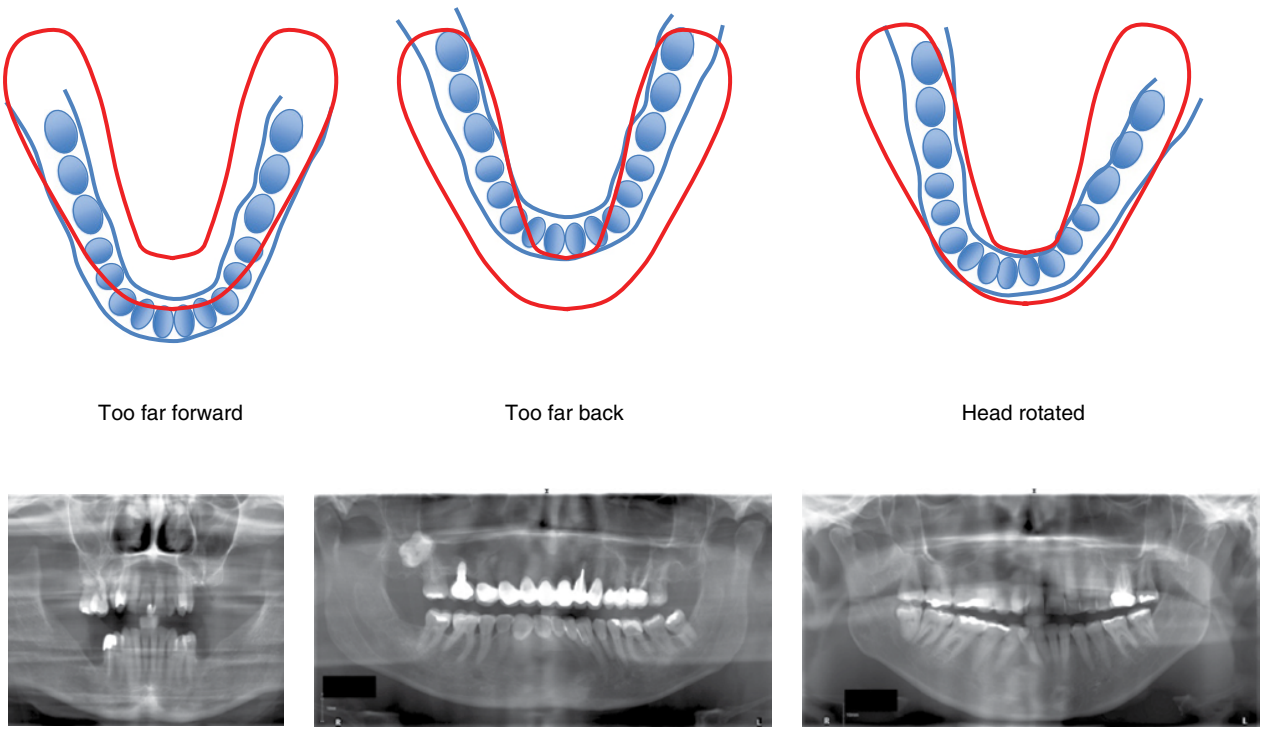


Figure 8.10 Positioning errors in panoramic radiography.

Patient Dose and X-ray Equipment

Action	Rationale
Patient dose: • Keep a record of doses emitted by your x-ray equipment for representative images, e.g. lower molar periapical exposure and panoramic exposure, as supplied by the RPA after annual inspection.	This will show that doses emitted by your dental x-ray equipment are beneath the 'diagnostic reference levels' recommended for dental radiography (Health Protection Agency, 2005).
Equipment: • Register new X-ray equipment with HSE. • Maintain a log of x-ray equipment and its maintenance.	Compliance with the Ionising Radiation Regulations (IRR) 2017 in the UK.
On installation: • Ensure a 'Critical examination' is performed by the installer. • Ensure an 'Acceptance test' is performed by the Legal Person.	Compliance with IRR 2017. This ensures that the installer has verified the correct installation and operation of the equipment, and the owner of the x-ray installation has obtained an independent assessment of the function of the equipment.
At least once every 3 years: • Perform routine safety tests of equipment. • Carry out new tests if equipment is moved or altered. • Perform day-to-day checks for safe working of equipment.	Compliance with IRR 2017. Ensures early identification of faults.

Films and Digital Receptors

Action	Rationale
Ensure cleanliness of processing area/dark-room.	Prevents artefacts such as developer or fixer scratches, and contamination of image receptors.
Film-based imaging: • Store film away from light, heat, developer fumes and radiation.	To avoid deterioration of the film emulsion leading to fogging of the film.
• Rotate stock.	To use stock before 'expiry date'.
• Ensure light-tightness when processing conventional film and use appropriate safe lights/viewing window filter.	To avoid film 'fogging', a dark area on the exposed film caused by low level light reaching the undeveloped film.
• Perform a 'coin test' (see next section).	This test checks for film fogging and measures the 'working time'.
Digital sensors: • Handle with care (especially the surfaces of photo-stimulable phosphor (PSP) plates, and avoid trauma to CCD/CMOS sensors and wires).	To avoid scratches and sensor damage leading to degradation of image quality (Figure 8.5).
• Blank PSP plates daily following the manufacturer's instructions.	To remove stimulated pixels caused by environmental exposure.
Cassettes (panoramic and cephalometric) Film-based cassettes: • Clean surfaces of intensifying screens once a month by wiping with mild soap solution or proprietary cleaner.	Prevents artefactual surface marks which may mimic a radiopacity.
• Check for proper closure and light-tightness of cassette by examining margins of image for dark shadows.	Light leakage into cassettes will fog the margins of the image and cause loss of film-screen contact (seen as loss of image definition).
Digital cassettes (PSP plates): • Ensure proper closure of cassettes. • Check plate surfaces for scratches and damage.	Plates may be damaged if the cassettes do not close and protect the plates properly, otherwise the resultant image may show artefacts.
Digital sensors: • Avoid trauma/collision with other equipment.	To avoid damage which may lead to costly replacement.

Performing a Coin Test

This test is designed to identify light leakage during handling and processing of conventional and digital film which may cause film fogging and thus affect image quality.

Action	Rationale
Identify the area where the films are handled and identify any potential source of light ingress. This may often be the film loading bay of an automatic processor or around a digital plate processor.	This will be the location for the coin test.
Begin the test with absolute darkness in the normal film handing area. This may involve closing the viewing window or turning off all overhead lights.	This allows the test to be set up without light contamination.
Place a piece of film or PSP that has been exposed to a 'flash exposure' of radiation into the normal handling area (e.g. on the floor of the film loading bay) and place 4 coins in a line at intervals across its surface.	The flash exposure ensures the emulsion has been sensitised. The coins will protect patches of the exposed film from light exposure during the test.
Cover the 4 coins and film completely with dark card. Begin the test by opening the viewing window or turning on the lights around the digital plate reader.	This is the starting point for this test.
Pull the card back to reveal the first coin, revealing it for 15 seconds. Pull back the card to reveal the second, third and fourth coins at 15-second intervals. Finally replace the card and close the viewing window or turn off the dark-room safe-lights.	Each coin receives a different exposure time to the ambient light conditions in the film handling area. The fourth coin receives the shortest exposure to the light.
Process the test film in complete darkness, if possible.	It is helpful to avoid any further light contamination.
Examine the resultant film for the shadows of the coins. Ideally the shadow of the third and fourth coins should not be visible.	The number of coin outlines indicates how quickly film fogging/light exposure is occurring, and therefore how much light is entering the film handling area. If the third and fourth coins are not visible, this would show that there is a 'film handling time' of 30 seconds before fogging begins to affect the film. If all coins, including the fourth coin, are visible, this indicates excessive light leakage and a 'film handling time' of less than 15 seconds.
Repeat this test at a given interval (e.g. every 6 months) or if conditions change in the processing environment, i.e. change of light bulb.	

Image Processing

Action	Rationale
Film-based imaging Chemical solutions should be: • Made up to manufacturer's instructions. • Always at the correct temperature: – 21°C for manual processing – as directed for automatic processors. • At the correct concentration.	Correct function of the developer and fixer solutions will only occur within the specified time if at the recommended temperature and concentration.
Digital imaging Digital images on PSP plates: • Should be processed instantly or as soon as possible.	The image will slowly degrade if not processed immediately.

(*Continued*)

Action	Rationale
• Be processed away from bright light.	Light levels should not exceed 50 Lux in the processing area to avoid light contamination causing pale areas.
Digital images on CCD/CMOS sensors: • Will appear instantaneously on the computer monitor, and therefore do not undergo a 'processing' stage.	
Digital monitors should be assessed regularly for dirt and also image resolution, brightness and contrast using a test object such as the standard monitor performance test (SMPTE test pattern).	This test object displays a range of grey scales and objects of different contrast and image resolution sizes, which will help to identify if a monitor is adjusted correctly or if the image quality is too poor for diagnostic purposes.

Audit

Audit of image quality, and other aspects such as radiation dose and equipment, is an important part of quality assurance. Audit is discussed in more detail in Chapter 24.

An audit of film quality is simple to implement and is effective in identifying areas where faults are commonly occurring. The audit may be performed on an ongoing basis or performed for a period of time.

Audit of Film Quality

Action	Rationale
All images are collected and analysed during the audit period, and allocated one of three quality grades (see 'Image Quality'): • Grade 1 = no faults • Grade 2 = some minor faults but image is still of diagnostic quality • Grade 3 = non-diagnostic image due to significant fault or faults.	The grading of images allows image quality to be compared against defined targets or standards. The targets recognised in the Royal College of Radiologists and National Radiological Protection Board Guidelines (1994) are: Grade 1 > 70% Grade 2 < 20% Grade 3 < 10%.

References

European Commission. (2004) Radiation Protection 136. European guidelines on radiation protection in dental radiology 2004. Luxembourg: Office for Official Publications of the European Communities. Available from: https://ec.europa.eu/energy/sites/ener/files/documents/136_0.pdf (accessed 6th July, 2017)

Health Protection Agency. (2005) *Doses to patients from radiographic and fluoroscopic x-ray imaging procedures in the UK – 2005 review*. London: Health Protection Agency (Radiation Protection Division).

Horner, K., Eaton, K.A. (2013) *Selection Criteria for Dental Radiography*. 2nd edn. London: Faculty of General Dental Practitioners (UK) and Royal College of Surgeons of England.

Ionising Radiation (Medical Exposure) Regulations 2018. London: HMSO.

Isaacson, K.G., Thom, A.R., Atack, N.E., Horner, K., Whaites, E. (2015) *Guidelines for the Use of Radiographs in Clinical Orthodontics*. 4th edn. London: British Orthodontic Society.

Lecomber, A.R., Downes, S.L., Mokhtari, M., Faulkner, K. (2000) Optimisation of patient doses in programmable dental panoramic radiography. Dentomaxillofacial Radiology 29(2):107–112.

National Radiological Protection Board/Department of Health. (2001) *Guidance notes for dental practitioners on the safe use of X-ray equipment 2001*. London: NRPB/Department of Health.

Royal College of Radiologists and National Radiological Protection Board (1994) Guidelines on radiology standards for primary dental care. Report by the Joint Working Party of the RCR and NRPB. Documents of the NRPB 5(3):1–57.

Rushton, V.E., Horner, K., Worthington, H.V. (2002a) Routine panoramic radiography of new adult patients in general dental practice: relevance of diagnostic yield to treatment and identification of radiographic selection criteria. Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology, and Endodontics 93(4):488–495.

Rushton, V.E., Horner, K., Worthington, H.V. (2002b) Screening panoramic radiography of new adult patients: diagnostic yield when combined with bitewing radiography and identification of selection criteria. British Dental Journal 192(5):275–279.

The Ionising Radiations Regulations 2017. Statutory Instrument 2017.

Wenzel, A., Møystad, A. (2010) Work flow with digital intraoral radiography: a systematic review. Acta Odontologica Scandinavica 68(2):106–114. Review.

9

Procedures in the Management of Dental Pain

Tara Renton

So What Is Pain?

The International Association for the Study of Pain (IASP)* defines pain as 'an unpleasant sensory and emotional experience associated with actual or potential tissue damage or described in terms of such damage'.

Pain experience is dependent upon:

- Age.
- Gender.
- Ethnicity.
- Culture.
- Pain experience.
- Personality.
- Stress.
- Depression.
- Anxiety.

Pain:

- May have an organic and psychological causation.
- Is an entirely individual response.
- May be assessed by psychological questionnaires to investigate functionality, disability and behaviour.
- May be superficially 'scored' using the Likert scale (https://simplypsychology.org/likert-scale.html).
- Is near impossible to measure due to the individuality of the pain experience which is different for every patient.

Assessment

As considered in Chapter 6, assessing a patient in pain requires specific skills, knowledge and excellent communication. Communication is key to eliciting the necessary history from a patient in pain. The clinician must be a good listener. Certain patients, however, may not be able to communicate the nature and severity of the pain they are experiencing. This greatly increases the challenge of completing an effective assessment.

The clinician is beholden to take a full and comprehensive history to build trust and understanding of the patient and their complaint. Acute pain will have onset in the last few days, or possibly weeks, but generally has been present for less than 3 months. The pain may be associated with key inflammatory signs (tumor, dolor, calor, rubor and loss of function) but if caused by a 'cold bacterium' may not have the traditional inflammatory signs (dry socket, for example). Acute pain is inflammatory pain that responds to anti-inflammatories (e.g. paracetamol and non-steroidal anti-inflammatory drugs – NSAIDs).

Management of Dental Pain

The management of dental pain includes:

- The management of patients presenting with pain as a symptom. The pain may be acute pain (usually of sudden or recent onset, possibly lasting <3 months) or chronic trigeminal pain (lasting >3 months). Pain is usually a symptom of some pathology or trauma or referred pain (cancer must be always excluded in recent onset pain not responding to normal interventions).
- The management of patients undergoing surgical and operative procedures of the face, jaws, teeth and mouth, requiring anaesthesia (local or possibly general). The management, while typically preoperative, may be intraoperative.
- Postsurgical pain management.

Management of Acute Symptomatic Pain

The management of acute symptomatic pain, which is often pulpal in origin or caused by infection or trauma,

*The International Association of the Study of Pain (IASP) is the organisation to which any clinician or basic scientist with an interest in pain belongs. https://www.iasp-pain.org/Taxonomy

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

typically begins with the management of the causation. This may involve a dental extraction, an endodontic procedure, the management of a dental abscess or wound, or measures to control various forms of infection.

Management of Intraoperative Pain

Intraoperative pain is typically managed by means of local anaesthesia with or without adjunctive sedation (for anxiolysis) or general anaesthesia when undertaking prolonged or extensive surgical procedures.

Management of Postoperative Pain

Post-operative pain is typically managed by means of education, reassurance and analgesics.

Management of Chronic Trigeminal Pain

According to Woda et al. (2005), chronic trigeminal pain may be classified as:

- Neurovascular pain conditions.
- Neuropathic pain conditions.
- Idiopathic (better now referred to as centralised or dysfunctional) pain conditions.

The management of chronic trigeminal pain involves a range of procedures and pain management regimens. Patients with chronic trigeminal pain may require specialist care.

Treatment Planning

The cornerstones of treatment planning for a patient in pain, as in all other aspects of dentistry are:

- Thorough history.
- Careful examination.
- Appropriate special tests.
- Eliciting the correct diagnosis.

In pain management the standard history and examination should be augmented with specific questions, observations and special tests (Table 9.1).

There is no absolute measure of pain because it is a purely subjective experience. However, pain assessment is essential in diagnosing and monitoring patients' response to treatment. Pain rating scales are often used in assessing pain intensity. A useful tool for remembering pain history questions is SOCRATES – *S*ite, *O*nset, *C*haracter, *R*adiation, *A*ssociated features, *T*iming, *E*xacerbating and alleviating factors, *S*everity.

Management of Acute Pain

Acute orofacial pain refers to pain initiating from the teeth or their supporting structures, the mucosa, gingivae, maxilla, mandible or periodontal membrane. It is one of the commonest reasons for individuals to seek dental care

Aetiology

There is a wide range of causes of acute orofacial pain, including:

- Most commonly, pulpitis causing dental pain (toothache).
- Infection of the soft tissues, most commonly pericoronitis.
- Periapical periodontitis.
- Dentine hypersensitivity.
- Dry socket.
- Acute trauma.

Management

The management of the conditions which give rise to acute orofacial pain is dealt with in different chapters of this manual. Common features of the different management strategies include:

- Thorough assessment, including special tests as indicated clinically.
- Differential and definitive diagnosis.
- Elimination of the causation.
- Remedial or surgical measures.
- Prevention of recurrence.

Management of Intraoperative Pain

Local Anaesthesia

Local anaesthesia is defined as a drug, administered for medical or surgical purposes, that induces reversible partial or total loss of sensation and may be topical, local, regional or general, depending on the method of administration and area of the body affected.

Key considerations include:

- Local anaesthesia is always the first choice of anaesthesia providing there are no contraindications.
- Application may be topical or injected by infiltration or block.
- An understanding of the pharmacology of local anaesthesia drugs is a prerequisite to the administration of local anaesthesia.
- Familiarity with the relevant anatomy and the variety of methods of administering local anaesthesia is a further prerequisite.
- The simplest local anaesthesia technique which is likely to be effective is usually the most appropriate.
- All patients must be monitored in accordance with current recommendations.

Table 9.1 Specific observations and special tests for patients in pain.

Observations and special tests	
Signs of inflammation	Redness, swelling, heat and tenderness
Response to anti-inflammatories	A positive response indicates that the pain is inflammatory; a negative response indicates that the pain may be neuropathic or dysfunctional pain and non-inflammatory
Response to antibiotics	A positive response indicates likely infective cause; a negative response indicates unlikely infective cause
Tenderness to percussion	A positive response is indicative of periapical periodontitis
Loss of function	Trismus, inability to bite on tooth, difficulty swallowing
Pulp testing, involving more than one type of pulp test	• Lack of response does not signify pulpal necrosis. A positive response from a multirooted tooth may not indicate that vital tissue is present in all canals • Hyper-responsiveness to cold may indicate reversible pulpitis • Hyper-responsiveness to heat may indicate irreversible pulpitis • Pain caused by sweet stimuli may indicate a failed, leaking restoration • Intermittent hypersensitivity, exacerbated by biting, may indicate 'cracked tooth syndrome'
Neuropathic signs	• Mechanical allodynia – pain to touch • Hyperalgesia – atypical, severe pain to painful or noxious stimulus
Periapical radiographs	• Periapical radiolucency is typically indicative of pulpal necrosis • Fractures, cracks and perforations may point to causation
Haematological investigations	• Elevated ESR and CRP levels are indicative of acute spreading infections • Excluding haematinic deficiency, hypothyroidism, diabetes and connective tissue disease is imperative in excluding peripheral painful neuropathies • For chronic pain and pain of unknown cause: – FBC with haematinics (Fe, B_{12}, folate) – Zinc – required for Fe absorption – Thyroid function tests – HBA1c – Autoantibody screening (ENAs and ANAs)
Signs of sinister disease	• Intense pain of sudden, recent onset • Painless, worsening trismus • Neuropathy • Asymmetry

ANA, anti-nuclear antibody; CRP, C-reactive protein; ENA, extractable nuclear antigen; ESR, erythrocyte sedimentation rate; FBC, full blood count.

- Patients must be discharged and cared for appropriately.
- Medicolegal considerations, including consent, patient instructions and detailed clinical notes, help to protect the patient and also minimise the risk of litigation.
- To provide local or regional pain relief for dental and surgical procedures with minimal discomfort to the patient whilst minimising complications.
- To minimise the need for sedation or general anaesthesia in the provision of routine dentistry.

The ideal local anaesthetic does not yet exist. The properties of the ideal local anaesthetic, compared to those of existing local anaesthetics, are listed in Table 9.2.

The advantages of local anaesthesia over general anaesthesia in the provision of dental care include:

- Convenience, speed of administration and good patient acceptance.
- Significantly lower mortality.
- High patient satisfaction.
- Well tolerated in patients with pulmonary disease.
- The patient's airway is maintained.
- Selective muscle relaxation.
- Reduced blood loss.
- Decreased incidence of dep vein thrombosis and pulmonary embolism – both complications of general anaesthesia and prolonged immobilisation.

The disadvantages of local anaesthesia in dentistry include:

- Patient remains conscious.
- Patient anxiety.
- Not reliable for surgery or operative procedures which may take more than 2 hours to complete.
- Risk of bradycardia, hypotension and fainting – vasovagal syncope.

Table 9.2 Properties of the ideal and current local anaesthetics.

Properties of the ideal local anaesthetic	Current local anaesthetics
100% effective	No
Sufficient pain relief	Yes
Fast onset	Yes
Last only for duration of procedure	Yes
Fast recovery	No
Pain relief only	No
Cheap	No
Painless and easy to administer	No
Well localised	No
Safe with no side effects	Yes
No risk of nerve injury	No
No systemic effects	No
Topical/no injection	No

Box 9.1 American Society of Anesthesiologists (ASA) scale.

I Fit and well patients requiring straightforward surgery who are expected to make a complete and uneventful recovery

II Patients with a medical condition which may complicate the delivery of care but is unlikely to affect outcome (e.g. hepatitis, coagulopathies, past history of endocarditis, steroids, epilepsy, mental handicap)

III Patients with medical condition(s), or past surgery which may additionally compromise outcome (complicated surgery, uncontrolled diabetes, immunosuppression)

IV Patients in whom the complications of surgery may be severe with marked local or systemic complications (inherited clotting disorders, uncontrolled local or systemic disease) and/or require contemporaneous specialised medical therapy (severe immunosuppression, haemophilia)

V/VI Not relevant to surgical dentistry

Contraindications of local anaesthesia in dentistry include:

- Patient:
  - Refusal.
  - Inability to collaborate with treatment (mental or physical disability, or < 7 years of age) or severe anxiety in adults.
- Surgical:
  - Procedure lasting more than 1–2 hours.
  - Large surgical domain – would require an overdose of local anaesthesia, let alone multiple injections, to gain surgical analgesia.
  - Previous failed attempts under local anaesthesia.
- Medical:
  - Bleeding dyscrasia causing additional haemorrhage and associated complications.
  - Hypovolaemia may increase toxicity of local anaesthetic.
  - Presence of sepsis/bacteraemia.
  - Certain neurological conditions and disease.
  - Increased intracranial pressure.
  - Fixed cardiac output states.

Patient Assessment

A satisfactory first visit is crucial to the success of subsequent treatment under local anaesthesia. Remember that for some patients even discussing dentistry can be frightening. The assessment should include:

- A full medical history. If in doubt, consult the patient's general medical practitioner or individuals providing any specialist care.
- A baseline recording of blood pressure with the result recorded in the patient's notes.
- To clarify operative risk, the patient may be classified according to the American Society of Anesthesiologists (ASA) scale (Box 9.1). Patients classified ASA I or ASA II are generally suitable for treatment in primary dental care. ASA III–IV patients should be referred to a specialist centre.
- A dental history, including details of many adverse experiences with, in particular, local anaesthesia.
- The patient's level of anxiety. Marked anxiety may be an indication for conscious sedation.
- Examination of the site(s) for the administration of the lopcal anaesthesia, together with an assessment of the sufficiency of the access.

Treatment Options

The following treatment options, as detailed in Figure 9.1, may then be considered and discussed with the patient:

- Local anaesthesia alone.
- Local anaesthesia with inhalational sedation (RA).
- Local anaesthesia with intravenous conscious sedation.
- Local anaesthesia with oral sedation.
- General anaesthesia as an outpatient.
- General anaesthesia as an inpatient.

The simplest technique that will enable the proposed treatment to be carried out safely and effectively is generally best.

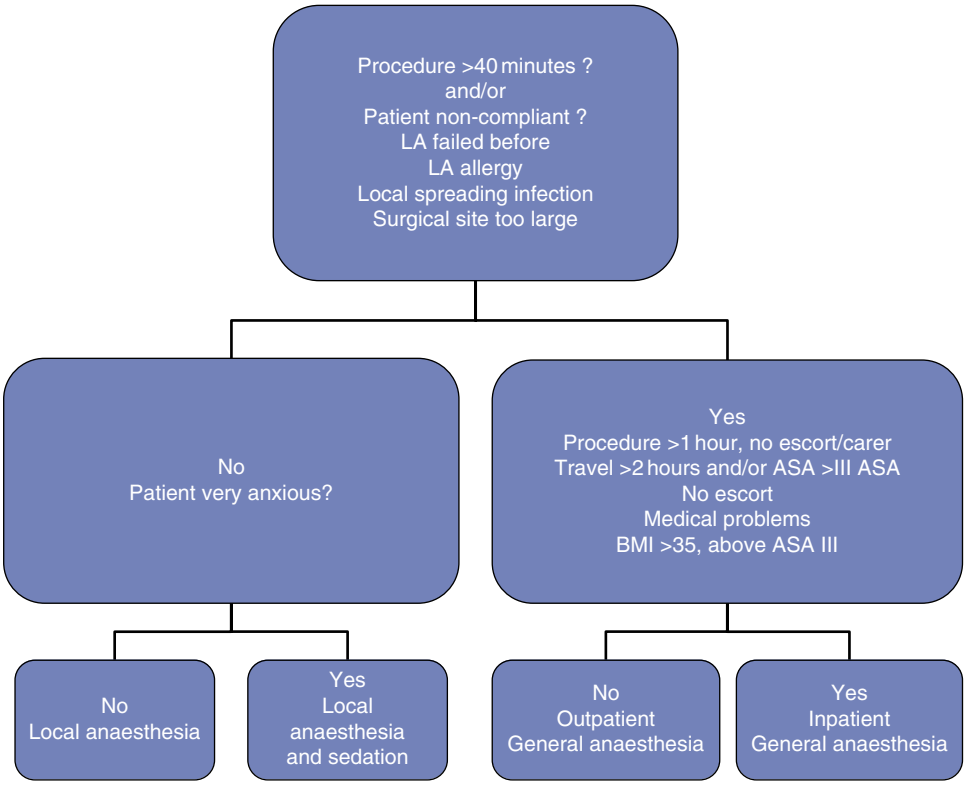


Figure 9.1 Algorithm for selection of appropriate anaesthesia for oral surgery.

Once the most appropriate treatment option has been agreed with the patient, pre- and postoperative instructions should be provided and discussed with the patient and consent obtained.

Regulations

There are specific regulations pertaining to practitioners who provide dental local anaesthesia. All such practitioners must be resuscitation–basic life support (BLS) trained, work in an environment with facilities for sterilising the syringes, and adhere to health and safety regulations with regard to sharps disposal and cross-infection control regulations.

Local Anaesthetics

The range of local anaesthetic agents available for, and commonly used in dentistry (British National Formulary – https://www.bnf.org/) includes:

- Lidocaine (lignocaine) – most commonly used.
- Prilocaine.
- Benzocaine – surface anaesthesia.
- Marcaine.
- Articaine.

Information on the duration and maximum doses of these anaesthetics is set out in Table 9.3.

The drug of first choice is lidocaine with adrenaline (1:80 000 UK; 1:100 000 (epinephrine) Europe and USA). The adrenaline acts as a vasoconstrictor, extending the duration of the action of the lidocaine.

Lidocaine has the following properties:

- Non-irritant to tissue.
- Spreads effectively and rapidly through tissues.
- Has few or no vasodilator effects.
- Anaesthesia is more rapid than with procaine.
- Good duration of anaesthesia.
- Has some topical action as a spray or gel.
- Maximum safe dose 200 mg (500 mg with vasoconstrictor).
- Non-allergenic.
- Without adrenaline, there are no contraindications for dental use.

Safety of Local Anaesthesia

Local anaesthesia is considered to be very safe, if appropriately administered and within maximum dose levels. However, prior to administration it is important to:

- Check for allergy.
- Check for history of poorly controlled hypertension.
- Check doses at extremes of age.

Table 9.3 Duration and maximum dose of local anaesthetics used in dentistry.

Anaesthetic	Duration without adrenaline min	Duration with adrenaline min	Maximum dose without adrenaline mg/kg	Maximum dose with adrenaline mg/kg
Esters				
Cocaine	45	—	2.8	—
Procaine	15–30	30–90	7.1	8.5
Chloroprocaine	30–60	—	11.4	14.2
Tetracaine	120–240	240–480	1.4	—
Amides				
Lidocaine	30–120	60–400	4.5	7
Mepivacaine	30–120	30–120	4.5	7
Bupivacaine	120–240	240–480	2.5	3.2
Etidocaine	200	240–360	4.2	5.7
Prilocaine	30–120	60–400	5.7	8.5
Not included				
• Ropivacaine				
• Benzocaine – surface anaesthesia				
• Levobupivacaine				

- Excercise caution in those with uncontrolled cardiac arrhythmias and severe hypertension.
- Avoid high doses in patients with severe liver disease as metabolism is impaired.
- Assess the risk of psychogenic side effects.

Pharmacokinetics

Local anaesthetics cannot block sodium channels from outside the axon; only uncharged local anaesthetics can cross the axon membrane.

pH

Most local anaesthetics, with the exception of benzocaine, are weak bases (pKa 8–9). pKa = pH when the local anaesthetic is 50% charged/uncharged. The smaller the difference between pKa and pH, the more non-ionised molecules. The more non-ionised molecules, the quicker the onset of action. The rate of diffusion of non-ionised molecules through the nerve cell membrane depends upon:

- Nerve morphology.
- Concentration of the anaesthetic solution.
- Lipid solubility.

Onset of Action

pKa ↓ (= ionisation ↓) = time to onset ↓.

Potency

Lipid solubility ↑ = potency ↑.

Duration of Action

Protein binding ↑ and lipid solubility ↑ = duration of action↑.

Diffusion of the anaesthetic agent away from the nerve depends on:

- Protein binding.
- Concentration of the anaesthetic.
- Lipid solubility.

Duration Times

These are listed in Table 9.4.

Effect of Increasing the Dose (Volume and/or Concentration)

- Time to onset ↓.
- Duration of action ↑.
- More profound motor block.
- But, risk of ↑toxicity.

Adjunctive Components

The most commonly used anaesthetic solutions contain several components, for example:

Xylocaine® 2% with Adrenaline (1:80 000)

- Lidocaine hydrochloride BP 21.4 mg – the anaesthetic agent.
- Adrenaline tartrate BP 22.7 mg – the vasoconstrictor.
- Sodium chloride 6 mg – to make the solution isotonic.
- Sodium metabisulfite 0.5 mg – to prevent oxidation of the adrenaline when exposed to light.

Citanest® with Octapressin®

- Prilocaine hydrochloride BP 30 mg – the anaesthetic agent.
- Felypressin 0.03 i.u. – the vasoconstrictor.
- Sodium chloride BP 6 mg – to make the solution isotonic.

Sodium Bicarbonate

Sodium bicarbonate is added to lidocaine with adrenaline to neutralise the solution, reduce the pain of injection and increase effectiveness. Buffered solutions should be discarded after one week, because the effectiveness of the adrenaline decreases by almost 25% during this time.

Hyaluronidase

Hyaluronidase is a bovine-derived enzyme that hydrolyses hyaluronic acid in the connective tissue and facilitates the diffusion of local anaesthetic. Although this increases the spread of anaesthesia, hyaluronidase decreases the duration of action and increases the risk of toxic reactions.

Sodium Metabisulfite

Sodium metabisulfite is added as a stabiliser. It makes the solution more acidic and may contribute towards pain ('burn') on injection. It may also provoke an allergic reaction.

Vasoconstrictors

The functions of a vasoconstrictor in an anaesthetic solution are to:

- Increase the duration of action by 30–50%, but only in combination with short-acting local anaesthetics (lidocaine-, prilocaine and marcaine).
- Increase the depth of anaesthesia.
- Decrease intravascular uptake.
- Reduce operative bleeding through vasoconstriction.
- Reduce systemic toxicity.

Vasoconstrictors are unstable in direct sunlight and heat, therefore local anaesthetic solutions containing a vasoconstrictor should be stored in a dark, cool place.

Adrenaline

Adrenaline is the most widely used vasoconstrictor in dentistry, because:

- It is a very potent vasoconstrictor.
- It has low systemic toxicity in concentrations below 1:50 000 (1:80 000 used in dentistry).
- It is slowly absorbed, and therefore very safe.

However, adrenaline must not be injected intravenously because it may cause tachycardia, increased blood pressure, arrhythmia, or ventricular fibrillation. Also, the administration of adrenaline may be contraindicated in patients with thyrotoxicosis and pre-existing cardiovascular disease. It must not be given in conjunction with general anaesthetic agents such as halothane.

Octapressin®

Octapressin® is:

- A relatively weak vasoconstrictor.
- Available only with prilocaine in a dose of 1:200 000 (0.3 i.u.).
- Safe to use in patients with thyrotoxicosis.
- Contraindicated in pregnancy.

Patients with ischaemic heart disease must only be given a small dose of Octapressin®, because >8 ml of Citanest® with Octapressin® may induce coronary vasoconstriction.

If anaesthetising a structure with end arteries – an ear or finger – only plain (non-vasoconstrictor containing) local anaesthetic solution should be used.

Patient-Related Factors

Age and Size

Careful dosage monitoring is required at extremes of age (<1 and >70 years of age). In very young and older patients, reduced elimination of the anaesthetic agent may allow a 10–20% reduction in dose.

Body Size

In very small patients (<50 kg), the dose for regional anaesthesia should be reduced by <30%. Larger doses are not normally required for dental purposes in larger patients.

Pregnancy

In pregnancy there is a hormonally increased sensitivity to local anaesthetic agents, together with an increased risk of toxicity.

Presence of Infection

Local anaesthesia is relatively ineffective in the presence of infection, given low tissue pH and vasodilation, notwithstanding the risk of spreading the infection.

Table 9.4 Local anaesthetic duration times.

	Pulpal (min)	Soft tissue (min)
Lidocaine with adrenaline	60	170
Articaine with adrenaline	60	190
Prilocaine plain	20	105
Marcaine with adrenaline	40	340

Medical Considerations

- Local anaesthesia is very safe.
- The commonest problems are psychogenic.
- Check for allergy.
- Check for history of cardiac arrhythmias.
- Check for history of hypertension.
- Check for hepatic and renal dysfunction.

Such medical complications may require dose reductions relative to degree of dysfunction, possibly <50%.

Myths

Common myths include the need to avoid the use of adrenaline-containing local anaesthetic in:

- Patients on monoamine oxidase (MAO) inhibitors.
- All hypertensive patients.
- All patients who have angina or have had a myocardial infarction.
- All patients with liver disease.

Also, bilateral inferior dental blocks are not necessarily dangerous, and evidence is limited in that Citanest® may induce labour in pregnant females.

Antinociceptive Effects

Other unsubstantiated effects of local anaesthesia include:

- Antiarrhythmic.
- Improved bowel function.
- Antithrombotic.
- Reduction of inflammation processes.
- Antibacterial.
- Influence on wound healing.
- Neuroprotection.
- Accumulation of metabolites – risk of methaemoglobinaemia.

Equipment

Syringes

Local anaesthetic syringes are amongst the most commonly used types of dental equipment. These syringes may be reusable, with the need to decontaminate and sterilise between patients, or single-use, disposable syringes, which minimise the risk of cross-infection and, given integral sheath protection, reduce the incidence of needlestick injuries. Aspiration may be achieved by means of aspirating tip plungers, as part of the design of the syringe, or by means of an aspirating bug as part of the design of the local anaesthetic cartridge. Reusable and single-use, disposable syringe systems may be:

- Self-aspirating.
- Aspirating.
- Non-aspirating.

It is a legal requirement to aspirate during block anaesthesia in the UK.

Conventional reusable syringes continue to be the most widely used form of syringe in the clinical practice of dentistry. There are several methods of reducing the risk of needlestick injuries when using such syringes. These include:

- Immediate removal of the used needle, using an artery clip, and disposal of the needle in a sharps disposal bin, which should be to hand.
- The use of a block of foam into which the needle is inserted immediately following use.
- The use of specially designed needle mounts, sheaths and removers.

Needles

Length and Gauge

The three standard dental needle lengths are:

- Long (~35 mm).
- Short (~25 mm).
- Ultra-short (~12 mm).

In general, it is suggested that long needles should be used for deep injections such as blocks of the inferior dental nerve to improve accuracy. Short needles are used for most other forms of local anaesthetic injection in dentistry. Ultra-short needles tend to be used for injections such as periodontal ligament injections.

The three standard dental needle gauges, or thicknesses, are:

- 25-gauge.
- 27-gauge.
- 30-gauge.

The higher the gauge, the finer the needle.

The choice of gauge depends on two main factors:

1) The need for a stiff needle. The thicker the needle, the more stable it is, and the less it deflects when pushed into tissue. A practitioner may decide to use a thicker needle when planning to inject on heavier-set individuals.
2) The need to aspirate. Neither 27-gauge nor 30-gauge needles are reliable for the aspiration of blood. Whenever the practitioner is injecting into an area where there is the possibility of entering a blood vessel, a 25-gauge needle should be used. Patients are not able to discern the difference between the prick of a 25-, 27- or 30-gauge needle. The key to reducing pain during injection, regardless of the needle gauge, is to inject slowly and steadily.

Needles – Key Points of Safety

- Never inject directly into nerves.
- Never place your hand or any other part of your anatomy over the sharp end of the needle.
- Always immediately dispose of the used needle.

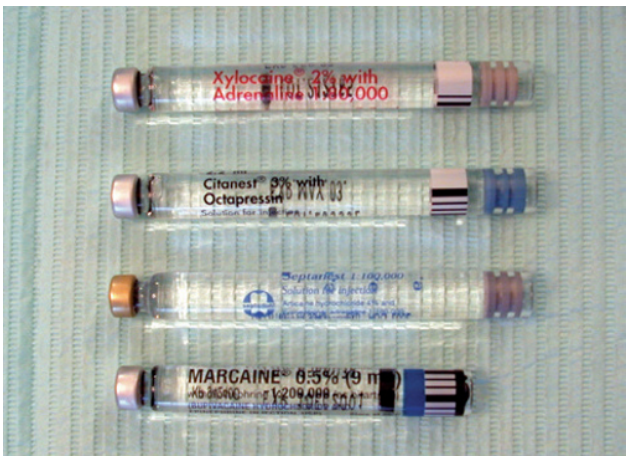


Figure 9.2 Cartridges of xylocaine, Citanest®, articaine and marcaine.

- Never bend a needle.
- Never insert the needle up to the hub of the syringe.

Cartridges (Figure 9.2)

Local anaesthetic cartridges are labelled according to:

- Volume – UK 2.2 ml (USA and Europe 2 ml).
- Name of drug, with or without a vasoconstrictor.
- Expiry date.

Prior to use, it is essential to check the contents and expiry date of a cartridge. The cartridge should also be checked for any evidence of damage. If a cartridge is found, or merely suspected, to have suffered damage, it should be rejected. The batch number of the cartridge should be recorded in the patient's notes.

All local anaesthetic cartridges should be stored in accordance with manufacturer's instructions to prevent contamination and denaturing.

Clinical Procedure

Success in local anaesthesia is underpinned by:

- The patient being fully prepared – briefed, consented and reassured.
- The dental team being fully prepared – there is nothing worse for an anxious patient than having to wait for missing items to be located.
- The procedure being undertaken efficiently, effectively and safely.
- The capability of the dental team to deal with any untoward event which occurs during the procedure.

Before any clinical procedure is started, typically with the administration of local anaesthetic, it is important to check the patient's:

- Identity – name, date of birth, address, hospital number, etc.
- Medical history.
- Blood pressure.
- Intended procedure.
- Consent.
- Comfort, including a preoperative visit to the toilet.

Then, always check:

- The cartridge loaded in the syringe – the anaesthetic agent, the presence or absence of vasoconstrictor and date of expiry.
- The suitability of the needle, and that it has been correctly fitted to the syringe and ready for use.
- And record the cartridge batch number in the patient notes.

Routes of Application

Local anaesthetics for dental purposes may be applied:

- Topically.
- By infiltration.
- To effect block anaesthesia.

Topical

Timing

- Prior to infiltration or block injection.
- Incision and drainage of superficial abscesses.
- Prior to cannula insertion.

Agents

- Benzocaine 20%.
- Xylocaine 4%.
- Ethylchloride spray.
- Eutetic mixture of lidocaine (2.5%) and prilocaine (2.5%) – EMLA.

Formulations

Skin

- EMLA cream is applied for 45–60 min under an occlusive bandage. An EMLA patch, which contains 25 mg lidocaine and 25 mg prilocaine, is used to anaesthetise the skin prior to inserting a needle or cannula as may be used in conscious sedation.
- Lidocaine 5% Versatis® patches, applied 12 hours on, 2 hours off, are designed for overnight use in the management of chronic pain conditions.
- Benzocaine powder is a slow-action, long-lasting good treatment for painful skin ulcers.

Mucous Membranes

- Lidocaine 2–4%/tetracaine 0.25–1% solution, cream or jelly.
- Cocaine 4% solution for use in the nose and pharynx, in particular when vasoconstriction is required.

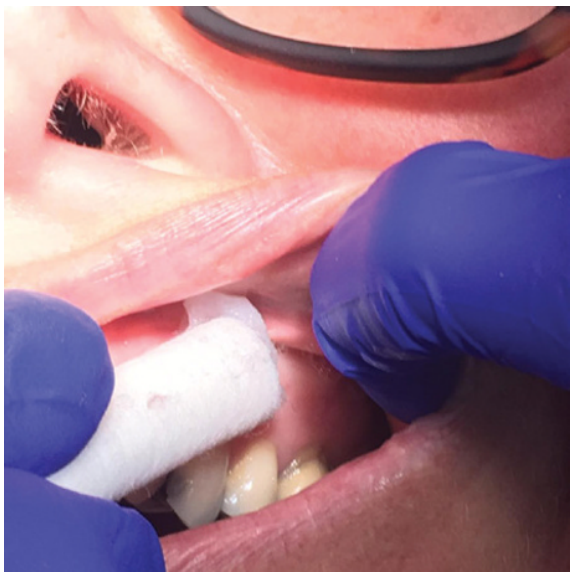


Figure 9.3 Application of a topical anaesthetic with a cotton wool roll.

Technique

- Dry the mucosa.
- Apply with a cotton roll or bud (Figure 9.3).
- Instruct the patient not to lick the area.
- Leave for the time recommended in directions for use – typically 2–3 minutes prior to an injection of local anaesthetic.
- Support with 'vocal sedation' and reassurance.

The injection, cannulation or other procedure should be performed within 1–2 minutes after removal of the topical anaesthetic for maximum effectiveness.

An excessive amount of topical anaesthesia typically anaesthetises too large an area, possibly causing patient discomfort, and increases the risk of toxicity. Topical anaesthetic sprays can be difficult to control and are not usually recommended for prepuncture, intraoral, mucosal anaesthesia.

Infiltration and Block Techniques Used in the Clinical Practice of Dentistry

- Infiltration:
  - Maxillary
  - Mandibular.
- Lingual/palatal anaesthesia via buccal infiltration.
- Inferior dental (mandibular) block.
- Mental nerve block.
- Infraorbital block.
- Palatal injections:
  - Palatal infiltration.
  - Greater palatine block.
  - Nasopalatine block.
- Intrapulpal.
- Intraligamental.
- Intraosseous.
- Adjunctive techniques.

Infiltration Anaesthesia

Infiltration anaesthesia is the most commonly used local anaesthetic technique. The anaesthetic agent is infiltrated directly into the surgical site. Infiltration local anaesthesia is ideal to achieve anaesthesia for soft tissue procedures and is most effective for dental procedures in the maxilla, which has a relatively thin cortical plate.

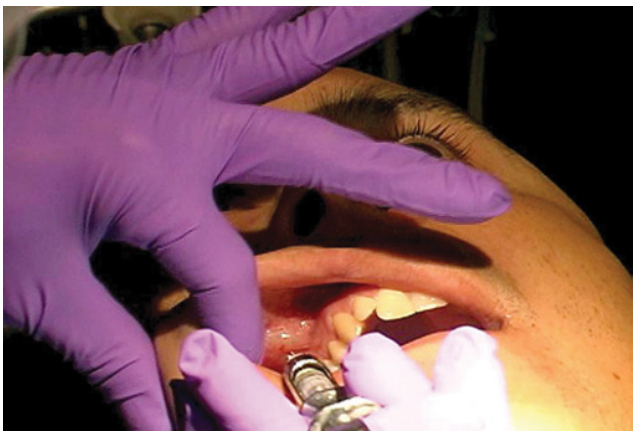
Infiltration techniques have the following advantages:

- Simplicity.
- Rapid onset of action after injection.
- Increased duration of anaesthesia compared with deeper placement techniques.
- Good patient acceptance.

Technique

- Place the patient in the supine or a near supine position to decrease the possibility of hypotension and a syncopal episode.
- Ensure the patient is comfortable, and that you are seated appropriately.
- With the tray for the local anaesthetic procedure placed out of sight of the patient, the syringe should be assembled – the contents of the cartridge and suitability of the needle being checked.
- Control unnecessary patient apprehension.
- Apply topical anaesthetic and, where necessary, adjust the lighting.
- In most cases, encourage the patient to close their eyes during the injection.
- Retract the lips and the soft tissues with fingers, not a dental mirror, ensuring that the injection site is taut.
- Pass the syringe into the oral cavity out of view of the patient, making a final check on the contents of the cartridge and the suitability of the needle.
- Warn the patient that they may feel a 'pinch' or 'prick'.
- Penetrate the taut tissues,bevel of the needle facing the bone, in one continuous movement, avoiding any contact with the underlying bone.
- Inject the required volume of anaesthetic solution, slowly and steadily. The deposition of the anaesthetic solution commonly distorts the landmarks of the site.
- Withdraw the needle from the tisssues and the syringe from the mouth, out of sight of the patient.
- Make the needle safe before putting down the syringe.
- Reassure the patient.

Following infiltration, diffusion of the local anaesthetic agent is rapid, especially in the upper anterior and premolar regions. Onset of anaesthesia takes approximately 2 minutes, with variations of around 15 seconds.



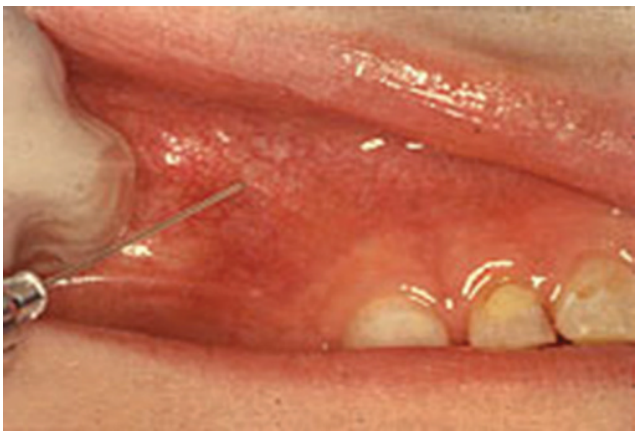


Figure 9.4 Maxillary infiltration.

Maxillary Infiltration (Figure 9.4)

Anterior Superior Alveolar Nerve

- Use a short or long needle, no less than 27 g.
- Have the patient open their mouth slightly, retract the lip with the thumb or first finger of your left hand, and tense the injection site.
- Hold the needle parallel to the lateral incisor and angle slightly posterior towards the root of the tooth.
- Penetrate the mucosa, advance and deposit 1–2 ml of solution.
- Withdraw and make safe the needle.

The target tooth and the two adjacent teeth should be anaesthetised within 2 or so minutes.

Middle Superior Alveolar Nerve Very similar to anterior superior nerve infiltration, except that the injection site is between the premolars. The long axis of the syringe should be parallel with the buccal plate.

Posterior Superior Alveolar Nerve Similar to other maxillary infiltration, but with the tip of the needle penetrating taut mucosa at the height of the maxillary buccal sulcus, over the distal root of the second molar. The needle is advanced posteriorly, superiorly and medially to a depth of 15 mm. Following aspiration, 1.5 ml of solution is injected. The area of anaesthesia should include all of the molars.

Mandibular Infiltration Mandibular infiltration is suitable for soft tissue procedures and, depending on patient and local factors and the anaesthetic agent selected, may be effective for certain dental procedures, in particular of the lower anterior teeth.

The technique for mandibular infiltration is similar to maxillary infiltration. As indicated in Figure 9.5, the needle is inserted at an angle in the direction of the apex of the target tooth

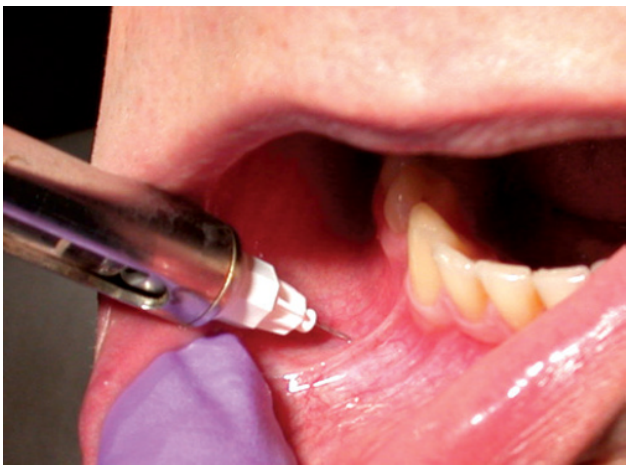


Figure 9.5 Mandibular infiltration.

Lingual/Palatal Anaesthesia via Buccal Infiltration

As illustrated in Figure 9.6, a mandibular infiltration may be supplemented by infiltration of the attached gingivae, which typically causes blanching of the lingual gingivae, indicating the spread of anaesthetic solution and effect to the soft tissues on the lingual aspect. Maxillary infiltrations, where indicated clinically, may be supplemented using this technique, possibly resulting in palatal anaesthesia (Figure 9.7).

Block Anaesthesia

Regional block anaesthesia has the following advantages over infiltration techniques when the surgical/operative intervention involves an area of the mouth:

- Fewer penetrations of the mucous membrane and smaller volume of local anaesthesia solution required.
- Profound pulpal and soft tissue anaesthesia.

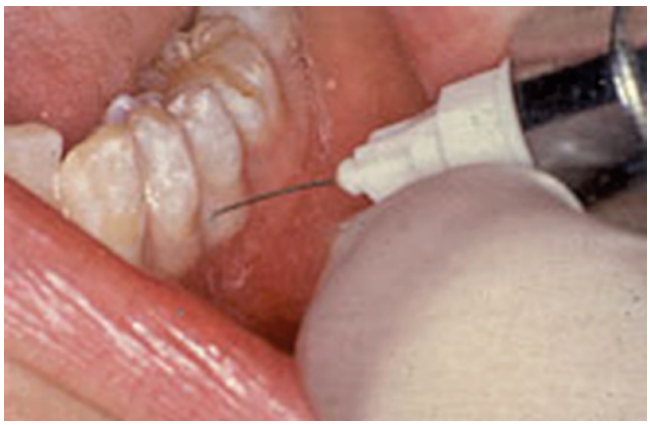
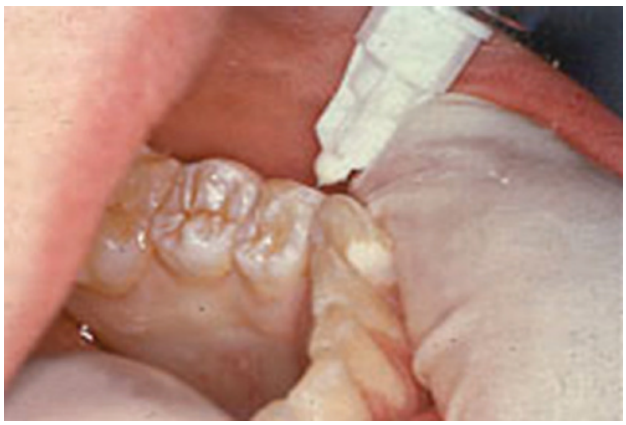



Figure 9.6 Infiltration of attached gingivae causing blanching and anaesthesia of the soft tissues on the lingual aspect of the mandible.

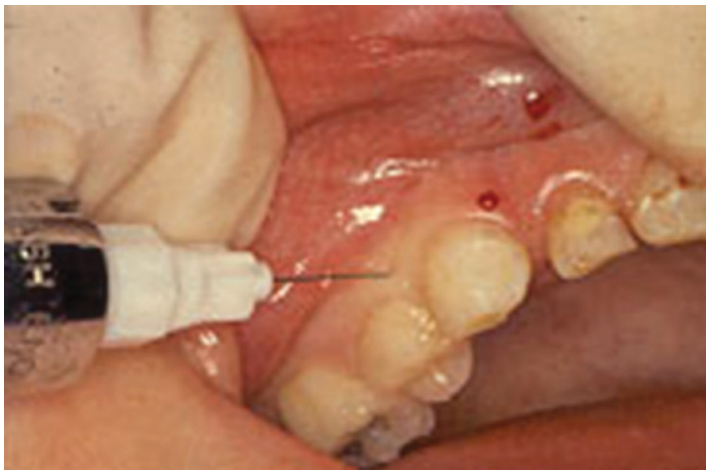
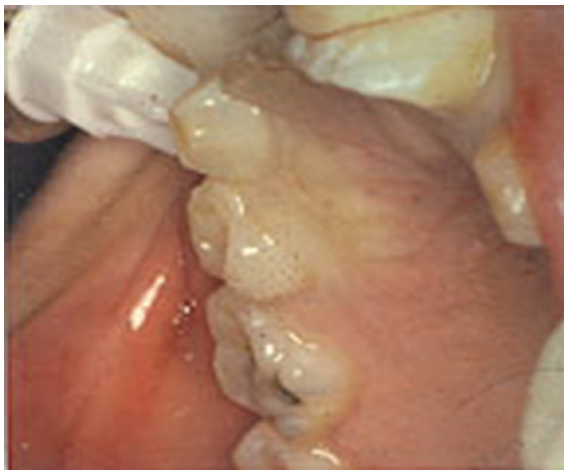



Figure 9.7 Maxillary infiltration resulting in palatal blanching and anaesthesia.

- Does not rely on diffusion of local anaesthetic agent through bone.
- Longer duration.
- Facilitates patient management in more complex and prolonged procedures.

Inferior Dental (Mandibular) Block Anaesthesia

The inferior dental nerve block is the most widely used block anaesthesia in dentistry. Success is largely operator dependent. However, in general, the technique is successful, both in terms of anaesthesia and patient acceptance (Table 9.5). Regional anaesthesia should be obtained in 3–4 minutes.

Table 9.5 Advantages and disadvantages of inferior dental block anaesthesia.

Advantages	Disadvantages
• Good bony landmarks • Relatively fast onset • Hemi-mandible anaesthesia • Profound pulpal anaesthesia • Duration sufficient for extended procedures (<2–3 hours)	• Area of injection is vascular: 10–15% chance of positive aspiration • Unlikely to anaesthetise accessory nerves • Unlikely to anaesthetise long buccal nerve • Difficult to see landmarks in some patients • Failure rate of 15–20%

Landmarks

- The coronoid notch.
- The external oblique ridge.
- The internal oblique ridge.
- The pterygomandibular raphe.
- The pterygotemporal depression.
- The contralateral mandibular bicuspids.

Techniques (Figure 9.8)

- Direct – most reliable.
- Indirect – Halstead technique.
- Akinosi – closed mouth technique.
- Gow-Gates – high block.

Direct Technique (Figure 9.9)

Procedure

- Place the patient in the supine or a near supine position to decrease the possibility of hypotension and a syncopal episode.
- Ensure the patient is comfortable, and that you are seated appropriately.
- With the tray for the local anaesthetic procedure placed out of sight of the patient, the syringe should be assembled – the contents of the cartridge and suitability of the needle being checked.
- Control unnecessary patient apprehension.
- Adjust the lighting and apply topical anaesthetic, where indicated clinically.
- Encourage the patient to close their eyes during the injection.
- Ask the patient to open their mouth widely.
- Locate the ramus between your thumb and first finger.

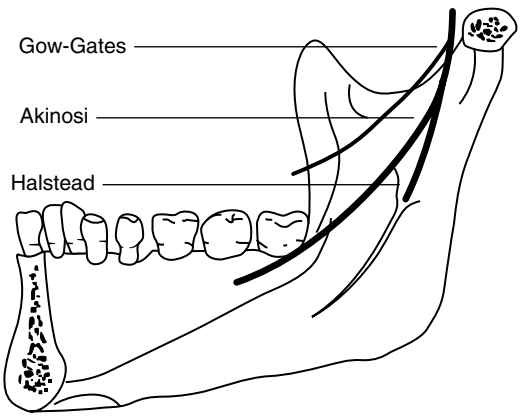


Figure 9.8 Sites for inferior dental block techniques.

- Identify the retromolar fossa.
- Locate the point of penetration by visualising a V shape, comprising the anterior border of the ramus of the mandible laterally and the pterygomandibular raphe medially. The ramus is palpable and the raphe visible.
- Introduce the syringe into the oral cavity across the mandibular premolars of the opposite side, parallel to the mandibular occlusal plane.
- Approach 1 cm above the mandibular occlusal plane.
- Penetrate the imaginary 'V' halfway up, level to the middle of the adjacent thumbnail.
- Insert the needle with the barrel of the syringe over the premolars on the opposite side.
- Advance the needle through tissue until bony contact is made, usually at a depth of 20–30 mm; 1 cm of a long needle should be visible when contact is made with bone.
- Withdraw 3–4 mm.
- Aspirate.
- Subject to clear aspiration, inject 1.5 ml slowly over a period of <60 seconds.
- Withdraw and dispose of the needle safely.
- Release thumb and finger hold on the ramus.
- Allow the patient to close and swallow.

Onset and Duration

- Onset of dental and bony (hard) anaesthesia is 3–4 minutes.
- Duration for hard tissue anaesthesia sufficient for surgical/operative intervention is <2–3 hours, depending on the type of local anaesthetic used and the use of a vasoconstrictor.
- Anaesthesia may persist for <4 hours.

Indirect Technique The indications for this technique include:

- Minimising lingual nerve injury during inferior dental blocks.

This method is similar to the direct technique; however:

- The needle is inserted with the syringe positioned parallel to the lower occlusal plane, 1 cm abovethe molar

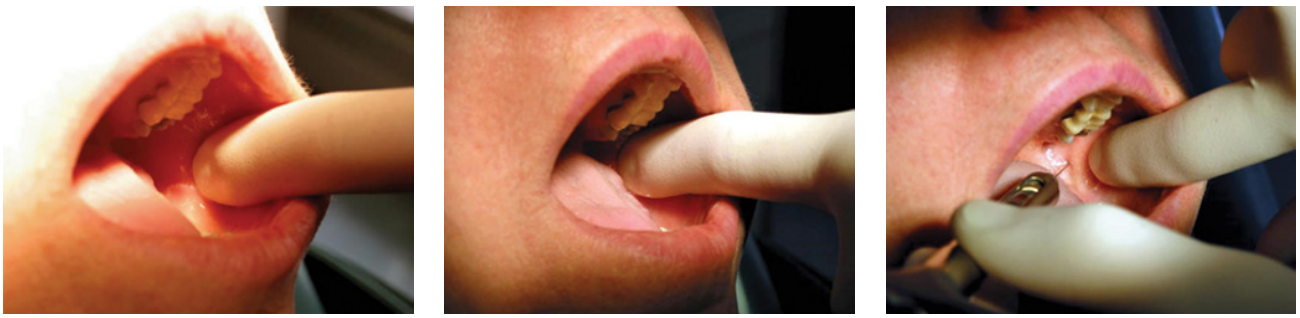


Figure 9.9 The direct technique for an inferior dental block.

teeth – the point of insertion is the same as that for the direct technique.
- The needle is inserted 1.5 cm and 0.5 ml of anaesthetic solution is injected.
- The needle is then retracted 0.5–1.00 cm, re-angled towards the lingual on the inner aspect of the mandible and advanced to touch bone (for some practitioners, but many avoid this).
- Following 1–2 mm withdrawal and negative aspiration, 1.5 ml of solution is injected slowly.
- The needle is then withdrawn and disposed of safely.

The area of anaesthesia is similar to that for the direct technique.

Vazirani–Akinosi Closed Mouth Technique (Table 9.6)

Landmarks
- The maxillary buccal mucogingival line and root apices of the maxillary teeth.
- The coronoid notch.
- The internal oblique ridge.
- The occlusal plane.

Procedure (Figures 9.10 and 9.11) Following preparation of the patient and the syringe:
- With teeth in light occlusion and the cheek retracted, the needle is advanced in the maxillary vestibule, with the syringe parallel to the occlusal plane at the level of the mucogingival junction.
- Move the finger retracting the cheek superiorly approximately 1 cm.
- Insert the needle tip between the finger and maxilla at the height of the maxillary buccal mucogingival line.
- Orientate the needle such that the needle looks as though it is going laterally in the direction of the ear lobe on the injection side. The needle remains parallel to the occlusal plane.
- After the needle has been inserted 5 mm, move the finger retracting the cheek to fully reflect the lip and and enhance vision.
- Advance the needle through tissue until bony contact is made, usually at a depth of 25–30 mm, leaving 5–10 mm of the necessary long needle visible.
- Withdraw the needle 1–2 mm with the aim of depositing local anaesthetic solution close to the anterior aspect of the condyle.
- Subject to negative aspiration, inject <1.5 ml of solution slowly over a period of <60 seconds.

Table 9.6 Advantages and disadvantages of the Vazirani–Akinosi mandibular block.

Advantages	Disadvantages
• Can be used for patients with trismus • Can be used for patients with a strong gag reflex • Mouth is closed, so injection may be less threatening to patient • Possibly less pain, because tissues are relaxed • Good for macroglossic patients	• Difficult to visualise depth of injection • Difficult in patients with widely flaring ramus • Difficult in patients with pronounced zygomatic ridge or internal oblique ridge

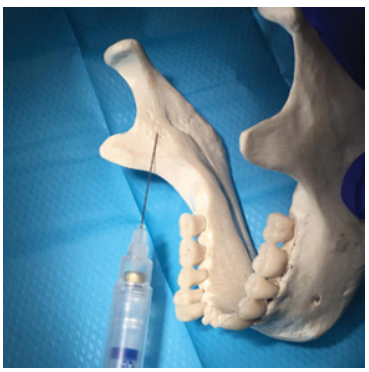


Figure 9.10 Illustration of the Vazirani–Akinosi technique on a dry skull.

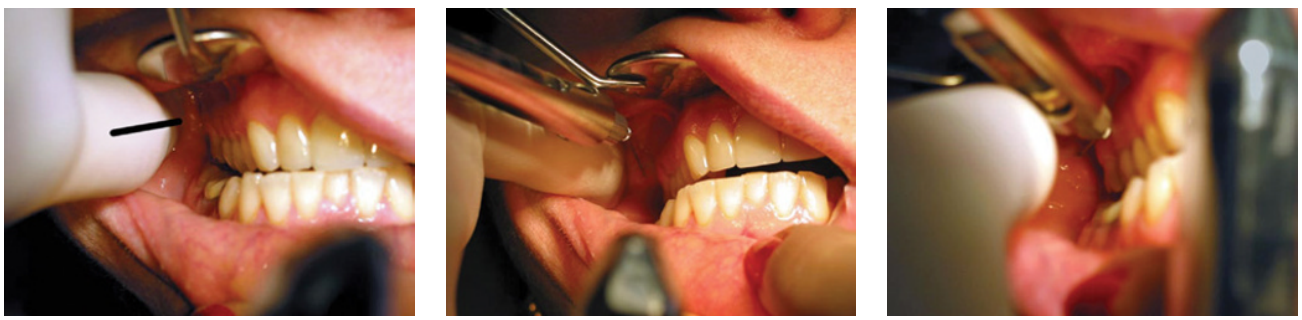


Figure 9.11 Clinical images of the Vazirani–Akinosi technique.

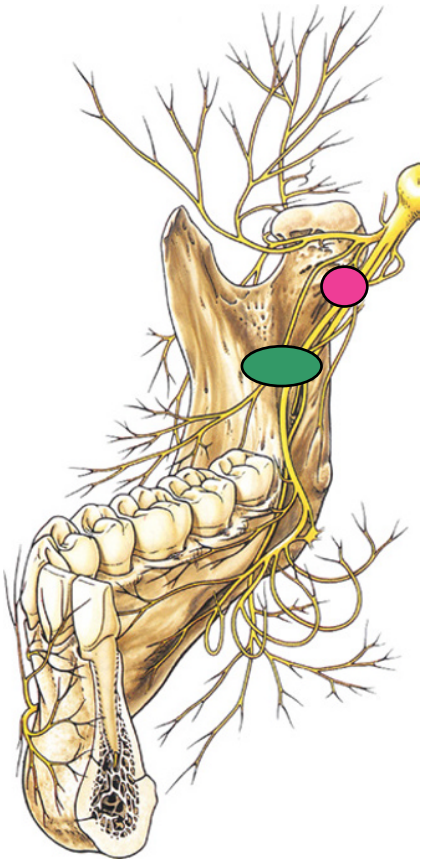


Figure 9.12 Illustration of the deposition of local anaesthetic solution with the Vazirani–Akinosi technique (green) compared to the direct and indirect inferior dental block techniques (red).

- Withdraw the syringe and dispose of the needle safely.
- Encourage the patient to open and move their jaw from side to side to help diffuse the anaesthetic solution.

Onset and Duration

- Onset for hard tissue anaesthesia is 3–4 minutes.
- Anaesthesia may remain profound for <2 hours.

Given the location of the deposition of the local anaesthetic solution (Figure 9.12), there is more possibility of obtaining long buccal nerve anaesthesia with the Vazirani–Akinosi technique, as compared to the direct and indirect inferior dental block techniques.

Gow-Gates Technique (Table 9.7)

Landmarks

- The coronoid notch.
- The internal oblique ridge.
- The pterygomandibular raphe.
- The neck of the condyle.
- The contralateral mandibular bicuspids.

Table 9.7 Advantages and disadvantages of the Gow-Gates inferior dental block technique.

Advantages	Disadvantages
• Perceptible endpoint (bone) • Fewer blood vessels at location of deposition, therefore less chance of positive aspiration • Long buccal nerve anaesthesia likely • Possible longer duration of anaesthesia • Less chance of anaesthetising accessory nerves	• Mouth wide open • Must use extraoral landmarks, which may increase the difficulty of the procedure

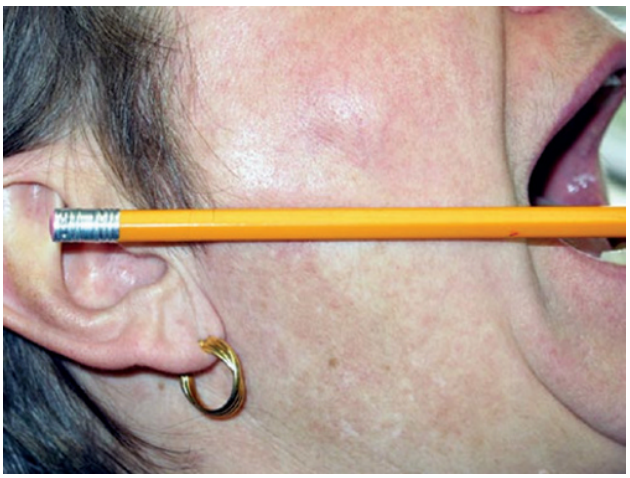


Figure 9.13 The imaginary line from the corner of the mouth to the tragal notch of the ear as a landmark for the Gow-Gates inferior dental block.

- The imaginary line from the corner of the mouth to the tragal notch of the ear (Figure 9.13).

Procedure (Figure 9.14) Following preparation of the patient and the syringe:

- Ask the patient to tilt their head back and open their mouth wide.
- With the patient's head tilted back and mouth open wide, palpate the coronoid notch and slide your finger or thumb to rest on the internal oblique ridge – angulation of the injection will parallel the junction of the two external landmarks.
- Move your finger or thumb superiorly approximately 10 mm.
- Rotate your finger or thumb to parallel an imaginary line from the ipsilateral corner of the mouth to the tragal notch of the ear.

Figure 9.14 Clinical images of the Gow-Gates technique.

- Insert the needle at a point between the palpating fingernail and the pterygomandibular raphe at the middle aspect of the fingernail.
- Ensure that the barrel of the syringe is located over the contralateral bicuspids.
- Advance the needle c.25 mm until it contacts bone – at the neck of the condyle.
- Withdraw the needle 1 mm to prevent injecting into periosteum, and aspirate.
- If aspiration is negative, slowly inject approximately 1.5 ml of solution.
- As the injection proceeds, ensure that the angle of the needle and barrel of the syringe remains parallel to the imaginary line from the corner of the mouth to the tragus of the ear.
- Withdraw the syringe and dispose of the needle safely.
- Encourage the patient to open and move their jaw from side to side to help diffuse the anaesthetic solution.

Onset and Duration

- Onset for hard tissue anaesthesia is 4–12 minutes, with the anterior area being last to become anaesthetised.
- The long buccal nerve will probably be anaesthetised.

It is increasingly recognised that inferior dental block anaesthesia is relatively inefficient and causes most systemic and local complications, including nerve injuries. Best evidence indicates that most future dentistry use infiltration anaesthesia.

Mandibular Buccal Block The mandibular buccal block is indicated when anaesthesia of the buccal mucosa is required.

Procedure Following preparation of the patient and the syringe:

- Ask the patient to open their mouth.
- Retract the cheek with your index finger.
- Insert the needle lateral and distal to the last mandibular molar at the level of the occlusal plane.
- Insert the needle to a depth of 2–3 mm, until contact is made with the anterior border of the ramus of the mandible.
- Withdraw the needle 1 mm.
- Inject 1.5 ml of anaesthetic solution slowly.
- Withdraw the syringe and dispose of the needle safely.

Onset and Duration

- Onset for soft tissue anaesthesia is 2–3 minutes.
- Anaesthesia may remain profound for <2 hours.

Mental Nerve Block

Either an intraoral or cutaneous approach can be used to block the mental nerve.

To block the nerve cutaneously, the foramen should be palpated, and a wheal of anaesthesia placed adjacent to and *never* into the foramen.

When an intraoral approach is used, the procedure is as follows:

- Prepare the patient and the syringe.
- Palpate the foramen with the middle finger of one hand and the lip lifted by the thumb and index finger of the same hand.
- Insert the needle at the inferior labial sulcus at the apex of the first bicuspid.
- Advance the needle until contact is made with the mandible.
- Withdraw the needle 1 mm.
- Inject 1–3 ml of anaesthetic solution slowly.
- Withdraw the syringe and dispose of the needle safely.

Care is required, as in all other block techniques, to avoid injecting directly into the nerve as this is likely to cause nerve injury.

Onset and Duration

- Onset of soft tissue anaesthesia is rapid.
- Onset for hard tissue anaesthesia occurs within 3–4 minutes.
- Anaesthesia may remain profound for <2 hours.

Infraorbital Block (Figure 9.15) The indications for an infraorbital block include:

- Maxillary infection that precludes the infiltration of local anaesthetic solution.
- Wish to limit the number of penetrations of the mucosa when a procedure involves a number of teeth and associated bone.

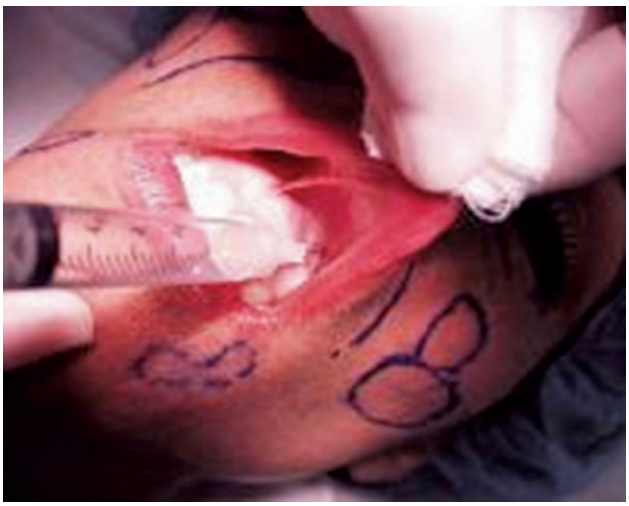


Figure 9.15 Infraorbital block administered by intraoral injection.

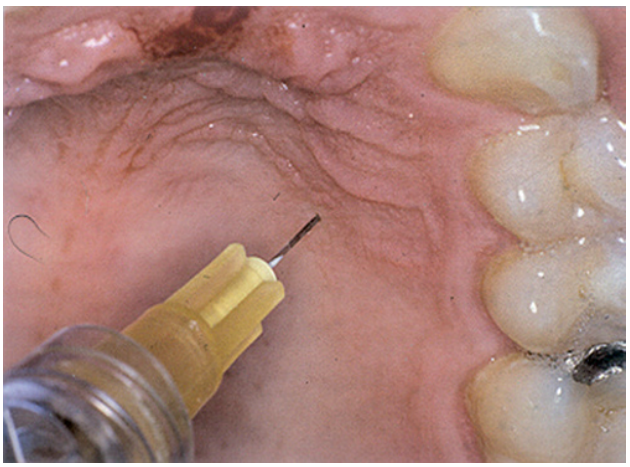


Figure 9.16 Palatal infiltration.

- Need for profound anaesthesia within the structures supplied by the infraorbital nerve.
- Facilitation of patient management in more complex and prolonged procedures.

An infraorbital block may be performed in one of two ways – direct cutaneous injection or intraoral injection.

Procedure Following preparation of the patient and the syringe:

- Palpate the infraorbital foramen with the middle finger of one hand, while the thumb and index finger of the same hand are used to raise the lip.
- While palpating the foramen, the needle is inserted into the superior labial sulcus over the canine fossa.
- Advance the needle close to, but not into the canal.
- If aspiration is negative, slowly inject 2 ml of anaesthetic solution in the vicinity of the foramen.
- Withdraw the syringe and dispose of the needle safely.
- Allow the patient to close and swallow.

Swelling of the lower eyelid and ecchymosis may occur with an infraorbital block.

If anaesthetic solution is injected into the orbit, considerable pain, diplopia, exophthalmos and blindness can occur.

Onset and Duration

- Onset of soft tissue anaesthesia is rapid.
- Onset of hard tissue anaesthesia occurs within 3–4 minutes.
- Anaesthesia may remain profound for <2 hours.

Palatal Injections

Palatal Infiltration The indications for palatal infiltration include:

- Local biopsies.
- Additional local anaesthesia for pulpitic molar teeth non-respondent to buccal infiltration.

Procedure (Figure 9.16) Following preparation of the patient and the syringe:

- Have the patient open their mouth wide.
- Locate the greater palatine foramen, distal to the intended site of injection.
- Use a cotton-tip applicator to apply pressure to the foramen. This helps to mark the spot and provide some analgesia – topical anaesthetic is of little use.
- Introduce the syringe into the mouth, with the long axis of the syringe and needle at right angles to the surface of the palate.
- Penetrate the mucosa halfway between the midline and target tooth, and advance the needle to make contact with bone.
- Withdraw the needle 1–2 mm.
- Aspirate and inject (c.0.5 ml) very slowly.
- Look for blanching of tissues.
- Withdraw the syringe and dispose of the needle safely.
- Allow the patient to close and swallow.

Palatal infiltration is painful as the palatal mucosa is attached with little 'give'.

The area of anesthesia should be the ipsilateral.

Palatal infiltration should never be attempted distal to the second molar.

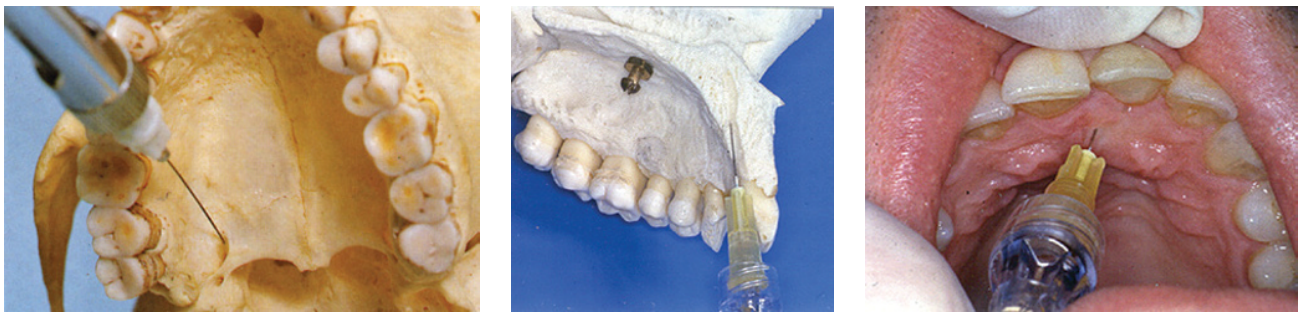


Figure 9.17 Greater palatine and nasopalatine blocks.

Onset and Duration

- Onset of soft tissue anaesthesia is rapid.
- Onset of hard tissue anaesthesia occurs within 3–4 minutes.
- Anaesthesia may remain profound for <2 hours.

Greater Palatine and Nasopalatine Blocks Nasopalatine and greater palatine blocks are both supplementary blocks. They are used in combination with other maxillary infiltrations or blocks, for anterior and posterior teeth respectively. In most cases, the success of the technique depends on familiarity with the anatomy of the palate (Figure 9.17).

Procedure Following preparation of the patient and the syringe:

- Have the patient open their mouth wide.
- Locate the foramen for the greater palatine or nasopalatine neurovascular bundle.
- Apply topical anaesthetic, which should be isolated from the dorsal surface of the tongue.
- Place the needle adjacent to the structure and aspirate, then infiltrate near the nerve – never inject directly into the nerve tissue.
- Look for blanching of tissues.
- Withdraw the syringe and dispose of the needle safely.
- Allow the patient to close and swallow.

Intrapulpal Injections This method involves the deposition of local anaesthetic solution directly into the pulp chamber under pressure. It is normally administered following the injection of an anaesthetic solution by another route.

Procedure

- If a large opening is present in the pulp chamber, the needle should be advanced into the canal until the fit is tight (Figure 9.18).
- Obliterating a large pulpal opening with gutta-percha or a cotton pledget may aid in the build-up of pressure.
- Otherwise an opening is made into the pulp using a small round bur to allow the snug fit of the needle.

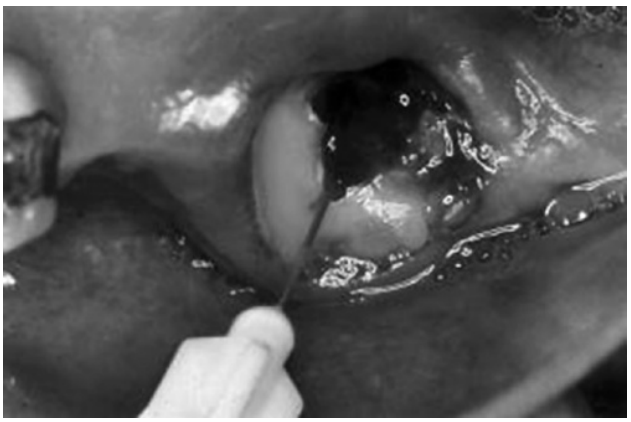


Figure 9.18 Intrapulpal anaesthesia in a multirooted tooth.

- The amount of solution injected is around 0.2 ml (Malamed, 1998).

Alternatively, an exposed pulp may be bathed in local anaesthetic solution for a period of 30 s; however, injection under pressure is more effective. In multirooted teeth, injections have to be performed in each root.

Advantages

- The method provides a means of overcoming failed anaesthesia using conventional techniques.
- Systemic effects of intrapulpal anaesthesia appear to be negligible.

Disadvantages

- Typically painful.
- Limited application.

Intrapulpal techniques are not indicated as a primary method of anaesthesia.

Intraligamental (Periodontal Ligament) Anaesthesia

Intraligamental (periodontal ligament) anaesthesia, in a sense, is a misnomer. The method is a form of intraosseous anaesthesia (Figure 9.19).

The injection can be performed using either conventional or specialised syringes.

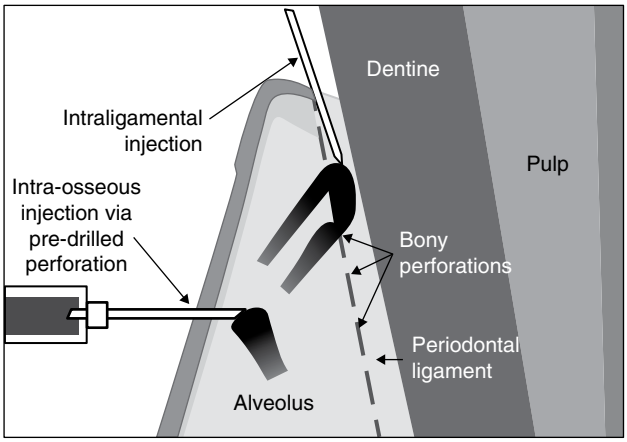


Figure 9.19 Intraligamental and intraosseous anaesthesia deliver anaesthetic into the cancellous space by different routes.

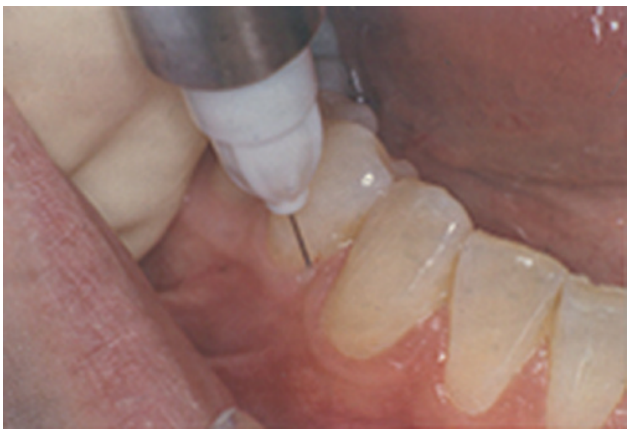


Figure 9.20 Clinical illustration of intraligamental anaesthesia.

Procedure (Figure 9.20)

- Anaesthetise the soft tissue by infiltration to control the pain of the injection.
- Swab the site(s) of penetration with an antiseptic solution.
- Insert the needle at 30° to the long axis of the tooth at the mesio-buccal aspect of the root.
- Wedge the needle between the tooth and the crestal bone – penetration deep into the periodontal ligament is usually not possible.
- Inject 0.2–0.3 –ml of local anaesthetic solution.
- Allow 10 seconds to pass to allow back pressure to dissipate and ensure that the local anaesthetic remains in place.
- Withdraw the syringe and dispose of the needle safely.

Onset and Duration The onset of anaesthesia is immediate.

The duration of pulpal anaesthesia is highly variable and somewhat unpredictable.

Table 9.8 Advantages and disadvantages of intraligamental anaesthesia.

Advantages	Disadvantages
• Immediate onset of anaesthesia • No soft tissue anaesthesia • Works well for 'hot' teeth • Good approach to anaesthetise accessory innervation • High success rate	• Patient may experience postoperative pain • Cannot be used in the presence of periodontal disease • High injection pressure is required • Multiple injections are required for multirooted teeth – one injection for each root • May not work on long-rooted teeth

Table 9.9 Advantages and disadvantages of intraosseous anaesthesia.

Advantages	Disadvantages
• Immediate onset of anaesthesia • No soft tissue (lip or tongue) anaesthesia • Can facilitate bilateral procedures in the mandible • Can anaesthetise a 'hot ' tooth • Good approach for accessory innervation • High success rate	• Short duration of anaesthesia • Must limit volume, given vascularity of cancellous bone • Difficult access to posterior mandible • Anatomical limitations • Some patients experience palpitations • Cannot be used in the presence of periodontal disease

Advantages and Disadvantages These are listed in Table 9.8.

Intraosseous Injection (Table 9.9)

With intraosseous injections, the local anaesthetic solution is deposited directly into the cancellous bone surrounding the teeth being treated. These techniques can be considered if primary nerve block has failed. The clinician must be aware that these injections are effectively intravascular injections so should be avoided in patients with medical contraindications to potential intravenous adrenaline and other local anaesthetic agents.

Procedure

- Take a radiograph to ensure that there is sufficient bone at the intended perforation site, to ensure that the periodontal ligament space and root surfaces will not be violated.
- Follow the instructions supplied with the delivery system.
- Inject an infiltration of 0.2–0.3 ml of local anaesthetic into the buccal fold near the area to be perforated. This anaesthetises the soft tissue and makes the perforation of the cortical plate painless.

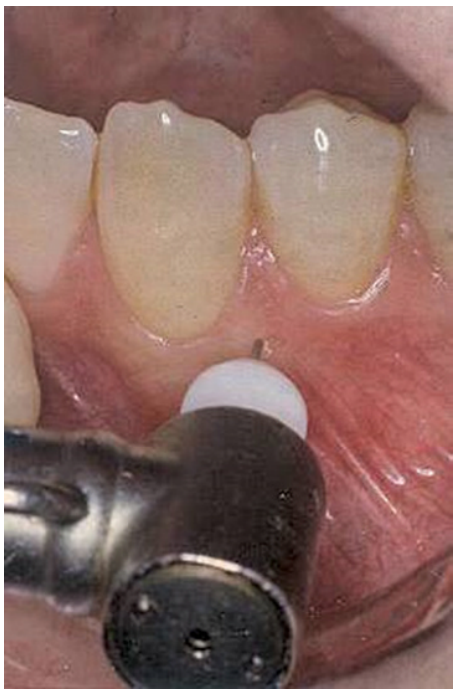


Figure 9.21 The use of a perforator to gain access to the cancellous space at the initial stage of intraosseous anaesthesia.

- Perforate the bone using whichever device has been chosen (Figure 9.21). The site of perforation must be on the attached gingiva, approximately 1–2 mm coronally to the mucogingival line.
- Negotiate the needle through the perforated bone into the cancellous space and inject 0.9 ml of local anaesthetic solution over about 45 seconds.

Anatomical limitations include inadequate bony space between the teeth, a cortical plate of bone that is too thick to perforate, a low-lying maxillary sinus and a horizontally impacted third molar. In addition, the technique cannot be used between central incisors due to the lack of cancellous bone.

Do not exceed the administration of one cartridge of intraosseous anaesthetic solution during an appointment.

This technique should not be used on patients with cardiac disease.

Onset and Duration

- The onset of anaesthesia is rapid – approximately 10–20 seconds.
- Duration of pulpal anaesthesia is 20–30 minutes, if a vasoconstrictor is used. Otherwise duration is limited.

Adjunctive Techniques

These may include the use of:

- Transcutaneous electronic nerve stimulation (TENS).
- Electronic dental anaesthesia.
- Jet injectors for topical anaesthesia.

Potential Problems with Local Anaesthesia

Although local anaesthesia is relatively safe when administered properly, problems which arise include:

Prior to Administration

- Poor patient cooperation.
- Contraindications to local anaesthesia.
- Difficulties in obtaining consent.

During Administration

- Limited access.
- Intravascular injection (see 'Systemic Effects').
- Pain on injection.
- Mucosal irritation.
- Anxiety reactions.
- Equipment breakage.
- Needlestick injury.

Following Administration

- Systemic effects.
- Vasoconstrictor effects.
- Toxic reaction.
- Drug interactions.
- Methaemoglobinaemia.
- Allergic reaction.
- Patient collapse.
- Psychogenic signs and symptoms.
- Failure to achieve anaesthesia.
- Undesired nerve blockade.
- Facial nerve paralysis.
- Hematoma.
- Infection.
- Prolonged anaesthesia.
- Soft tissue injury.

Postoperatively

- Neuropathy.
- Trismus.

Systemic Effects

Symptoms of systemic effects include:

Central Nervous System

- Excitation:
  - Restlessness, excitement and talkativeness.
  - Circumoral paraesthesia.
  - Tongue paraesthesia.

  - Dizziness.
  - Blurred vision.
  - Tinnitus.
  - Restlessness.
  - Confusion/agitation.
  - Muscular twitching.
  - Seizures – tonic/clonic.
- Depression:
  - Loss of consciousness.
  - Respiratory arrest.
  - Death.

Cardiovascular System

- Bradycardia.
- AV dissociation.
- Myocardial ischaemia.
- Hypotension.
- Cardiac arrest.

Safe Doses

A 2.2 ml cartridge of 2% lidocaine with 1:80 000 adrenaline contains 44 mg of lidocaine.

The safe dose for 2% lidocaine with 1:80 000 adrenaline is 7 mg/kg body weight.

A good rule of thumb to stay safe is 1× 2.2 ml cartridge of 2% lidocaine with 1:80 000 adrenaline for every 10 kg of body weight.

Maximum Doses

These are listed in Table 9.10.

Toxicity

Toxicity is dose related (Figure 9.22).

Toxic Doses

Adults

- Lidocaine and adrenaline 11 cartridges.
- Prilocaine and felypressin 4 cartridges.
- Articaine and adrenaline 7 cartridges.
- Bupivacaine with adrenaline 10 cartridges.

Table 9.10 Maximum doses of 2% lidocaine with 1:80 000 adrenaline, according to patient weight.

Patient weight	Dose
10 kg (22 lb)	44 mg (2.2 ml) – 1 cartridge
20 kg (44 lb)	88 mg (4.4 ml) – 2 cartridges
30 kg (66 lb)	132 mg (6.6 ml) – 3 cartidges
40 kg (88 lb)	176 mg (8.8 ml) – 4 cartridges
50 kg (110 lb)	220 mg (11 ml) – 5 cartridges
60 kg (132 lb)	264 mg (13.2 ml) – 6 cartridges
70 kg (154 lb)	300 mg (15 ml) –6/7cartridges

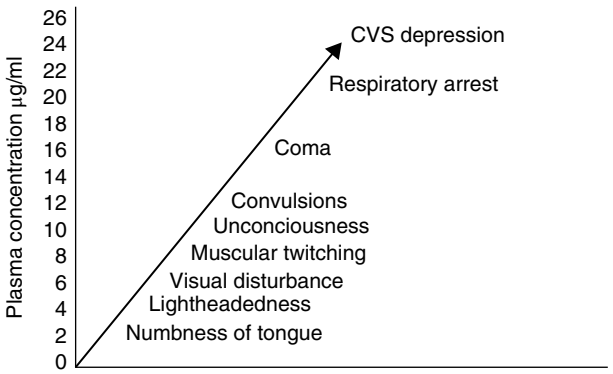


Figure 9.22 Toxic effects of increasing plasma concentration of local anaesthetic agent.

Child (<5 Years of Age, 18–20 kg)

- Lidocaine and adrenaline 2 cartridges.

Allergic Reactions

Allergic reactions to local anaesthetics are very rare. Signs of an allergic reaction to a local anaesthetic may include:

- Rashes.
- Urticaria.
- Angioneurotic oedema.
- Mucous membrane congestion.
- Symptoms of asthma – bronchospasm.
- Patient collapse.
- Psychogenic signs and symptoms.

Failure to Achieve Anaesthesia

Failure to achieve anaesthesia is most common in endodontic procedures and least common when undertaking exodontias. Reasons for the failure to achieve anaesthesia include:

Operator

- Poor understanding of relevant anatomy.
- Poor technique.
- Needle deflection.
- Failure to take account of all available information.
- Failure to recognise effect of infection.
- Failure to wait for effect (4–12 minutes).
- Use of out of date anaesthetic.

Patient Factors

- Patient build.
- Shape of mandible.
- Trismus.
- Needle-to-jaw size discrepancy.
- Misleading anatomical landmarks.
- Accessory nerve supply.
- Psychological.

- Presence of infection.
- Hyperalgesia and altered nerve physiology.
- Non-cooperation.

Management of Failures to Achieve Local Anaesthesia
Failures to achieve local anaesthesia may be managed by one or more of the following:

- Wait longer.
- Reassess the anatomy.
- Check available radiographs for anatomical anomalies.
- Repeat the injection with altered technique.
- Change the type of local anaesthetic used.
- Use one or more supplemental techniques.
- Delay the procedure and manage any existing infection.

Complications

Facial Nerve Paralysis Facial nerve paralysis may occur if local anaesthetic reaches the facial nerve within the parotid capsule. The patient may be unable to close the eye and suffer drooping of the corner of the mouth on the affected side. The paralysis (palsy) should last only for the duration of the anaesthetic. The patient should be reassured and provided with an eye pad or patch to protect the cornea of the open, non-blinking eye.

Haematoma A haematoma may be formed by bleeding from a blood vessel during injection, or when a blood vessel is damaged on withdrawal of the needle. The patient will notice swelling and possibly bruising and complain of discomfort and stiffness or trismus. Bruising tends to last for up to 14 days.

Infection Infection is an additional local complication of anaesthetic use that usually occurs when proper sterile technique is not used. Cleansing the skin surface with alcohol is adequate in otherwise clean or non-infected areas. If signs of infection are noted, treatment includes appropriate culture studies and antimicrobial therapy. If abscess formation occurs, drainage may also be required.

Prolonged Anaesthesia – Nerve Damage Nerve neuropathy most commonly occurs following inferior dental block anaesthesia. The incidence is 1:20 000 to 1:30 000. Damage to the inferior alveolar or lingual nerve may be caused by needle trauma, chemical injury, haemorrhage, nerve ischaemia or a combination of all four. Injection-induced neuropathy may cause anaesthesia, paraesthesia or more commonly dysaesthesia and pain. Neuropathy should resolve within days. If it persists beyond 2 months it may be permanent. Treatment is symptomatic.

The potential of different local anaesthesia agents to cause neuropathy is articaine > prilocaine > mepivacaine > lidocaine > bupivacaine. Prolonged neuropathy is concentration based.

Methods to avoid nerve injury include:

- Avoid using articaine (4%) or other high concentration local anaesthetic solutions for inferior dental blocks.
- Avoid multiple attempts to achieve inferior dental block anaesthesia.
- Use articaine infiltrations as an alternative to inferior dental blocks.

Needlestick Injury
The main risk posed by needlestick injury is exposure of the worker to blood-borne viruses (BBVs). The main viruses are:

- Hepatitis B (HBV).
- Hepatitis C (HCV).
- Human immunodeficiency virus (HIV).

The risk of viral infection following percutaneous exposure to HIV-infected blood in healthcare settings is less than 1:1000. In the case of HBV, an effective protective vaccine is available, but no such protection is available for other BBVs.

Protocol after Needlestick Injury

- Encourage bleeding.
- Wash the wound thoroughly.
- If HIV is suspected or known in the source patient, seek urgent administration of anti-HIV prophylactic drugs to minimise the risk of infection developing.
- Record the incident.
- Report the injury, as indicted by local protocols.
- Complete a critical event audit to identify ways to prevent recurrence.

Trismus Trismus is relatively common following an injection for dental local anaesthesia. It tends to be caused by a needle being inserted into one of the muscles of mastication, most commonly medial pterygoid, resulting in bleeding, spasm or both.

Trismus may start 1–6 days postoperatively and be of variable severity.

Always exclude spreading infection before treating conservatively.

Patient Instructions
Instructions to patients to be treated under local anaesthesia should include:

- On the day of treatment take your routine medicines at the usual times.
- Numbness may last up to 4 hours after the dental procedure.
- Care is required to avoid damaging teeth and tissues while the anaesthetic persists.
- It is often prudent to start taking analgesics when you get pins and needles as the local anaesthetic wears off.

- If the numbness does not wear off, or there is stiffness or swelling, return for review.

Personal Protection

Personal protection in the administration of dental local anaesthetics includes:

- Hand washing after each patient contact and after contact with blood or body fluids.
- Covering any cuts or abrasions with waterproof plasters.
- Routine use of appropriate personal protective equipment (PPE).
- Immediate replacement of a punctured glove.
- Wearing a disposable plastic apron.
- Routine use of eye protection – visors, goggles or safety spectacles.
- Never re-sheathing a needle.
- Immediate and safe disposal of needles and any other sharps into appropriate, puncture-proof sharps bins.
- Never overfilling sharps containers.

Conclusions

- Local anaesthesia is vital to dental surgery.
- Local anaesthetics are effective, inexpensive, easily accessible and relatively safe.
- Familiarity with dental anatomy, proper technique and appropriate patient management are critical to success in dental local anaesthesia.

Management of Postsurgical Pain

Oral analgesics are commonly prescribed for a few days following oral surgery or other procedures, after which patients are typically pain-free or can switch to a lower dose, over-the-counter medication such as a non-steroidal anti-inflamatory drug (NSAID; e.g. ibuprofen, aspirin).

Pain may have a profound effect on the cardiovascular, pulmonary, endocrine and gastrointestinal systems. If acute pain is not treated adequately, there is a risk that it may become chronic in nature. Postsurgical pain control is a necessity, not merely a measure to provide patient comfort.

Postsurgical Pain Management Protocols

Recommended medications and dosages are typical for a healthy 70-kg adult. Adjustments should be made based on the patient's health status, medications, age, allergy profile and body weight.

Mild/Moderate Pain

In a healthy adult, 1000 mg of acetaminophen (paracetamol) can be given every 6 hours to a maximum of 4 g in a 24-hour period. In addition, 600 mg of ibuprofen may be given every 4–6 hours to a maximum of 2400 mg in a 24-hour period. Opiates and opioids should be avoided because they cause considerable side effects and provide minimal additional analgesic benefits on top of NSAIDs and paracetamol.

Moderate/Severe Pain

In a healthy adult, 1000 mg of acetaminophen can be given every 6 hours to a maximum of 4 g in a 24-hour period. In addition, 600 mg of ibuprofen may be given every 4–6 hours to a maximum of 2400 mg in a 24-hour period. Opiates and opioids should be avoided because they cause considerable side effects and provide minimal additional analgesic benefits on top of NSAIDs and paracetamol.

Severe Pain

Always consider that if a patient complains of very severe pain after routine dental surgery there is probably a nerve injury. Gabapentin and tricyclic antidepressants should be used for nerve injury pain. If the surgery is extensive and higher levels of pain are expected, a multimodal approach is indicated. This should include acetaminophen (two 325 mg tablets every 4–6 hours), ibuprofen (600 mg every 4–6 hours to a maximum of 2400 mg in a 24-hour period) and a potent narcotic such as tramadol (a narcotic-like medication) 50 mg. Patient controlled analgesia with patient admission is usually organised if postsurgical pain is likely to be severe (joint surgery, for example).

If severe pain does not respond to a multimodal approach, this may be indicative of secondary pain issues, drug addiction, underlying myofascial pain syndrome, dry socket and alternate pain sources such as referred pain syndromes.

Management of Chronic Pain

Managing patients with chronic pain is complex, reflecting the complexity of chronic pain impact on patients' lives. The behaviour and suffering caused by chronic pain is an individual response and often predicated upon the patient's genotypic and phenotypic makeup. Behavioural and psychological techniques are the main approach in facilitating rehabilitation of these patients. Educating the patient in understanding their diagnosis is core. Medical management is an adjunct in reducing pain levels by 50% if we are lucky, but often the side effects of these medications provide additional problems for patients, and compliance is often poor.

Chronic Temporomandibular Joint (TMJ) Pain

The management of chronic TMJ pain is considered in Chapter 15.

Temporal Arteritis

Temporal arteritis is characterised by tortuous scalp arteries, daily headaches of moderate to severe intensity, scalp sensitivity, fatigue and various non-specific complaints with a general sense of illness. The pain is continuous, with superimposed sharp, shooting pains, possibly extending to the tongue. Most (95%) sufferers are over 60 years of age. The erythrocyte sedimentation rate (ESR) is markedly elevated. Management is based on referring the patient to A&E for urgent parenteral steroids and a high dose steroid prescription for prevention of blindness.

Chronic Neuropathic Pain

This includes several conditions:

- Trigeminal neuralgia (typical or atypical).
- Postherpetic neuralgia (PHN).
- Glossopharyngeal neuralgia.
- Post-traumatic neuralgia or chronic postsurgical pain.
- Burning mouth syndrome.
- Other peripheral neuropathies affecting the trigeminal system.

Trigeminal Neuralgia (Typical or Atypical)

Typical trigeminal neuralgia is characterised by sudden, stabbing, electric shock-like or burning bursts (<2 min) of severe lancinating pain in one or more branches of the trigeminal nerve. Between attacks the patient is completely asymptomatic. The pain may be precipitated from trigger areas or by certain daily activities such as eating, talking, washing the face or brushing the teeth. The syndrome is most common in patients over 50. The course may fluctuate over many years. Remissions of months or years are not uncommon.

Management The first-line treatment of choice is anticonvulsant medication. Surgery such as microvascular decompression or radiofrequency gangliolysis offers good results, although there is associated long-term morbidity of facial paraesthesia.

Postherpetic Neuralgia (PHN)

Herpetic skin eruption is caused by the reactivation of latent varicella zoster virus in the sensory nerve ganglia. Associated neuropathic, possibly severe pain that persists 2 or more months after the acute eruption is known as postherpetic neuralgia; it is typically associated with allodynia and hyperalgesia.

Management High dose antivirals, steroids and amitriptyline or pregabalin are often prescribed for otherwise healthy individuals. Topical 5% lidocaine patches worn 12 hours on and 12 hours off may be effective.

Glossopharyngeal Neuralgia

Glossopharyngeal neuralgia is an extremely rare condition characterised by pain attacks similar to those experienced in trigeminal neuralgia but located unilaterally in the distribution of the glossopharyngeal nerve. Pain is most common in the posterior pharynx, soft palate, base of tongue, ear, mastoid or side of the head. Swallowing, yawning, coughing or phonation may trigger the pain.

Management is similar to that for trigeminal neuralgia.

Post-Traumatic Painful Neuropathy Chronic Postsurgical Pain Related to Sensory Nerve Injury or Painful Post-Traumatic Trigeminal Neuropathy (PPTTN)

Traumatic injuries to the lingual and inferior alveolar nerve may induce a pain syndrome associated with the development of a neuroma. Pain commonly persists 2–6 months after the injury and often may be permanent.

Management is similar to that used for other chronic pain conditions including reassurance, explanation, psychological interventions and medical management following the NICE guidance for neuropathic pain in adults.

Burning Mouth Syndrome (BMS)

Burning mouth disorder related to local and systemic causes of peripheral painful neuropathy must be excluded first (candidosis, gastric reflux, diabetes, haematinic deficiencies, connective tissue disorders, etc.). BMS is a diagnosis of exclusion and the causes of this condition remain undiscovered but it is a recognised neuropathic pain condition. Tricyclic antidepressants are commonly used in medical management of these patients.

Burning mouth syndrome (BMS) is defined as a chronic, idiopathic oral mucosal pain or discomfort in which no clinical lesions or systemic diseases are identified. There is predilection for the condition amongst females in the menopausal to postmenopausal age group. Afflicted patients report a constant burning sensation, typically in the anterior portion of the tongue, although the anterior portion of the hard palate and the labial mucosa are other common sites.

Management Reassurance and clonazepam used topically may be helpful, as may cognitive behaviour therapy.

Chronic Idiopathic (Dysfunctional or Centralised) Trigeminal Pain

This condition is likely to be associated with multiple pain conditions. Patients presenting with migraine, fibromyalgia, lower back pain or irritable bowel syndrome

may have a genotypic predisposition to chronic pain. These conditions in the trigeminal system include:

- Preauricular arthromyalgic pain related to temporomandibular joint pain – see Chapter 15.
- Persistent idiopathic facial pain.
- Persistent dentoalveolar pain.

Persistent Idiopathic Facial Pain (PIFP) Facial migraine and trigeminal autonomic cephalalgias must be excluded first before making a diagnosis of persistent (>6 months) idiopathic facial pain (PIFP). PIFP has been referred to as atypical facial pain and refers to 'unexplained' pain in the territory of the trigeminal nerve that does not fit the classic presentation of other cranial neuralgias, a diagnosis of exclusion. The pain, which is usually long-lasting, if not continuous, is unilateral and without autonomic signs or symptoms. It is described as a severe ache or a crushing or burning sensation.

Persistent Dentoalveolar Pain (PDAP)
Previously called atypical odontalgia or phantom tooth pain, this is a variation of PIFP in which intense discomfort is centred around a tooth or group of teeth with no obvious disease. PIFP is more common in women than in men. In some patients the pain may be one of a possible number of consequences of significant psychological or psychiatric disease. PDAP occurring after dental surgery or intervention must be considered as chronic postsurgical neuropathic pain.

Management usually involves a multidisciplinary approach, including psychological counselling, but with avoidance of any invasive treatments. Anticonvulsants and antidepressants are the mainstays of medication treatment.

References

Malamed, S.F. (1998) The management of pain and anxiety. In: Cohen S, Burns RC, eds. Pathways of the Pulp. 7th edn. St. Louis: Mosby; pp. 665–666.

Woda, A., Tubert-Jeannin, S., Bouhassira, D., et al. (2005) Towards a new taxonomy of idiopathic orofacial pain. Pain 116:396–406.

Further Reading

Akinosi, J.O. (1977) A new approach to the mandibular nerve block. British Journal of Oral Surgery 15:83–87.

Afsar, A., Haas, D.A., Rossouw, P.E., Wood, R.E. (1998) Radiographic localization of mandibular anesthesia landmarks. Oral Surgery, Oral Medicine, Oral Pathology 86, 234–241.

Aldous, J.A. (1968) Needle deflection: A factor in the administration of local anesthetics. Journal of the American Dental Association 77:602–604.

Antenucci, F., Giannoni, M., Baldi, M., Marci, M.C. (1990) Subcutaneous emphysema during intraligamental anesthesia. Dental Cadmos 15:87–89.

Bedi, R., King, N.M., Brook, A.H. (1984) Local anaesthesia for children: recent developments. Dental Update 11:283–288.

Birchfeld, J., Rosenberg, P.A. (1975) Role of the anesthetic solution in intrapulpal anesthesia. Journal of Endodontics 1:26–27.

Clark, M.S., Silverstone, L.M., Lindenmuth, J., et al. (1987) An evaluation of the clinical analgesia/anesthesia efficacy on acute pain using the high frequency neural modulator in various dental settings. Oral Surgery, OralMedicine, Oral Pathology 63:501–505.

Coggins, R., Reader, A., Nist, R., et al. (1996) Anesthetic efficacy of the intraosseous injection in maxillary and mandibular teeth. Oral Surgery, OralMedicine, Oral Pathology 81:634–641.

Cohen, H.P., Cha, B.Y., Spangberg, L.S.W. (1993) Endodontic anesthesia in mandibular molars: a clinical study. Journal of Endodontics 19:370–373.

Cowan, A. (1986) A clinical assessment of the intraligamentary injection. British Dental Journal 161:296–298.

Davidson, L., Craig, S. (1987) The use of the periodontal ligament injection in children. Journal of Dentistry 15:204–208.

DeNunzio, M. (1998) Topical anesthetic as an adjunct to local anesthesia during pulpectomies. Journal of Endodontics 24:202–203.

D'Souza, J.E., Walton, R.E., Petersen, L.C. (1987) Periodontal ligament injection: an evaluation of the extent of anesthesia and post-injection discomfort. Journal of the American Dental Association 114:341–344.

Dunbar, D., Reader, A., Nist, R., et al. (1996) Anesthetic efficacy of the intraosseous injection after an inferior alveolar nerve block. Journal of Endodontics 22:481–486.

Friedman, M.J., Hochman, M.N. (1998) The AMSA injection: a new concept for local anesthesia of maxillary

teeth using a computer-controlled injection system. Quintessence International 29:297–303.
Friedman, M.J., Hochman, M.N. (1999) P-ASA block injection: a new palatal technique to anesthetize maxillary anterior teeth. Journal of Esthetic Dentistry 11:63–71.
General Medical Council. (2007) Important note for doctors: Update to Serious Communicable Diseases guidance. Non-consensual testing following injuries to health care workers. London, GMC.
Gow-Gates, G.A.E. (1973) Mandibular conduction anaesthesia: a new technique using extraoral landmarks. Oral Surgery, Oral Medicine, Oral Pathology 36:321–328.
Gray, R.J.M., Lomax, A.M., Rood, J.P. (1987) Periodontal ligament injection: with or without a vasoconstrictor? British Dental Journal 162:263–265.
Grundy, J.R. (1984) Intraligamental anaesthesia. Restorative Dentistry 1:36–42.
Gurney, B.F. (1967) Anesthesiology and pharmacology in endodontics. Dental Clinics of North America November:615–631.
Heasman, P.A., Beynon, A.D.G. (1986) Clinical anatomy of regional analgesia: an approach to failure. Dental Update 13:469–476.
Health and Safety Executive. (1992) Safe disposal of clinical waste. London: HMSO. ISBN 0 11 886355X.
Health Protection Agency. (2006) Eye of the Needle. London: Health Protection Agency.
Kaufman, E., Galili, D., Garfunkel, A.A. (1983) Intraligamental anaesthesia: a clinical study. Journal of Prosthetic Dentistry 49:337–339.
Malamed, S.F. (2004) Handbook of Local Anesthesia. 5th edn. St. Louis: Mosby.
Meechan, J.G., Thomason, J.M. (1999) A comparison of two topical anesthetics on the discomfort of intraligamentary injections. Oral Surgery 87:362–365.
Meechan, J.G., Donaldson, D., Kotlicki, A. (1995) The effect of storage temperature on the resistance to failure of dental local anesthetic cartridges. Journal of the Canadian Dental Association 61:143–1458.
Meechan, J.G., Gowans, A.J., Welbury, R.R. (1998) The use of patient controlled transcutaneous electronic nerve stimulation (TENS) to decrease the discomfort of regional anaesthesia in dentistry: a randomized controlled trial. Journal of Dentistry 26:417–420.
Miller, A.G. (1983) A clinical evaluation of the Ligmaject periodontal ligament injection syringe. Dental Update 10:639–643.
Mollen, A.J., Ficara, A.J., Provant, D.R. (1981) Needles – 25-gauge versus 27-gauge – can patients really tell? General Dentistry 29:417–418.
Nusstein, J.M., Beck, M. (2003) Effectiveness of 20% benzocaine as a topical anesthetic for intraoral injections. Anesthesia Progress 50:159–163.
Nusstein, J., Reader, A., Nist, R., et al. (1998) Anesthetic efficacy of the supplemental intraosseous injection of 2% lidocaine with 1:100,000 epinephrine in irreversible pulpitis. Journal of Endodontics 24:487–491.
Parente, S.A., Anderson, R.W., Herman, W.W., et al. (1998) Anesthetic efficacy of the supplemental intraosseous injection for teeth with irreversible pulpitis. Journal of Endodontics 24:826–828.
Pashley, D.H. (1986) Systemic effects of intraligamental injections. Journal of Endodontics 12:501–504.
Pertot, W.J., Dejou, J. (1992) Bone and root resorption. Effects of the force developed during periodontal ligament injection in dogs. Oral Surgery 74:357–365.
Peurach, J.C. (1985) Pulpal response to intraligamentary injection in the Cynomologus monkey. Anesthesia Progress 32:73–75.
Plamondon, T.J., Walton, R.E., Graham, G.S., et al. (1990) Pulp response to the combined effects of cavity preparation and periodontal ligament injection. Operative Dentistry 15:86–93.
Quarnstrom, F. (1992) Electronic dental analgesia. Anesthesia Progress 39:162–177.
Rawson, R.D., Orr, D.L. (1985) Vascular penetration following intraligamental injection. Journal of Oral and Maxillofacial Surgery 43:600–604.
Reisman, D., Reader, A., Nist, R., et al. (1997) Anesthetic efficacy of the supplemental intraosseous injection of 3% mepivacaine in irreversible pulpitis. Oral Surgery, Oral Medicine, Oral Pathology 84:672–682.
Repogle, K., Reader, A., Nist, R., et al. (1997) Anesthetic efficacy of the intraosseous injection of 2% lidocaine (1:100,000 epinephrine) and 3% mepivacaine in mandibular first molars. Oral Surgery, Oral Medicine, Oral Pathology 83:30–37.
Roahen, J.O., Marshall, F.J. (1990) The effects of periodontal ligament injections on pulpal and periodontal tissues. Journal of Endodontics 16:28–33.
Roberts, G.J., Rosenbaum, N.L. (1991) A Colour Atlas of Dental Analgesia and Sedation. London: Wolfe; p.50.
Roberts, G.J., Holzel, H.S., Sury, M.R.J., et al. (1997) Dental bacteremia in children. Pediatric Cardiology 18:24–27.
Roda, R., Blanton, P. (1994) The anatomy of local anesthesia. Quintessence International 25:27–38.
Saroff, S.A., Chasens, A.I., Doyle, J.L. (1986) External tooth resorption following periodontal ligament injection. Journal of Oral Medicine 41:201–203.
Schleder, J.R., Reader, A., Beck, M., et al. (1988) The periodontal ligament injection: a comparison of 2% lidocaine, 3% mepivacaine and 1 : 100,000 epinephrine to 2% lidocaine with 1 : 100,000 epinephrine in human mandibular premolars. Journal of Endodontics 14:397–404.
Sloss, D. (2001) Pain control and the apprehensive patient. Dentistry Today 20:68–71.
Williams, W. (2001) A new perspective on local anaesthesia: Part 2. Dentistry March:29–37.

10

Procedures in Conscious Sedation

David Craig

Introduction

Many patients regard all dental treatment, and especially surgical procedures, as stressful and potentially painful. Reactions range from 'normal' apprehension, through various degrees of anxiety to irrational fear or even phobia. The adverse physiological effects of these psychological responses can increase the risk of treatment and should be controlled. This is particularly important for patients suffering from medical conditions which are made worse by fear. Internationally, conscious sedation is increasingly recognised to be an integral element of the control of pain and anxiety and an important aspect of the modern practice of dentistry (General Dental Council, 2002; Intercollegiate Advisory Committee for Sedation in Dentistry (IACSD), 2015).

Conscious sedation has been defined as:

> A technique in which the use of a drug or drugs produces a state of depression of the central nervous system enabling treatment to be carried out, but during which verbal contact is maintained throughout the period of sedation. The drugs and techniques used to provide conscious sedation should carry a margin of safety wide enough to render loss of consciousness unlikely. The level of consciousness must be such that the patient remains conscious, retains protective reflexes, and is able to understand and respond to verbal commands. (IACSD, 2015)

In the UK, the most commonly used dental conscious sedation techniques (titrated intravenous midazolam or titrated inhaled nitrous oxide/oxygen) have an excellent safety record. For many patients, conscious sedation combined with effective local anaesthesia has been a very acceptable alternative to general anaesthesia. Ensuring that patients understand the benefits and risks of local anaesthesia, conscious sedation and general anaesthesia is an important part of the consent process. Despite the safety, efficacy and cost benefits of using conscious sedation techniques there are still indications for general anaesthesia for some dental/surgical procedures and certain patient groups.

Typical signs and symptoms of anxiety are:

Signs	Symptoms
Clenched fists/sweaty hands	Fainting
Pallor	Sweating
Distracted appearance	Dry mouth
Not sitting back fully in the dental chair	Need to visit lavatory
Holding handbag/tissue tightly	Nausea
Throat clearing	Tiredness
Looking around	
Not smiling	
Touching/fiddling	
Licking lips	
Very quiet or voluble	
Aggressive behaviour	

This chapter provides an introduction to conscious sedation techniques for dental procedures: patient assessment and treatment planning, essential pharmacology, sedation equipment, clinical sedation techniques and the avoidance/management of sedation-related complications. Before administering any form of conscious sedation the dental team must have received appropriate training in accordance with contemporary professional guidance.

Patient Assessment and Treatment Planning

A satisfactory first visit is crucial to the success of subsequent treatment under conscious sedation. There is a

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

great deal of information to be acquired from the patient. At the same time, it should never be forgotten that the patient is also assessing the dental team. The first meeting should ideally be outside the surgery environment and in the nature of an informal 'chat'. The following topics should be explored:

What Is the Problem?

It is often helpful to get the patient to complete a questionnaire asking the nature of their fears. Suitable questionnaires for adults include the Modified Dental Anxiety Scale (Corah, Gale and Illig, 1978; Humphris, Morrison and Lindsay, 1995) (Figure 10.1) and for children the Modified Venham Scale of Anxiety (Venham, 1979) (Figure 10.2). This breaks the ice, and other questions may be included that will steer the conversation in the right direction. Remember that for some patients even discussing dentistry or meeting a dentist can frightening.

Understanding the precise causes of an individual's anxiety makes it easier to prescribe the most appropriate dental care and anxiety management regimen. The latter may include pharmacological and/or non-pharmacological techniques (e.g. cognitive behavioural therapy, hypnosis, acupuncture).

The Modified Dental Anxiety Scale

Can you tell us how anxious you get, if at all, with your dental visit?
Please indicate by inserting "X" in the appropriate box

1. If you went to your dentist for **TREATMENT TOMORROW**, how would you feel?

Not anxious ☐ Slightly anxious ☐ Fairly anxious ☐ Very anxious ☐ Extremely anxious ☐

2. If you were sitting in the **WAITING ROOM** (waiting for treatment), how would you feel?

Not anxious ☐ Slightly anxious ☐ Fairly anxious ☐ Very anxious ☐ Extremely anxious ☐

3. If you were about to have a **TOOTH DRILLED,** how would you feel?

Not anxious ☐ Slightly anxious ☐ Fairly anxious ☐ Very anxious ☐ Extremely anxious ☐

4. If you were about to have your **TEETH SCALED AND POLISHED,** how would you feel?

Not anxious ☐ Slightly anxious ☐ Fairly anxious ☐ Very anxious ☐ Extremely anxious ☐

5. If you were about to have a **LOCAL ANAESTHETIC INJECTION** in your gum, how would you feel?

Not anxious ☐ Slightly anxious ☐ Fairly anxious ☐ Very anxious ☐ Extremely anxious ☐

Figure 10.1 Modified Dental Anxiety Scale. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

How nervous do you feel at this moment?

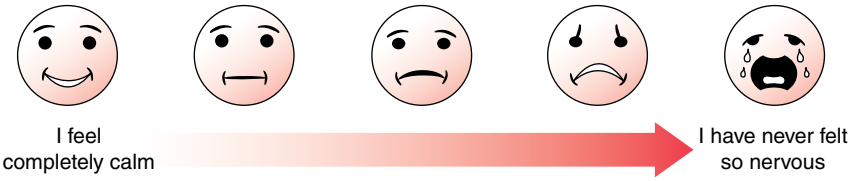


Figure 10.2 Modified Venham Scale of Anxiety. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

Medical History

A detailed medical history must be obtained. From the sedation point of view, special note should be made of respiratory and cardiovascular problems, liver and kidney disease. Prescribed medication may alert the operator to undisclosed medical conditions and also raise the question of drug interactions. Some medicines potentiate the effect of sedation drugs. It may sometimes be necessary to discuss the patient's medical history with their general medical practitioner or hospital consultant. A baseline recording of arterial blood pressure, heart rate and arterial oxygen saturation should be obtained and the result recorded in the clinical notes.	Baseline readings, taken before any drugs are administered, are essential in order to be able to compare the 'normal' and intraoperative values for an individual patient.
It is important to appreciate that in many cases it is helpful to prescribe sedation. In other cases the sedation technique may require modification.	

Examples Where Sedation Is Almost Certainly Beneficial

Angina pectoris	
Angina may be provoked by anxiety or stress during the dental procedure. This may cause a tachycardia and increase the work of the heart.	Apart from the other usual anxiety management measures employed, the use of sedation protects patients from these effects and significantly reduces the likelihood of angina-related symptoms.
Controlled hypertension	
Most hypertensive patients are taking medication, and some may have a normal arterial blood pressure in the assessment clinic; however, many still have higher than normal levels. The anxiety of treatment can cause an increase in heart rate and an elevation of blood pressure.	Sedation modifies these responses and protects the patient.
Asthma	
It is particularly important to ascertain if attacks are known to be provoked by stress.	Sedation reduces the physiological response to stress and so reduces the risk of an attack.
Epilepsy	
Midazolam is particularly useful in reducing the likelihood of fits when the patient is poorly controlled.	Midazolam has anti-seizure properties and may be used in the management of status epilepticus.
Movement disorders	
In patients with uncontrolled movements, intravenous sedation will often suppress or at least reduce abnormal motor activity.	As midazolam wears off, the uncontrolled movements return to their usual intensity.

Examples of Conditions Where the Technique Might Require Modification

Controlled heart failure	
Patients might be distressed when supine, and liver perfusion (and therefore drug metabolism) is likely to be reduced.	Asking the patient if they will be comfortable fully reclined and adjusting the dental chair and operating position appropriately may be all that is necessary. It is also useful to enquire how many pillows the patient has at night.
Chronic anaemia (diagnosed and managed)	
Be aware of the potential effects of falling oxygen saturation levels and respond promptly.	Undiagnosed and poorly managed anaemia may lead to incorrect pulse oximetry readings. Management of a low oxygen saturation involves the administration of supplemental oxygen and possibly other measures (see 'Management of Sedation-Related Complications').

Chronic airways disease(s)	
Interpretation of oxygen saturation levels in smokers and patients with chronic obstructive pulmonary disease (COPD) may be difficult. The possibility that the patient's respiratory drive is oxygen (rather than carbon dioxide) dependent must be considered.	Administering oxygen to a patient whose respiratory drive is oxygen dependent may lead to apnoea.
Well-controlled diabetes	
Ensure that the patient is managed appropriately. If possible, have a chairside measure of blood sugar at the beginning of treatment to avoid any later difficulties in assessing levels of consciousness.	Avoiding unnecessary starvation prior to sedation and ensuring that the patient's escort is fully informed about the nature of the patient's diabetes and the effects of sedation reduces the probability of intraoperative and postoperative problems.

Examples Where Caution Is Required

Referral should be considered for the following:

Severe Cardiorespiratory Disease The patient may be breathless at rest or after minimal exertion.

Hepatic Disease If there is active liver disease or known impairment of function, drug metabolism may be ineffective and sedation abnormally prolonged.

Severe Psychological Illness Refer if the patient is using anti-psychotic drugs or 'major tranquillisers'.

Drug Abuse Refer if the patient is opioid and/or benzodiazepine dependent or a frequent recreational drug user. Sedation in cannabis users is notoriously difficult to manage. Failure to achieve an adequate level or length of sedation is common.

Alcohol Check for high levels of alcohol intake or known alcoholism. Patient who present for treatment who have clearly recently consumed alcohol should not be sedated.

Having collected this information it is possible to summarise the operative and/or sedation risk according to the scale of physical fitness devised by the American Society of Anesthesiologists (ASA; Kluger et al., 2002) (see Box 9.1).

Patients classified as ASA I or II are generally considered suitable for treatment in general dental practice or other primary dental care setting.

Patients falling into categories III and IV should be referred to a specialist centre such as a teaching hospital or specialist sedation clinic.

Some patients oscillate between ASA II and ASA III according to the severity of their disease and other factors such as the season of the year or a change in medication. Examples of this type of fluctuating condition include poorly controlled asthma, diabetes mellitus and epilepsy. It may be preferable to refer such patients or wait until their condition becomes more stable (ASA II) before providing treatment under sedation.

If a patient suffers from two relevant illnesses, or appears to be ASA II but with the use of multiple drugs it is probably sensible to consider the patient to be ASA III. The ASA scale is a useful 'shorthand' method of recording a patient's medical status but it requires common sense and careful application in order to avoid creating either unnecessary concern or false confidence.

When assessing the medical status of an elderly patient, it must be remembered that some physiological functions decline naturally with age and even the apparently healthy patient with no declared medical problems cannot be treated exactly like a young fit adult. Elderly patients with one controlled illness (e.g. angina) may be suitable for treatment in a primary care setting but the presence of two known conditions (bearing in mind that other disease processes may be present but undiagnosed) should indicate referral.

Dental History (Dental Sedation Teachers' Group/Society for the Advancement of Anaesthesia in Dentistry, 2001)

The patient's experiences at the dentist over the years are important. The following questions may yield valuable information which will assist during treatment planning.

Useful Dental History Questions

When did dental anxiety start?	The answer may reveal that dental anxiety or phobia was triggered by a 'bad experience' (often in late childhood).
What provoked the fear?	Many patients cannot identify a specific episode. Some patients even find trying to recall previous visits distressing.
Are there any specific triggers?	Although some patients cite the administration of local anaesthetic, the dental drill and 'instruments in the mouth', many say that they are scared of everything about dentistry – and all dentists!
When did the patient last visit a dentist?	This date may give an indication of the patient's interest in their dental health and also provides a convenient starting point for more detailed questions about previous treatment.
Has the patient had treatment under general anaesthetic or conscious sedation in the past?	Many patients find this difficult to answer – they know that they were 'asleep' but whether this was general anaesthesia or due to the amnesic effects of intravenous midazolam is often unclear.
If sedation, what technique was used?	Knowing which sedation techniques have been successful in the past may help to decide which is most likely to be effective under the present circumstances. But be aware that a patient's memory and understanding of sedation may be limited, for example, they may remember having a mask placed on the face but was this general anaesthetic or inhalation sedation?
Was this treatment successful?	Success is a relative term – it is important to establish if the intended dental treatment was completed and not only whether the patient found the experience pleasant or not. If treatment was unsuccessful, why? What happened? Was the patient referred elsewhere?
What concerns the patient most about their teeth?	In order to encourage attendance it is sometimes better to carry out cosmetic dentistry (for example, restoration of an unsightly upper incisor) before addressing more serious (but less visible) problems with posterior teeth.
Are there any current symptoms (particularly pain)?	Pain must be addressed but, wherever possible, it is better to avoid extractions at the first visit.

Remember that non-anxious patients may also be better managed under sedation if the proposed dental procedure is potentially threatening and/or prolonged.

Social Factors

The patient's domestic circumstances are very important. An escort will be required for all intravenous sedation appointments (but not usually for adults treated using inhalation sedation). In addition, having responsibility for children or elderly relatives may make it difficult for the patient to attend or to be able to be recovered safely at home. Be aware that, in their eagerness to be accepted for treatment under sedation, some patients may be untruthful about their domestic circumstances. For example, they may confirm that an escort will be available but fail to say that this is a taxi driver who will simply abandon them at their front door.

Dental Examination

Although some patients will allow a full intraoral examination, the dentist may have to be content with a visual examination at this stage. Many patients fear the dental probe and so this should only be used when absolutely necessary, and then with extreme caution. For a very few patients, intraoral radiographs may also be threatening or cause gagging, and so have to be carried out under sedation.

Discussion and Treatment Planning

Selection of the most appropriate method of pain and anxiety control requires careful consideration of a number of interlinking factors including the proposed dental treatment, the patient's health and degree of anxiety, the operator's training and experience and the environment in which the treatment is to be carried out. No matter how fashionable, it is not possible to design a 'care pathway' or 'protocol' which incorporates all the relevant factors. The correct and most successful approach involves a commitment by the whole team (dentist/sedationist/nursing staff) to carefully consider a range of options and choose the best for an individual patient. A 'one size fits all' approach to pain and anxiety management is not appropriate.

Once a preliminary dental treatment plan has been formulated, the following treatment options may then be considered and discussed with the patient:

Local anaesthetic (LA) alone	Appropriate for most non-anxious individuals and also some phobic patients who are not anxious about either LA or the proposed procedure, for example, scaling.
LA with inhalational sedation (nitrous oxide/oxygen)	The option of choice for children and mildly anxious adults undergoing relatively non-threatening procedures, for example, fillings.
LA with intravenous sedation (midazolam)	Best for more severely anxious adults and/or those undergoing surgery or other prolonged and/or threatening procedures, for example, surgical removal of third molar teeth. (Note that IV midazolam is increasingly being used for very anxious younger patients for whom inhalational sedation is unlikely to be effective).
LA with oral or intranasal sedation (midazolam) (IACSD, 2015)	Helpful for needle-phobic patients and patients with a disability which makes the use of intravenous sedation difficult or impossible. (But note that practitioners using oral or intranasal midazolam must have training in and experience of administering IV midazolam).
LA with 'alternative' or 'advanced' sedation techniques (IACSD, 2015)	For the very small number of patients for whom none of the above techniques is effective. Requires additional training and experience.
General anaesthesia (GA)	Sometimes the only option – indications include very severe dental phobia, a large amount of treatment required, the age of the patient, severe disability or proven allergy to all LA drugs.

The simplest technique which will enable treatment to be carried out is generally considered to be the most appropriate. However, it is entirely *inappropriate* to subject patients to a rigid (often protocol-driven) cascade of management options which only permits the dentist to offer more appropriate sedation techniques when all simpler modalities have failed. This is unnecessarily distressing for patients (and the dental team) and often only serves to increase anxiety and make subsequent management more difficult. An example would be a severely anxious needle-phobic patient requiring extensive dental treatment who would clearly benefit from the prescription of intranasal midazolam followed by intravenous sedation being forced to endure the distress and indignity of having to first demonstrate that inhalational sedation is inappropriate.

Written consent is required for both the dental procedure and the administration of all forms of conscious sedation. Consent for dentistry under conscious sedation must, under all but emergency circumstances, be obtained at the assessment appointment rather than when the patient attends for treatment. If extractions or advanced procedures are required, these must be agreed on a tooth-by-tooth basis; however, this is not usually practical for routine restorative dentistry involving multiple fillings, scaling and polishing.

Finally, patients must be given written and verbal pre- and postoperative instructions and be given the opportunity to ask questions. Some sedationists (particularly anaesthetists) prefer that patients are starved in preparation for treatment under conscious sedation. However, there is no compelling evidence that this is necessary or even desirable when conscious sedation is administered according to current guidelines.

Patient Instruction Prior to Sedation for Dental Treatment

For your safety, please read and follow these instructions carefully	
Before sedation – on the day of treatment:	
• Take your routine medicines at the usual times	Missing essential medication may put the patient at risk.
• Have only light meals and non-alcoholic drinks on the day of your appointment	There is no convincing evidence that abstaining from either liquids or solids increases safety when sedation is administered as described here and it is possible that anxiety may be increased by changing the patient's normal routine. For some patients, for example diabetics, starvation represents a real hazard.
• Bring a responsible adult with you – someone who is able to escort you home and then care for you for the rest of the day. (Not mandatory for adult patients receiving nitrous oxide/ oxygen sedation)	A fit adult escort is required for IV sedation in order to care for the patient on the journey home and then until the patient is fully recovered. Discharging a patient without an appropriate escort is likely to lead to disciplinary action.
After sedation – until the following day:	
• Do not travel alone – travel home with your escort • Do not drive or ride a bicycle • Do not operate machinery • Do not drink alcohol • Do not return to work or sign legal documents	Patients recovering from sedation are often unaware that their judgement and memory are impaired. This may lead to accidents or inappropriate behaviour.

Physiological Control and Monitoring

In order to fully understand the principles of safe sedation practice, it is necessary to review certain aspects of physiology, in particular those relating to the respiratory and cardiovascular systems. A knowledge of the anatomy of the upper airway assists in airway management. Familiarity with the pattern of veins in the cubital fossa and on the dorsum of the hand is essential for the administration of intravenous sedation.

Respiratory Physiology

The major function of the respiratory system is to ensure continuous effective gas exchange so that oxygen enters the bloodstream and carbon dioxide is removed.

Quiet breathing is characterised by the rhythmic expansion and relaxation of the lungs and thorax. The diaphragm is the most important muscle of respiration but the intercostal muscles contribute to the increase in the volume of the thorax during inspiration. The accessory muscles of inspiration are not used during quiet breathing. Expiration is normally a passive process resulting from the elastic recoil of the lungs. Active expiration, primarily involving the muscles of the anterior abdominal wall and the intercostal muscles, is seen during exercise and hyperventilation.

The size of the thorax and lungs determines the lung capacities whereas lung volumes are determined by inspiratory and expiratory effort (Figure 10.3).

Tidal volume (TV) is the volume of gas inhaled during a normal inspiration. A fit adult patient at rest normally has a tidal volume of approximately 500 ml. Minute volume (MV) is the product of the tidal volume and the respiratory rate. A normal adult at rest breathes approximately 12 times each minute. Thus, the minute volume for an adult is usually about 6 litres. These figures provide the sedationist with a physiological basis for estimating the initial fresh gas flow required when using inhalational sedation techniques.

The dead space volume refers to the portion of the airways which is not available for the exchange of gases. Dead space increases with age and a reduction in cardiac output. The term 'alveolar ventilation' is used to describe the volume of gas entering the alveoli each minute and taking part in gas exchange. It is important to recognise that a patient who has very shallow breathing (where the tidal volume is less than the dead space volume) is effectively not breathing at all. Hypoventilation is common following the administration of central nervous system (CNS) depressant drugs such as benzodiazepines.

Pulmonary gas exchange occurs at the alveolar capillary membrane, where only two or three cells separate alveolar gas from the bloodstream. Oxygen and carbon dioxide cross the alveolar membrane by diffusion. Most

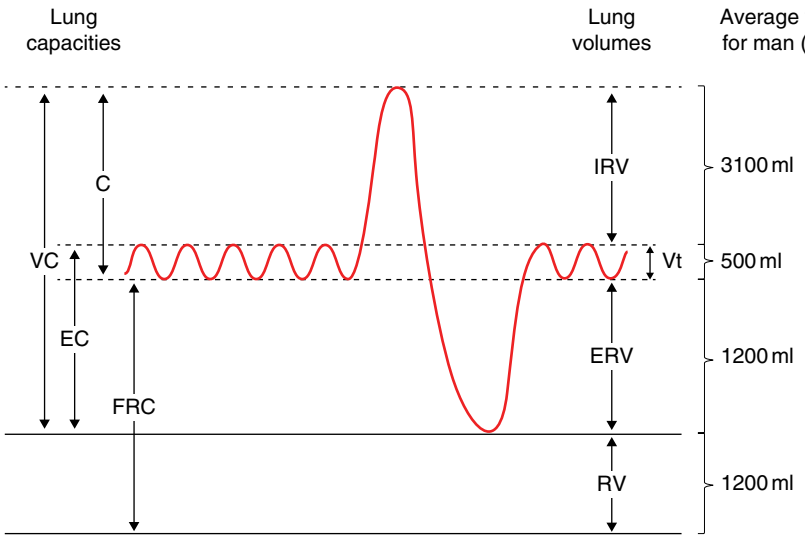


Figure 10.3 Lung volumes and capacities. EC, expiratory capacity; ERV, expiratory reserve volume; FRC, functional residual capacity; IC, inspiratory capacity; IRV, inspiratory reserve volume; RV, residual volume; VC, vital capacity; Vt, tidal volume. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

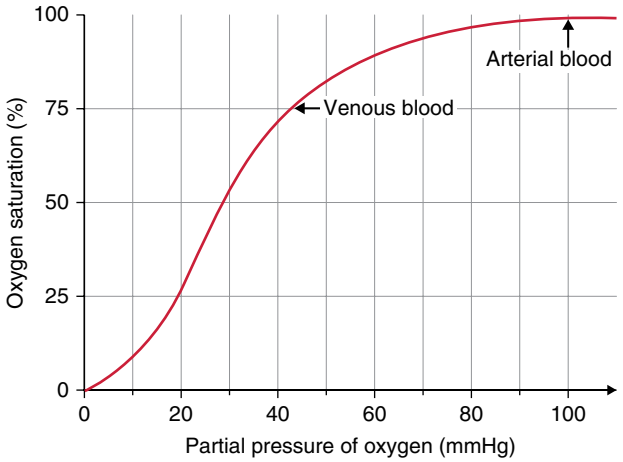


Figure 10.4 Oxygen–haemoglobin dissociation curve. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

of the oxygen is transported to the periphery of the body in combination with haemoglobin. Oxygen combines loosely and reversibly with haemoglobin. Each molecule of haemoglobin can combine with four atoms of oxygen, but the association of each atom alters the affinity of the haemoglobin molecule for subsequent oxygen atoms. This results in the characteristic sigmoid shape of the oxygen dissociation curve (Figure 10.4).

The oxygen dissociation curve shows the oxygen saturation of haemoglobin on the y-axis and the partial pressure of oxygen (oxygen tension) on the x-axis. The plateau at the top of the curve results from the saturation of the binding sites with oxygen. This provides a potential reserve of oxygen when the partial pressure of oxygen falls. The steep vertical section of the curve allows for optimum loading and unloading of oxygen.

During sedation a pulse oximeter is used to estimate the patient's arterial oxygen saturation (the y-axis on the oxygen dissociation curve). However, the unremitting hunger of all the cells of the body for oxygen is only satisfied by a continuous supply and adequate partial pressure of oxygen. The shape of the dissociation curve determines the precise relationship of the axes and thus the relationship between the displayed arterial oxygen saturation (SaO_2) and the quantity of oxygen available for cellular respiration. Careful consideration of the curve and the underlying biochemistry demonstrates the significance of the recommendation that the SaO_2 must be maintained above 90% throughout sedation and the immediate recovery period.

Carbon dioxide is carried in the blood in solution, in the form of bicarbonate, and attached to protein as carbamino compounds. Carbon dioxide is much more soluble than oxygen and so the quantity of carbon dioxide carried in solution is significant. Most of the carbon dioxide carried in the blood is present in the form of bicarbonate.

$$H_2O + CO_2 \rightleftharpoons H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$$

Respiration is an automatic process under the control of the brain's respiratory centre (Figure 10.5). The respiratory centre receives a large number of inputs, including those from the central and peripheral chemoreceptors, lung mechanoreceptors and the higher centres of the central nervous system (CNS). Changes in the rate and depth of breathing are produced by control of the firing rate in the nerves supplying the muscles of respiration.

At rest, at least 60% of the respiratory drive is derived from the central chemoreceptors in the medulla. The central chemoreceptors respond to changes in the pH (H^+ ion concentration) of cerebrospinal fluid (CSF). When the level of carbon dioxide in the blood rises, carbon dioxide diffuses into the CSF from the cerebral blood vessels, liberating H^+

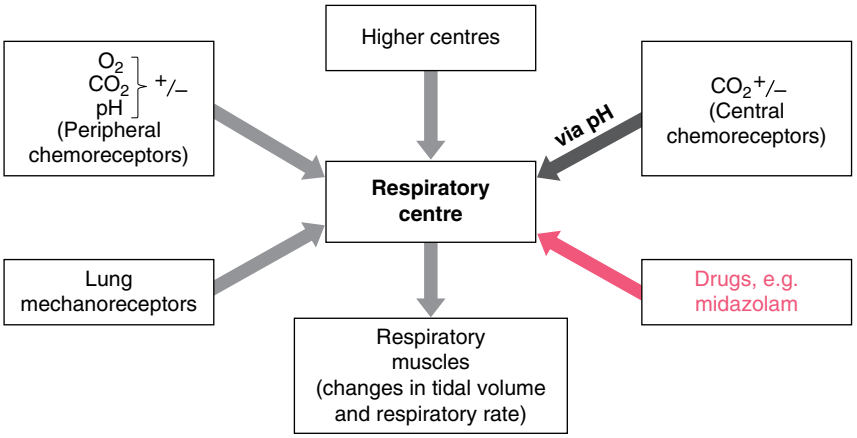


Figure 10.5 Control of respiration. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

ions which stimulate the chemoreceptors. Thus, the carbon dioxide level in blood regulates ventilation by its effect on the pH of the CSF. Under normal circumstances the body maintains the pH of CSF within very narrow limits.

The initial response to a rise in carbon dioxide is an increase in tidal volume followed by an increase in respiratory rate. That is, the patient first takes deeper breaths and then breathes more rapidly. Certain sedatives agents (particularly benzodiazepines and opioids) reduce the respiratory drive and cause a reduction in chemoreceptor sensitivity. They reduce the rate and depth of breathing (causing carbon dioxide levels to rise and oxygen levels to fall) and diminish the normal ventilatory response to these changes. This is why a pulse oximeter is considered to be an essential monitor during intravenous sedation and high dosage oral sedation using benzodiazepines.

Cardiovascular Physiology

The main purpose of the circulatory system is to deliver a continuous supply of oxygen and nutrients to the cells of the body and to remove the waste products of cellular metabolism (carbon dioxide and water).

The heart receives a sympathetic and a parasympathetic nerve supply. Sympathetic stimulation increases the heart rate and also the force of contraction of the myocardial muscle. An increase in sympathetic drive is part of the body's normal response to fear and anxiety. Parasympathetic stimulation reduces the heart rate. The sympathetic nervous system is almost entirely responsible for the control of the vascular system (with the exception of the coronary, cerebral, pulmonary and renal circulations).

The average adult has a blood volume of 5–6 litres and a resting cardiac output of 5.5 litres per minute. Cardiac output is usually described as being the 'product' of heart rate and stroke volume.

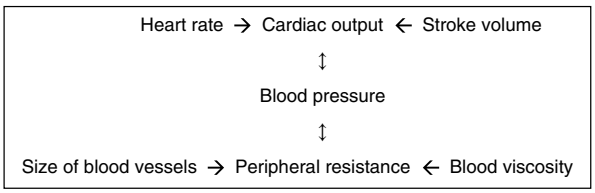


Figure 10.6 Factors influencing blood pressure.

Heart rate → Cardiac output ← Stroke volume

Heart rate (normally 60–80 beats per minute) is generated by the activity of the sino-atrial node but this rate is modified by autonomic tone, higher responses to pain and anxiety, baroreceptor mechanisms, chemoreceptor responses to hypoxia and hypercarbia and circulating hormones (particularly catecholamines).

Autonomic tone depends on the balance between sympathetic and parasympathetic nervous systems. At rest, the heart beats at a rate which is mostly dependent upon vagal (parasympathetic) tone. Input from higher centres, for example in response to anxiety and pain, increases sympathetic tone and hence heart rate.

Specialised stretch receptors (baroreceptors) located in the heart and major blood vessels provide a negative feedback mechanism for the control of systemic arterial pressure. A fall in arterial blood pressure is associated with a decrease in the firing rate in the baroreceptor nerve supply. This results in a reflex increase in the heart rate and vice versa. The amount of blood ejected by the heart (cardiac output) balanced against the resistance to blood flow offered by the peripheral circulation (peripheral resistance) determines the pressure generated in the major blood vessels (Figure 10.6).

Blood vessel size relates to arteriolar tone, which is controlled by the sympathetic nervous system and circulating catecholamines. Increased sympathetic activity results in vasoconstriction and decreased activity results in vasodilatation.

Differences Between Adults and Children

Children, especially very young children, should not be thought of as small adults. There are a number of important anatomical and physiological differences which distinguish 'paediatric' and adult patients. The following list summarises the differences which may be relevant to the use of sedation for paediatric patients:

- Children have a higher metabolic rate than adults and this leads to increased oxygen consumption and increased carbon dioxide production. The younger the child, the higher is the metabolic rate.
- The head and tongue are relatively large. The neck is shorter and the larynx located higher and more anteriorly. The trachea is proportionately narrower compared with adults. Children tend to breathe through the nose rather than through the mouth.
- Tidal volume is usually smaller than in adults but the respiratory rate is increased. The respiratory rate for 5–12-year-old children is normally between 15 and 20 breaths per minute. This means that the minute volume (the product of the tidal volume and the respiratory rate) of children and adults is much more similar than might be expected from a simple comparison of size. An initial fresh gas flow of 6 litres per minute is therefore a reasonable starting point for the administration of inhalational sedation for both adults and children. The inspiratory phase of breathing tends to be more diaphragmatic as the ribs are horizontal, reducing the lateral expansion of the chest.
- Children between 5 and 12 years of age have a higher heart rate (80–120 beats per minute) than adults although arterial blood pressure is lower (typically 90–110 mmHg, systolic). Haemoglobin levels are increased. The superficial veins are smaller than in adults and may have more fatty tissue covering them. This may make venepuncture difficult. The brachial pulse is often more easily palpated than the radial or even the carotid pulse. Arterial oxygen saturation measurements are similar for adults and children.

Monitoring

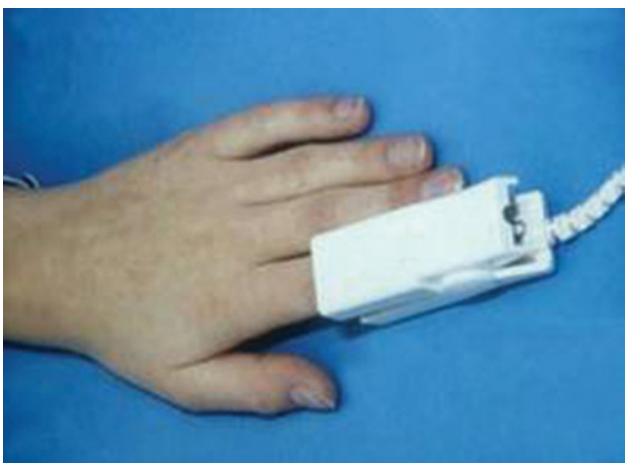
In addition to any electromechanical devices (e.g. pulse oximeter), the sedationist and nurse must be constantly aware of the patient's respiration (rate and depth), the presence of airway obstruction, depth of sedation and skin colour. Periodic estimation of systemic arterial blood pressure and an electrocardiogram (ECG) may be advisable for some unfit patients.

Respiratory rate is quite variable (12–20 breaths per minute in adults), but this is nearly always reduced during sedation and so must be monitored closely. The depth of breathing is also reduced. Apnoea may occur with an overdosage of (or idiosyncratic response to) midazolam. Such side effects are potentially life threatening if recognition and management are not swift. Some degree of respiratory depression is probably present in all sedated patients, but serious problems are most likely to occur immediately following induction.

Pulse oximetry (Figure 10.7) measures the patient's arterial oxygen saturation and pulse rate using a probe, which is attached to the finger or ear lobe. The pulse oximeter detects changes in the patient's oxygen supply, oxygen uptake by the lungs and the delivery of oxygen to the tissues via the circulation. Thus it is an excellent monitor of both respiratory and cardiovascular function. However, correct functioning can be affected by metallic nail varnish or fake nails and excessive light falling on the probe. Oxygen saturations below 90% must be investigated and the cause immediately corrected. Asking the patient to take several deep breaths resolves the majority of cases of midazolam-induced respiratory depression. If this fails, intermittent positive pressure ventilation (IPPV) must be started and the administration of flumazenil considered.

Bradycardia or tachycardia during sedation must be investigated. The former may be due to hypoxia or

(a)



(b)

Figure 10.7 (a) Pulse oximeter with (b) finger probe. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

vagal stimulation; the latter is often the result of painful stimuli. Most pulse monitors have audible alarms, which can be set to give an audible and visible warning if the heart rate falls or rises beyond clinically acceptable levels. For adult patients who are ASA I or II, the bradycardia and tachycardia alarm limits are normally 50 beats/min and 150 beats/min respectively.

Measurement of Systemic Arterial Blood Pressure Using a Manual Sphygmomanometer and Stethoscope (Figure 10.8)

The sphygmomanometer cuff is applied around the upper arm, leaving a clearance of 5 cm (2 inches) between the lower end of the cuff and cubital fossa.	Correct placement of the cuff is important in order to obtain an accurate measurement. Placing the cuff too low makes placement of the stethoscope difficult.
The brachial pulse (on the medial side of the cubital fossa) is located and the cuff inflated until the radial pulse (on the thumb side of the wrist) disappears.	This ensures that the cuff has been inflated to a pressure which is above the patient's systolic blood pressure.
The diaphragm of the stethoscope is then placed over the brachial artery and the pressure in the cuff is slowly lowered. In order to maintain a steady fall in pressure, the release valve must be opened more and more as the pressure falls. As the pressure descends, no sounds are heard until the systolic blood pressure is reached, when tapping sounds, corresponding to the heart rate, are heard in the stethoscope. The pressure at which these sounds first appear is noted. This gives the systolic blood pressure.	The systolic blood pressure corresponds to the maximum pressure in the aorta and large arteries. It is frequently raised in anxious patients.
As the cuff pressure continues to be reduced, the sounds become louder and louder, but at the diastolic pressure they suddenly change their quality and become muffled. A little lower down they finally disappear. The point at which the sounds become muffled is taken as the diastolic blood pressure.	The diastolic blood pressure corresponds to the minimum pressure in the aorta and large arteries. Like the systolic BP it may also be raised in anxiety but a high diastolic BP often indicates underlying cardiovascular disease.

'Normal' blood pressure is 120/80 (mmHg) or 16/10 (kPa). However, small variations are commonplace and the systolic blood pressure is often raised in anxious subjects. Although moderate hypertension which is controlled is not a contraindication to sedation, patients with a diastolic blood pressure above 100 mmHg should be investigated before sedation is given.

Automatic sphygmomanometers are available and are very easy to use (Figure 10.9). However, cheaper models tend to be technique sensitive and unreliable readings are often obtained. If in doubt, the blood pressure should be re-taken using a manual sphygmomanometer and stethoscope.

Inhalation Sedation Using Nitrous Oxide and Oxygen (Crawford, 1990; Roberts, 1990a, b; Shaw et al., 1996)

Pharmacology of Nitrous Oxide (Table 10.1)

Nitrous oxide is a colourless and virtually odourless anaesthetic gas. The gas has a blood/gas solubility coefficient of 0.47 and a minimum alveolar concentration (MAC) of 105%. The blood/gas solubility coefficient determines the rate at which the gas concentration in the lungs equilibrates with that being administered which, in turn, relates to the speed of induction and of recovery. Nitrous oxide is poorly soluble in blood and so induction and recovery are rapid.

The MAC value is related to the potency of the gas and determines the concentration needed to induce sedation. Nitrous oxide is not very potent, which means that it is a very safe gas for dental sedation. It is compressed at 800 lb per square inch (43.5 bar) to a liquid and supplied in cylinders which are coloured blue.

In sufficient concentrations (in excess of 100%), the drug will induce light surgical anaesthesia, but only at the expense of adequate oxygenation. In lesser concentrations, it has excellent analgesic and sedative properties. There are very few cardiovascular or respiratory effects and no direct depression of myocardial function or reduction in ventilation. The drug has a central analgesic and anaesthetic effect (the exact mechanism is not clear) and is excreted unchanged via the lungs very rapidly after its administration is discontinued.

Nitrous oxide has excellent anxiolytic, sedative and analgesic properties, with little or no depression of myocardial function or ventilation. Induction and recovery are rapid and it has a wide margin of safety. Inhalational

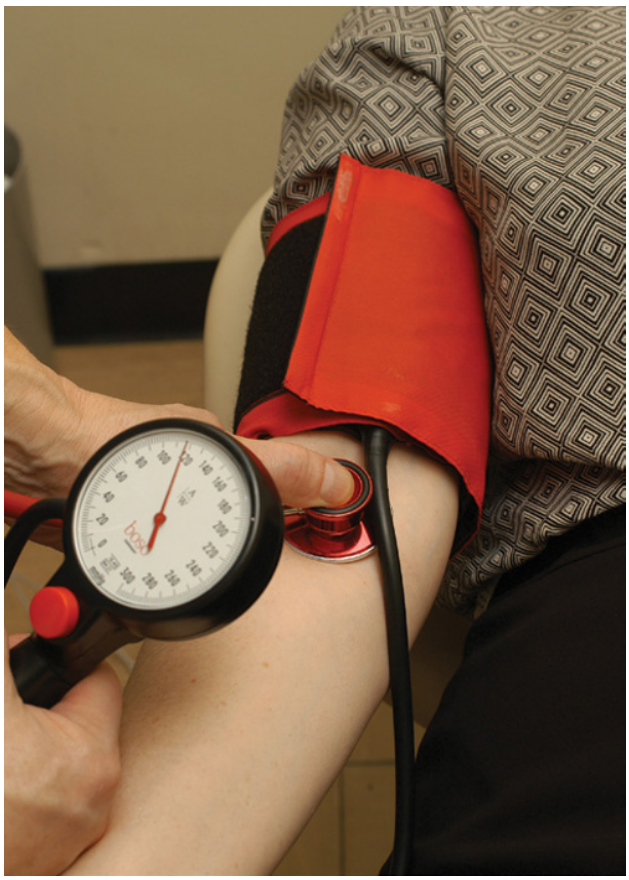


Figure 10.8 Aneroid sphygmomanometer and stethoscope. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

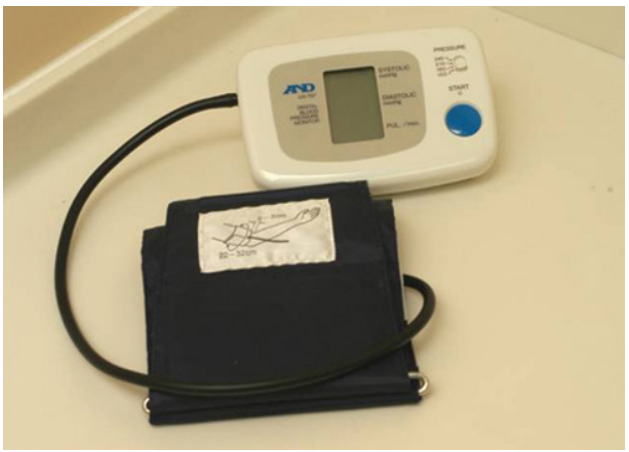


Figure 10.9 Electronic sphygmomanometer. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

Table 10.1 Properties of nitrous oxide.

Induction characteristics	Smooth
Anxiolysis	Yes
Cardiorespiratory stability	Stable
Ease of titration	Easy
Induction and recovery rate	Rapid
Metabolism	<1%
Ease of breathing	Non-pungent
Potency (MAC)	Weak (105%)
Blood gas solubility	Low – 0.47
Speed of change in sedation level	Rapid
Systemic toxicity	Yes – prolonged use
Environmental effects	Yes
Analgesia	Yes

sedation may also be useful for venepuncture in some needle-phobic patients.

The variation between individual patients is such that, whilst one person may be adequately sedated with 20% nitrous oxide, another individual may require in excess of 50%. A titration technique of administration is employed in order to avoid the risk of over-sedation.

Because of the relatively poor solubility of nitrous oxide in blood and body tissues, there is rapid outflow of nitrous oxide across the alveolar membrane when the incoming gas flow is stopped. This may dilute the percentage of alveolar oxygen available for uptake by up to 50%. This phenomenon is called diffusion hypoxia and is prevented by giving 100% oxygen for at least 2 minutes at the end of the procedure.

Advantages of Inhalational Sedation

No 'needles'.	Many anxious patients are needle phobic. However, LA is usually required – but *only* when the patient is sedated.
Level of sedation is easily altered.	The level of sedation may be increased or decreased in line with the patient's anxiety relating to specific items of treatment, for example, LA, drilling, scaling. Note that patients differ widely – some perceive LA to be most the most unpleasant part of treatment whereas for others, scaling is most testing.

Minimal impairment of reflexes.	Pharyngeal and laryngeal reflexes are preserved, making accidental inhalation of fluids or debris very unlikely.
Rapid induction and recovery.	This facilitates efficient scheduling of patients, rapid discharge and, for the patient, a prompt return to a normal routine.
Some analgesia.	But rarely sufficient for significant dentistry to be carried out with effective LA.
An escort is not mandatory for fit adult patients.	Nitrous oxide has a high MAC and it is not metabolised, so full recovery is usual in less than 30 minutes (but each patient must be assessed individually).

Disadvantages of Inhalational Sedation

Sedation depends also on good psychological support.	Nitrous oxide facilitates psychological suggestion. Inhalational sedation often fails if the sedationist relies on nitrous oxide alone.
The mask may make oral access difficult.	Particularly when treating upper anterior teeth.
Variable postoperative amnesia.	May be an advantage as the patient is able to recall that treatment was not as terrifying as anticipated.
Nitrous oxide pollution.	Prolonged exposure may damage the health of the dental team but this is unlikely with effective active scavenging.

Contraindications to Inhalational Sedation

Nasal obstruction, e.g. cold, polyps, deviated septum	Inability to inhale the gas renders the technique useless but nasal blockage may not be permanent.
Cyanosis at rest	A patient who is 'blue' at rest must be referred for specialist care.
Poor cooperation	The patient must be able to follow simple instructions and able to tolerate the nasal mask and breathing system.
First trimester (12 weeks) of pregnancy	There is some evidence that nitrous oxide can affect the foetus during the first trimester of pregnancy.
Fear of masks	Commonly associated with a previous unpleasant gas induction for GA. Some patients also dislike the smell of the 'rubber' mask.

Nitrous Oxide Pollution and Waste Gas Scavenging

Long-term exposure to nitrous oxide may result in an increased incidence of liver, renal and neurological disease and there is evidence of bone marrow toxicity and interference with vitamin B_{12} synthesis, which may lead to signs and symptoms similar to those of pernicious anaemia. For this reason, the Health and Safety Executive specifies a maximum level of 100 ppm of nitrous oxide time-weighted over 8 hours (Skelly, 1992). In order to achieve this level and so keep nitrous oxide pollution to a minimum, scavenging must be employed (Figure 10.10).

Equipment

Modern inhalational sedation (RA) machines are similar to traditional Boyle's anaesthetic machines, but modified so as to make them safe for use by a dental sedationist (Figures 10.11 and 10.12).

Nitrous oxide is supplied in a blue cylinder containing both a gas and a liquid phase; oxygen comes as compressed gas in a black cylinder with a white collar. Most portable inhalational sedation machines are designed to operate with two nitrous oxide and two oxygen cylinders. One cylinder of each gas is 'IN USE'

Figure 10.10 Active waste gas scavenging. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

Figure 10.11 Inhalational sedation unit. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

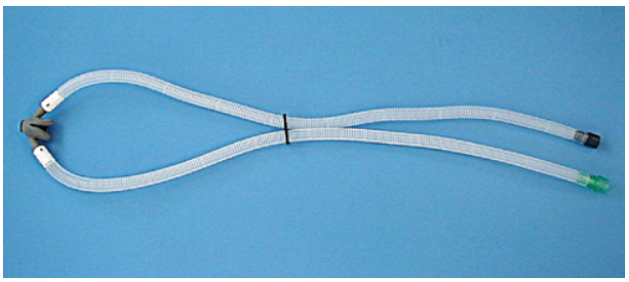


Figure 10.12 Inhalational sedation breathing system. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

whilst the other is held in reserve and designated 'FULL'. Only the 'IN USE' cylinders should be turned on. A Pin Index System ensures that the nitrous oxide and oxygen gas cylinders cannot be accidentally interchanged.

Nitrous oxide and oxygen pressure gauges give an indication of the contents of each cylinder. However, whereas the oxygen gauge falls in a linear manner, the nitrous oxide gauge starts to fall only when the liquid phase is exhausted and pressure in the gas phase is reducing.

The popular MDM RA machine 'head' has flow meters for nitrous oxide and oxygen, a control valve for regulating the total gas flow and a mixture dial for adjusting the percentage of oxygen and nitrous oxide. All modern inhalational sedation machines are incapable of delivering a gas mixture containing less than 30% oxygen and also have a failsafe mechanism which shuts off the nitrous oxide if oxygen ceases to flow.

The mixed gases emerge at the common gas outlet to which the breathing system is connected. The reservoir bag is useful for adjusting the total gas flow to an individual patient's minute volume and also for monitoring respiration during treatment. Reservoir bags are made of rubber and are liable to perish, especially in the area of the bag mount (at the neck of the bag) and also down the 'seams'.

Although designs vary, all modern inhalational sedation breathing systems comprise an inspiratory limb, a nasal mask and an expiratory limb. Systems for use with 'active' scavenging differ from those for use with 'passive' removal of waste gases. Active scavenging is achieved by connecting the expiratory limb of the breathing system to a low power suction device, whereas passive scavenging often involves simply placing the open end of the expiratory tube as far away as possible, preferably outside the operating environment.

Nasal masks are available in a variety of styles and sizes. Older style breathing systems must be cold sterilised, but some of the newer materials are suitable for autoclaving. Modern nasal masks have both fresh gas and scavenging connectors (Figure 10.13).

Inhalational Sedation Machine Checks

Cylinders: 'FULL' and 'IN USE'	Most inhalational sedation machines have two nitrous oxide and two oxygen cylinders.
Pressure gauges	The needles of the gauges should move when the gas supply is turned on.
All connections	Cylinder and pipeline connections work loose over time. The sound of escaping gas often provides a clue to a loose connection.
'Flow' and 'Mixture' controls	These controls sometimes become stiff to turn – servicing is required.
Oxygen flush control	Because pressing this produces an oxygen flow of 25l/min, it must only used when the breathing system is not attached to a patient.
Reservoir bag	With time, reservoir bags perish along the seams and around the neck – by far the most common fault on inhalational sedation machines. Reservoir bags must be latex-free.
Breathing system and range of masks	Must be autoclavable or single-use.
Scavenging system	Active scavenging involves suction applied to the expiratory limb of the breathing system. Much more efficient than a passive system where the expiratory limb is simply routed away from the operating area.

Clinical Procedure

After the operator has checked that the inhalational sedation machine is working and that extra gas cylinders are available (or that piped gases are flowing), the patient is laid supine in the chair and the procedure explained.

MDM inhalation sedation machine check sequence:

- Turn on all oxygen and nitrous oxide cylinders.
- Turn on 'in use' oxygen cylinder.

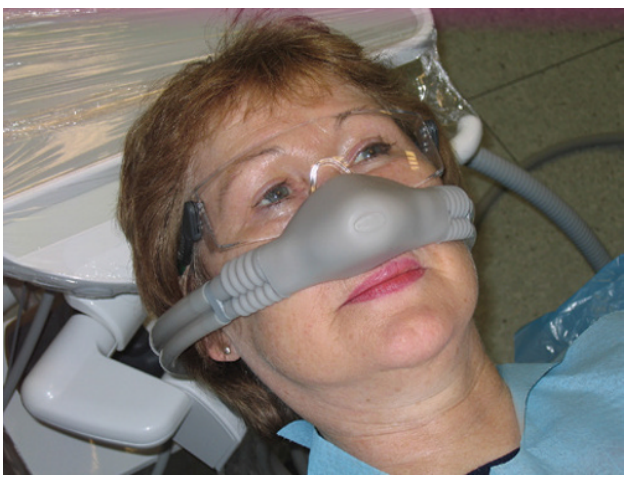


Figure 10.13 Porter nasal scavenging mask.

- Set mixture control to 100% oxygen and adjust flow control to 6l/m.
- Check nitrous oxide flowmeter is still reading 'zero.'
- Turn on 'in use' nitrous oxide cylinder.
- Change mixture to 50% oxygen.
- Check oxygen and nitrous oxide flowmeters both show flow of 3l/min.
- Occlude common gas outlet with palm of hand and press oxygen flush.
- Ensure reservoir bag inflates and that there are no leaks (seams and neck).
- Turn off oxygen cylinder.
- Check nitrous oxide flowmeter falls to zero (takes a little time).
- Turn 'in use' oxygen cylinder back on.
- Set mixture control to 100% and turn flow control to 'off.'
- Machine is ready for use.

The machine is then adjusted to administer 100% oxygen at a flow rate of 6l/min and the correct size nasal mask selected. Patients often prefer to place the mask over their own nose, rather than having someone else do it. It is important to maintain a steady flow of conversation and encouragement. The oxygen flow rate (minute volume) may be checked by observing the movement of the reservoir bag. If there is under- or over-inflation, the gas flow must be increased or decreased respectively.

Ten per cent nitrous oxide is then added (90% oxygen) and the patient informed that they may feel:

- Light-headed.
- Altered visual/auditory sensation.
- Tingling of hands and feet.
- Suffusing warmth.
- Remote from the immediate environment.

This concentration is maintained for one full minute, during which plentiful verbal reassurance is given. The concentration of nitrous oxide is increased by 10% for a further full minute (to a total of 20% N_2O) and then in increments of 5% until the patient appears and feels sufficiently relaxed.

Nitrous oxide concentrations of between 20% and 50% commonly allow for a state of detached sedation and analgesia without any loss of consciousness or danger or obtunded laryngeal reflexes. At these levels, patients are aware of operative procedures and are cooperative without being fearful. If, after a period of relaxation, the patient becomes restless or apprehensive, it is probable that the concentration of nitrous oxide is too high.

When the dental procedure has been completed, the nitrous oxide is turned off and 100% oxygen administered for 2 minutes (to prevent diffusion hypoxia). Recovery is usually complete within 15–30 minutes.

Intravenous Sedation Using Midazolam (National Patient Safety Agency, 2008)

Pharmacology of Benzodiazepines (Table 10.2)

Benzodiazepines act throughout the central nervous system. Specific benzodiazepine receptors are located on neuronal membranes within the brain and spinal cord. All benzodiazepines have a common core shape, which enables them to attach to these receptors. The effect of attaching benzodiazepines to cell membrane receptors is to alter an existing physiological 'filter'.

Table 10.2 Properties of midazolam.

Water soluble	Yes
Solvent	Aqueous
Irritant	No
Presentation	10 mg/5 ml or 10 mg/2 ml or 5 mg/5 ml
Distribution half-life	6–15 min
Elimination half-life	1.5–2 hours
Usual dose	2–7.5 mg
Late active metabolites	None
Analgesia	No

The normal passage of information through sensory neurones to the brain is 'damped' or filtered by the GABA system. GABA (gamma-aminobutyric acid) is an inhibitory chemical released from sensory nerve endings as electrical nerve stimuli pass from neurone to neurone via synapses. Once released, GABA attaches itself to receptors on the cell membrane of the post-synaptic neurone (Figure 10.14). The post-synaptic membrane becomes more permeable to chloride ions, which has the effect of stabilising the neurone and increasing the threshold for firing. During this refractory period, no further electrical stimuli can be transmitted across the synapse. In this way, the number of sensory messages, which travel the whole distance from their origin to the areas of the brain where they are perceived, is reduced or filtered.

Benzodiazepine receptors are located close to GABA receptors. The effect of having a benzodiazepine in place on a receptor is to prolong the time it takes for repolarisation after a neurone has been depolarised by an electrical impulse. This further reduces the number of stimuli reaching the higher centres and produces pharmacological sedation (anxiolysis, hypnosis), amnesia, muscle relaxation and anticonvulsant effects.

Benzodiazepines are central nervous system depressants. They all have a similar shape with a ring structure on the same position of the diazepine part of each molecule. By contrast, flumazenil, the benzodiazepine antagonist, does not have this ring structure and has a neutral effect on the workings of the GABA system.

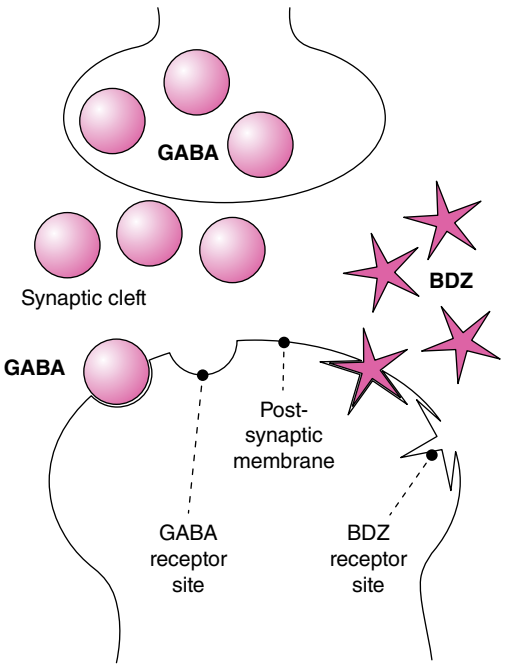


Figure 10.14 GABA and benzodiazepine (BDZ) receptors. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

Flumazenil is an effective antagonist, as it has a greater affinity for the benzodiazepine receptor than active benzodiazepine drugs and therefore displaces them. Flumazenil has a shorter half-life than midazolam. When it was first introduced there was a suggestion that administering flumazenil to a sedated patient would result a short period of reversal followed by 're-sedation' some 50–60 minutes later. This is not clinically relevant. The displaced midazolam continues to be redistributed and metabolised independently of the presence of flumazenil.

The anterograde amnesia produced by midazolam is a desirable effect in terms of reducing the patient's memory of stressful or prolonged treatment. The most profound amnesia occurs immediately after induction, but some disturbance to short-term memory may persist for several hours or even until the following day. It is therefore essential to warn both patients and their escorts. It is advisable not to guarantee complete amnesia as this effect varies between patients and in the same patient on different occasions. The effect of anterograde amnesia is often misinterpreted by patients with the result that they believe that they have been unconscious. This may lead to difficulties if the patient returns for further treatment under sedation when they may insist that they are under-sedated or more 'awake' than on previous visits.

The muscle relaxant effect of benzodiazepines contributes to the difficulty in standing, walking and maintaining balance experienced by many patients following treatment.

Paradoxical or unusual effects are exhibited by some patients when sedated with benzodiazepines. Patients who misuse CNS active drugs (particularly cannabis and opioids) are often difficult to sedate. This may be manifest as failure to achieve sedation, an unusually short period of effective sedation, hyperactivity or an unusual pattern of recovery.

Allergy to benzodiazepines is fortunately very rare. However, as the common core structure of these drugs is almost identical, a patient who exhibits an allergic reaction to any benzodiazepine must not be managed with flumazenil, which would only worsen the situation.

Metabolism of a benzodiazepine takes place in the liver. It has no metabolites which are active once the parent drug has been removed. This is a major advantage of midazolam and is the principal reason for its being considered the drug of choice for outpatient conscious sedation. The water-soluble metabolites of the benzodiazepines are excreted via the kidneys.

All benzodiazepines produce respiratory depression. This is usually mild in healthy patients if the drug is administered intravenously by slow titration. It can, however, be a significant problem in unwell or elderly people. Even in a fit, healthy individual, a rapid injection or a large quantity of midazolam has the potential to depress respiration to the point of apnoea. Benzodiazepine-induced respiratory depression affects all patients who are sedated with these drugs by any route of administration. For this reason respiration must be monitored clinically by observation of the rate and depth of breathing and, since it is not always easy to detect small changes in respiratory function, a pulse oximeter is mandatory. Capnography is considered desirable by some authorities but is not currently mandatory.

Benzodiazepines have few significant cardiovascular effects in healthy people. There is a decrease in mean arterial pressure, cardiac output, stroke volume and systemic vascular resistance. This may present as a small fall in arterial blood pressure immediately following induction of sedation. However, this is normally compensated by the baroreceptor reflex and is of negligible clinical significance except in people with compromising cardiovascular disease.

For dental conscious sedation midazolam is the benzodiazepine of choice. It has a variety of presentations (e.g. 10 mg/5 ml; 10 mg/2 ml; 5 mg/5 ml). The more dilute formulations are easier to 'titrate", that is, to administer in small increments, while observing the patient's response. The National Patient Safety Agency recommends the 5 mg/5 ml concentration (Figure 10.15) for use by sedationists (Society for the Advancement of

Figure 10.15 Midazolam 5 mg/5 ml. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

Anaesthesia in Dentistry, 1990). Whatever concentration is used, a titration technique must *always* be used in order to reduce the risk of over-sedation. It is impossible to determine the correct dosage of midazolam by any form of calculation based on the patient's physical characteristics, for example, age or body weight, body mass index, etc. Overdosage and/or excessively rapid 'bolus' injections may cause profound respiratory depression or even respiratory arrest. Midazolam usually produces a period of sedation (acute detachment from the individual's surroundings) for 20–30 minutes followed by a state of relaxation for a further hour or so.

'Anxiolysis' is different from sedation. Anxiolysis (literally 'dissolving anxiety') may be described as 'dissociating the patient from the perceived threat'. An ideal sedation drug would be anxiolytic rather than sedative, as this would leave the patient fully aware, but completely unconcerned about the dental treatment. Unfortunately, no such drug exists. It is important to consider the degree of anxiolysis and not just the level of hypnosis (drowsiness) when assessing the quality of sedation.

Anterograde amnesia means a reduction in recall following administration of the drug. With midazolam, most patients have little or no recall of the operative procedure. This situation must, of course, be fully explained to both the patient and their escort before discharge.

Advantages of Intravenous Midazolam Sedation

Rapid onset (3–4 minutes or less)	Rapid onset facilitates efficient scheduling and settles the patient quickly (peak effect at 10 minutes).
Adequate patient cooperation	Cooperation is often less than perfect but it is important that it is sufficient for the treatment to be carried out safely.
Good amnesia	Amnesia is helpful for one-off unpleasant procedures, for example third molar surgery, but it is unlikely that the patient will be able to recall that treatment was, in fact, better than anticipated.

Disadvantages of Intravenous Midazolam Sedation

No clinically useful analgesia	Effective LA is essential. One cannot use sedation to compensate for ineffective pain control. Probably the most common reason for 'failed' sedation.
Respiratory depression	All patients receiving IV midazolam suffer some degree of respiratory depression due to direct depression of the respiratory centre and also de-sensitisation of the CNS chemoreceptors. This must be recognised and promptly managed.
Occasional disinhibition effects	Similar to people who have had too much alcohol – there is over-reaction to stimuli. Most common in immature adults.
Occurrence of sexual fantasies (rare)	This is a known side effect of benzodiazepines. Good team work and a chaperone are essential in order to avoid problems.
Postoperative supervision for a minimum of 8 hours is required	The recovery time is related to the elimination half-life of midazolam and the recognition that not all patients respond in the same way.
Older patients are easily over-sedated	Although the pharmacology of this phenomenon is not certain it is thought to be related to receptor density, drug binding and circulatory changes in older patients. Problems are easily avoided by using a slower titration rate.
Less predictable sedation in young patients	Younger patients do not sedate as reliably as adults. The reasons for this are not known.

Contraindications to Midazolam Sedation

Allergy to any benzodiazepine represents an absolute contraindication to IV sedation with midazolam. Benzodiazepine allergy is very rare.	In the unlikely event of an allergic reaction to midazolam, flumazenil must *not* be administered. Since it is also a benzodiazepine, it would aggravate the anaphylaxis.

A degree of caution is needed with the following:

- Pregnancy and during breast feeding.
- Severe psychiatric disease.
- Alcohol or drug abuse.
- Impairment of hepatic function.
- Phobia of needles and injections
- Poor veins.
- Domestic or professional responsibilities.
- Doubts about the ability to provide a suitable escort.

Equipment (Using Midazolam 5 mg in 5 ml)

Syringes

The vast majority of adult patients (<65 years of age) require more than 5 mg midazolam to produce effective sedation, therefore the most commonly used size is 10 ml containing 2 ampoules of midazolam, 5 mg in 5 ml.

Cannulae

All patients undergoing intravenous sedation must have a flexible plastic cannula placed in a vein, so as to ensure reliable, continuous venous access throughout the procedure (Health and Safety Executive, 1998). The most convenient sizes are 20 and 22 gauge. The Wallace 'Y-CAN' system (Figure 10.16) has the advantage of not allowing blood to spill from the proximal end of the cannula, as the metal stylet is withdrawn following venepuncture and the appearance of flashback. Safety cannulae (e.g. the BD Nexiva Safety Cannula System, Figure 10.17(a–d)), which reduce or eliminate the possibility of a needlestick injury caused by the stylet, are now widely available and should be used whenever possible.

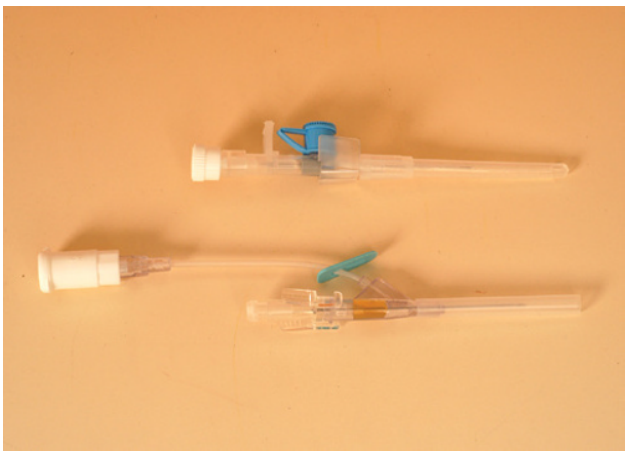


Figure 10.16 Wallace Y-CAN.

Butterfly needles are no longer recommended for routine use. This is because they are more likely to be displaced through the vein wall should the patient move unexpectedly and they usually become occluded by blood clot 5–10 minutes after administration of the sedative drug. They are also more likely to lead to a needlestick injury. Safety cannulae do not suffer these disadvantages and are not more difficult or more painful to insert. However, finding a suitable vein for venepuncture may sometimes be challenging and, under these circumstances, a small gauge butterfly needle may offer the only chance of success, for example, when the small and delicate veins on the flexor surface of the wrist are used. Great care must then be taken to ensure that the stainless steel needle does not accidentally 'cut out'.

Other Equipment

The following items are also required:

- Gauze to hold the drug ampoule while it is broken (for glass ampoules).
- A straight 21 gauge hypodermic needle for drawing up.
- A disposable tourniquet (or suitably trained assistant).
- Chlorhexidine swab for cleaning skin prior to venepuncture (e.g. ChloraPrep®).
- Stopwatch/watch with a second hand for timing drug increments.
- Transparent dressing for securing cannula (e.g. Tegaderm®).
- Plaster or small dressing to cover the venepuncture site.

Clinical Procedure

It is important to ensure that the patient is fully prepared for the procedure and the dental team fully prepared for the patient, that is, all the necessary equipment and drugs are readily available. Nothing is more disconcerting to an anxious patient than having to wait while missing items are located or faulty equipment replaced. When the patient enters the surgery everything must be ready, so that the operator or sedationist can fully concentrate on putting the patient at ease. Having induced sedation, it is then important that the dentist is ready to proceed without delay.

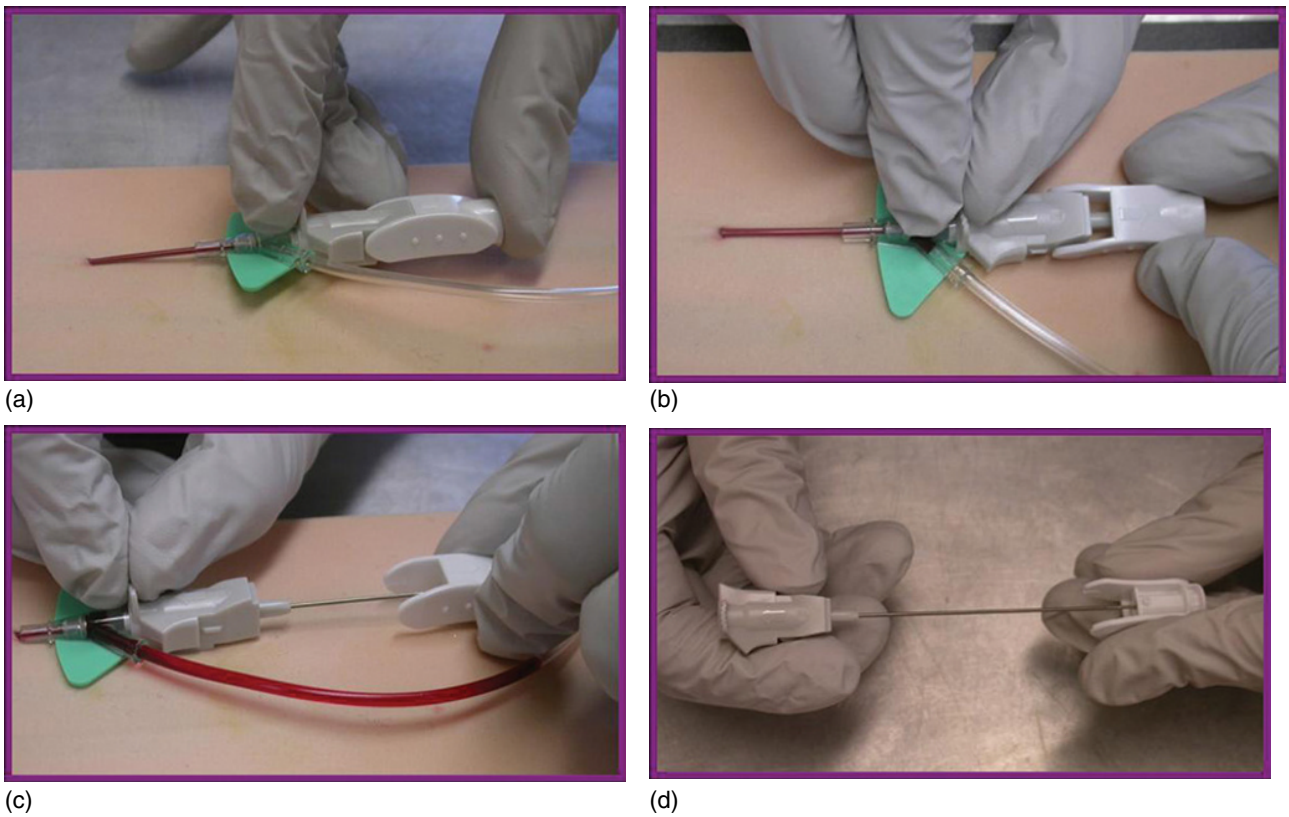


Figure 10.17 (a–d) The BD Nexiva Safety Cannula System. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

The appearance of the clinical environment is also important in putting the patient at ease. Many dental surgeries are less than hospitable and some are frankly alarming. It is important to avoid having resuscitation posters and anatomical diagrams displayed within the patient's line of vision and to keep threatening equipment out of sight or covered. Someone must offer friendly support from the moment the patient enters the surgery. Having one person do this is better than relying on the whole team, as everyone may assume that it is someone else's responsibility.

Before any clinical procedure is started (including venepuncture), it is important to check the patient's identity (name, hospital number, etc.), medical history and blood pressure. Written consent must have been obtained for both the procedure and the sedation. It is also imperative to confirm that the patient has a responsible adult escort, who is able and willing to look after the patient for the rest of the day. A patient who is unable to provide a suitable escort must not be sedated. It is important to be wary of patients who say they will 'phone a friend' or have arranged a taxi and their next-door neighbour to look after them. These arrangements are seldom satisfactory and place the patient at risk. If there are any doubts, it is better not to proceed with the use of sedation. A final check should be made to ensure that the patient has emptied their bladder.

The following description of the administration of intravenous midazolam (10 mg/10 ml) is appropriate for most fit and healthy adult patients between the ages of 16 and 65. However, even within this age group, variation in the response to sedation is common.

The dental chair should be adjusted to the supine position and the patient made comfortable. Electromechanical monitoring must be established before the patient is sedated, in order to establish baseline readings. Pulse oximetry is mandatory (The Royal College of Surgeons of England, 1993). Continuous blood pressure monitoring, an ECG and even capnography may be advisable for seriously unfit patients. If supplemental oxygen is indicated, this is the time to apply the nasal cannulae and turn on the oxygen (a flow of 2 l/min is sufficient).

Successful intravenous cannulation calls for an accessible vein. The dorsum of the hand and the cubital fossa generally provide a good choice of suitable veins but other sites may need to be considered, particularly in those individuals who have received numerous intravenous injections from healthcare professionals or by their own hand. The pattern of veins varies enormously so the

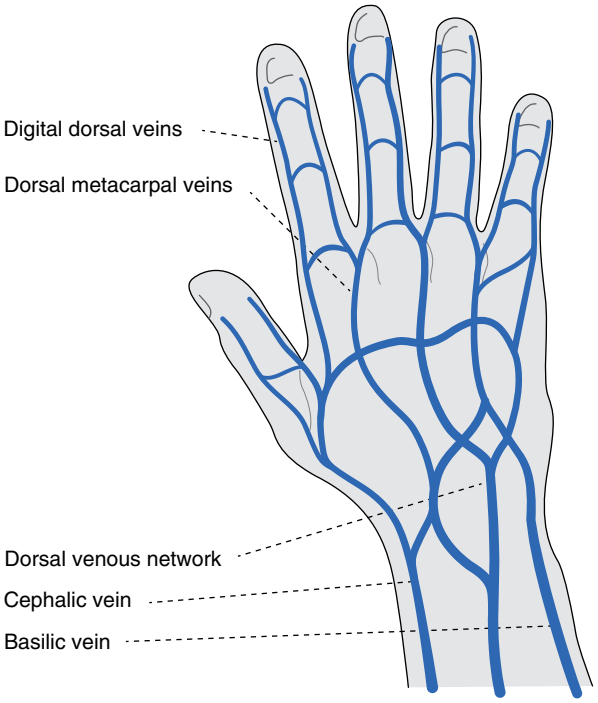


Figure 10.18 Veins of the dorsum of the hand. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

figures and notes provided here must be interpreted with caution. Venepuncture cannot be learned from a book but a little anatomical knowledge will greatly increase the chances of success.

There is no single 'best' site for venepuncture. Sedationists should avoid falling into the trap of using the same area (dorsum of hand, cubital fossa) in every patient. The ideal vein for venepuncture is one which is of medium size (very large veins are sometimes difficult to enter with a small cannula), visible and reasonably well tethered to the underlying tissues. It is sensible to survey both the dorsum of the hand (Figure 10.18) and the cubital fossa (Figure 10.19) on both arms before making a final decision. Some patients express a preference but, unfortunately, this is not always for the most accessible vein. Other patients appear to enjoy the challenge offered by their 'difficult' veins.

In the cubital fossa, the large median basilic vein is often a tempting target, but it is frequently quite mobile and easily slips away from the tip of the cannula. Stabilisation of the vein may flatten it and make a clean entry into the lumen difficult. Also, this vein overlies the brachial artery and the median nerve, either of which may be violated if the angle of approach is too steep and/or the cannula penetrates too deeply. The median cephalic vein is usually smaller but is less mobile and does not overlie any important structures. The cephalic vein is often visible and is another safe choice.

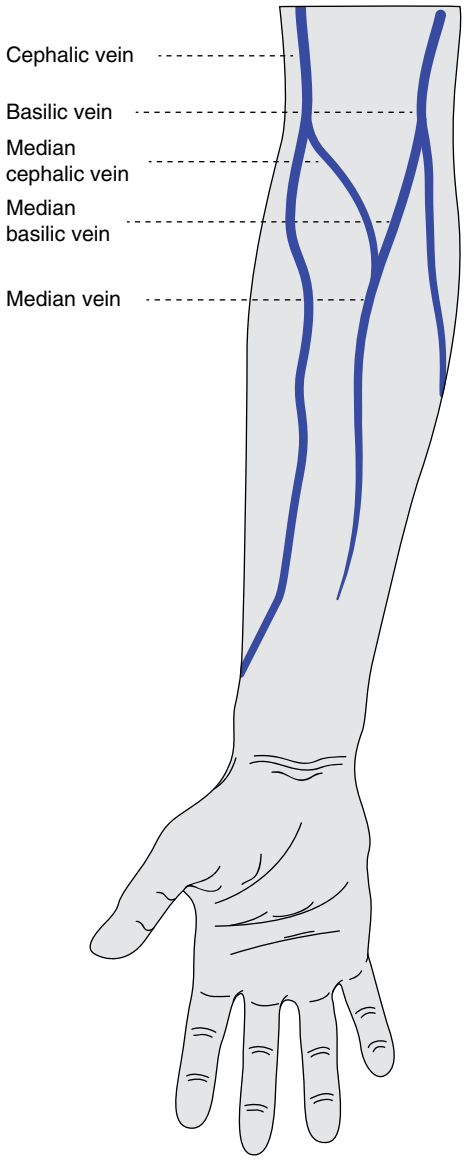


Figure 10.19 Veins of the cubital fossa. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

There are few hazards associated with the dorsum of the hand, but the veins are sometimes quite small and tortuous. There is often a marked variation between the veins of the left and right hands. It is sensible to try to avoid using these veins in patients whose professional activity might be affected by a failed venepuncture and the resulting haematoma.

The veins on the flexor surface of the wrist are sometimes useful when other sites have proved difficult or impossible. These veins are usually very narrow but reasonably well tethered and so venepuncture (using a very small gauge cannula or even a butterfly

needle) is often relatively straightforward. Contrary to popular belief, venepuncture at this site is no more (or less) uncomfortable than at other, more conventional, sites. The great (long) saphenous vein, as it passes in front of the medial malleolus, may also be considered.

The use of topical anaesthetic agents, such as Ametop™ or EMLA™, reduces the discomfort of venepuncture, but these creams must be applied some time before venepuncture in order to achieve good analgesia. EMLA™ reduces peripheral vasodilatation and so venepuncture may be slightly more difficult.

The skin must be cleansed with a suitable antiseptic wipe and the most readily visible and/or palpable vein selected for venepuncture. The sedationist then inserts the cannula into the vein and checks for the appearance of blood within the chamber of the cannula ('flashback'). Aspiration confirms the correct positioning of the cannula, which is then secured with a non-allergenic transparent dressing.

It goes without saying that the patient must receive adequate support and encouragement during what may be rather an uncomfortable ordeal. A good flow of supportive chat is required. Remember to remove the tourniquet or ask the assistant to stop squeezing before proceeding to the next stage.

The prepared drug in a 10 ml syringe is attached to the port of the cannula and injected slowly, according to the regimen below. The patient should be warned of a cold sensation at the needle site and as the drug travels up the arm. Provided the sedationist is sure that the needle is correctly sited, the patient should be reassured that this sensation will pass within a short period of time. However, the injection must be stopped immediately if pain is felt radiating distally, as this indicates an arterial injection.

A completely or partially extravascular injection is usually accompanied by pain and swelling at the site of the injection. In this case, venepuncture must be repeated, preferably in another limb, and with appropriate sympathy and encouragement.

Recommended Titration Regimen (Healthy Patients 12–65 Years of Age)

2 mg (2 ml) injected over 30 seconds	A slow initial bolus allows the operator to observe the patient for any adverse reactions (very rare).
Pause for 90 seconds	Pausing allows time for the injected midazolam to travel to benzodiazepine receptors in the CNS.
Further increments of 1 mg (1 ml) administered every 30 seconds until sedation is judged to be adequate	Slow titration ensures that each individual receives the optimum amount of midazolam and avoids over-sedation.

Talk to the patient and watch for any adverse responses, in particular respiratory depression.

The correct dose has been given when there is a slurring of speech and/or a slowed response to commands and the patient exhibits a relaxed demeanour. With midazolam, ptosis (Verrill's sign) is unreliable and so this should not be used to judge the adequacy of sedation.

Some sedationists estimate the depth of sedation by asking the patient to close their eyes and then try to touch the tip of their nose with an index finger. Inability to demonstrate the appropriate level of coordination is reputed to indicate that the patient is adequately sedated.

Patients over the age of 65 often require much smaller doses of midazolam. A suggested administration regimen for these patients is:

- 1 mg (1 ml) injected over 30 seconds.
- Pause for 4 minutes.
- Further increments of 0.5 mg (0.5 ml) administered every 2 minutes until sedation is adequate.
- Patients in this age group often need no more than 1–2 mg in order to provide more than 1 hour of sedation.

Local analgesia should be administered shortly after an adequate level of sedation is attained. Approximately 30–40 minutes of sedation time is usually available and this should be more than adequate for most procedures. It is acceptable to top up the sedation from time to time, if the procedure is prolonged, but this is rarely necessary during the first 20 minutes. Additional increments of midazolam should be small; 1 mg is usually adequate (0.5 mg in the elderly).

At the end of the procedure, the patient should remain under the direct supervision of the sedationist or suitably trained recovery staff. No patient may be discharged until sufficiently recovered so as to be able to stand and walk without assistance. Although most patients will not be fit for discharge until at least 1 hour following the administration of the last increment of midazolam, there is no fixed time limit and recovery staff should be discouraged from 'watching the clock'.

Figure 10.20 Flumazenil. *Source:* Craig and Skelly (2004). Reproduced with permission of Quintessence.

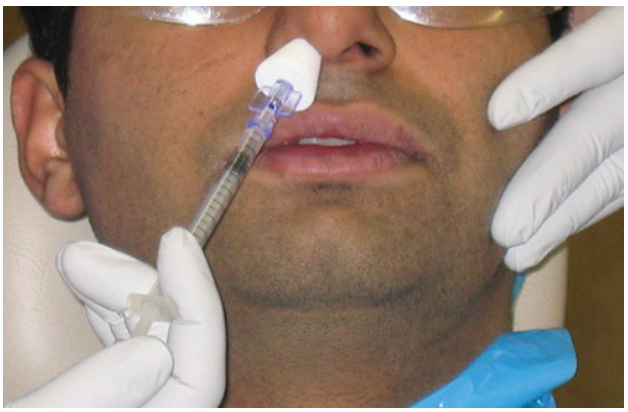


Figure 10.21 Administration of intranasal sedation using a mucosal atomisation device (MAD).

The patient should be discharged into the care of the escort, who must also be given written and verbal instructions. The patient should rest quietly at home for the remainder of the day and refrain from drinking alcohol, driving and operating machinery for a minimum of 8 hours. It is important to make the escort aware that the patient should be observed for the first few hours, not simply put to bed out of sight. It is unreasonable and unnecessary to demand that patients travel home by private rather than public transport.

Flumazenil (Anexate®, Figure 10.20) antagonises the action of midazolam, reversing the sedative, cardiovascular and respiratory depressant effects (but not the amnesia). Although flumazenil is usually recommended for use only in emergency situations (e.g. benzodiazepine overdose), elective reversal may be helpful for some patients. In this case, it is imperative that the usual postoperative instructions for intravenous sedation are given and followed. Although flumazenil has a shorter half-life than midazolam, clinically significant 're-sedation' does not occur when midazolam is used for short clinical procedures.

Oral and Intranasal Sedation Using Midazolam (Boyle, Manley and Fleming, 2000; Manley, Skelly and Hamilton, 2000)

Oral and intranasal sedation are useful where the patient is needle phobic and will not accept venepuncture. The sedation produced may be adequate for the dental procedure to be carried out or it may then be necessary to administer intravenous sedation in the normal way.

The most commonly used drug is midazolam. In adults, the 'standard' oral dose is 20 mg and the 'standard' intranasal dose is 10 mg. Note that neither of these routes permits titration of the drug and so both are potentially less safe than intravenous sedation. Midazolam has a bitter taste and so it must be added to a strong-flavoured fruit juice for oral administration. Intranasal midazolam is much more rapidly absorbed than oral midazolam but may cause short-lasting nasal irritation, sneezing and, occasionally, mild epistaxis.

Intranasal midazolam is most effective when a high concentration formulation (40 mg/ml) is employed. This is not commercially available but is obtainable from some hospital pharmacies with a manufacturing facility. Figure 10.21 shows the intranasal administration of midazolam using a 1 ml syringe fitted with a mucosal atomisation device (MAD).

The operative and postoperative management of patients who have received oral or intranasal midazolam is very similar to that for intravenous midazolam. The depth of sedation is similar (but rather less predictable), monitoring with a pulse oximeter is mandatory and the discharge and escort criteria are identical. It is recommended that patients who receive intranasal or oral sedation should have a cannula inserted as soon as adequate sedation has been achieved.

Although midazolam does not have a product licence for oral or intranasal administration, both routes are commonly used in other areas of sedation practice, for example, accident and emergency medicine. However, practitioners should not use these routes without appropriate training and clinical experience. Experience of cannulation and intravenous sedation is essential (IACSD, 2015).

Sedation for Younger Patients

Inhalational sedation using a titrated dose of nitrous oxide in oxygen is the only completely tried and tested conscious sedation technique currently recommended for young children.

Intravenous sedation with midazolam has often been said to be 'reliably unpredictable' in patients under 16 years of age and 'predictably unreliable' below the age of 12. Some young patients sedate satisfactorily whereas others become disinhibited, more anxious or even frankly aggressive. Despite a number of recent studies it has not been possible to identify any factors which may be used to predict the likelihood of success. Until more research has been carried out, therefore, intravenous midazolam should only be considered for children when all other options have been considered. In any case, these techniques must only be used by experienced sedationists working in an appropriate environment (IACSD, 2015). The use of flumazenil to manage a young patient with disinhibition following intravenous midazolam is not recommended as the data currently available suggest that the situation is often made worse rather than improved.

Orally administered benzodiazepines (e.g. midazolam) appear to produce more reliable sedation for this age group. However, the time taken for the drug to act is much less predictable than with intravenous sedation owing to differences in the rate of gastric absorption, first-pass metabolism and protein binding. Most patients become sedated somewhere between 10 and 30 minutes following oral administration. Its widespread use in dental and medical disciplines has shown this to be a safe, appropriate and effective technique. Orally administered antihistamines have been used for paediatric sedation in medicine for many years but their use in dentistry has been mostly limited to special care patients.

Benzodiazepines may also be administered intranasally and although this technique offers a number of advantages for certain groups, particularly very young patients, needle phobics and those with disabilities, the route requires specific training and experience.

Whichever technique is used for paediatric sedation it is a requirement that the practitioner and the team are experienced in the use of the drug and its route of administration. It is important to remember that oral and intranasal sedation produces a similar level of sedation to that achieved by intravenous midazolam and so the pre- and postoperative instructions to the patient, monitoring and arrangements for discharge must be identical to those for intravenous sedation. Oral sedation should not be regarded as a 'safer' or 'easier' option than intravenous sedation. In many ways it is potentially less safe owing to the poor predictability of onset, depth of sedation and recovery.

Detailed guidance on the use of conscious sedation in children and young people is available in guidance published in 2010 (NICE, 2010; IACSD, 2015).

Management of Sedation-Related Complications

Serious complications associated with carefully administered conscious sedation are rare. Minor problems are more common but, fortunately, easily managed by a well-prepared team. Careful case selection, based on a detailed medical, dental and social history, will often allow the dental team to anticipate potential difficulties and take appropriate action.

Respiratory Depression

The most serious potential complication associated with intravenous sedation is respiratory depression. The effect is normally most pronounced during the first 10 or so minutes of sedation. It is also sometimes seen later if there is a lull in clinical activity. The difficulty in recognising mild or even moderate respiratory depression underlines the necessity for continuous pulse oximetry in addition to careful clinical monitoring.

Management of midazolam-induced respiratory depression involves the following steps:

Check the pulse oximeter probe is correctly sited.	This is the most common problem!
Ask the patient to take several deep breaths. In the majority of cases, this will resolve the problem.	Stimulating the patient via the higher centres in the CNS overrides the 'automatic' control of respiration which is dependent upon normal functioning of the central chemoreceptors.
But, if this fails:	
Open the airway (head tilt/chin lift or jaw thrust) and perform intermittent positive pressure ventilation using a ventilating bag, preferably with an oxygen supply attached.	The head tilt/chin lift and jaw thrust manoeuvres pull the tongue forwards, away from the posterior pharyngeal wall and thus open the upper airway.
If this fails:	
Administer flumazenil (500 mcg by slow intravenous injection). Continue to ventilate and encourage breathing.	Flumazenil reverses the respiratory depressant effects of all benzodiazepines.

Airway Obstruction

Obstruction of the airway may occur during any form of sedation. Excessive downward pressure without adequate support of the mandible during the extraction of molar teeth is a common cause. Accumulation of water and dental debris in the oropharynx can also be a problem. This is easily managed by the use of properly positioned high volume suction.

Injection Problems

Extravascular injection of midazolam is usually uncomfortable. If this occurs the cannula must be repositioned. Intra-arterial injection is rare and causes pain distal to the injection site. If this is suspected, the injection should be stopped and the cannula re-sited. Although it is painful, intra-arterial midazolam is unlikely to cause long-term sequelae.

A small amount of bruising often occurs following an intravenous injection. Bruising associated with removal of the cannula can be minimised by maintaining firm pressure over the puncture site while keeping the limb raised above the level of the heart.

Over- and Under-Sedation

A small amount of over-sedation with intravenous midazolam is not usually a serious problem. The most common effect is poor patient cooperation – the patient refuses to open their mouth and so treatment is delayed. Gross over-sedation using midazolam may cause profound respiratory depression or even apnoea requiring prompt and effective management.

Mild over-sedation with nitrous oxide is often more troublesome as the patient may feel panicky and reject further treatment. Over-sedation of young children is particularly undesirable.

Intentional under-sedation 'to improve safety' is simply bad practice and may lead to increased dental phobia. Failing to provide an adequate depth of sedation is a common failure of the inexperienced sedationist.

Disinhibition

Many patients show signs of mild disinhibition when sedated with midazolam, for example, giggling, crying, talkativeness or panic attacks, which may seriously interfere with dental treatment. Firm management by the dental team may restore calm and tranquillity but further bouts may occur. Aggressive and abusive behaviour is probably another manifestation of disinhibition.

Paradoxical Effects

Intravenous midazolam sometimes results in a 'paradoxical effect'. The patient becomes more rather than less anxious and treatment may not be possible. This is particularly common in children and adolescents. The administration of more midazolam often makes matters worse and the effects of flumazenil are unpredictable. The best approach is to abandon treatment and allow the patient to rest quietly.

Prolonged Recovery

Recovery from intravenous midazolam is variable due to variability in redistribution of the drug from the receptor sites (short-term recovery) followed by metabolism and excretion (long-term recovery). Some groups of patients (particularly those taking or using CNS depressant drugs) have notoriously unpredictable recovery times. For the majority of these patients, management simply involves patience and careful monitoring. Flumazenil may be helpful but should not normally be used when the patient has psychiatric or medical conditions which involve treatment with potent CNS depressants or stimulants, in particular benzodiazepines.

Hypotension

Most intravenous sedation drugs tend to cause a decrease in the systemic arterial blood pressure. Unlike respiratory depression, the fall in blood pressure is usually self-limiting and, as such, requires no active treatment. A patient with a naturally low arterial blood pressure should be moved slowly from the supine position to the sitting position to reduce the possibility of postural hypotension.

Hiccups

A small number of patients experience hiccups following intravenous sedation with midazolam. Most cases appear to be associated with either excessive midazolam or rapid injection (or both). Midazolam-induced hiccups are notoriously refractory.

Nausea and Vomiting

Many anxious dental patients feel 'sick' at the thought of a visit to the surgery. However, nausea and vomiting are rare and preoperative reassurance that neither midazolam nor nitrous oxide is likely to cause problems may help. Patients who regularly vomit following sedation may benefit from the administration of an anti-emetic drug during induction.

Sexual Fantasies

Much has been written about the occurrence of sexual fantasies in patients receiving intravenous sedation using

midazolam. The extent of the problem is unknown. The best advice that can be offered is to ensure that no sedated (or recovering) patient is ever left alone with only one member of the dental team.

Failure of Sedation

Conscious sedation techniques are not always successful. Early recognition of impending failure is important in order to avoid starting a dental procedure which it may not be possible to complete. An open and honest discussion with the patient and their escort will reduce the disappointment of a failed sedation appointment. Alternative sedation techniques or general anaesthesia should be considered.

Itchy Nose

Many patients sedated with midazolam want to scratch the tip of their nose. Allowing them to do so (or doing it for them) is the only known remedy.

References

Boyle, C.A., Manley, M.C.G., Fleming, G.J.P. (2000) Oral midazolam for adults with learning disabilities. Dental Update 27:190–192.

Corah, N., Gale, E., Illig, S. (1978) Assessment of a dental anxiety scale. Journal of Dental Research 97:816–819.

Craig, D., Skelly, M. (2004) Practical Conscious Sedation. Vol 15, Quintessentials of Dental Practice Series. London: Quintessence.

Crawford, A.N. (1990) The use of nitrous oxide-oxygen inhalation sedation with local anaesthesia as an alternative to general anaesthesia for dental extractions in children. British Dental Journal 168:395–398.

Dental Sedation Teachers' Group/Society for the Advancement of Anaesthesia in Dentistry. (2001) Conscious Sedation: A Referral Guide for Dental Practitioners. London: Society for the Advancement of Anaesthesia in Dentistry.

General Dental Council. (2002) The First Five Years. London: GDC.

Health and Safety Executive. (1998) Occupational exposure limits. London: HMSO.

Humphris, G., Morrison, T., Lindsay, S. (1995) The Modified Dental Anxiety Scale: Validation and United Kingdom Norms. Community Dental Health 12:143–150.

Intercollegiate Advisory Committee for Sedation in Dentistry (IACSD). (2015) Standards for Conscious Sedation in the Provision of Dental Care. London: Intercollegiate Advisory Committee for Sedation in Dentistry.

Kluger, M.T., Tham, E.J., Coleman, N.A., et al. (2002) American Society of Anesthesiologists task force on preanesthesia evaluation. Anesthesiology 96:485–496.

Manley, M.C.G., Ransford, N.J., Lewis, D.A., et al. (2008) Retrospective audit of the efficacy and safety of the combined intranasal/intravenous midazolam sedation technique for the dental treatment of adults with learning disability. British Dental Journal 205:523.

Manley, M.C.G., Skelly, A.M., Hamilton, A.G. (2000) Dental treatment for people with challenging behaviour: general anaesthesia or sedation? British Dental Journal 188:358–360.

National Institute for Clinical Excellence. (2010) Sedation in under 19s: using sedation for diagnostic and therapeutic procedures. London: NICE.

National Patient Safety Agency. (2008) Rapid Response Report (NPSA/2008/RRR011): Reducing risk of overdose with midazolam injection in adults. London: National Patient Safety Agency.

Roberts, G.J. (1990a) Inhalation sedation (relative analgesia) with oxygen/nitrous oxide gas mixtures. 1. Principles. Dental Update 17: 139–146.

Roberts, G.J. (1990b) Inhalation Sedation (Relative Analgesia) with Oxygen/Nitrous Oxide Gas Mixtures. 2. Practical Techniques. Dental Update 17:190–196.

Scottish Dental Clinical Effectiveness Programme. (2006) Conscious Sedation in Dentistry: Dental Clinical Guidance. National Dental Advisory Committee. Dundee Dental Education Centre, Frankland Building, Small's Wynd, Dundee DD1 4HN: Scottish Dental Clinical Effectiveness Programme.

Shaw, A.J., Meechan, J.G., Kilpatrick, N.M., Welbury, R.R. (1996) The use of inhalation sedation and local anaesthesia instead of general anaesthesia for extractions and minor oral surgery in children: a prospective study. International Journal of Paediatric Dentistry 6:7–11.

Skelly, A.M. (1992) Sedation in dental practice. Dental Update 19:61–67.

Society for the Advancement of Anaesthesia in Dentistry. (1990) Guidelines for physiological monitoring of patients during dental anaesthesia or sedation. London: Society for the Advancement of Anaesthesia in Dentistry.

The Royal College of Surgeons of England. (1993) Guidelines for sedation by non-anaesthetists. Report of a Commission on the Provision of Surgical Services working party. London: The Royal College of Surgeons of England.

Venham, L. (1979) The effect of mother's presence on child's response to dental treatment. Journal of Dentistry for Children 46:219–225.

11

Procedures in Operative Dentistry

Richard Foxton

Introduction

The aim of this chapter is to describe the operative procedures that restore the function and appearance of teeth which have lost tooth structure through various processes. Enamel and dentine can be lost because of:

- Dental caries.
- Tooth wear.
- Trauma.
- Root resorption.
- Developmental disturbances in enamel/dentine formation.
- Iatrogenic causes.

Prior to carrying out any operative treatment on a patient, a full history and examination should be taken. This should include determining what the expectations of the patient are, a full medical and dental history and extra/intraoral examination. The periodontal tissues should be examined, the teeth and the patient's static and dynamic occlusions. A restoration may have fractured and a careful examination of the patient's occlusion may detect an interference or overerupted tooth.

Special tests should then be carried out. These might include sensibility testing and radiographs. Bitewings and long cone periapical radiographs can show more detail then a dental panoramic tomogram. Percussion tests may also be indicated.

A diagnosis should be made and possible treatment options presented to the patient along with their respective cost. The patient should be given enough information so that they can make an informed decision. The clinician should be able to communicate effectively with the patient and any accompanying person and be able to discuss the advantages and disadvantages of each treatment option in lay terminology.

It is important to develop a painless technique to deliver effective local anaesthesia as this will help the patient have a positive experience. Proficiency in placing a rubber dam will also instill confidence in the patient towards the operator.

The following topics will be discussed in this chapter:

1) Management of dental caries.
2) Correct use of dental adhesives.
3) Composite resin.
4) Glass ionomer cement.
5) Amalgam.
6) Operative management of tooth wear.
7) Repairing fractured restorations.
8) Restoring the endodontically treated tooth.

Dental Caries

The following questions should be considered:	
1) Is caries present?	
2) How can caries be detected?	Caries can be detected using: • Good vision. • Good lighting. • Bitewing radiograph. • Transillumination.

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

3) Where is the caries?	How does dental caries appear? Caries has many appearances.
4) Does the caries involve enamel only?	Early carious lesions may present as white lesions in enamel, which may not have cavitated, whereas lesions that have been present for some time may have caused significant destruction of enamel and dentine.
5) Does the caries involve dentine?	It should be remembered that a 'white spot' enamel carious lesion that has not cavitated may have in fact progressed into dentine as the Figures 11.1 and 11.2 show.
6) Has the lesion cavitated?	
7) Can the lesion be treated non-operatively?	
8) Is operative treatment required?	

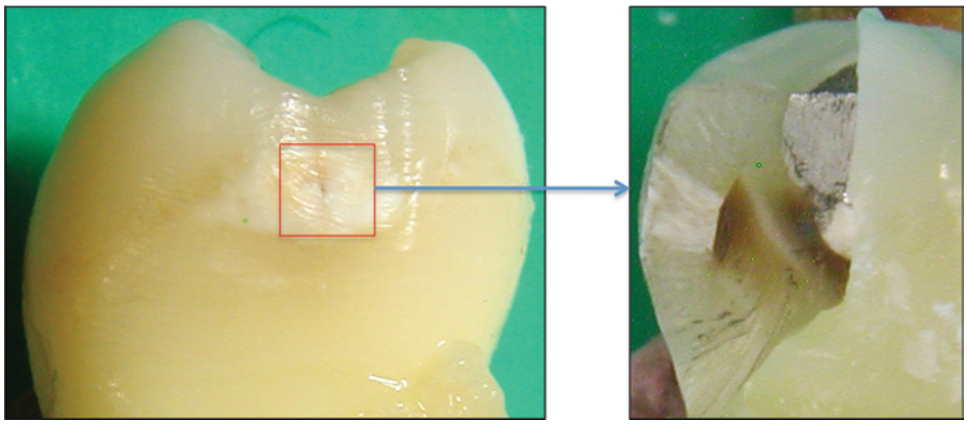


Figure 11.1 Early 'white spot' lesion showing spread into dentine even though there is no obvious cavitation on the enamel surface.

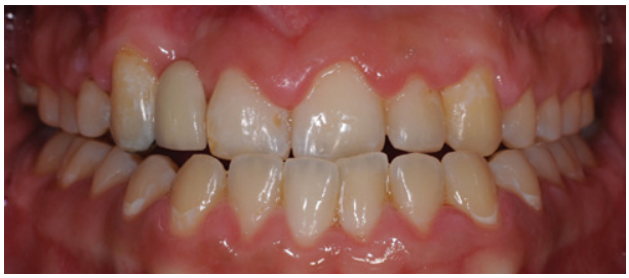


Figure 11.2 'White spot' lesions at the cervical margins of the teeth.

9) How at risk of caries is the patient? A decision should be made on whether the patient is at: • Low risk of caries. • Medium risk of caries. • High risk of caries.	Assessing caries risk is important. If the patient is assessed as being at 'low risk' of caries, then a decision might be made not to intervene operatively. If the patient is assessed as being 'high risk' and if the caries process has entered the dentine, operative intervention might be instigated sooner. The patient's medical history will reveal any medications with side effects or medical conditions that may cause a dry mouth. Saliva is an important buffer and lack of saliva will render the patient at a high risk of developing carious lesions. The patient should be asked about their diet to determine the frequency of any acidic or sugary intakes of food or drink. Their level of plaque control should be assessed and how often they use a fluoride toothpaste and mouthwash.

Non-Operative Management of Caries

If caries is detected in a tooth, then this should be recorded in the clinical notes and a decision made whether to treat non-operatively or operatively.

We have entered the era of minimal intervention in medicine and dentistry. With respect to caries management this may involve non-operative as opposed to operative intervention.

Nonoperative treatment may consist of:

1) Plaque elimination.
2) Topical application of fluoride.
3) Topical application of remineralising agents.

1) Plaque must be present for caries to commence and therefore removal of plaque/biofilm through good oral hygiene together with avoidance of frequent intake of sugar will prevent the caries commencing or progressing.
2) Fluoride can act by:
   - Increasing resistance of enamel to 'acid attack'.
   - Remineralisation of early lesions.
   - Interference with microorganisms in the biofilm.
3) Remineralising agents:
   - New agents such as casein phosphopeptide calcium phosphate (CPP-ACP) have been invented to supersaturate the saliva next to a carious lesion with calcium and phosphate ions, which will inhibit demineralisation and promote remineralisation.
   - Bioactive glasses that provide calcium and phosphate on reaction at the tooth surface have been incorporated into toothpastes.

Operative Management of Caries

Once the lesion of caries has cavitated and is a 'plaque trap', or the caries has been observed on a bitewing to progress beyond the enamel–dentine junction (EDJ) into dentine, operative intervention has to be considered. The important question to consider is if caries is to be removed, where should it be removed from and how much should be removed whilst still preserving as much enamel and dentine as possible. Teeth which become grossly carious may remain asymptomatic and vital (Figure 11.3).

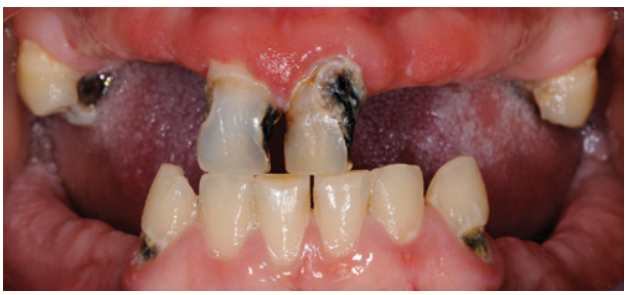


Figure 11.3 A patient with several grossly carious anterior teeth, which are asymptomatic and gave positive sensibility testing results.

What Does the Evidence Tell Us About Managing Caries Operatively?

To date, there has only been one significant clinical trial in which caries was sealed in using composite restorations bonded to enamel around the lesions.

Mertz-Fairhurst et al. (1998) treated frank cavitated caries extending no deeper than halfway into dentine between the EDJ and the pulp chamber, or between the EDJ and the nearest pulp horn by placing a 45–60° bevel in the enamel surrounding the frank cavitated lesion. The deep soft portions of the caries remained untouched. The bevel and the adjacent enamel were etched for 60 s followed by application of the bonding agent. Using hand instruments, a self-curing resin-based composite was placed. Then all the occlusal, buccal and lingual pits and fissures were etched for 60 s, washed thoroughly and covered with a pit and fissure sealant. Surprisingly, in the majority of cases, the caries beneath the sealed resin-bonded composite restorations ceased to progress. No pulps became non-vital in the 10-year study. This study is now proving to be a pivotal study in the modern-day management of dental caries.

To date, despite the results of this study, it is not deemed acceptable practice among clinicians to leave soft dentinal caries untouched in the cavity. However, this may change in future years.

What is Current Thinking Regarding Removal of Carious Dentine?

The decision when to remove carious tooth tissue is complicated by the fact that it is an irreversible procedure. It is common practice that surgical intervention is

Figure 11.4 Longitudinal section of tooth through a carious lesion illustrating the colour changes that have extended into dentine. The lesion appears dark brown at the EDJ and more 'translucent' as the lesion progresses deeper into the dentine. Image courtesy of Dr Masatoshi Nakajima, Tokyo Medical and Dental University.

delayed until the caries is clearly visible in dentine. Once the lesion has involved the outer third of dentine, shown by radiographs, then it should be removed. When removing carious dentine, it is important to consider in what way the dentine has been altered by the carious process as this will dictate what should be removed and what should be left. This necessitates an understanding of the histological changes that have taken place in the carious dentine.

Figure 11.4 illustrates that the carious lesion gradually undergoes a series of colour changes from the EDJ towards the pulp. At the EDJ, the lesion appears dark brown in colour, amber in the deeper aspects and then more translucent nearer the pulp. These colour changes reflect the histological changes that the dentine has undergone as a result of the carious process.

Dentine caries proceeds through three changes: demineralisation by dissolution of the inorganic component, calcium hydroxyapatite; degeneration of the organic substance; and bacterial invasion (Deery, 2013).

The lesion is cavitated at the EDJ and in the outer aspect of the lesion, the intermolecular crosslinks of the collagen are broken and the collagen fibres lose the crossbanded structure, which exists as a base to which the calcium hydroxyapatite crystals become attached. As a result, the apatite crystals become dislodged and are scattered around as small granules. Within the dentinal tubules, the odontoblast processes are replaced by bacteria. This region cannot be remineralised and is insensitive with regards to pain. This region has been given the name 'caries-infected dentine' (Fusayama, 1979; Ogawa et al., 1983).

Within the inner aspect of the carious dentine, the initial acid attack on the collagen fibres is reversible. The acid dissolves the hydroxyapatite from the crystal peripheries in the peritubular and intertubular dentine. The dissolved calcium phosphate diffuses into the dentinal tubules and begins to precipitate new whitlockite crystals. Under the optical microscope, this layer looks 'transparent' due to its refractive index. This inner aspect is not infected with bacteria and is remineralisable and therefore should be preserved. This region has been given the name 'caries-affected dentine' (Fusayama, 1979).

When a decision has been made to remove the carious dentine, the aim must be to remove the 'caries-infected' dentine and leave the 'caries-affected' dentine. This requires much thought as a subjective judgement must be made in the clinical situation through colour observations and an assessment of the softness/hardness of the dentine. The hardness of carious dentine has been measured using the diamond indenter of a Knoop Hardness Detector and has shown to change across the carious lesion (Ogawa et al., 1983).

In Figure 11.5, the 'y' axis represents the Knoop hardness of the dentine surface and the 'x' axis represents the distance from the EDJ (left) to the pulp (left). Near the EDJ, where the bacteria have invaded the lesion, the lesion is very soft because of the dissolution of the hydroxyapatite crystals and the denatured collagen fibrils (Mattos et al., 2013). This soft, 'caries-infected' dentine should be removed. However, caries removal should *stop* when the 'caries-affected' dentine is reached. There is no clear demarcation between these two regions and it is only through a subjective assessment of the increased

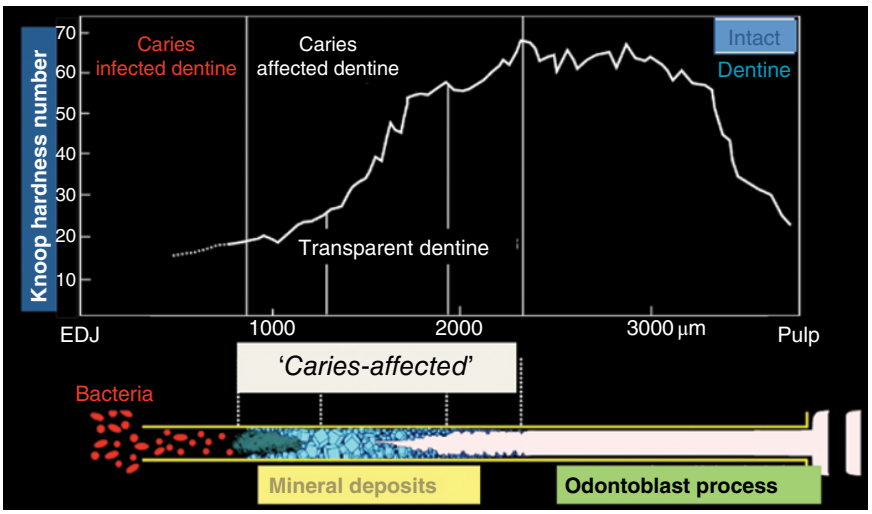


Figure 11.5 A schematic graph in which the 'x' axis shows the distance from the enamel–dentinal junction (EDJ) and the 'y axis' shows the Knoop hardness number of the dentine surface in the regions of 'caries-infected dentine', 'caries-affected dentine' and sound, intact dentine nearer the pulp. Image courtesy of Professor Tagami, Tokyo Medical and Dental University.

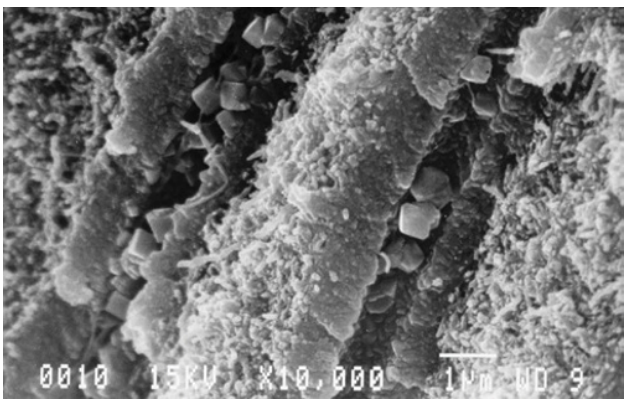


Figure 11.6 A scanning electron micrograph of 'caries-affected' dentine showing the whitlockite crystals in dentinal tubules. Image courtesy of Dr Masatoshi Nakajima, Tokyo Medical and Dental University.

hardness in the region of the 'caries-affected' dentine that a clinical decision can be made. It can be seen in Figure 11.5 that there is an increase in surface hardness in the deeper 'caries-affected' region (Figure 11.6). Below the graph is a diagram of a dentinal tubule showing how the tubule is filled with mineral deposits.

If a decision has been made to intervene operatively, sensibility testing should be carried out prior to administering local anesthetic. The results should then be documented. The radiograph should be consulted to give a 'rough guide' to the extent of the caries lesion. Placement of a rubber dam prior to cutting the tooth is advisable, if acceptable to the patient, as the cavity will be protected from ingress of saliva.

A systematic approach should be undertaken when removing caries-infected dentine. This can be considered to consist of four steps:

1) Gain access to the caries-infected dentine.
2) Removal of peripheral caries.
3) Management of deeper caries overlying the pulp.
4) Modification of cavity design according to which restorative material will be used.

Gaining Access to the Caries-Infected Dentine

Access to the caries must be gained. This may entail access through the sound enamel of an occlusal surface or removal of an existing restoration. Cutting is best achieved using a diamond or tungsten carbide bur in a high-speed handpiece under copious water spray. Demineralised and grossly unsupported enamel should be removed but sound enamel and dentine should be preserved as much as possible (Figure 11.7).

Removal of Peripheral Caries

Once access to the dentinal caries has been achieved, removal of any soft, caries-infected dentine should commence at the periphery of the lesion adjacent to the EDJ. All the soft 'caries-infected' dentine should be removed (Figure 11.8). In recent years, there has been a debate among cariologists as to how clean or free from caries the EDJ should be. Laboratory research has shown that adhesives have a stronger bond to sound caries-free dentine than they do to caries-affected dentine. Therefore, the dentine adjacent to the periphery of the cavity must be free of any caries so that optimal bonding can be achieved. Ideally this would consist of an enamel margin and sound dentine adjacent to the EDJ. This would allow optimum bonding of the dental adhesive to enamel and dentine. Optimum bonding would create a hybrid layer in dentine and penetration of adhesive into enamel that would be resistant to bacterial penetration.

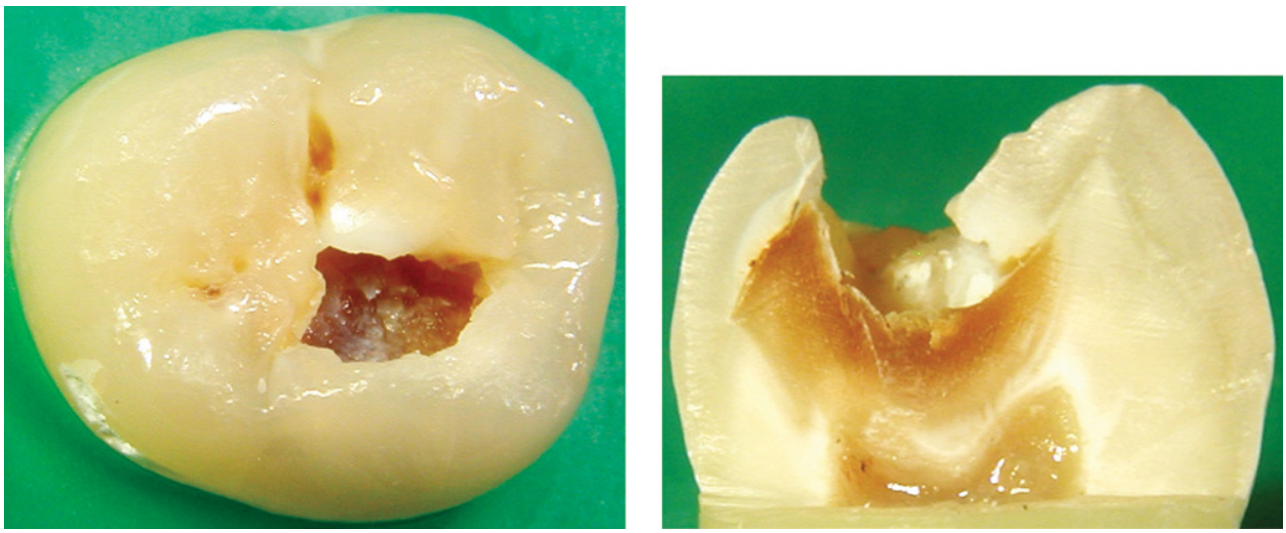


Figure 11.7 An occlusal cavitated lesion extending into the dentine of an extracted molar tooth. The full extent of the carious lesion is not visible at present and therefore the first step is to gain access to the lesion.

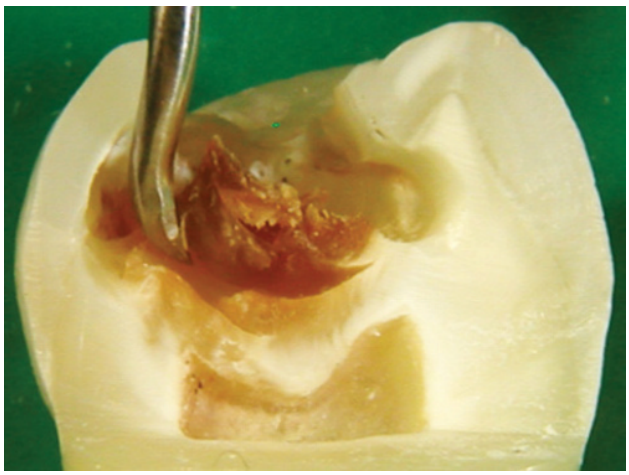


Figure 11.8 Very soft so-called 'caries-infected' dentine on the cavity floor is carefully removed by hand instrumentation. This allows a tactile evaluation of the 'softness' or 'hardness' of the cavity floor.

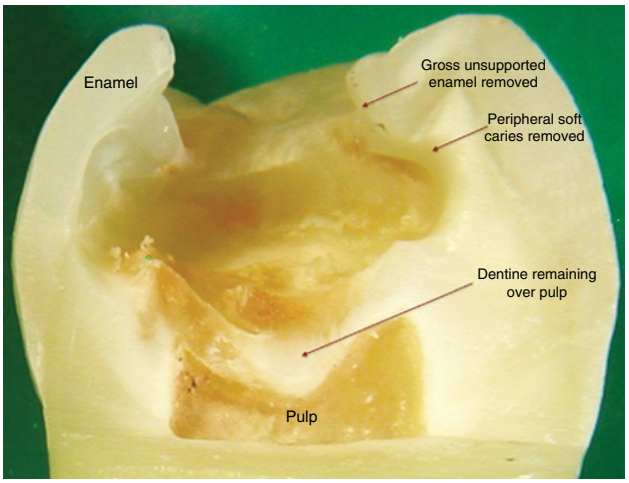


Figure 11.9 Removal of very soft so-called 'caries-infected' dentine has been accomplished.

Management of Deeper Caries Overlying the Pulp

After a decision has been made on the management of the carious dentine close to the EDJ, operative treatment of the floor of the lesion can commence. To ensure that caries removal from the floor of the cavity is not overdone, it is important to be aware that a careful approach should be undertaken taking into consideration when the caries-infected dentine is likely to have been removed and the caries-affected dentine reached. This can be only achieved using instruments that offer tactile feedback, such as excavators. If the caries has not spread too deep into the dentine, it will be possible to stop excavating the carious dentine when it stops feeling soft and feels harder and scratchy (Figure 11.9).

The Dentine–Pulp Complex

Any teeth requiring operative treatment should have their vitality assessed prior to administering local anesthetic, using sensibility tests such as response to electric pulp testing and ethyl chloride. A positive response to ethyl chloride or the electric pulp test does not indicate vitality but the condition of the nerve fibres within the pulp. Vitality testing would involve assessment of blood flow into the pulp using Doppler assessment, which at present is not clinically practical.

If the tooth gives a positive sensibility test prior to operative treatment and has not caused the patient discomfort, then all efforts should be made not to damage the pulp. As previously discussed, dentinal caries was sealed in one clinical trial and the teeth did not lose vitality over a 10-year period. Therefore, after the EDJ and peripheral caries have been managed, the temptation to chase the caries removal towards the pulp should be resisted. Indirect pulp capping involves leaving deep caries when it is thought that further removal of the caries will result in pulpal exposure. The results of the Mertz-Fairhurst *et al.* (1998) study support leaving deep caries as long as a well-bonded adhesive restoration can be placed on top.

Step-wise caries removal has been proposed whereby a calcium hydroxide liner is placed over the residual caries and the cavity restored. The restoration is then removed along with the deep caries several months later. In practice, re-entering the lesion is not widely practiced. Again, the evidence of the Mertz-Fairhurst study would indicate that re-entry is not necessary.

If the pulp is inadvertently exposed, then it is possible to place a direct pulp cap. The response of the pulp tissue will depend on whether the tooth has a good blood supply. When permanent teeth in young patients suffer trauma and complex enamel–dentine fractures then it is possible to carry out a pulpotomy and place calcium hydroxide powder on the pulpal tissue once it has stopped bleeding. A layer of glass-ionomer cement is placed over the non-setting calcium hydroxide powder and then composite resin used to replace the missing enamel and dentine. Once root formation is complete then pulpotomy is less likely to be successful. Mineral trioxide aggregate (MTA) is an alternative material to calcium hydroxide powder. MTA is a promising material to use as a direct pulp capping material but it can take up to 20 min to set and has been reported to discolour the tooth. White MTA is now available and this may cause less discolouration. If the pulp exposure is 'pin-point' in size, then protection from microorganisms in saliva through the placement of a rubber dam is essential, and direct capping with a setting calcium hydroxide-based material carried out. Alternatively, a new bioactive cement based on tricalcium and dicalcium silicate and calcium chloride, which forms calcium hydroxide when setting is available.

Procedures to be Undertaken when Managing Deep Caries

1) Ensure rubber dam isolation is in place and the tooth has been anaesthetised.
2) After removing soft 'caries-infected' dentine at the EDJ, a decision should be made on the harder 'caries-affected' dentine at the EDJ. If enamel is present and aesthetics are not a concern then hard, stained dentine at the EDJ can be left and removed if aesthetics will be affected.
3) If no peripheral enamel is present, then achieving a good seal on dentine will be more challenging as good dentine bonding is more reliably achieved to sound dentine unaffected by caries.
4) Consideration should be given to leaving soft deep caries if pulpal exposure is likely. In young patients, pulp horns will be more readily exposed. The adhesive can then be placed and the cavity restored with a definitive material such as composite resin.
5) If a pulp exposure has occurred and it is 'pin-point' in size, disinfect the pulp by gently blotting a cotton wool pledget soaked in chlorhexidine and then place a setting calcium hydroxide liner or Biodentine™.
6) If the pulp exposure is larger, a 'Cvek' pulpotomy is possible if the root is likely to have a reasonable blood supply such as would be found in an immature single-rooted tooth.
7) In older patients and multirooted teeth, consideration must be given to pulpectomy and endodontic treatment as the blood supply may not be sufficient.

Cavity Restoration

Once the caries has been removed, which material to be used in the resultant cavity should be decided. Ideally, the patient must be adequately informed of the possible materials along with their advantages and disadvantages so that they can make an informed decision. However, various factors may need to be considered and this can make selection of the appropriate material quite complicated. The most durable restoration that preserves as much tooth as possible should be chosen. If it is in the 'aesthetic zone' it should have a good appearance.

Factors to consider are:

1) Patient wishes after having been informed of the possible options.
2) Remaining enamel and dentine.
3) Ability to achieve adequate moisture control.
4) Location of cavity in the mouth. Is it in an area where good aesthetics is important or is it in a posterior tooth, which could be subjected to loading or parafunctional activities?
5) Operator skill and knowledge of how to use materials correctly and control the occlusion.

The developments in composite resin technology and dental adhesives has enabled composite resin to be placed directly into/onto a tooth in increasingly challenging situations. Because composite resin is retained by adhesive mechanisms involving resin infiltration, tooth structure does not need to be sacrificed to create mechanical retention for the material. However, this is only possible if the operator knows how to apply a dental adhesive correctly, which adhesive could be used and what is the likely histology of the tooth structure being bonded to. If the

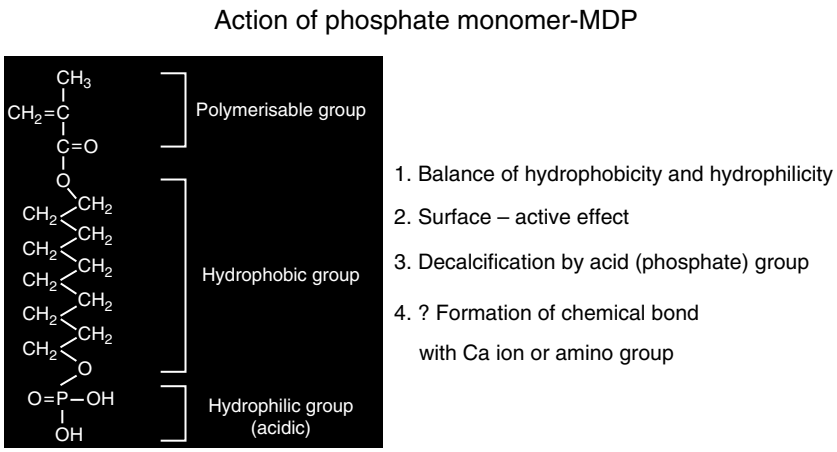


Figure 11.10 The chemical structure of MDP showing hydrophobic and hydrophilic ends.

adhesive is applied correctly, then it is possible to bond composite resin directly to a tooth, which can then function for several years, even if there is little remaining enamel and dentine. If not, then the converse is true.

Other materials can adhere to tooth structure by purely chemical means such as glass-ionomer cement and bioactive cements and can be used as a restoration; however, these materials wear under occlusal loading and should be covered with composite resin if they are to function under occlusal forces for a long period of time.

Dental amalgam is a time-proven material that offers the advantage that it can be used when gaining adequate moisture control near the gingival margin is challenging and can function under occlusal loading. If amalgam is 'bonded' to the tooth structure – an unpredictable procedure – then less tooth structure needs to be removed to create mechanical retention. If the amalgam is not 'bonded' to the tooth structure, then the cavity will need to possess adequate resistance and retention form. Patients may have concerns regarding the appearance of amalgam restoration and the fact that mercury is part of the alloy.

Dental adhesives and what clinical steps should be followed to ensure their optimum performance are now examined.

Dental Adhesives

A dental adhesive consists of a solvent, which may be mainly water-based, such as ethanol, acetone or a similar material. The solvent carries chemicals into the enamel and dentine and some can also displace small amounts of water and organic fluids from the tooth surface. Within the solvent are resin materials, which will form the resin surface onto which composite will bond, and a 'priming' chemical.

A primer is a bifunctional monomer that can bind to hydrophobic resin and has a hydrophilic end that has an affinity with organic fluids that are found in dentine. Phosphate monomers and HEMA are examples of primer compounds. Phosphate monomers are also acidic. This is how the self-etching adhesives work. The priming solution is acidic so it simultaneously demineralises enamel/dentine and prepares the surface to allow resin infiltration either simultaneously (one-step self-etching adhesives) or with the separate application of a hydrophobic bonding resin. An example of a phosphate monomer is MDP (Figure 11.10).

Once the adhesive has penetrated the enamel/dentine surface, the resins must be polymerised and so a light-activated photoinitiator such as camphoquinone is also present. Micron- and submicron-sized filler particles are also present in the adhesive to improve the mechanical properties of the adhesive once it has been polymerised.

Adhesives may or may not require the application of phosphoric acid to enamel and dentine and this is a way of classifying the different types (Figure 11.11).

Enamel can be etched by the application of phosphoric acid (Figure 11.12). However, the structure of enamel might vary from patient to patient. The enamel might be 'fluorosed' or could have been affected by a genetic defect such as in amelogenesis imperfecta. Therefore, the exact application time for applying phosphoric acid cannot be stated but 20–30 s application time is probably sufficient to etch the surface. Further research is, however, needed on enamel affected by amelogenesis imperfecta. Clinically, a 'frosty white' appearance after etching will indicate phosphoric acid has been applied for long enough. Extending the etching time does not appear to have any negative affect on the enamel structure.

After washing and drying the enamel surface, the adhesive is applied according to the manufacturer's instructions. Usually, gentle rubbing, air-thinning and one or more coats of adhesive are required prior to light curing but because the enamel stays dry after drying, adhesive application is quite straightforward.

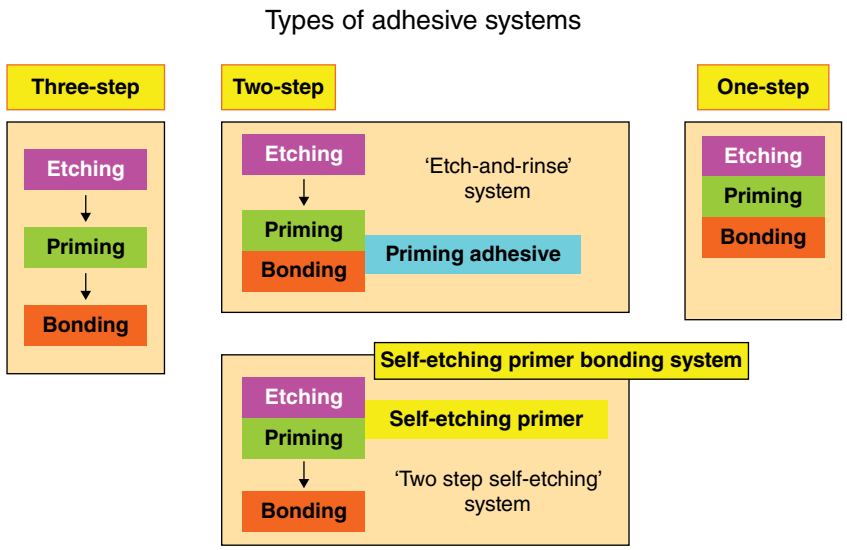


Figure 11.11 Types of adhesive systems. Image courtesy of Dr Ogata of Tokyo Medical and Dental University.

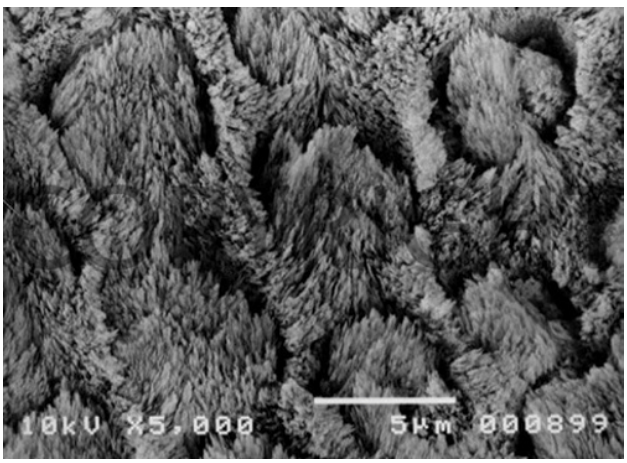


Figure 11.12 An enamel surface after etching with phosphoric acid. It is easy to see here how the resin can infiltrate into the interprismatic spaces and be micromechanically 'locked' in after polymerisation. Courtesy of Dr Shimada, Tokyo Medical and Dental University.

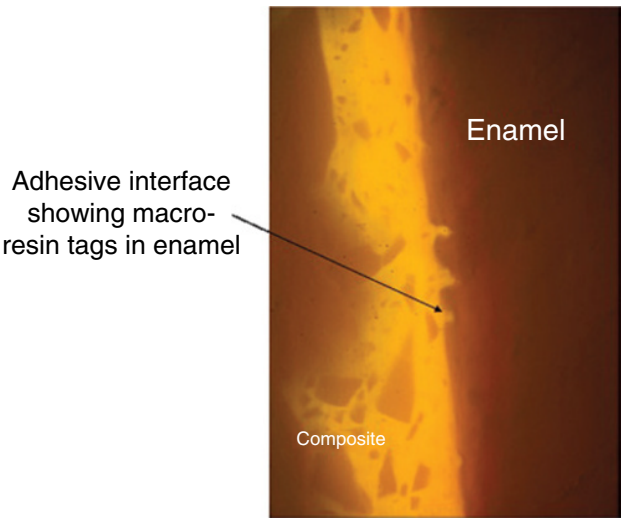


Figure 11.13 Polymerised macro resin tags of an all-in-one adhesive (One-Up Bond F Plus, Tokuyama Dental Corporation, Tokyo, Japan) in an enamel surface.

After successful resin application and polymerisation, resin tags can be observed under the microscope (Figure 11.13).

Bonding to dentine is more challenging because it contains organic fluids and therefore is a hydrophilic environment, whereas resin is hydrophobic. For many years, manufacturers struggled to produce adhesives which could penetrate the dentine surface. If the tooth surface is prepared or cut, a 'smear layer' will be formed. This smear layer must be either removed either by dissolving with phosphoric acid or modified by applying a self-etching primer before the resin can enter the dentine surface.

Phosphoric acid will remove hydroxyapatite mineral from the 'intertubular dentine' and dissolve the 'smear plugs' in the dentinal tubules exposing the collagen matrix. Without mineral to support it, the collagen matrix will collapse. If the matrix can be kept expanded, resin can flow around the collagen fibres and be micromechanically retained after polymerisation. On young dentine, phosphoric acid can be quite aggressive and may over-etch the dentine. On older sclerotic dentine, etching may be more challenging. Tay and Pashley (2004) wrote that the dentine surface of sclerotic lesions was hypermineralised to a depth of 15 µm. Work by Perdigão and Lopes (2001) on the depth of the etching effect of phosphoric acid on dentine found that after 2 min of etching (Figure 11.14), the mean depth of demineralisation was 8.1 µm.

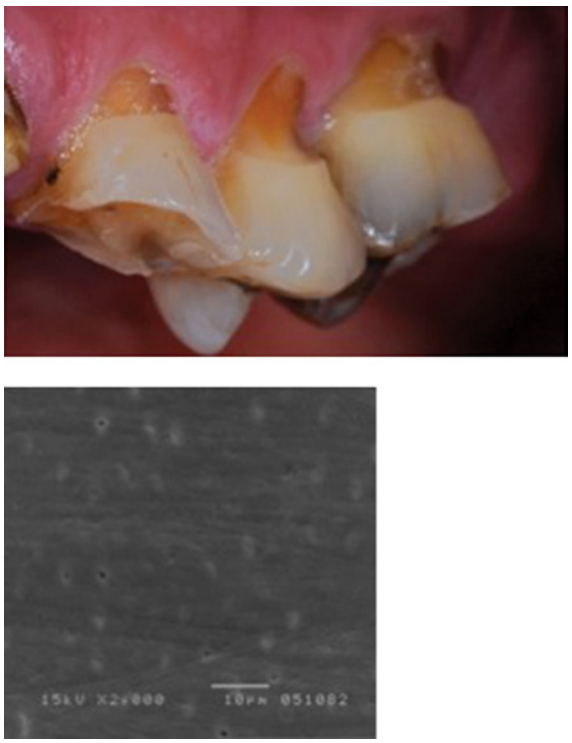


Figure 11.14 Typical cervical lesions in a patient with advanced tooth wear. The patient experienced no pain from the lesions when the air from the three-in-one syringe was applied to them. This would indicate very few tubules were open (lower image). If the tubules were open then one would expect the patient to feel pain on application of air from the three-in-one syringe. A provisional assessment of the dentine surface of these lesions would be that the surface was likely to be hypermineralised in places and either a longer phosphoric etching time was required or the surface should be removed with a stainless steel rose-head bur and then etched to achieve the desired substrate for bonding, as advocated by Tay and Pashley (2004). Micrograph reproduced courtesy of Quintessence International and *Journal of Dentistry*.

Therefore, it is very important that careful consideration is given to the state of the dentine. The dentine of a young patient is quite likely to have lots of open tubules. If so, then a shorter etching time is preferable, e.g. 20 s. If the dentine is in an older patient and worn, in which case the tubules will most likely be sealed with mineral deposits, it may be resistant to etching. A much longer period of etching will be required.

Two-step self-etching adhesives do not require the prior application of phosphoric acid and so are less aggressive in terms of surface demineralisation and there is less distance for the resin to diffuse into afterwards. However, on worn sclerotic dentine, the author has found additional etching with phosphoric acid, in addition to applying a two-step self-etching adhesive, can provide successful long-term adhesion.

The objective of bonding to dentine is to create a 'hybrid' zone of polymerised resin embedded in the dentine surface. Professor Nakabayashi of Tokyo Medical and Dental University was one of the first to successfully bond to dentine and coined the term 'hybrid layer'. The 'hybrid' layer is a resin–dentine interdiffusion zone that also seals the dentinal tubules against advancing bacteria, which is created after polymerisation of the adhesive.

The strength of this bond is not really because of the resin tags, which you can see in this demineralised section (Figure 11.15), but in the 'intertubular' region. Good infiltration of the demineralised surface with resin and the creation of a good 'quality' hybrid layer is the key to success.

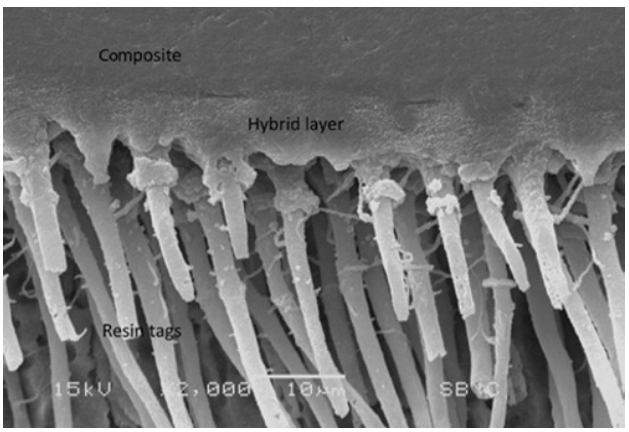


Figure 11.15 Dentine bonding. Image courtesy of Dr Andrea Cavalcanti, UFBA, Brazil.

The 'gold standard' adhesive used in laboratory testing is the three-step system where phosphoric acid is applied first, followed by the priming solution and then the hydrophobic bonding resin.

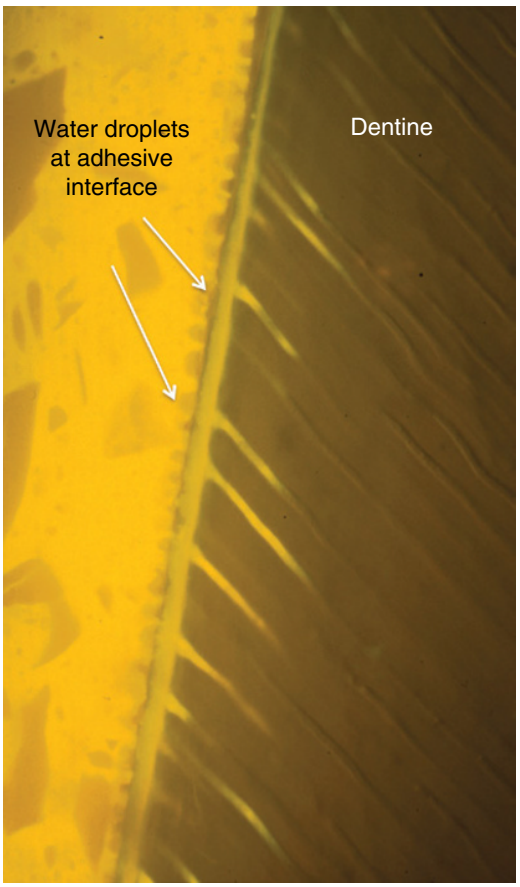


Figure 11.16 Water droplets at the adhesive interface (One Up Bond F Plus, Tokuyama Dental Corporation, Tokyo, Japan) between composite resin and dentine.

Etch-and-rinse adhesives require application of phosphoric acid and then the adhesive itself. These adhesives can be technique sensitive and so close adherence to the manufacturer's instructions is very important. This is because after rinsing off the phosphoric acid, the dentine should be kept very slightly moist, which can be difficult to assess.

Two-step self-etching adhesives do not require phosphoric acid etching of the dentine surface except when the dentine surface is worn and sclerotic. The dentine is etched to a shallower depth compared with phosphoric acid-etched dentine, which makes it easier for the resin to infiltrate completely. Because no rinsing off is required there are no concerns about residual moisture. However, clinical studies have shown good results for both etch-and-rinse and self-etching adhesives.

In recent years, dentists have wanted adhesives that are quick and easy to apply. In response to this, manufacturers have developed all-in-one adhesives. These adhesives are moderately hydrophilic and have been shown to be susceptible to water penetration and structural failure of the adhesive interface as shown in Figure 11.16.

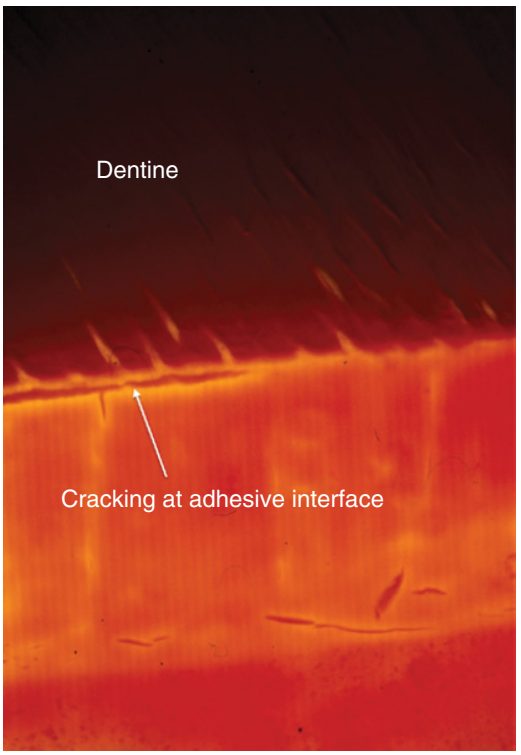


Figure 11.17 Cracking at the adhesive interface (I Bond) between composite resin and dentine.

It is the author's opinion that with the growing trend of restoring larger posterior cavities with direct composite resin to preserve tooth structure, the existence of water droplets at the interface between the adhesive and composite resin, or cracks within the hybrid layer (Figure 11.17), cannot help the long-term survival of a repeatedly loaded posterior direct composite resin restoration.

Manufacturers are now attempting to develop one-step adhesives, which do not exhibit the problems stated previously. However, there is little clinical evidence of their long-term performance.

Factors to be Considered When Applying an Adhesive

1)	Consider the surface for application of adhesive?: • Is it enamel? • Is it dentine?	
2)	Does blowing the dentine surface with air cause pain?	This indicates open tubules. A self-etching type of adhesive may be preferred to avoid overetching the dentine.

3) Is the cavity floor caries-affected dentine?	Only a few adhesives have been tested on this substrate.
4) Is the dentine likely to be older, worn sclerotic dentine?	Consideration should be given to extending the etching time or etching before using a self-etching adhesive.
5) Follow the manufacturer's instructions.	Different adhesives use different solvents. More volatile solvents such as acetone may require additional applications.
6) Etch peripheral enamel even if using a two-step self-etching adhesive.	Two-step self-etching adhesives exhibit reliable dentine bonding but additional etching of peripheral enamel can reduce staining of the restoration margins.

Placement of Composite Resin

Composite resins are continuously being developed by manufacturers and the trend is towards incorporating filler particles less than 1 µm in size and materials, which exhibit less shrinkage on curing (Figure 11.18). Unfortunately, due to cost and length of time involved there will always a lack of clinical trials and evidence, which could be used to select the most appropriate material.

This is particularly pertinent since composite resin is increasingly being used to restore larger cavities or build up broken down or worn teeth. In these demanding clinical microenvironments each increment of composite resin placed should be polymerised to its maximum possible state and with no voids placed. Polymerisation shrinkage will occur to a greater or lesser extent and can

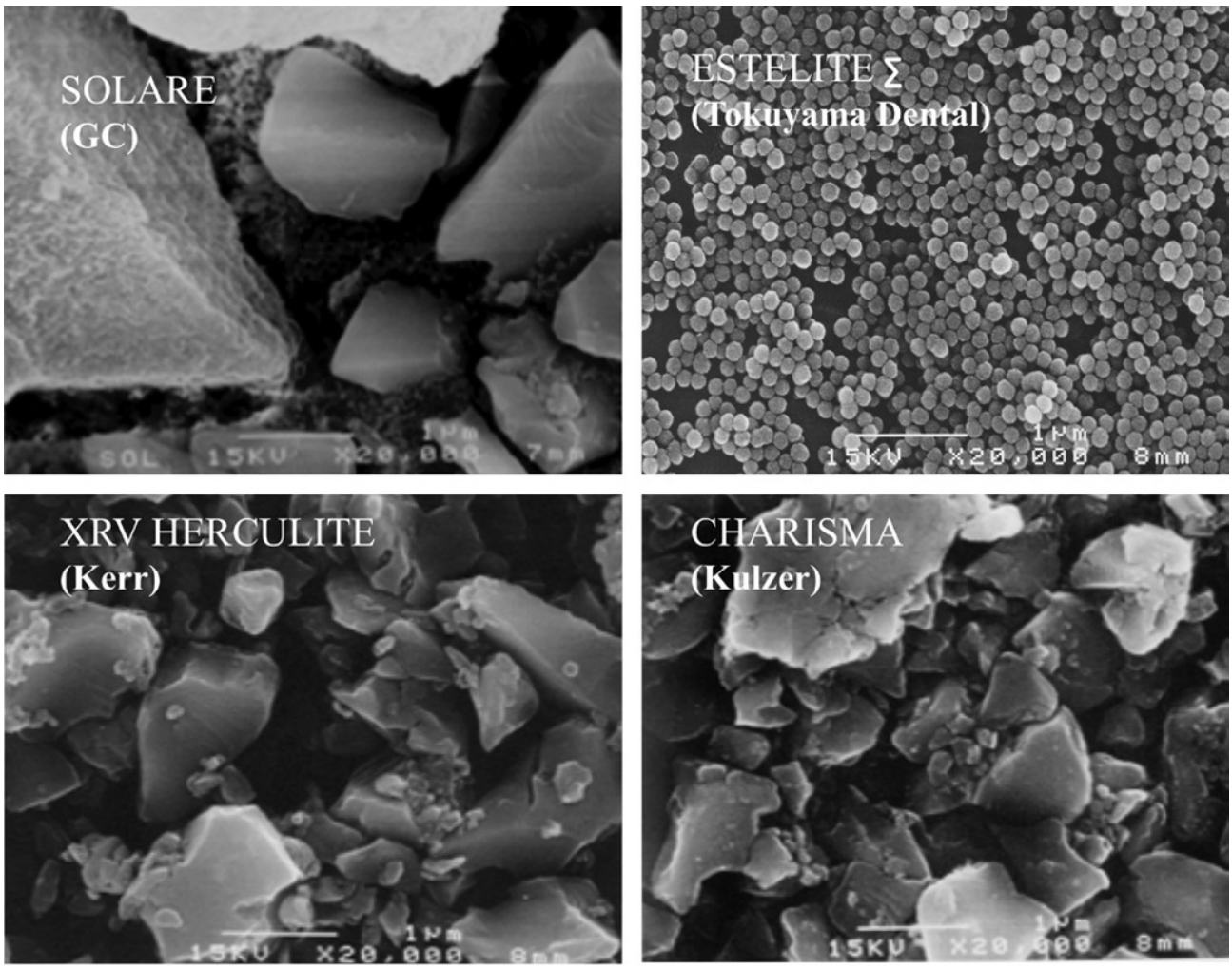


Figure 11.18 SEM images of four different composite resins.

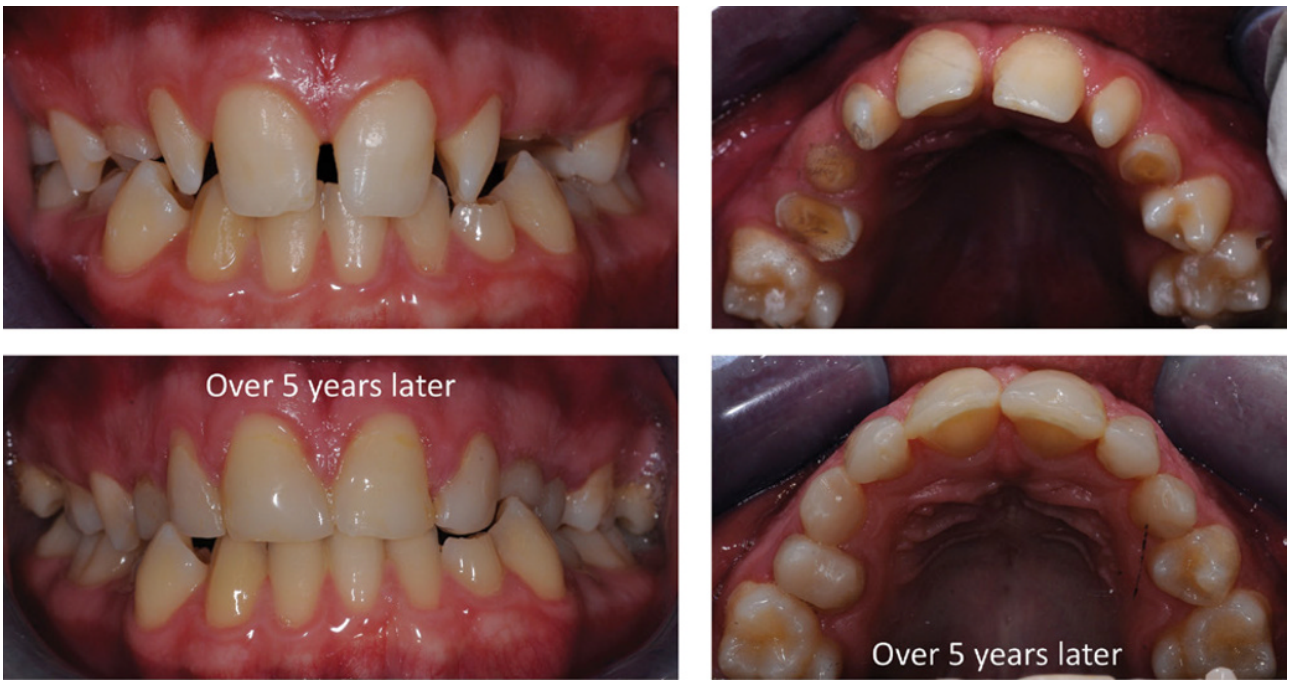


Figure 11.19 Composite build-ups present after 5 years. The teeth were initially restored when the patient was aged 13. Although the composite build-ups on the anterior teeth exhibit some chipping, the patient was very happy with their appearance and did not want any treatment. The build-ups placed on the posterior deciduous teeth are still present despite little or no coronal tooth structure remaining and demonstrates what can be achieved with careful material selection (Clearfil SE Bond, Kuraray Noritake; Palfique Estelite Sigma composite resin, Tokuyama Dental Corporation, Tokyo, Japan) and an appreciation of the likely histology of the remaining dentine.

be minimised by placing increments in thin sections and at angles within a cavity. The author places increments with a thickness of around 1 mm. Although this means that it may take several minutes to build up a tooth or fill a large cavity, the effects of polymerisation shrinkage will be minimised and the occurrence of voids will be lessened.

Using thin increments of composite resin will enable the light to polymerise not only the increment but also the molecules on the surface of the underlying layer that were prevented from polymerising because of oxygen inhibition. This will ensure the composite resin possesses the optimum mechanical properties to withstand forces within the oral cavity (Figure 11.19).

Moreover, if a non-sticky direct composite resin is selected then thin increments can be quickly and easily placed. Some composite resins can also be polymerised with a 20 s light-curing time, which will shorten the time required for incremental placement. If the composite resin is sticky, then there is a tendency for the material to pull away from the cavity floor and adhere to the instrument, which may introduce voids into the resin layer. These voids could theoretically become areas of weakness within a restoration.

When the proximal surface must be restored, a matrix must be used to limit the placement and wedging employed to prevent the resin being cured beyond the cavity margins. Removal of excess polymerised composite resin can be somewhat time consuming. Figure 11.20 shows the restoration of a proximal cavity in a typodont tooth.

Various matrices and wedging systems are now available and will be chosen according to operator preference. Care should be taken when finishing composite resin restorations. The surface of the final increment of composite resin will not polymerise because the surface molecules will have been prevented from crosslinking by oxygen and therefore an agent can be placed that allows these surface molecules to crosslink after light curing.

Gross excess composite should be removed with finishing diamonds in a high-speed handpiece while taking care to create the correct morphology. It is helpful to look at the restoration from different angles and to look at the restoration from the patient's perspective when creating the morphology. The finishing burs should be carefully angled at different planes on the restoration to prevent unnecessary flattening of the restoration. White stones and rubber points with diamond polishing pastes can create a surface which is not completely smooth but has surface irregularities mimicking the natural tooth.

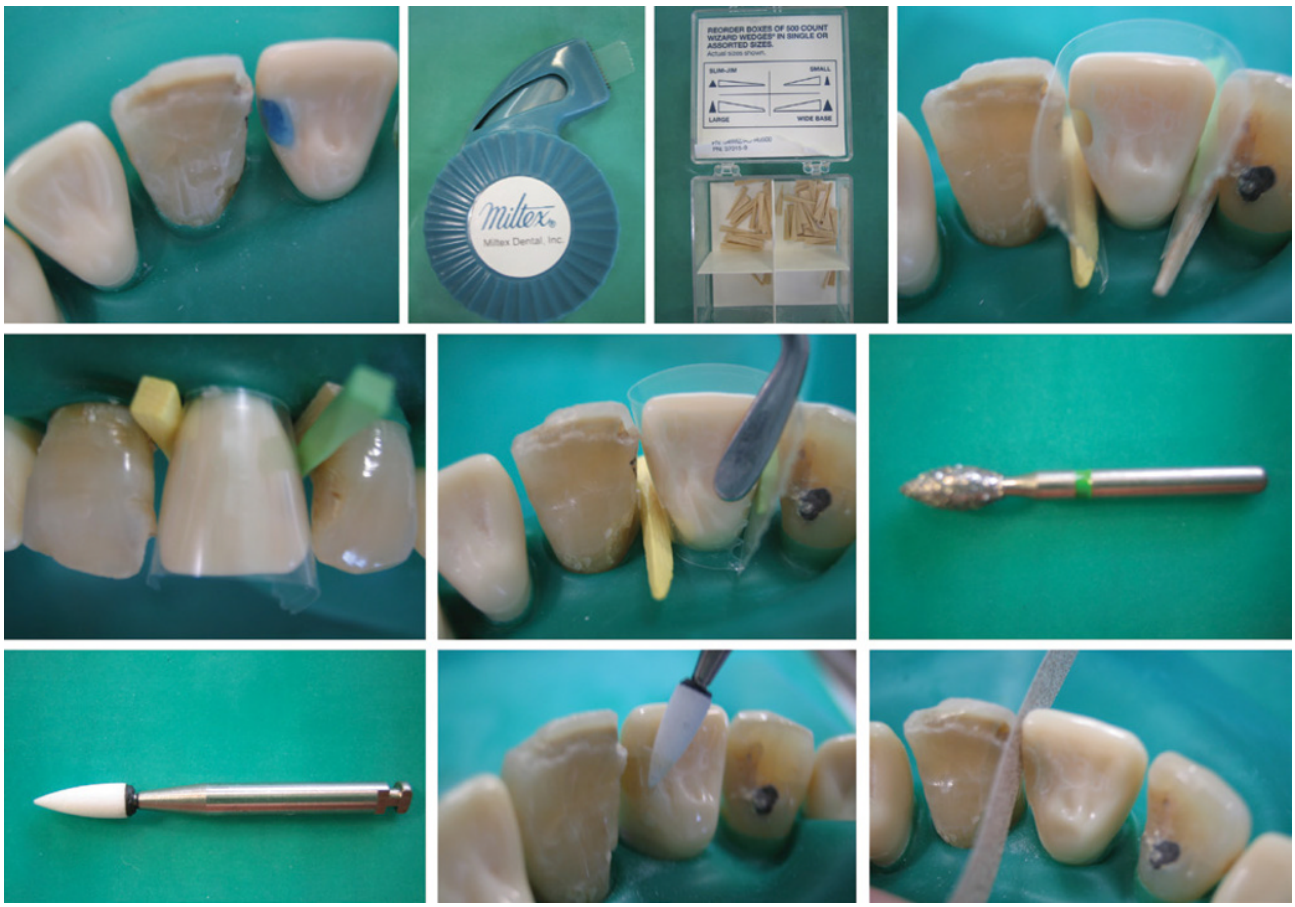


Figure 11.20 Restoration of a proximal cavity in a typodont tooth.

Figure 11.21 shows a large amalgam restoration with a significant proximal overhang, which was causing the patient significant discomfort. The buccal papilla is swollen and discoloured. After replacement of the restoration with a well-contoured posterior composite restoration, the papilla's colour now matches the surrounding mucosa and the swelling has reduced.

The following box outlines the clinical steps that are appropriate when placing a composite restoration.

1) Ensure tooth is adequately anaesthetised and ideally isolated using a rubber dam.	Avoiding contaminating the cavity margins with saliva will ensure optimum conditions for adhesive application and composite placement.
2) After removing the appropriate amount of caries ensure the cavity margins are smooth. Bevelling of the cavity margins is not necessary except when restoring the labial aspect of an anterior tooth when a long bevel can be made.	Smoothing the cavity margins will remove damaged prisms and enable better adaptation of the composite resin. A sinuous long bevel in the labial enamel of an anterior tooth will allow the composite resin to blend with the adjacent enamel.
3) If a restoration is being replaced, taking a putty impression of the tooth beforehand will allow a matrix to be cut, which will make recreation of the morphology very straightforward. If several worn teeth are being built up then a diagnostic wax-up can be requested and duplicated to allow a putty impression to be taken.	A putty matrix is almost essential when creating a layered composite resin restoration using different shades. Dentine can be replaced with dentine shades. Sometimes an opaque shade will prevent the restoration exhibiting too much translucency. The matrix will show how much space is left in the incisal region if a more translucent, enamel shaded or coloured resin is indicated.

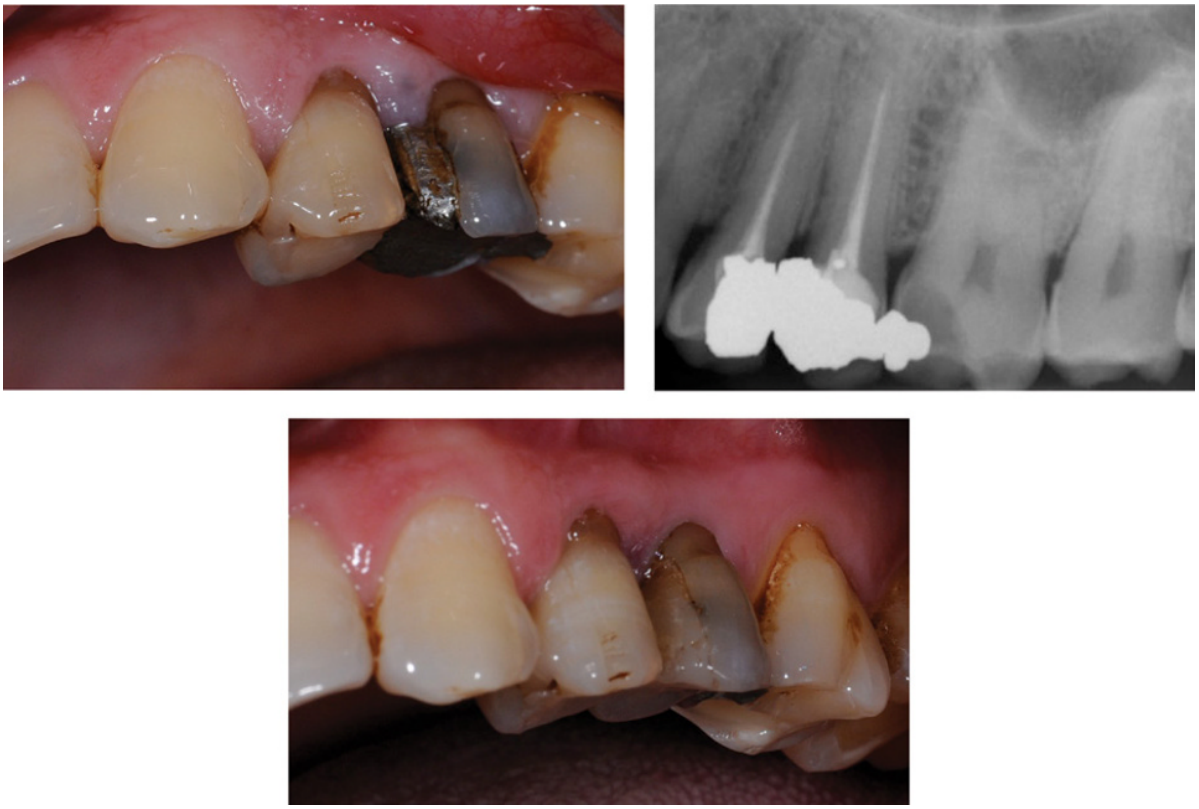


Figure 11.21 Replacement of a large 'overhanging' amalgam restoration with composite resin.

4) If the restoration involves a proximal wall, a matrix strip/band with gingival wedging to get optimum adaptation is essential. Care should be taken to ensure the matrix is correctly adapted to the adjacent tooth to prevent an open contact, which could act as a troublesome food trap. 5) For anterior teeth, PTFE ('plumbers') tape is softer and more forgiving than Mylar matrix strips, although it is not marketed for intraoral use. 6) For posterior teeth, various sectional matrix systems are now available along with specially made rings, which fit snugly against a tooth to hold the thin sectional matrix in position along with conventional bands. 7) Wedges may be light transmitting to ensure better polymerisation of the composite resin. 8) Apply the adhesive as discussed previously.	
9) Carefully place the first increment of composite resin. Particular care should be taken to ensure the composite resin is carefully adapted to the cavity floor. This first increment should also be thin. Less than 1 mm thickness is recommended.	When the adhesive is light cured, the surface molecules will not polymerise because they have been inhibited by oxygen in the surrounding air. If the first increment of composite resin is sufficiently thin, light can pass through this increment and polymerise the underlying uncured surface adhesive molecules. This ensures the adhesive possesses optimum mechanical properties to withstand the pulling forces of the overlying composite which are exerted when the composite shrinks. This is another reason why the first increment should be a thin layer. Sometimes, a thin layer of flowable composite can be applied in posterior cavities. A thin layer of flowable resin will ensure good adaptation to the cavity floor.

10) Add successive increments of composite resin, whilst ensuring that each increment has been completely light cured. The tip of the light-curing unit should be clean and the power output of the light-curing unit regularly checked.	The composite resin should not be too 'sticky' as this will ensure easier placement. Good quality composite resins have been developed not to be too 'sticky' and are easy to place. If a plastic sleeve is not placed over the light-curing tip, resin will stick to the curing tip and reduce the intensity of light being emitted from the tip. Checking the power density of the light will ensure the maximum amount of light is applied to the composite resin.
11) Complete the morphology as much as possible prior to light curing. This is particularly recommended when placing the final occlusal increments of composite resin in posterior teeth.	Because composite resin sets immediately on light curing it is not possible to reshape the material afterwards using hand instruments. Excess cured resin will require removal using diamond burs in a high-speed hand piece. If the occlusal morphology can be optimised prior to curing this will minimise the time required to finish the restoration. Various procedures have been developed to make occlusal adaptation easier. These include: Biting together with the composite covered by 'clingfilm' plastic so the opposing cusps indent into the occlusal surface. This technique would require removal of the rubber dam if applied. A clear silicone can be used to take an impression of the occlusal surface before restoring the tooth. This can be used to 'stamp' the surface of the 'uncured' resin prior to polymerisation.

Glass-Ionomer/Resin Modified Glass-Ionomer Cement

Glass-ionomer cements have been available for several decades. Their fluoride content makes them suitable for use as a transitional material when managing caries and as a definitive restorative material in cervical cavities where aesthetic appearance is not a primary concern. Glass-ionomer cements are set by an acid-base reaction, which takes several days to complete. The surface of the restoration should be protected from oral fluids for several hours. Application of an adhesive on the surface of the setting glass-ionomer cement will protect it from excess fluids while it sets.

Resin-modified glass-ionomer cements were developed in an attempt to combine glass-ionomer technology and composite resin technology. Because their appearance does not match that of composite resin, they are not frequently used in areas of aesthetic concern. They have been reported to leach fluoride ions in lower concentrations than conventional glass-ionomer cements and so are not indicated as a replacement for glass-ionomer cement as a transitional material. The mechanical properties of resin-modified glass-ionomer cement are superior to conventional glass-ionomer cement and so it is suitable as a restoration for cervical cavities if aesthetics is not a primary concern. It is not clear whether it is superior to conventional glass-ionomer cement as a dentine replacement in 'sandwich' restorations because it will undergo some shrinkage because the resin requires light curing. However, this offers the advantage of faster setting.

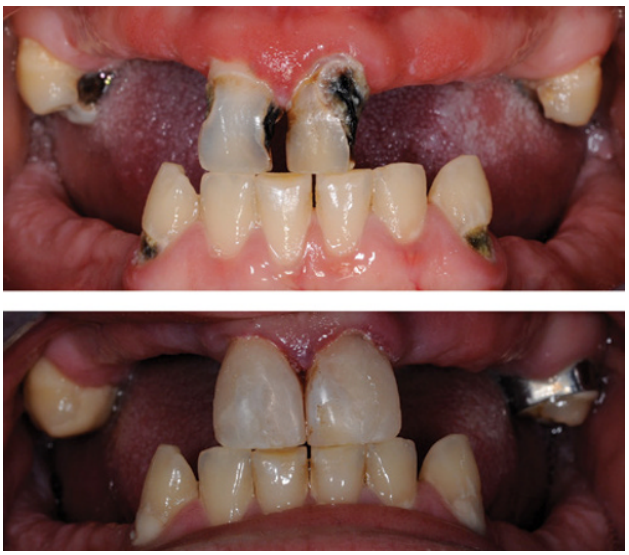


Figure 11.22 Transitional management of caries using glass-ionomer cement.

The medically compromised patient shown in Figure 11.22 presented with extensive caries in multiple teeth. As can be seem in the lower image, the upper

right first molar has been provisionally restored with resin-modified glass-ionomer cement, the two upper central incisors were restored with composite resin after provisional glass-ionomer restorations, and the two lower canines have provisional glass-ionomer restorations.

The following box lists the clinical steps for placement of a glass-ionomer restoration.

1) After cavity preparation, apply the dentine conditioner according to manufacturer's instructions.	
2) Mix and apply the glass-ionomer material. The author prefers a mixture that is less viscous when restoring cervical cavities and a more viscous mix when placing the cement as a dentine replacement in posterior teeth. Shape material quickly before it begins to set. The setting reaction proceeds quickly. Applying a dentine adhesive will increase the bond strength of resin-modified glass-ionomer cement. However, it is the author's opinion that if a dentine adhesive were to be applied then carefully incrementally placed composite resin is the restorative material of choice.	All the instruments should be to hand once the assistant begins mixing the glass-ionomer cement. If the cement is mixed by hand, then the consistency can be controlled. A creamier mix will be easier to place in a cervical cavity but will have lower mechanical properties than a thicker mix. A thicker mix is easier to place but will not flow and adhere as well as a creamier mix. Premixed capsules avoid the inconvenience of hand mixing and waste powder and liquid. However, the setting reaction can proceed quite quickly and so the material should be placed in the cavity as fast as possible. This is easy when the mixing machine is adjacent to the operator but more problematic on larger undergraduate teaching clinics when the assistant must leave the treatment cubicle.
3) The setting cement should be protected from surrounding fluids for the first 24 h. Applying a dental adhesive onto the surface of the set glass-ionomer cement will fulfill this objective. It is not necessary to etch the surface of the glass-ionomer cement as this will be sufficiently rough to be micromechanically retentive.	The glass-ionomer setting reaction takes several days to complete and protection from excess surrounding fluids is essential to obtain optimum mechanical properties. Achieving optimum mechanical properties will help achieve longer survival.

Dental Amalgam

Dental amalgam is being phased out as the restorative material of choice, particularly as patients are increasingly requesting aesthetic restorations for posterior as well as anterior teeth. Two-step self-etching and three-step etch-and-rinse adhesives exhibit very strong adhesion to tooth structure when placed correctly. Therefore, directly placed composite resin restorations will make the strongest bond to tooth structure. No other restorations can compete with this. However, if moisture control or access is difficult then an amalgam restoration in a posterior tooth may be a better option as a poorly bonded composite is going to exhibit substantial microleakage and is likely to perform much worse than 'average' dental amalgam over a long period of time. Large composite build-ups take time particularly those of posterior teeth and therefore good access and cooperation is necessary. Some patients will refuse to have amalgam in their mouths and in this case an indirect restoration may be required.

A conventional amalgam requires the cavity to exhibit adequate 'resistance' and 'retention' form. The enamel should not be unsupported and therefore healthy enamel and dentine may need to be removed to achieve these objectives. Amalgam can be 'bonded' to enamel and dentine if a chemically-setting adhesive resin cement is applied just before the amalgam is packed into the cavity. The adhesive cement will bond to the enamel and dentine, and also adhere to the amalgam particles as they are packed into the cavity. Composite resins are increasingly showing good long-term survival even when completely overlaying the entire occlusal surface and so if a 'bonded' amalgam is indicated then so is a composite resin.

The amalgam alloy is manufactured as either 'lathe-cut', 'spherical' particles or as an 'admix'. The alloy composition should have a high copper content to eliminate the 'tin-mercury' or gamma 2 phase, which will give rise to creep and corrosion in the long term.

Figure 11.23 shows a patient with Sjögren's syndrome who has a very dry mouth and is continuously at risk of caries. The three posterior teeth have been restored with large 'bonded' amalgam restorations. The clinical dilemma is if anything can be done. Crowning these teeth will remove what little peripheral enamel remains and a core of just amalgam. Leaving these restorations renders the little remaining peripheral enamel at risk of fracture. Large posterior composite restorations could also have been attempted.

The clinical steps for placing an amalgam restoration are as follows:

1) Check the occlusion before cavity preparation and record the occlusal contacts on the tooth being treated.
2) Complete caries removal and cavity preparation. Remove severely unsupported enamel.
3) Manage the dentine–pulp complex as appropriate.

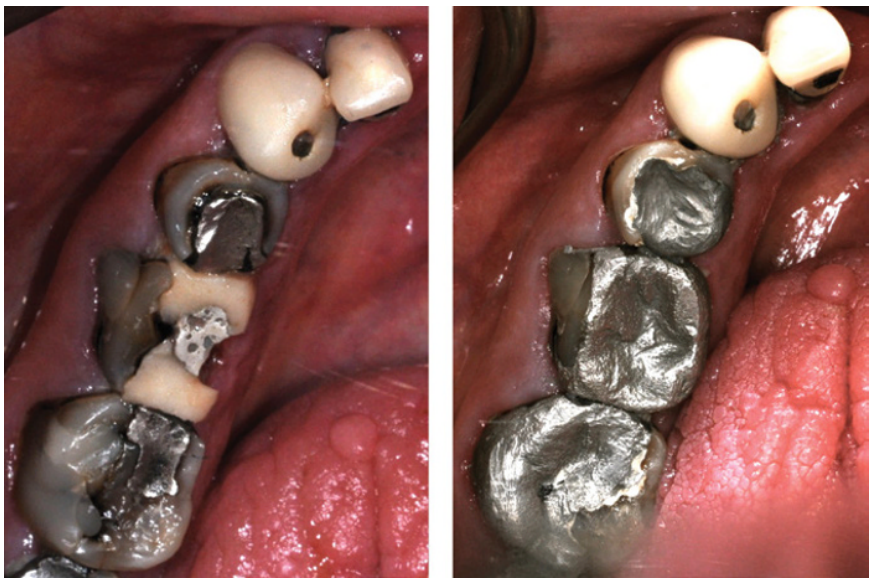


Figure 11.23 Replacement of restorations with large amalgam restorations.

4) If dentine tubules are likely to be exposed on the cavity floor, these should be sealed up with an adhesive. Thicker materials such as glass-ionomer cement will allow less space for the amalgam. As teeth age, the dentinal tubules will sclerose and so a tooth that has been in the mouth for many decades may not require tubule sealing.
5) If bonding the amalgam, prepare the chemically setting resin cement. If a material such as Panavia EX or Panavia 21 is to be used, the enamel and dentine will need to be primed first. For amalgam bonding any cement that bonds to tooth structure and chemically sets can be used. This would also include zinc phosphate and glass ionomer cements as well as chemically-curing resin cements.
6) Place a matrix band if appropriate and wedge the band if necessary. Ensure the matrix band is well adapted to the adjacent tooth to form a contact point. Vaseline the band if applying resin cement to the cavity for amalgam bonding.
7) Mix the amalgam and pack into the cavity. Packing should be in increments, which should be carefully and firmly adapted to all aspects of the cavity. The amalgam should be overpacked.
8) Care should be taken when removing the matrix band since any marginal ridge created can be easily damaged. Sectional matrices can be removed horizontally and circumferential bands can be carefully removed vertically or cut away.
9) The amalgam should be carved and cusps and marginal ridges created where necessary. All excess material should be carefully removed.
10) The occlusion should be checked with articulating paper and if a conformative approach has been adopted, the occlusal contacts should be the same as they were prior to cavity preparation.
11) Polishing of the amalgam restoration is not now required.

Rehabilitation of a Worn Dentition Using Adhesive Techniques and Minimal Loss of Tooth Tissue

The following case illustrates how knowledge of adhesive materials, respect of the substrate to be bonded to and combining direct and indirect techniques can rehabilitate severely worn teeth with minimal further loss of tooth tissue. The male patient was in his late sixties and was unhappy with the appearance of his teeth and that food kept getting stuck in and around his teeth. His medical and social history indicated that there were erosive elements that could account for the loss of tooth substance. He was medically fit and well and appreciated that a complete rehabilitation would require many appointments. He was not deemed to be at risk of caries and his oral hygiene was reasonably good. Upper and lower alginate impressions were taken, together with a facebow record and a jaw relationship in centric relation.

The models were mounted on a semiadjustable articulator. There was insufficient interocclusal space for placement of restorative materials without removing significant amounts of tooth structure. A decision was made to restore the dentition at an increased vertical dimension. The amount of tooth structure lost was gauged and the incisal pin was lowered accordingly to create space on the articulator. This was discussed with

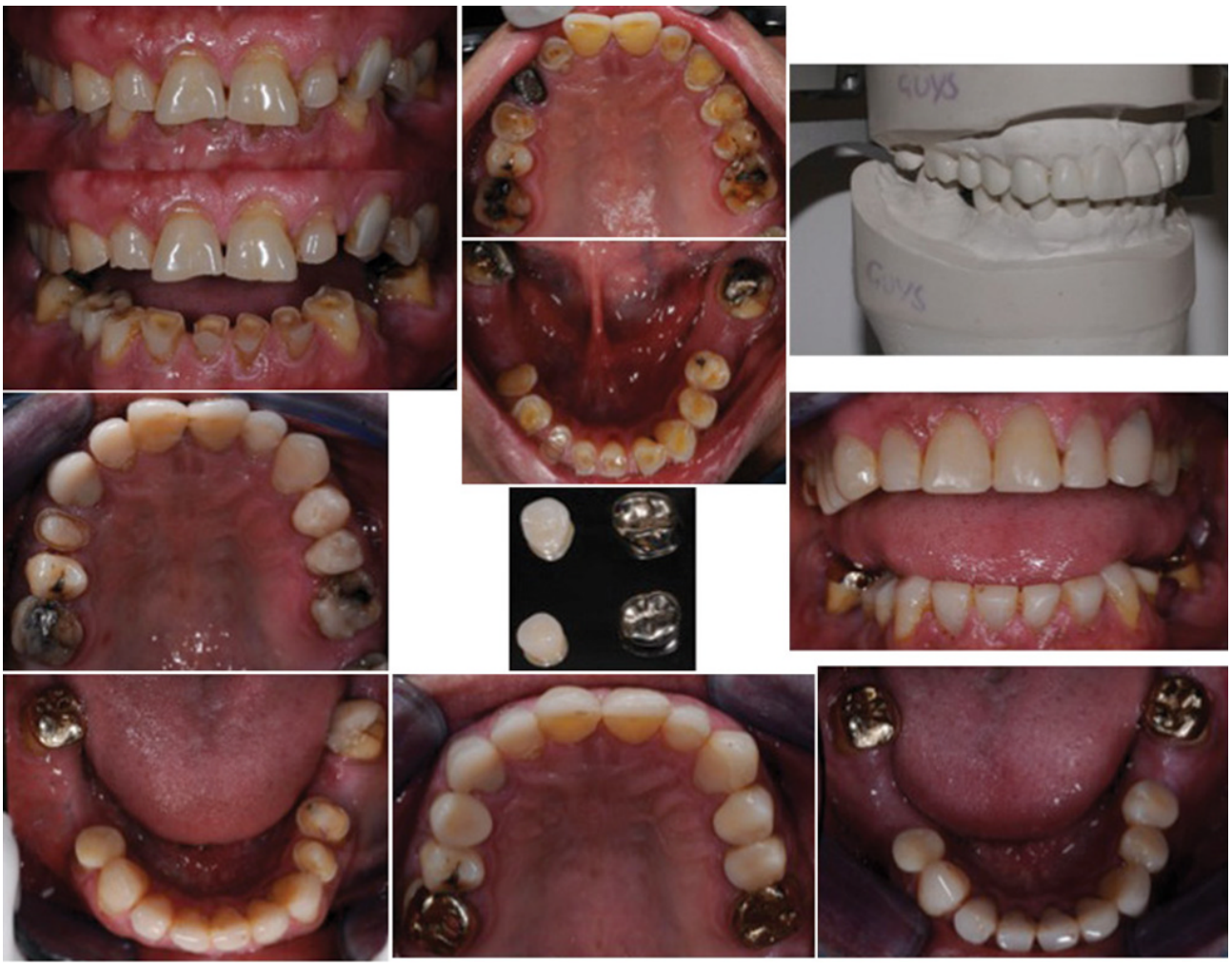


Figure 11.24 Restoration of worn anterior teeth with direct composite resin (Clearfil SE Bond, Kuraray Dental, Okayama, Japan; Tokuyama Estelite Sigma, Tokuyama Dental Corporation, Tokyo, Japan). Worn premolar teeth with indirect composite onlays and molars with gold onlays.

the patient who agreed to proceed and the posterior teeth that required restoring were assessed for restorability. The worn posterior amalgam restorations that exhibited staining and ditching around their margins were removed and then an alginate impression was taken of the teeth to assess the amount of remaining tooth structure so the appropriate restoration could be designed. A diagnostic wax-up of a new occlusal scheme at the increased vertical dimension was fabricated, which was then shown to the patient.

The diagnostic wax-up was duplicated to allow construction of putty matrices, which would aid the placement of composite resin. The upper left canine was restored with a fibre post and it was decided to restore all the upper and lower anterior teeth in direct composite resin. The premolars would be restored with indirect composite onlays as the patient did not want to show gold and the posterior molars restored with adhesively retain gold onlays (Figure 11.24).

Clinical steps are listed in the following box.

1) Take a full medical and social history to try to identify aetiology of tooth wear.	
2) Commence prevention, diet advice, fluoride and remineralisation therapies.	Complex operative treatment should be carefully considered and institution of a preventive regime will allow further assessment of patient's motivation towards lengthier treatment.

3) Reassess and discuss treatment options with the patient. Ensure the patient is aware of 'lifetime' maintenance requirements of any restorations placed and arrangements are in place prior to commencing treatment.	There are several treatment options for the case shown ranging from no treatment, an adhesive build-up or a conventional approach using crown lengthening and full coverage coronal restorations. In very severe tooth wear, overdentures may also be indicated. The adhesive 'additive' approach preserves what little remains of the teeth.
4) If operative treatment is indicated: • Take upper and lower alginate impressions in stock trays. • Take face-bow recording. • Record centric relation in 'teeth apart' position. • Assess restorability of teeth whose restorations require investigation. • Take alginate impression of teeth after removing restorations and any caries.	
5) Assess how much interocclusal space is required for restorations. Space can be created by: • Conformative approach, which would involve crown lengthening. • Assessing if space is available when the models are mounted in centric relation. • Make space by increasing the occlusal vertical dimension. Because the occlusal surfaces of both the anterior and posterior teeth exhibited tooth wear, the occlusion would need to be reorganised.	A 'Dahl' approach is not indicated because the tooth wear is generalised and the posterior occlusal surfaces require restorations.
6) Fabricate diagnostic wax-up taking into consideration the need for anterior guidance and bilateral even occlusal contacts.	The new reorganised occlusal scheme is planned with the diagnostic wax-up.
7) Duplicate wax-up in stone.	The actual operative treatment becomes 'conformative' because treatment conforms to the 'wax-up'. Putty matrices and soft acrylic 'blow downs' can be made on the duplicate stone models. These will guide the placement of the composite resin.
8) Commence with anterior teeth. Choose shade of composite. Good isolation required. Place rubber dam or use other moisture control methods.	
9) Evaluate the exposed dentine. Here the dentine is old and sclerotic. A long etching time of 1–2 min application of phosphoric acid to both enamel and dentine is necessary. Select adhesive. In this case, it was a two-step self-etching primer adhesive (Clearfil SE Bond, Kuraray Dental, Okayama. Japan). These adhesives regularly perform well in laboratory studies and clinical evidence for their use is good.	Using phosphoric acid with a two-step self-etching primer becomes a 3-step approach.
10) Build anterior teeth in pairs as described previously. Need to allow time to place composite stops on posterior teeth to prevent overeruption as the occlusal surfaces need to be restored. If carefully bonded, the posterior composite occlusal stops will act as a core material later for the occlusal onlays.	It may not be possible to do all six anterior teeth at once, so work in pairs; upper central and lateral incisors first maintain symmetry. Bond the occlusal composite stops as if they were definitive restorations so they can be kept as 'cores' as the vertical dimension has been increased.
11) Ensure anterior guidance is established on anterior teeth and guidance in lateral excursions.	Complete anterior restorations before moving to posterior teeth (Tokuyama Estelite Sigma composite resin, Tokuyama Dental Corporation, Tokyo, Japan).
12) Prepare posterior teeth for onlays either one arch at a time or upper and lower quadrants. Contacts need to be cleared and finishing margins prepared on buccal, lingual and proximal surfaces.	
13) Take impression using a material such as an addition-cured silicone and fabricate indirect restoration in desired material.	

14) Record intercuspal position using preferred material for taking the jaw registration.	
15) Fabricate restorations. Apply rubber dam and assess fit.	Indirect composite onlays allow for easy adjustment. Ceramic onlays are mechanically stronger but harder to adjust and repair. Require 2 mm thickness occlusally.
16) Place separating strips and wedges.	
17) Apply a metal primer to fitting surface of precious metal onlays. Silanate fitting surface of indirect composite resin onlays.	Composite, metal and ceramic surfaces of restorations should be treated accordingly. Indirect composite resin can be silanated. Ceramic can be etched with hydrofluoric acid and silanated. Precious metal should be treated with a metal primer before applying the adhesive resin cement.
18) Apply chemically-cured or dual-cured resin cement to fitting surface of restoration and cement in place. Carefully remove excess resin cement using hand instruments and brushes.	The adhesive resin cement should adhere well to tooth structure. Manufacturers have developed 'self-adhesive' resin cements but there is little clinical data on these materials to date.
19) Place air-inhibiting agent around restoration margins and place light source where cement exposed if dual-cured cement.	
20) Ensure floss can pass between contact points.	
21) Check occlusion using articulating papers and adjust accordingly.	

Repairing Fractured Restorations

1) Diagnose cause of failure.	Failure can be caused by factors such as secondary caries, mechanical failure, tooth fracture, microleakage, pulpal symptoms and occlusal factors.
2) Failure of a restoration does not mean automatic replacement. Studies have shown that removing composite resin can often lead to enlargement of the cavity. This will be especially true if the composite was placed to match the surrounding tooth structure exactly.	
3) Adding to an existing composite restoration poses a particular challenge because there will be no free monomers to bond new composite resin because maximum polymerisation would have occurred when the composite was first polymerised.	
4) A suggested technique for repairing a fractured composite resin is: • Anaesthetise the tooth if dentine is likely to be exposed. • Place the rubber dam. • Air-abrade the composite surface to be bonded to. • Etch the composite resin and any surrounding tooth structure with phosphoric acid. • Apply an adhesive and light cure. • Apply new composite resin.	From the various studies published on bonding to 'aged' composite, air-abrading the surface with aluminium oxide particles seems to be effective in allowing micromechanical retention of a thin layer of adhesive resin. Theoretically, the glass filler particles could be silanated with a silane coupling agent to facilitate chemical bonding with composite resin but the published studies have not shown a significant improvement over air abrasion. Air abrasion roughens the surface to enable micromechanical retention of the resin. Etching with phosphoric acid will clean the surface and etch any peripheral tooth structure.
5) If amalgam needs repairing or needs to be bonded to in case of a cusp fracture for example, retentive grooves can be cut then a chemically setting opaque adhesive resin can be applied to the amalgam surface. Composite is bonded to the set cement.	Opaque adhesive resin cement will mask the grey colour of amalgam and allowing bonding of composite resin. Free monomers in the air-inhibited layer on the surface of the resin cement will allow chemical bonding of the first increment of composite resin. Opaque adhesive resin cement will mask the grey colour of amalgam and allowing

Restoring the Endodontically Treated Tooth

Despite numerous clinical and laboratory studies there are still no precise recommendations for restoring the endodontically treated tooth. If a posterior endodontically treated tooth has lost one or more marginal ridges it is significantly more at risk of root fracture. The strong adhesion and improved wear resistance of directly placed composite resin has widened its applications.

Anterior teeth are subject to shearing forces and to resist these forces it is often necessary to place a post into the root to aid retention of the core. However, placing carefully bonded composite resin into the root after removing some of the root filling may be sufficient to resist these forces (Figure 11.25). Posts can be direct or indirect and either carbon/glass fibre or metal. Metal posts have shown to increase the risk of root fracture when compared with glass fibre posts.

The amount of remaining coronal dentine will also determine the restorability of the tooth. A minimum of 2 mm is required to create a ferrule to aid retention of an extracoronal restoration. This can be achieved with surgical crown lengthening if required, subject to adequate root length and patient consent. Cuspal protection is indicated for root-filled posterior teeth to help prevent root fracture.

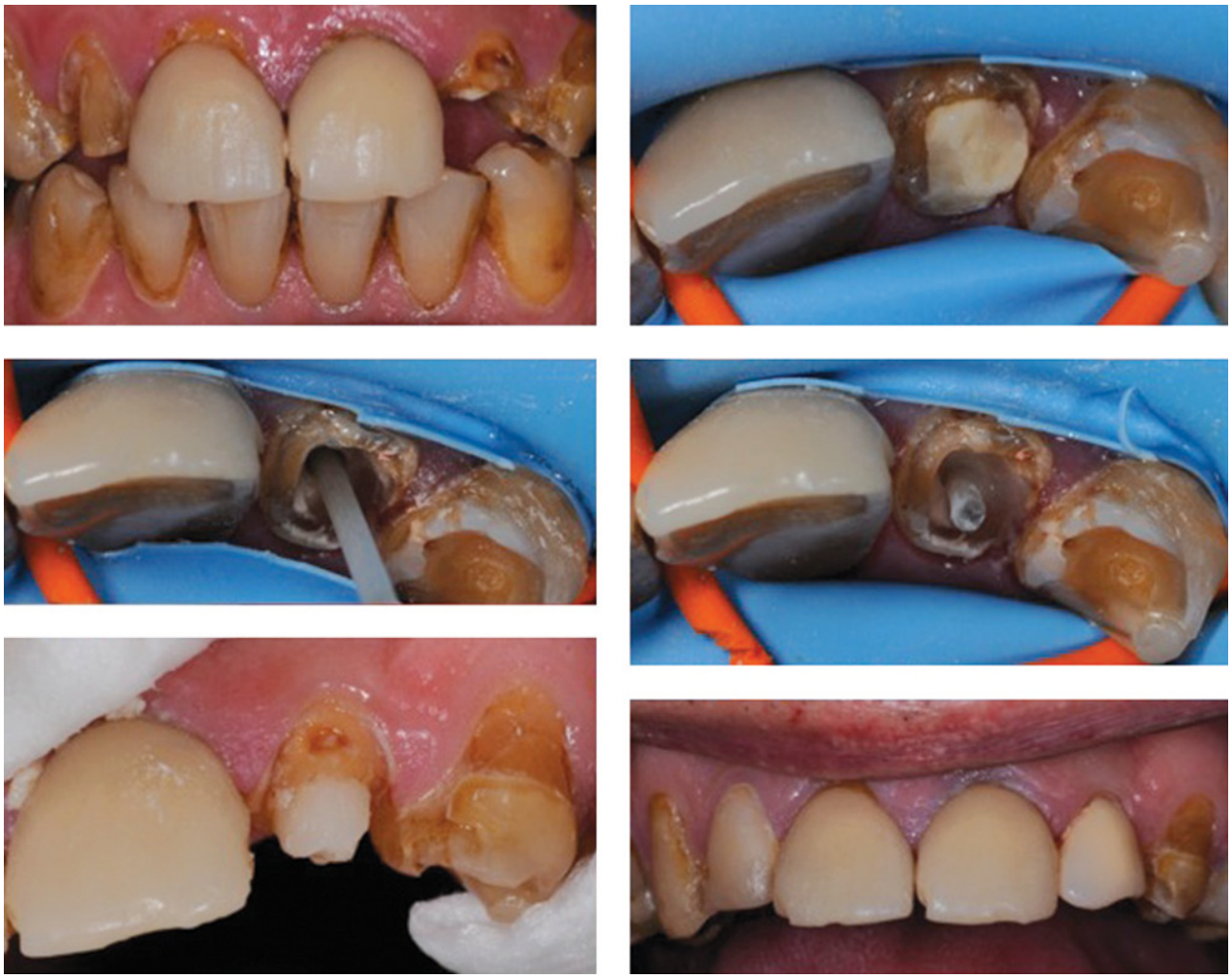


Figure 11.25 Restoration of worn anterior upper right and left lateral incisor teeth. Direct composite resin (UR2) and fibre post/indirect composite resin crown (UL2). The patient was very nervous of dental treatment and wanted the minimum treatment possible to preserve his wearing dentition. He was also afraid of wearing a protective splint at night.

For anterior teeth:	
1) Consider remaining coronal tooth structure. If it is less than 2 mm in height, then the restorability of the tooth needs to include adhesive direct build-up with composite resin.	
2) Evaluate the root length from a periapical radiograph. The post preparation needs to ensure that a minimum of 5 mm root filling material remains to avoid disturbing the apical seal.	
3) Apply a rubber dam.	
4) Remove gutta percha from root canal using Gates–Glidden burs.	
5) Select the fibre post and prepare the root canal with matching drill.	The fibre post should be bonded with an adhesive resin cement. Recently developed self-adhesive cements offer the advantage of ease of use. Fibre posts offer several advantages over metal posts: • Failure of teeth with fibre posts are less catastrophic than with metal posts. • The fibre post can be removed with magnification and replaced with a new post.
6) Ensure the post is long enough and extends occlusally to retain the core.	
7) Etch the root canal with phosphoric acid. Bond the fibre post according to the manufacturer's instructions.	
8) Build up tooth with composite resin core.	
For posterior teeth: 1) If the tooth has been endodontically treated, intracoronal retention for the core can be achieved by removing gutta percha from the obturated root canals up to a depth of 2–3 mm. This can be achieved using Gates–Glidden burs in ascending sizes. 2) Fill the space created with either composite resin or amalgam. Then build up the core in either composite resin or amalgam.	A core retained within the root canal system is termed a 'Nayyar core'. Because direct composite resin can bond to the remaining tooth structure, it is not clear whether a post needs to be placed in a posterior tooth for a core. Ensuring that there is sufficient remaining coronal tooth structure (2–3 mm minimum) to create a ferrule for the extracoronal restoration is likely to be the more important factor influencing the long-term survival of the tooth.

References

Deery, C. (2013) Caries detection and diagnosis, sealants and management of the possibly carious fissure. British Dental Journal 214:551–557.

Fusayama, T. (1979) Two layers of carious dentin: diagnosis and treatment. Operative Dentistry 4:63–70.

Mattos, J., Soares, G., Ribeiro, A. (2014) Current status of conservative treatment of deep carious lesions. Dental Update 41:452–456.

Ogawa, K., Yamashita, Y., Inchijo, T., Fusayama, T. (1983) The ultrastructure and hardness of the transparent layer of human carious dentin. Journal of Dental Research 62:7–10.

Perdigão, J., Lopes, M. (2001) The effect of etching time on dentin demineralization. Quintessence International 32:19–25.

Tay, F., Pashley, D. (2004) Resin bonding to sclerotic dentin: a review. Journal of Dentistry 32:173–196.

12

Procedures in Endodontics

Francesco Mannocci, Justin Barnes, David Jones, Edward Brady, Malissa Sikun and Manjeet Ahlowalia

Diagnosis

The diagnostic process is made up of three stages: history taking, examination and special tests/investigations. These procedures are fully described in Chapter 6. Only aspects directly pertinent to endodontic diagnosis will be considered here.

Presenting Complaint

Endodontic presenting complaints commonly include pain/discomfort, swelling, discharge, bad taste, and/or tooth discolouration.

History of Presenting Complaint

A pain history (Table 12.1) is essential not only to arrive at a diagnosis but also to determine the urgency for treatment. Pain aggravated by thermal stimuli is an indicator of pulpitis and severe pain is usually an indicator of irreversible pulpitis or periapical abscess.

Special Tests/Investigations

Special tests/investigations are an aid to diagnosis. The clinician should not rely on one test/investigation to arrive at a diagnosis; several should be performed and collectively analysed.

Palpation of Sulci

Procedure: roll index finger, under pressure, over buccal/labial and lingual/palatal mucosa in the region of the root apices. Instruct patient to signal if they feel an unpleasant sensation. Compare with contralateral side.

Analysis: tenderness to palpation is usually an indicator of inflammation of the periapical tissues.

Percussion of Teeth

Procedure: *gently* 'tap' teeth using a dental mirror handle. Repeat on occlusal, buccal/labial, and lingual/palatal surfaces. Randomly number the teeth and instruct patient to signal if they feel an unpleasant sensation. Comparison with contralateral and to obviously unaffected unilateral teeth is essential

Analysis: tenderness to percussion is usually an indicator of inflammation of the periodontal ligament. This may be endodontic or, less frequently, non-endodontic in origin (e.g. trauma, parafunction).

Bite Test

The bite test uses a plastic bite stick (e.g. Tooth Slooth) to determine if there is a cracked cusp.

Procedure:

- Place indentation of a plastic bite stick on cusp tip.
- Instruct patient to close their teeth together with pressure and signal if they feel pain on biting or on release of biting.
- Repeat on each cusp tip of tooth.

Analysis: a painful response, usually on release of biting, is an indicator of a cracked tooth.

Pulp Sensibility Tests

Sensibility tests assess the response of pulpal nerves to various stimuli, for example cold, hot and electric. The results of these tests can be used to infer whether the pulp is vital or not.

- The results of sensibility tests are subjective and qualitative. Interpretation of the results should be made carefully as tests are not 100% accurate.
- Care should be taken to identify false results.
- False positive results may occur more often in multirooted teeth where only partial necrosis has occurred, in anxious patients, or due to conduction from adjacent teeth.
- False negative results may occur in immature teeth, calcified coronal pulp chambers, traumatised teeth, or in teeth with large coronal restorations.

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

Table 12.1 Pain history questions.

Category	Questions
Character	'Describe the pain for me'
Severity	'How severe is the pain on a scale of 1 to 10 with 10 being the worst pain you have every experienced?'
Chronology (onset, frequency, duration)	'When did the problem start?' 'When does the pain come on?' 'Are you kept awake or woken by the pain?' 'How long does the pain last?' 'How often do you get the pain?'
Site and referral	'Where do you feel the pain?' 'Can you locate the pain to a specific tooth or just a general area?' 'Does the pain radiate anywhere else?'
Aggravating factors	'Is there anything which brings on or makes the pain worse?' 'Do cold or hot substances make the pain worse?'
Alleviating factors	'Is there anything which alleviates the pain?' 'Have you taken painkillers or antibiotics for the pain?'

Cold Sensibility Test

Cold tests can be performed using a variety of materials:

- Ice.
- Ice cold water while the tooth is isolated under a rubber dam.
- Ice crystals formed on foam pellets or cotton wool pledgets using ethyl chloride or refrigerant sprays (e.g. Endo-Frost, Figure 12.1).
- Dry ice sticks (CO_2 snow).

It is generally accepted that the colder the stimulus, the more reliable the test.
Procedure:

- Dry teeth.
- Instruct patient to indicate when they feel a sensation. Apply cold stimulus to tooth surfaces.
- Compare with the contralateral tooth and adjacent teeth.
- Repeated testing may be required to ensure reproducibility of results.

Analysis: it is generally accepted that a fleeting sharp sensation is an indicator of a healthy pulp, and a lingering ache or throbbing is an indicator of an irreversibly inflamed pulp. No response may be an indicator of a necrotic pulp.

Heat Sensibility Test

Heat tests are only performed when the patient is complaining of pain aggravated by a hot substance and the diagnosis is not easily achieved by using a cold sensibility test. Heat tests can be performed using a variety of materials and equipment:

Figure 12.1 Refrigerant spray for cold sensibility testing.

- Heated gutta percha point (tooth should be coated with petroleum jelly).
- Warm water while the tooth is isolated under a rubber dam.
- Heated probe (e.g. Elements obturation unit).
- A prophy cup to create frictional heat.

Procedure: similar to cold testing.
Analysis: similar to cold testing.

Electric Sensibility Test

Electric tests are performed using a battery-operated electric pulp tester (Figure 12.2).
Procedure:

- Dry teeth.
- Instruct patient to signal when they feel a 'tingling sensation'.
- Place a conducting medium (e.g. prophy paste) on the pulp tester probe. Apply probe to tooth surface over where the pulp horns are located.
- Complete circuit with lip hook or patient holding end of probe.

Figure 12.2 Electric pulp tester.

- Slowly increase current on unit until patient gives signal.
- Compare with the contralateral tooth and adjacent teeth.
- Record reading of lowest current, which elicits a response.

Analysis: a response is usually an indicator of a healthy pulp. No response is usually an indicator of a necrotic pulp.

Physiometric Tests

Physiometric tests assess the pulpal blood supply and are therefore true vitality tests, e.g. laser Doppler flowmetry, pulse oximetry. These tests are technique sensitive, take time to assess data and are generally not frequently used in daily clinical practice.

Local Anaesthetic Test

Administration of local anaesthetic can be useful when the patient is unable to localise pain to a specific tooth or region.
Procedure: local anaesthetic is administered as an infiltration or intraligamental.
Analysis: if selective local anaesthesia of the suspected tooth stops the pain, then this is the source of the pain. If the local anaesthesia does not stop the pain, then the clinician may need to look at other areas for the source of the pain. This may include considering non-odontogenic causes of pain.

Test Cavity Preparation

A test cavity should only be performed when all other special tests are inconclusive.
Procedure: as with any invasive procedure, explain the nature of the test and obtain consent from the patient. Under rubber dam and without local anaesthesia, drill a small cavity through enamel (or restoration) into dentine using a diamond bur in a high-speed handpiece. Restore cavity.
Analysis: a response is an indicator of a vital pulp, which may or may not be inflamed. No response is usually an indicator of a necrotic pulp.

Removal of Restoration

It is useful to remove the entire coronal restoration to assess restorability of the tooth and identify any underlying tooth fractures or caries. The exception to this may be a recently provided well-fitting cast restoration.

Photography

It is now routine to take high quality photographs to record the preoperative status.

Radiographic Examination

Periapical radiographs provide useful information to aid endodontic diagnosis.

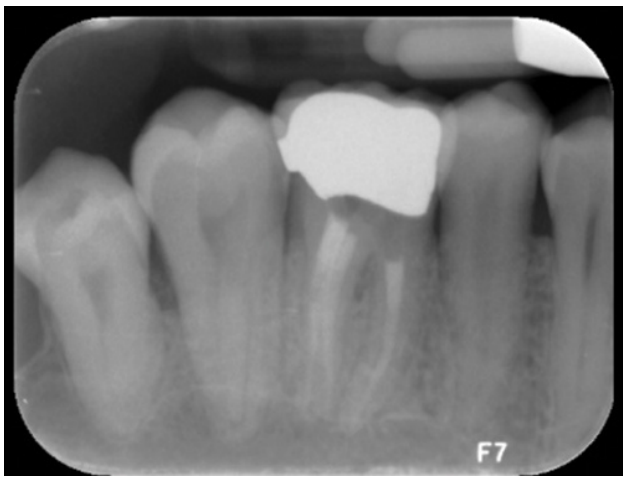
- Sometimes a parallax view provides additional valuable information.
- If a sinus is present, then a radiograph should be taken with a gutta percha point inserted in the sinus so that the origin of the infection can be more easily identified.

Procedure:

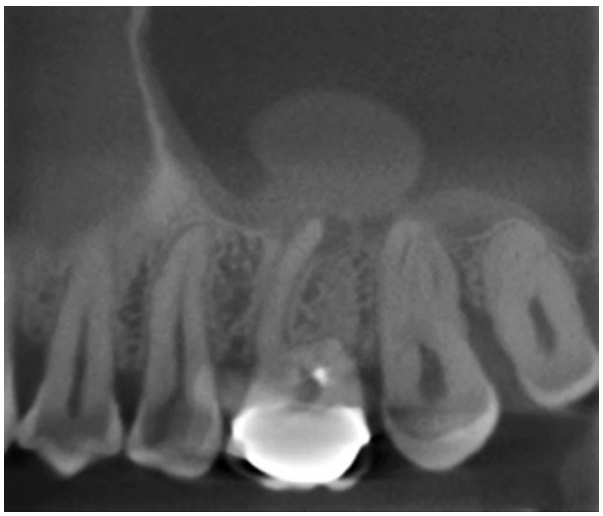
- Use a paralleling technique.
- Place the film, phosphor plate or charged-couple device sensor in a holder and position parallel to the long axis of the tooth.
- Position the collimated X-ray tube head using an aiming device.
- View film-based radiographs in optimal conditions, i.e. on a light box, blocking out extraneous light. View digital radiographs on a computer screen using imaging software.

Analysis:

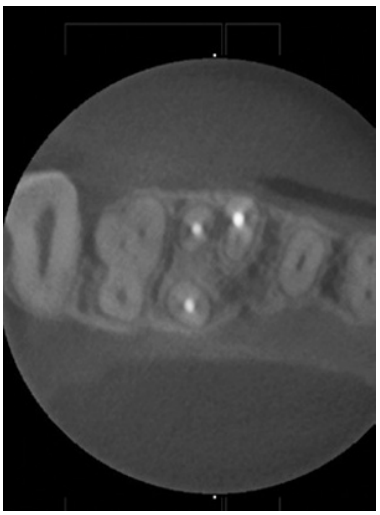
- Widening of the periodontal ligament space, a breach in the lamina dura, or a periapical radiolucency in the



(a)



(b)



(c)

Figure 12.3 (a) Root canal treated maxillary first molar showing apparently healthy periapical tissues. (b) Apical radiolucency associated with the mesial root and with a significant thickening of the antral mucosa. (c) The mesiobuccal root shows an untreated mesiopalatal canal.

surrounding bone are all indicators of apical periodontitis.

- Asymmetrical loss of the root and 'ballooning' of the root canal are indicators of root resorption. For treatment planning, it is also important to assess the number of roots, degree of curvature of roots, and the quality of any existing root filling and coronal restoration.

The clinician should remember the limitations of conventional radiographs, i.e. two-dimensional representation with superimposition of structures. Cone beam computed tomography (CBCT) may be indicated:

- To obtain a more accurate assessment of the extent of external resorptions.
- To obtain an assessment of the risk of perforations associated with internal resorptions or complex anatomy.
- When the presence of a periapical radiolucency is difficult to ascertain due to the superimposition with adjacent anatomical structures such as the maxillary sinus, or due to the presence of thick cortical bone plate surrounding the lesion (Figure 12.3).

Conclusion

Endodontic diagnosis is always an educated guess based upon a complex array of tests; it is only after the collection of all the information that a reliable diagnosis can be reached.

Preparation for Endodontic Treatment

Preparation of the patient includes:

- An explanation of the procedure and expected length of treatment.
- A discussion regarding the likelihood of success/outcome.
- Discussion of alternatives to root canal treatment and discussion of their implications (extraction, implant, do nothing).
- Advising the patient if a crown will be necessary following completion of treatment.
- An understanding on the part of the patient that the tooth may prove to be unrestorable if something untoward is discovered (e.g. a crack).

This comprises informed consent.

Preparation of the tooth for endodontic treatment can be thought of as falling into two distinct parts:

- Procedures to facilitate endodontic treatment.
- Isolation with a rubber dam.

Procedures to Facilitate Endodontic Treatment

Prior to commencing access cavity preparation:

- All caries must be removed from the tooth.
- It is also normal practice to remove all restorations from the tooth. This enables a thorough assessment of the quantity and integrity of the remaining tooth structure to be performed.

In cases where there is adequate sound dentine and enamel, then access cavity preparation can be commenced. In other cases a variety of procedures may be necessary to further prepare the tooth for endodontic treatment.

Such procedures may include:

- Using restorative materials to build up a tooth to facilitate isolation.
- Cementation of a copper or orthodontic band.
- Surgical crown lengthening.
- Orthodontic extrusion.

On some occasions it may be necessary to use a composite or glass ionomer to build up one or two walls of a tooth. This may be necessary to prevent leakage of saliva and irrigant around a cavity margin or simply to create a reservoir for the irrigant during endodontic treatment.

In cases where there is concern regarding the propagation of cracks or fracture of a weak tooth during endodontic treatment, the cementation of a copper band or orthodontic band may be beneficial. Orthodontic bands are suitable for use when the cavity margins are supragingival and a suitably sized band can be quickly cemented with zinc phosphate or glass ionomer cement. Once the cement has set, a rubber dam can be applied and the tooth accessed as normal.

Copper bands are more useful when the cavity margins are subgingival, or the cavity margins vary in depth. Copper bands are favoured in this situation because they can be trimmed and burnished to accommodate such discrepancies. The contact points are removed from the tooth to be treated using abrasive strips and the occlusal surface reduced. A suitably sized band is selected and trimmed appropriately before being cemented and burnished. Placing bands on teeth in this manner facilitates the isolation, endodontic treatment and restoration of teeth with subgingival cavity margins, as well as reinforcing vulnerable teeth during treatment.

It is desirable for such bands to be removed as soon as possible after treatment, but it is acceptable to leave them *in situ* until it is time to prepare the tooth for a crown, provided the patient can maintain adequate oral hygiene.

After removing any caries and all intracoronal restorations, if there is insufficient coronal tissue remaining for restoration or there is not enough to create a ferrule, the restorability of the tooth must be questioned.

- In some circumstances it may be possible to perform surgical crown lengthening to increase the amount of coronal tissue available.
- Following the surgery, in particular for posterior teeth, well-fitting temporary crowns should be provided for a 2–3 month healing phase before the construction of the definitive restoration.
- Another option in this situation is rapid orthodontic extrusion of the tooth, although an orthodontic opinion would need to be sought to confirm suitability for this procedure.

In some situations, the clinician may choose not to remove all restorations from the tooth prior to embarking on endodontic treatment. Such occasions may include:

- Recently cemented crowns.
- Recently placed large fillings.
- Veneers.

In these situations, the patient must be made aware that there is the potential for damage to these restorations, necessitating replacement, with the associated costs.

Undertaking a root canal treatment through crowns or existing fillings is generally contraindicated due to the risk of leaving undetected decay and paths of coronal leakage of bacteria into the root canal space. If attempting to perform endodontic treatment through a crown, the clinician must be aware that the restoration

will prevent transmission of light into the tooth and so will reduce visualisation of the internal anatomy, making the procedure more time consuming. In these situations, the operating microscope, which provides magnification and axial light, is invaluable

Rubber Dam

When one considers the biological aim of endodontic treatment (i.e. to eradicate all bacteria from the root canal system) it is obvious that the prevention of contamination of the surgical site by saliva and other fluids is essential for a favourable outcome. The simplest and most effective means of achieving this is by using a rubber dam.

A rubber dam is easy and, with practice, quick to place. Its use will facilitate:

- Prevention of bacterial contamination.
- Soft tissue retraction.
- Improved visualisation of the surgical site.
- Prevention of irrigant leakage into the patient's mouth.
- Protection against inhaling/ingesting instruments.

The importance of a rubber dam in endodontics simply cannot be overstated. Most defence organisations consider its use mandatory and will not defend a dentist who has not used a rubber dam during endodontics.

The use of a rubber dam will make the procedure easier to tolerate for the patients because they perceive it to be less invasive. Soft tissues such as the lips and tongue are retracted improving access for the dentist, making the procedure less stressful and much easier and faster. The colour contrast between the surgical site and the rubber sheet improves visualisation of the tooth.

Rubber dam apparatus usually consists of a clamp, frame, forceps, punch and a rubber sheet. The rubber sheet comes in a variety of thicknesses and styles, and may be made of latex or be latex-free. A hole-punch is required to create a clean hole near the centre of the sheet for the tooth which is being isolated. Most punches allow for a variety of sizes of holes to be created, and the size most appropriate for the tooth must be selected to create a snug fit (Figure 12.4).

Rubber dam clamps come in a variety of shapes and sizes and vary between manufacturers. In general, they are classified as winged or wingless. Winged clamps are designed so that the clamp and the rubber dam are placed onto the tooth in one application. Wingless clamps are placed directly onto the tooth and then the rubber dam is passed over the clamp and onto the tooth. The forceps are used for the application of the clamp in both these techniques.

Clamps can also be defined based upon the jaws used to engage the neck of the tooth. 'Retentive' clamps have

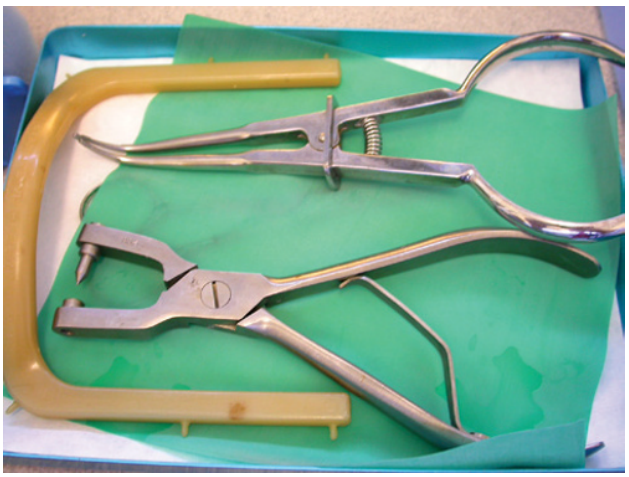


Figure 12.4 Rubber dam kit.

quite sharp, pointed jaws that are orientated apically which grip the tooth firmly and reflect the gingival tissues. These clamps are useful in broken-down teeth, or teeth with insufficient undercuts to retain a 'bland' clamp. The jaws of 'bland' clamps are orientated towards each other and are designed to simply engage the natural undercut of the tooth. 'Tiger' clamps have serrated jaws, which are very effective for gripping molar teeth firmly.

Clamps can also be categorised based upon the type of tooth they are used for:

- Anterior.
- Premolar.
- Molar.

When attempting to treat a tooth that cannot be clamped (for whatever reason) the split-dam technique might be an alternative especially for maxillary anterior teeth. This involves:

- Isolating the teeth on either side of the tooth to be treated.
- Splitting the dam between them to bring the tooth through the rubber dam.

Unfortunately, this technique usually results in poor isolation and leakage, even when supplementary sealing agents such as Ora-Seal are used.

Ora-seal (and similar products) are non-setting cellulose-based, or composite-based substances, which effectively prevent the ingress of saliva into the operating field if a defect in the isolation is present. Wedjets are another useful addition to the rubber dam armamentarium. These are pieces of rubber dispensed in a similar manner to dental floss, which can be stretched through the contact points of teeth to help keep the rubber dam *in situ*. A mouth prop is also useful in some patients when placed

on the other side of the mouth, before applying the frame, especially when the patient is unable to keep the mouth open for a long time.

Access Cavity Preparation

Good access cavity preparation is key to performing successful, predictable endodontics. The aims of access cavity preparation are the same in every tooth:

- Removal of the entire pulp chamber roof.
- Identification of all canals.
- Establishment of straight-line access to the primary canal curvature.

The preoperative periapical radiograph provides useful information regarding the size and depth of the pulp chamber, as well as where the canal orifices can be expected to be located.

- Using a long, tapered diamond bur, carefully drill deeper into the tooth along its long axis. It is sensible to aim for the largest pulp horn as the site of initial penetration into the pulp chamber. Whilst doing this, be mindful of the depth and orientation of the bur – if the bur is deeper than expected and the pulp chamber has not been found, then it may be sensible to take a radiograph to ensure that the cavity is correctly positioned and assess the risk of perforation.
- Once the chamber has been perforated with the diamond bur, the roof of the entire chamber should be removed. This can be done with a round, slow-speed bur using upwards cutting strokes.
- Alternatively, a safe-ended tungsten carbide bur such as the Endo-Z (DENTSPLY Maillefer) is very efficient at opening the chamber whilst protecting the pulpal floor.
- When the entire roof of the pulp chamber has been removed, pulp stones or overhanging lips of dentine from the interface between the floor and walls of the cavity are also removed.

Ultrasonic instruments are very useful for this purpose and can rapidly clean and define the pulp chamber. Again, good illumination and magnification provide significantly improved results at this stage. It should be possible to identify the access to the main canals at this stage, and it is usually possible to observe any additional canals, such as an MB2.

- Once the entrances have been identified it is imperative to straighten the coronal part of the canals if adequate access to the apical portion is to be gained.
- Initially, the entrance to the canal should be enlarged using Gates–Glidden burs sizes 2, 3 and 4. These burs should be used with a brushing stroke on withdrawal against the pulp chamber wall. The resulting debris should be washed away with an irrigant such as sodium hypochlorite or ethylene diamine tetra-acetic acid (EDTA). Avoid the temptation to attempt to force files into the canal at this stage, as this may cause ledge formation.
- Once the entrances to the canals have been secured, the cavity outline should be modified to allow easy access to the canal orifices. At this stage, any further flaring of the entrance of the canal can be done with the Gates–Glidden burs or rotary Ni-Ti files. When straight-line access has been achieved it is possible to continue to instrumentation of the rest of the canal.

Knowledge of the internal and external anatomy of teeth is essential for good access cavity design.

Upper Incisor Teeth

These teeth typically have only one canal, but often have two pulp horns. The largest pulp horn lies within the bulk of the crown of the tooth and is narrow buccopalatally, but quite wide mesiodistally. The second pulp horn lies under the cingulum of the tooth and is generally larger in central incisors than laterals. It is very important to remove all the pulpal tissue from the crown of the tooth to prevent discolouration and therefore the access cavity should be carried down onto the cingulum. The resulting cavity shape is triangular. It is important to ensure that the palatal aspect of the cavity is orientated apically by brushing the wall here with a Gates–Glidden bur. If this part of the cavity is not orientated correctly, then straight-line access is not possible and there is a risk of labial perforation or ledging.

Upper Canine Teeth

Upper canines have only one pulp horn which correlates to the incisal cusp.

The pulp chamber is wider buccopalatally than mesiodistally and therefore has an oval shape. The access cavity should reflect this shape. The palatal aspect of the cavity should be orientated apically.

Upper First Premolar

This tooth has a pulp chamber, which is usually oval in shape and narrower mesiodistally than buccopalatally. There are two pulp horns, which correspond to the overlying cusps. The buccal pulp horn is usually larger than the palatal. The resulting access cavity should be oval, and run in a buccopalatal orientation. Occasionally a

second buccal canal may be identified, in which case the access cavity is modified to become more triangular.

Upper Second Premolar Teeth

This access cavity is of a similar design to an upper first premolar tooth, although usually it does not need to be so extensive buccopalatally.

Upper First Molar Teeth

This large tooth can have quite complex internal anatomy. The pulp chamber generally has four pulp horns (mesiobuccal, mesiodistal, mesiopalatal, distopalatal) and therefore the access cavity has a rhomboid shape, which is broader buccally than palatally, and centred slightly more mesially than distally. The palatal pulp horn is generally the largest, making this the easiest point of perforation into the chamber. Once the roof of the pulp chamber has been removed it is usually easy to identify the three main canals (mesiobuccal, distobuccal and palatal).

A high proportion of these teeth have a second mesiobuccal canal (the MB2) (Figure 12.3). Its approximate location can usually be determined by imagining a line drawn between the palatal and mesiobuccal orifice, and another from the distal canal, which meets the first line at 90°. The MB2 can usually be found at this intersection point. Ultrasonic instruments are very useful to remove the overlying dentine lip to reveal the canal. Once identified, the MB2 should not be instrumented until the MB1 has been fully prepared. A high proportion of MB1s and MB2s merge and premature instrumentation of the MB2 can result in blockage or ledging of the main canal and can also result in an unnecessary enlargement of the apical portion of the canal.

Upper Second Molar Teeth

The pulp chamber anatomy of the upper second molar is very similar to that of the upper first molar tooth. The main difference is one of scale – the pulp chamber of the upper second molar tooth is smaller and the canal orifices of the two buccal canals are located closer together therefore the access cavity is smaller. This tooth may have additional canals such as the MB2, or more rarely a DB2.

Upper Third Molar Teeth

This tooth has a highly variable anatomy, which makes access cavity design less predictable. The standard principles of accessing the chamber, removing the roof of the pulp chamber, identifying the canals and achieving straight-line access should be used to determine the cavity form.

Lower Central and Lateral Incisors

Like upper incisors, these teeth require narrow, triangular access cavities with the base oriented towards the incisal edge and the apex towards the cingulum. It is important to carry the access cavity onto the cingulum to allow complete removal of the pulp chamber roof and straight-line apical access. Perforation is common in these teeth when the lingual aspect of the cavity is insufficient. The pulp chamber of these teeth is wider buccolingually than mesiodistally. A significant proportion of these teeth have two canals – the second is located lingual to the main canal, so adequate access preparation is essential to identify this canal.

Lower Canine Teeth

These teeth commonly have only one pulp horn, but may have two canals. The access cavity should have an oval form and care should be taken to extend it lingually to access the lingual wall or a lingual canal. The pulp chamber is wider buccolingually than mesiodistally, giving the resultant oval form to the access cavity.

Lower First Premolar Teeth

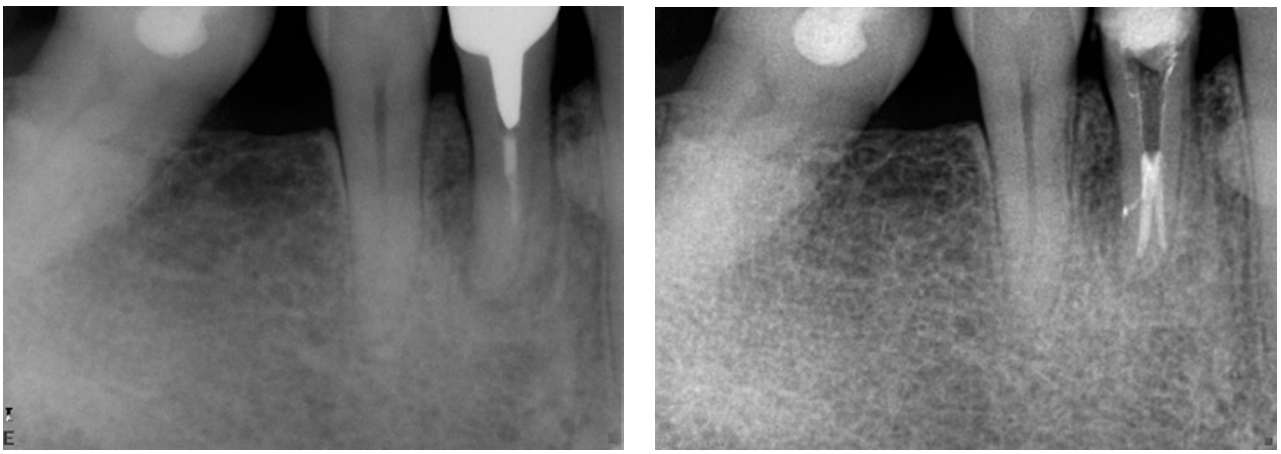
These teeth have a large buccal pulp horn and a smaller lingual one. The pulp chamber is wider buccolingually than mesiodistally, and is centred on the middle of the occlusal surface. The resulting access cavity should have an oval form and will be extended more onto the buccal cusp than the lingual. It is possible for there to be two or more canals in this tooth so care should be taken to search for other orifices. The crown of this tooth is often lingually inclined; therefore it is often necessary to extend the buccal aspect of the cavity quite close to the cusp to facilitate straight-line access and identification of other canals.

Lower Second Premolar Teeth

These teeth are similar to the lower first premolar teeth, except the lingual pulp horn tends to be larger. There is still considerable variation in the number of canals, but in most cases only one is present; two canals are present in 8–10% of cases (Figure 12.5). The crown of the tooth is less lingually inclined than that of the lower first premolar tooth and therefore less buccal extension is needed. Consequentially, the access cavity extends further up the lingual cusp than in the lower first premolar tooth.

Lower First Molar Teeth

This tooth has a large pulp chamber with, typically, three or four root canals. The chamber is roughly rectangular



(a) (b)

Figure 12.5 (a) Preoperative radiograph of a root canal treated mandibular premolar. The image of a second root suggests the presence of a second canal. (b) Final radiograph following re-root canal treatment showing the obturation of the second canal.

and centred in the middle of the tooth, but is narrower distally than mesially and the shape of the access cavity must reflect this. Most commonly there are two mesial (mesiobuccal and mesiolingual) and one distal canal, which lies in a plane between the mesial canals. However, frequently there are two distal canals. If the distal canal orifice seems to lie either buccal or lingual of the midline of the tooth, then a second orifice should be sought. Often when there are two distal canals there are communications between them and they often meet apically. A small proportion of lower molars have a third mesial canal, which lies in the groove between the MB and ML canals. An operating microscope and ultrasonic instruments are very useful in identifying this canal.

Lower Second Molar Teeth

The pulp chamber of this tooth is of a similar, but smaller, shape to the lower first molar. This tooth may have between two and four canals. This tooth has the highest incidence of C-shaped canals (Figure 12.6).

Lower Third Molar Teeth

This tooth has a highly variable anatomy, which makes access cavity design less predictable. The standard principles of accessing the chamber, removing the roof of the pulp chamber, identifying the canals and achieving straight-line access should be used to determine the cavity form.

Root Canal Preparation

The objective of root canal treatment is to remove irreversibly inflamed or infected necrotic pulpal tissue from the root canals and to seal the root canal space with a root filling to prevent leakage of bacteria and bacterial products from the root canal into the periapical tissues. The aim of treatment is to restore and/or maintain periapical health

Root canal treatment is carried out in two phases:

- Root canal preparation.
- Root canal obturation.

Root canal preparation involves:

- Chemomechanical debridement of the root canal space to remove remnants of pulpal tissue and microorganisms.
- Preparation of a suitable canal shape that can be effectively obturated.

Instruments Used in Root Canal Preparation

Root canal preparation is achieved using specialised instruments, which are either used by hand or are mechanically driven.

Stainless Steel Instruments

Traditionally, endodontic instruments have been manufactured from stainless steel. These instruments are flexible when their cross-section is small, but as the thickness of the instrument increases, stiffness markedly increases. This is a disadvantage when preparing curved canals as it restricts the size of instrument that may be used.

Hand Files

Stainless steel hand files are manufactured according to ISO sizing and normally have a 2% taper (increase in diameter of 0.2 mm/mm). The diameter of the instruments (measured 1 mm from the tip) ranges from size 04 (0.04 mm) to 140 (1.4 mm). Instruments are colour

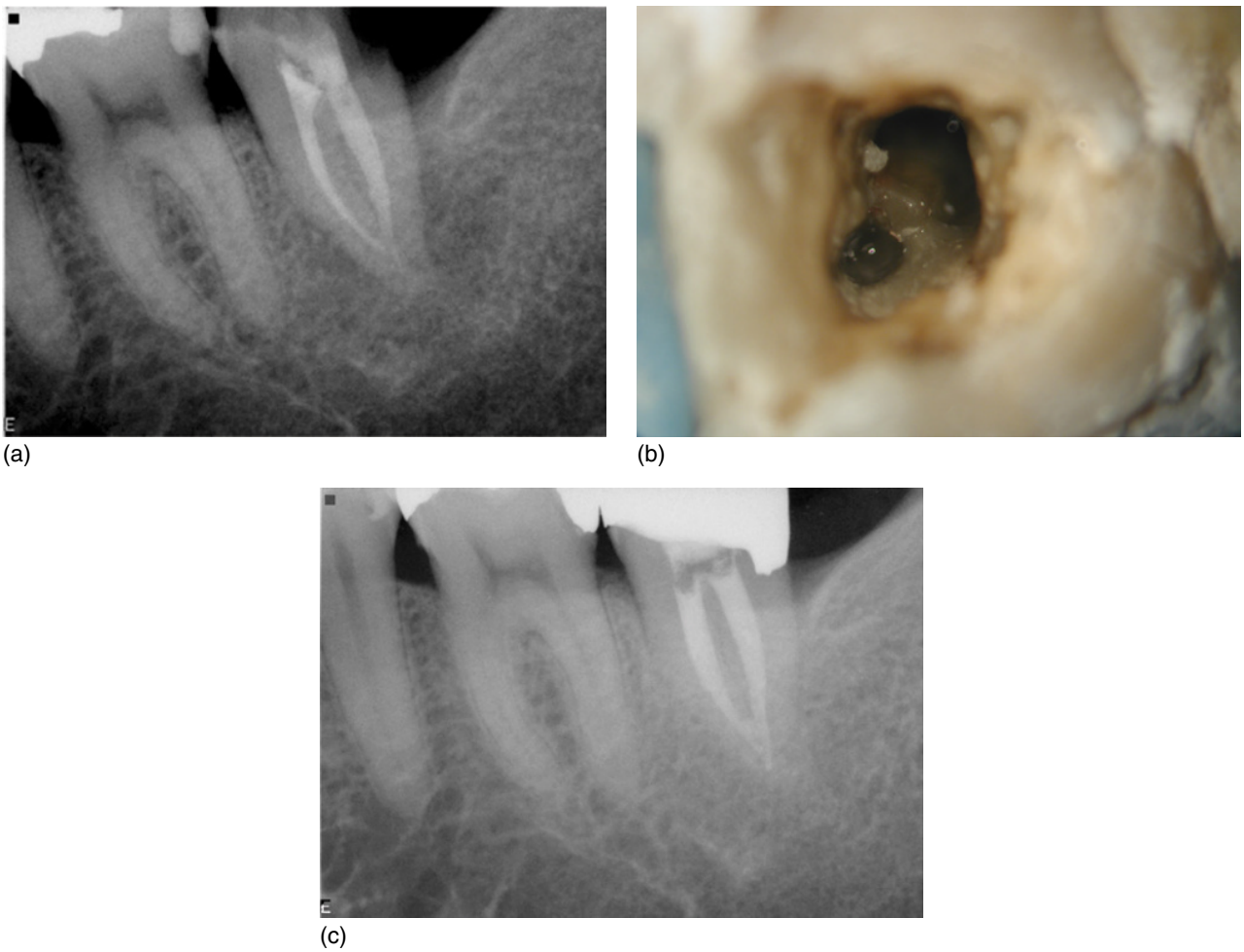


Figure 12.6 (a) Failed root canal treatment of a C-shaped second mandibular molar. (b) Successful retreatment of a failed root canal treatment of a C-shaped second mandibular molar. (c) One year recall radiograph following retreatment showing complete healing.

coded in a standard sequence. A variety of lengths are available, the most usual being 18 mm, 21 mm, 25 mm and 31 mm.

K-Type Files K-type files are the most widely used hand instruments. They are manufactured by twisting a square-, triangular- or rhomboid-shaped blank of stainless steel wire to produce an instrument with sharp cutting flutes along the length of the instrument. They may be used in a push–pull motion or using a 'balanced force' technique.

Hedstroem Files Hedstroem files are manufactured by machining a spiral groove into a round stainless steel blank to produce sharp cutting edges. They are used in a push–pull action to plane the walls of the root canal and have an aggressive cutting action on withdrawal. They should not be rotated in the canal, as they are susceptible to breakage. They are useful for removing old root filling materials in retreatment cases.

Gates–Glidden Burs

Gates–Glidden burs are used to flare the straight coronal section of the canal. They have a side cutting action with a non-cutting tip. Care must be taken when using Gates–Glidden burs, as they have aggressive cutting action and excessive force can result in perforation of the canal wall or breakage of the instrument. Six sizes are available, indicated by the number of bands on the shank of the instrument.

Nickel Titanium Instruments

Nickel titanium (NiTi) instruments have revolutionised root canal preparation in recent years. NiTi alloy is very flexible and returns to its original shape following deformation. These properties have enabled the development of instruments of a greater taper (usually 4% or 6%) than

is possible with stainless steel, which can be operated in continuous rotation in a handpiece rotating at between 150 and 500 rpm, although some instruments are available which are used by hand. NiTi instruments have the advantages of simplifying the preparation of root canals and producing a well-centred preparation with a suitable taper. However, they must be operated with great care, and only after practice on extracted teeth, as they are liable to break in inexperienced hands.

Manipulation of Hand Files

Watch-Winding

This is a useful technique for initial canal negotiation of the coronal and apical sections of the canal. The technique involves:

- Gently rotating a small file alternately clockwise and counterclockwise, approximately 30°, whilst maintaining gentle apical pressure.
- When progression becomes difficult, the file should be withdrawn to remove debris.
- Use of copious irrigant and lubrication facilitates the progression of files apically.

Balanced Force Technique

The balanced force technique is a hand preparation technique, which facilitates the cutting of dentine to allow the apical progression of files whilst maintaining a centred preparation and reducing the incidence of procedural errors. The technique is carried out as follows:

- The file is inserted into the canal until resistance is felt and turned a quarter of a turn to engage dentine in the flutes of the file.
- The file is then rotated anticlockwise for a turn whilst maintaining apical pressure (to prevent the file from reversing out of the canal). This action cuts dentine from the walls of the canal and a characteristic 'click' may be heard and felt.
- A further clockwise rotation through a quarter turn collects debris on the flutes of the file before withdrawing from the canal.

Initial Canal Negotiation

- Initial negotiation is carried out with a size 08, 10 or 15 K-file, which is gently worked apically using a watch-winding motion to ensure that the canal is negotiable. If the canal is fine or tortuous, a size 06 or 08 file should be used.
- The pulp chamber should be flooded with irrigant and a lubricant may be used to facilitate negotiation.
- Instruments should never be forced as this can result in ledges and blockages.
- Sequentially larger files, up to size 20 should be used to create a glide path in the coronal section of the canal.

Coronal Flaring

The coronal section of the canal is flared before instrumenting the apical section of the canal. The advantages of flaring coronally are:

- Removal of the bulk of infected pulpal tissue and debris to prevent coronal bacteria and debris from being pushed into the apical part of the canal.
- Removal of coronal obstructions and straightening of the coronal part of the canal to enable unrestricted access to the apical part of the canal. This minimises the risk of creating apical blockages and allows better access and tactile feedback for instrumentation of the apical part of the canal.

Coronal flaring may be achieved using a combination of stainless steel hand files and Gates–Glidden burs or NiTi hand/rotary files after having estimated the working length on the preoperative radiograph.

- Use sequentially smaller instruments as you move from the coronal to the apical aspect of the canal; each instrument creates space for the use of instruments of smaller size to advance further down the canal.
- Gates–Glidden burs must be used judiciously, especially sizes 4 and above as they are liable to cause perforations if used carelessly.
- If using NiTi instruments, the manufacturer's protocol should be followed. Some systems have specific files (orifice shapers) which are designed for coronal flaring, whilst in other systems, files of decreasing taper or diameter are employed in a crown-down approach.
- Frequent irrigation and recapitulation with a size 10 or 15 hand file is essential to flush away debris and to prevent canal blockage.

Working Length Determination

The working length is the length of the canal, measured from an occlusal reference point, to the terminus of the root canal preparation. Coronal flaring often causes straightening and a slight reduction in the length of the canal; it is therefore advisable to establish the working length after coronal flaring. The working length may be determined using radiographs or an electronic apex locator. An apex locator is exceptionally useful for quick determination of the canal length, but a radiograph provides information on canal length, position and curvature, which cannot be obtained using an apex locator alone. For optimal accuracy, it is recommended that a combination of the above methods is used.

Use of Apex Locators

- Estimate the canal length from an accurate preoperative radiograph.
- Ensure there is no fluid in the pulp chamber or coronal half of the canal (improve isolation if necessary).
- Introduce the lip clip into the patient's mouth.
- Attach the file clip to the file in the root canal.
- Gently work the file apically until the gauge on the apex locator indicates that the file is at the apex. This is the zero reading and indicates the length to the apical foramen.
- Ensure that the rubber stopper on the file is contacting a reproducible coronal reference point before removing the file.
- Measure the recorded length. The working length will be 0.5–1 mm short of the recorded length
- Consider using a periapical radiograph if unable to obtain a reliable reading

Apex locators may give unreliable readings in the following circumstances:

- If the file contacts a metallic restoration (for example a metal crown or an amalgam restoration).
- If the file comes into contact with vital pulp.
- Low batteries.
- In the presence of excess fluid (for example if the rubber dam is leaking).
- If the apical foramen is wide.

Working Length Radiograph

- Estimate the canal length from an accurate preoperative radiograph.
- Place a file (ideally at least a size 10, so that it is visible radiographically) into the canal to the estimated working length.
- Identify a reproducible coronal reference point (e.g. a cusp tip) and ensure that the rubber stoppers on the files are contacting the reference point before and after taking the radiograph.
- Take a radiograph using a paralleling technique using an endodontic film holder, e.g. the Endoray film holder (Dentsply Maillefer).
- If the radiograph shows the file to be within 2 mm of that deemed to be the correct length any necessary adjustments to the length of the file can be made and instrumentation may be continued. If the file is more than 2 mm from the correct length, the length should be adjusted and another working length radiograph taken to confirm the correct working length.

Apical Canal Preparation

When coronal flaring has been completed, the full length of the canal is negotiated. If the canal is narrow, fine instruments should be used to negotiate the canal to the full length. It may be necessary to precurve stainless steel hand files to negotiate sharp canal curvatures.

After working length determination, apical canal preparation may be completed using stainless steel hand files alone or a combination of NiTi (rotary or hand) files and stainless steel files. The aim is to produce an apical canal shape, which tapers smoothly into the coronal preparation.

Apical Preparation Using Stainless Steel Hand Files (Modified Double Flare Technique)

Apical preparation is carried out in two stages:

- Apical enlargement.
- Creation of apical taper.

Apical Enlargement

- Files are used in sequentially larger sizes at the established working length to increase the size of the apical preparation.
- Usually the apical part of the canal should be enlarged to at least two file sizes larger than the first file to bind at the working length.
- The largest file used to the full working length is the *master apical file*. The size of this file depends upon the size of the original canal and the canal curvature, but the smallest acceptable apical preparation is usually equivalent to a size 25 instrument.
- Frequent irrigation and recapitulation is essential to prevent blockages.

Apical Taper

- Files of increasing size are used sequentially in an apical to coronal approach, stepping back in 1 mm increments. This creates an apical taper and blends the apical preparation with the coronal flare.

Apical Preparation with Nickel Titanium Files

Generally, when NiTi files are used, the coronal flaring and apical preparation are carried out using a NiTi file system according to the manufacturer's protocol. The advantage of NiTi files is that a tapered preparation is produced more simply than when stainless steel hand files are used. Most NiTi systems are used in a coronal to apical (crown-down) approach, either using files of the same taper with decreasing tip size or using files of the same tip size with decreasing taper.

- Before using NiTi instruments in the apical part of the canal, a glide path should be created with a size 20 hand file to the full working length.
- The apex should be gauged using hand files to determine the diameter of the canal.
- Instrumentation is completed until a NiTi file of suitable diameter and taper reaches the full working length.

- Care must be taken not to force NiTi files apically or to allow them to rotate in the canal for too long, as they are liable to break, especially in curved canals.
- As soon as resistance is felt, the file should be removed and the flutes cleaned.
- Frequent irrigation and recapitulation is essential to prevent blockages and file breakage.

Patency Filing

Patency filing refers to the placement of a small hand flle, for example a size 8, 0.5 mm through the apical foramen during canal preparation to prevent blockage of the apical part of the canal by debris.

Irrigation

During instrumentation, canals should be copiously irrigated with NaOCL solution to flush away debris and microorganisms and to clean the parts of the canal that are inaccessible to mechanical instrumentation. Frequent irrigation is essential to prevent blockage of the canal by debris created during instrumentation.

- A Luer-lock syringe and a needle with a cut away tip should be used.
- Apply gentle pressure to the plunger of the syringe, using a forefinger rather than a thumb to avoid the extrusion of irrigant apically.
- Measure the depth of penetration, which should be at least 2 mm short of the working length. This will reduce the risk of inadvertent extrusion of irrigant through the apex.
- Irrigate frequently during the procedure and always ensure that there is a reservoir of irrigant in the pulp chamber during instrumentation.

Agitation of Irrigant

Irrigants should be agitated (for instance using a gutta percha point corresponding to the master apical file or an ultrasonic file) within the root canal to encourage the dissolution of organic matter and the removal of bacteria.

- Recapitulate the canal with a small file after irrigating to promote irrigant exchange in the apical part of the canal and to prevent blockages from debris produced by instrumentation.
- When instrumentation has been completed, the irrigant may be agitated by the introduction of a well-fitting gutta percha cone into the canal and moving the cone up and down in the canal with push–pull strokes of 3–5 mm.
- Passive ultrasonic irrigation is the most effective means of irrigant agitation. It involves the introduction of an ultrasonically activated file into the root canal to warm and agitate the irrigant. This aids the penetration of the irrigant into the parts of the canal that are inaccessible to mechanical instrumentation and dislodges organic debris and bacterial biofilm.

Irrigants

Sodium Hypochlorite

Sodium hypochlorite at a concentration of 0.5–5% is the root canal irrigant of choice. It is a highly effective antimicrobial agent and it can dissolve pulp tissue remnants. Regular replenishment and agitation are essential to maintain a level of efficacy and to circulate the irrigant to the inaccessible parts of the root canal system.

EDTA

EDTA is a chelating agent, which removes the mineralised inorganic component of the dentine. It is used to remove the smear layer, a layer of debris accumulated on the root canal walls after mechanical instrumentation. EDTA does not dissolve organic matter, so it should be used in conjunction with sodium hypochlorite.

Chlorhexidine

Chlorhexidine solution is an effective antibacterial agent, but it does not dissolve organic matter. Its use in endodontics is questionable.

Intracanal Medicaments

Calcium hydroxide is the intracanal medicament of choice. It has limited solubility and a high pH and is an effective broad-spectrum antimicrobial agent with a sustained period of action. Its actions include:

- Inhibition of bacterial proliferation.
- Further reduction in the bacterial load.
- Degradation of residual necrotic tissue.
- Control of apical serous exudate.

Placement of medicament and temporary dressings:

- Root canals are dried with paper points to remove irrigant before placing an intracanal medicament.
- The medicament may be placed into the canal using a small-sized hand file or a spiral filler.
- Proprietary brands of calcium hydroxide paste are available in a syringe format or in single use packages to simplify placement.
- A pledget of cotton wool is placed in the floor of the pulp chamber and a durable, well sealing temporary restoration is placed.
- Ideal temporary filling materials are a reinforced zinc oxide eugenol cement (e.g. IRM) or glass ionomer cement as they are durable and provide a good seal against salivary bacteria until the next appointment.

Root Canal Obturation Techniques

Obturation is carried out following thorough cleaning and shaping of the root canal system. It is done to fill the empty root canal spaces to:

- Prevent the penetration of residual bacteria from the root canal system into the periapical tissues.
- Prevent coronal microleakage of bacteria coming from the oral cavity into the root canal system.
- Prevent the proliferation of remaining microorganisms in the root canal system by physically limiting the intracanal space available for these microorganisms to occupy.
- Prevent percolation of tissue fluids from the periradicular tissues into the root canal system via the apical foramen/foramina and lateral canal/s.

Filling of the canal system should not be seen as the final stage of root canal treatment as restoration of the clinical crown to prevent coronal microleakage is crucial for the long-term survival of the tooth (Saunders and Saunders, 1994).

A plethora of materials, ranging from orangewood sticks to precious metals such as silver to dental cements, have been advocated for root canal obturation. However, gutta percha used with a sealer remains the material of choice because it is versatile and can be used in nearly all cases where there is an apical stop following canal preparation.

Gutta percha can be used to fill the root canal system in three main ways:

1) Obturation with cold gutta percha.
2) Obturation with heat-softened gutta percha:
   Intracanal heating technique.
   Extracanal heating technique.
3) Obturation with solvent-softened gutta percha.

Cold Lateral Compaction

The most popular method of root canal filling using cold gutta percha is the cold lateral compaction technique. This method evolved from the old single cone method as clinicians came to the realisation that single point filling does not adequately fill the entire root canal space.

Overview

A master gutta percha point is chosen that corresponds in size to the ISO size of the final root canal enlarging instrument known as the master apical file. The master cone is placed (along with sealer) in the canal and is compacted with lateral spreaders in a vertical direction. The space created by the spreader is then filled with additional smaller or accessory gutta percha points, which are further compacted until the entire root canal is filled.

The requirements for successful lateral compaction are:

- A flared canal preparation with an apical stop.
- A well-fitting master gutta percha point of standard size and 0.02 taper; a gutta percha point of 0.04 or 0.06 taper would prevent deep spreader penetration.
- A series of spreaders of different sizes and shapes.
- An assortment of accessory points which match the size and taper of spreaders.
- An appropriate sealer.

Technical Steps

Master Cone Selection

A master gutta percha point of the same size as the master apical file is selected. The point is then inserted with tweezers into the canal. There should be resistance to further insertion at a distance 0.5–1.0 mm short of the working length (tug-back). A radiograph is then taken to confirm the position of the point in relation to the radiographic apex.

If the gutta percha point is in the correct position within the root canal with space visible lateral to the master cone (seen on the radiograph) then lateral compaction can proceed.

If the gutta percha point is in the correct position within the root canal with no space visible lateral to the master cone radiographically then the canal must be reshaped to an increased taper. This will then permit the effective penetration of the spreader against the master cone to a point slightly short of the full working length.

If the gutta percha point is in the correct position but is loose and radiographically exhibits a wiggly or S-shaped appearance, the cone is too small for the prepared canal. A small degree of discrepancy (±0.05 mm variation in the tip size) may exist within the same batch of gutta percha points. As such, a selection of gutta percha points of the same nominal diameter can be tried inside the canal until one with the best fit is found. The use of a sizing instrument such as the EndoGauge (Dentsply Maillefer) is also helpful in this situation. Alternatively, the cone could be cut in 1 mm increments from the tip until tug-back is felt at the full working length. If the point is reduced in length, care should be taken to ensure that the tip is not flattened before it is reinserted into the canal. The use of a sharp blade is recommended.

If the cone fits short of the desired length, the following conditions may exist:

1) Dentine chips may be packed into the apical portion of the canal during instrumentation. This can be avoided by patency filing with small hand files and irrigating copiously at regular intervals during instrumentation.
2) The canal may be ledged. Attempts must be made to bypass and remove the ledge before proceeding with root filling.
3) The canal may be curved in a buccolingual direction and therefore not visible radiographically. Careful assessment of previous radiographs (preferably those that have been taken at different angulations) and a sound knowledge of the anatomy of the root canal are essential.
4) The master cone may be too large. The slight variation in size within a batch of gutta percha points may lead to the selection of a cone that is larger than the intended dimension. A smaller cone will need to be used. A sizing instrument is useful in this case.
5) The canal was not widened adequately at the apex or the canal was not sufficiently tapered. As with gutta percha points, files of the same ISO size also suffer some degree of size discrepancy. It is imperative that the master apical file be negotiated until it can pass freely to the end-point of preparation without excessive apical force. It may be necessary to select a new file and reinstrument the canal to the working length until the file is loose.

If the gutta percha point goes beyond the working length, the cone can be cut in 1 mm increments from the tip until tug-back is felt at the full working length. Alternatively, the canal can be re-prepared with a larger master apical file and a larger cone then used to fill the canal.

Selection of Spreaders and Accessory Gutta Percha Points

Once the master apical point has been selected, it is important to select a spreader that can negotiate into the canal to within 1 mm of the end-point preparation. A rubber stop should be used to identify the length of insertion.

The canal should be dried thoroughly with paper points. The sealer is then mixed and the master point is coated with it. The point is used to cover the root canal walls with the sealer, using an in–out movement, before seating to the full length (usually indicated by a notch made into the gutta percha by the tweezers which will lie adjacent to a reference point on the tooth).

Completion of Lateral Compaction

The spreader is placed alongside the point and pushed with controlled apical pressure until it reaches roughly 1 mm from the end-point preparation. Gentle apical pressure should be applied for about 10 s and then the spreader withdrawn slowly.

The first accessory point of similar size to the spreader is chosen and its tip dipped into sealer. This point is then inserted into the space created. The spreader is again positioned between the gutta percha and the outer wall of the canal. At this time, the spreader should not be expected to enter the canal to the same length. A second accessory point is inserted and the sequence of spreader application and accessory point insertion is continued until the canal is filled.

The excess gutta percha protruding out of the canal should be removed with a heated excavator and condensed vertically at the orifice. If an immediate post placement is required then more gutta percha can be removed coronally leaving at least 4 mm of gutta percha apically. Finally, a periapical radiograph should be taken using a long-cone parallel technique to verify that the root filling is properly placed and adequately condensed.

Heat-Softened Gutta Percha Techniques: Intracanal Heating

Warm Vertical Compaction Techniques

Cold gutta percha is inserted into the canal and then heated so that it becomes softened and condensable. A variety of techniques using intracanal heat exist.

One example is the thermatic compaction of gutta percha using a handpiece-driven compactor. This uses the frictional heat generated by a rotating condenser to plasticise the gutta percha and drive the softened material into the root canal under pressure. The problem with this technique is the limited control over the apical portion of the gutta percha, which may be inadvertently extruded through the apex in its plasticised state.

Another technique involved the use of heated gutta percha, which is compacted into the canal in multiple layers using pluggers of different sizes. With the introduction of the System B Heat Source, this technique has been made simpler as it allows the vertical compaction of gutta percha in a single continuous wave.

Continuous Wave of Condensation Technique

A prerequisite to this technique is that the canal should be shaped to create a continuous taper with the smallest diameter at the foramen. This provides a resistance form and prevents extrusion of the gutta percha during vertical compaction. Root filling is done in two stages: down pack and back fill.

In down pack the apical portion of the canal is filled using a wave of heat that is carried along the master gutta percha point in a corono-apical direction. The movement of thermoplasticised gutta percha as it fills the canal is referred to as a continuous wave of condensation. In back fill the remaining middle and coronal portions of the canal are filled by injecting thermoplasticised gutta percha into the canal.

Technical Steps

Master Cone Selection The master gutta percha point is selected in the same manner as described in the cold lateral compaction technique.

Down Pack A System B plugger is selected that fits to within 5–7 mm of the working length, without undue binding with the canal walls. A rubber stop is used to mark the length against a reference point. A hand plugger such as the Machtou plugger is also marked to the same length with a rubber stop.

A light coating of sealer is applied to the canal walls and onto the master cone, which is then seated into place. The System B tip (Figure 12.7) is set at 200 °C, with full power and the heater activated via the fingertip micro switch. The activated tip is then pushed into the bulk of gutta percha in an apical direction until the rubber stop is about 3 mm short of the reference point. The heater is deactivated and the cooling plugger is pushed further into the gutta percha until the rubber stop reaches the reference point. This position is held for 10 s to compensate for gutta percha shrinkage as it cools. A brief burst of heat is then applied while maintaining apical pressure and the System B tip is withdrawn. A cold Machtou plugger should then be inserted into the canal and apical pressure applied for 20 s to compact the apical segment of gutta percha.

Back Fill The remaining middle and coronal portions of the canal are obturated with thermoplasticised gutta percha. This is usually delivered into the canal with an injection system such as the Obtura II. The Obtura tip must be inserted into the canal and allowed to sink into the top of the gutta percha mass of the down pack before back filling. Alternatively, back fill can be done by introducing increments of heated gutta percha into the canal and successively compacting with cold hand pluggers. The coronal part of the back fill should end at the level of the pulp floor.

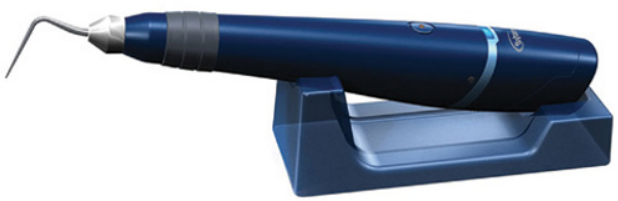


Figure 12.7 System B.

Heat-Softened Gutta Percha Techniques: Extracanal Heating

Here, gutta percha is warmed and softened outside the mouth before being compacted into the canal. A number of extracanal heating techniques exist and these include the use of:

- Thermoplastic delivery systems such as the Obtura II. This is most often used in conjunction with the System B during warm vertical compaction and has been described earlier. The Obtura II can also be used to fill internal resorptive defects of the root canal.
- Precoated carriers.
- Operator-coated carrier-condensers.

Precoated Carriers

This technique involves the use of core carriers called obturators. Initially the core carrier delivery system was solely designed with metallic cores onto which gutta percha was coated. Advances in technology have resulted in the development of plastic core carriers and their uses have superseded the metallic carriers. The first and more popular gutta percha precoated carrier is Thermafill (Dentsply-Maillefer). Other carrier-based obturation systems available on the market include Dens-Fil (Dentsply Canada), Soft-Core (Soft-Core Texas, USA), resin-based obturators (Real Seal One, Sybron Endo, USA) and cross-linked gutta percha obturators (Gutta-Core, Dentsply)

All precoated carrier systems consist of a series of uncoated carriers called verifiers, obturators, and a specially designed oven.

Technical Steps

Prior to obturation a verifier of the estimated size is carefully inserted into the canal to the full working length without undue apical force. A radiograph is then taken to confirm the position of the point in relation to the radiographic apex.

Once the verifier has been chosen, an obturator of the same size is selected and the working length marked with a rubber stop. The obturator is then placed in the heating chamber of the oven for the specific timeframe designated. While the obturator is being heated, the canal is

dried and coated with a small amount of sealer. When heating is complete, the obturator is removed from the oven and immediately seated into the canal at the working length. The excess gutta percha is removed and the remainder compacted vertically into the canal orifice (particularly in oval or C-shaped canals). Next, the plastic shaft of the carrier is removed with a bur at a level 1–2 mm above the orifice whilst holding the handle with firm apical pressure. The handle is then discarded.

Operator-Coated Carrier-Condensers

Examples of this technique are the AlphaSeal system and the MicroSeal system. In this technique NiTi rotary compactors are coated with heat-softened gutta percha by the operator and then inserted into the canal. The rotations of the compactor will drive the softened root filling material into the root canal in an apical direction.

Solvent-Softened Gutta Percha Techniques

The most commonly used solvents are chloroform and eucalyptol. Nowadays, solvent-softened gutta percha is rarely used due to its highly evaporative and toxic nature. Its use is mostly limited to the chloroform dip technique to create custom-fitted cones.

Chloroform Dip Technique

A slightly large gutta percha cone is selected and the apical 2–5 mm of the point is dipped in chloroform or in another suitable solvent for a few seconds. The softened cone is inserted into the canal to working length with gentle pressure. The chloroform acts to soften the superficial layers of the gutta percha point and allows the point to mould to the shape of the apical part of the prepared canal. The point is marked for orientation and the process repeated until a satisfactory fit is obtained. The customised point is removed and allowed to dry. The gutta percha cone can then be compacted into the canal with sealer using the cold lateral condensation technique.

Surgical Endodontics

Definition

Surgical endodontics include all surgical procedures involved in the treatment of persistent apical periodontitis when orthograde root canal treatment/retreatment has failed or root canal retreatment is impractical.

Primary root canal treatment failure is most commonly associated with a persistent intraradicular infection. Failure to heal may also be associated with an extraradicular infection, a foreign body, or a cyst. In most instances root canal retreatment is advocated. Endodontic microsurgery can be recommended if a satisfactory root canal retreatment fails to resolve a lesion or if the benefits of surgery outweigh the benefits of root canal retreatment.

Indications

- Persistent apical periodontitis associated with a satisfactory root filling.
- Persistent apical periodontitis associated with an irretrievable root filling.
- Persistent apical periodontitis associated with the apical portion of an irretrievable radicular post.
- Root canal difficult or impossible to access (i.e. calcification or perforation of the root canal) (Figures 12.8 and 12.9).
- Investigatory procedures used for detection of cracks and root fractures.
- Biopsy.
- Drainage.
- Enucleation of cysts.
- Removal of foreign bodies from the periradicular tissues.
- Root resection, hemisection.

Contraindications

- Medical complications.
- Poor restorability status.
- Poor periodontal status.
- Cracked or fractured roots.
- Poor patient compliance.
- Poor access.
- Operator inexperience.

Surgical Operating Microscope

The use of microscopes in endodontic surgery has undoubtedly had a major positive impact on the outcome of surgical treatment. It allows the operator to tackle technically complex cases and provide treatment with a greater degree of confidence and precision. When using a surgical operating microscope (SOM) the size of the osteotomy can be kept relatively small which allows for quicker healing. Magnification is particularly useful in detecting cracks, isthmuses, unfilled canals and distinguishing the root from the surrounding cortical bone. Visual acuity is further enhanced by a light source 10 times more powerful than that of a conventional overhead dental light. Furthermore, SOMs have an absence of shadowing, as the light beam produced is coaxial to the operator's line of sight.

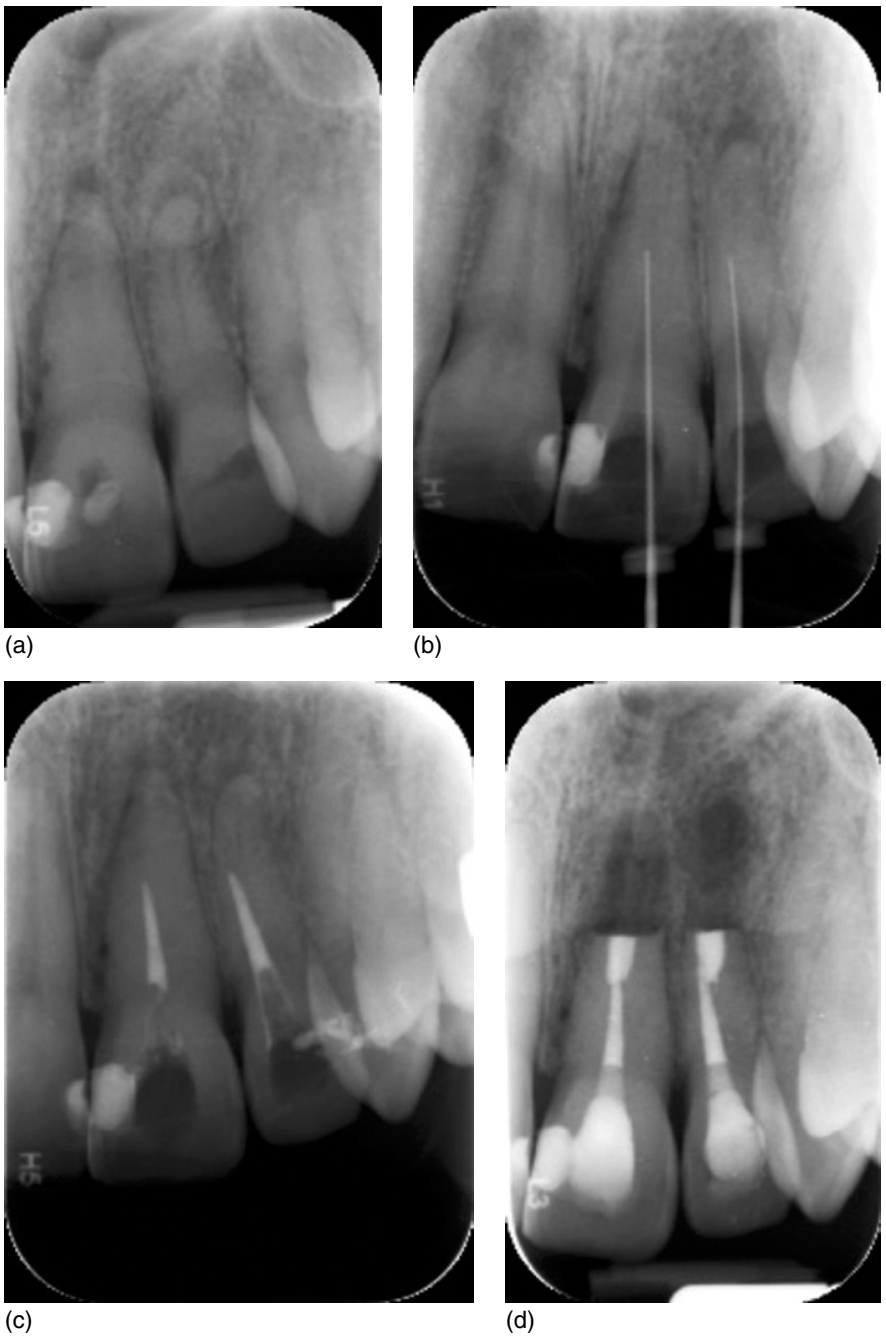


Figure 12.8 Following an unsuccessful attempt to instrument the apical portion of the heavily calcified root canals of UR1 and 2 (a–c) the apicectomy of the two teeth in question was performed. (d) The apical 3 mm of the roots were resected and the remaining 3 mm of uninstrumented root canals were retroprepared and subsequently obturated with MTA.

Treatment Planning

A preoperative radiograph of the tooth to be treated is essential for treatment planning. Two or three radiographs can be taken at varying angles within the horizontal plane (parallax principle) to minimise anatomical noise and geometric distortion

CBCT has been shown to be useful in treatment planning for endodontic microsurgery. The spatial relationship of the roots to the surrounding anatomy

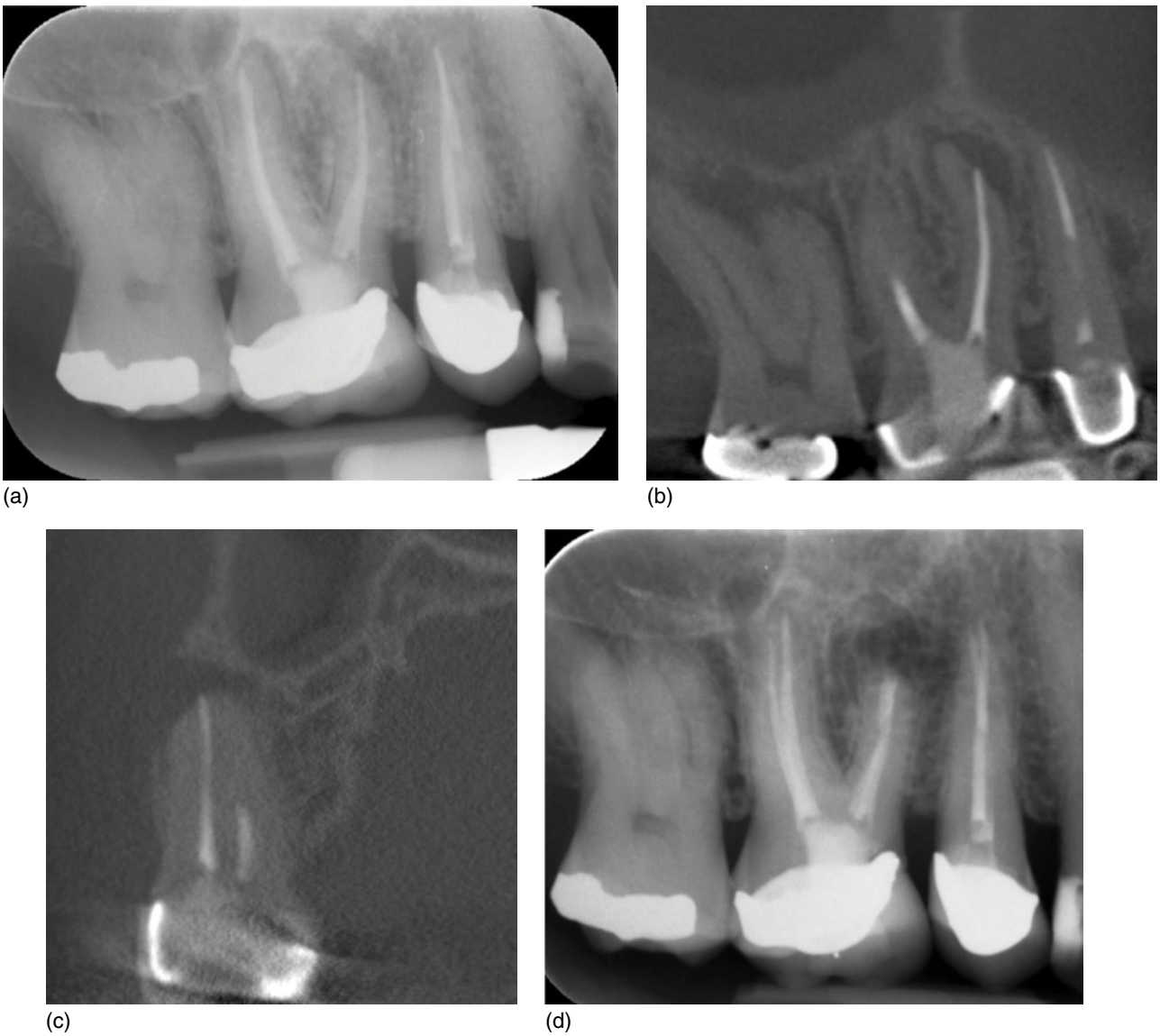


Figure 12.9 (a) Radiolucency is associated with the apical portion of the mesiobuccal root. The position of the terminus of the root canal in relation to the terminus of the root canal obturation is unclear. The coronal (b) and sagittal (c) slices of the CBCT allow the detection of a perforation of the apical portion of the root canal and of an inadequate obturation of the second mesiobuccal canal. (d) Postoperative radiograph after the completion of the apicectomy.

can be precisely evaluated (e.g. proximity to inferior alveolar nerve) as can the size of the lesion. CBCT is more sensitive at detecting periapical lesions compared with conventional periapical radiography (Figure 12.9(a–d))

Informed Consent

A thorough explanation of the procedure should be given to the patient. The patient should have a clear understanding of the intended benefits the treatment is likely to give and also be provided with information relating to the risks involved with the procedure, including postoperative pain, swelling, trismus, paraesthesia lingually and/or labially, and oral–antral communication.

Oral Hygiene

Prior to surgery, patients should receive oral hygiene instruction to ensure their plaque score on the day of

surgery is minimal. An initial rinse with chlorhexidine is advocated prior to commencement of treatment to help disinfect the surgical site.

Local Anaesthesia

Unless contraindicated, an adrenaline-based anaesthetic should be used which will have the added benefit of providing haemostasis and thereby improve visual acuity. Mepivacaine could be considered as an adrenaline-free alternative if warranted. Local anaesthetic should be administered a minimum of 15 min prior to commencement of treatment to ensure an adequate level of anaesthesia.

Flap Design

A flap should be designed to provide the operator with good vision and access to the surgical site. As supraperiosteal blood vessels run vertically, relieving incisions should be vertical to minimise the number of blood vessels severed. Once raised, it is good practice to keep the flap covered with a damp piece of gauze to help prevent the flap dehydrating.

The soft tissues that are involved when a flap is raised are: the alveolar mucosa, which is a relatively thin tissue that is loosely attached to the underlying bone and is non-keratinised; the attached mucosa, which is a thicker tissue, firmly attached to the underlying bone and is keratinised; and the marginal gingival.

Semi-Lunar Flap

The semi-lunar flap involves the alveolar mucosa only. It provides poor access to the surgical field and vision of the surgical field is compromised. Control of bleeding is difficult as the tissues are highly vascular and reapproximation is technically more difficult with resultant healing by scar tissue formation.

Vertical Flap

The vertical flap provides particularly good access when treating teeth with particularly long roots. Reapproximation of the wound edges is relatively easy. This flap is not used regularly as reapproximation occurs over the site of the osteotomy, which may compromise healing via secondary infections occurring through the wound site.

Submarginal Flap

The incision for the submarginal flap is placed at least 3 mm superior to the junctional epithelium to prevent ischemia of the marginal gingiva. This flap design is often used when prevention of recession is of particular importance. However, this can often heal with scarring.

Intrasulcular Flap

The intrasulcular flap provides good access and vision of the surgical field. However, recession is a common postoperatively. This flap can include one or two vertical relieving incisions.

Papilla-Based Incision Flap (Velvart)

This flap design has proven to be excellent at preservation of the interdental papillae. Reapproximation requires the use of magnification and sutures no larger than 5/0.

Flap Retraction

Retraction of the soft tissues is necessary to maintain access and vision of the surgical field. It is a task that can be carried out by the nurse or surgeon and there is a range of different retractors fit for this purpose. A common reason for swelling following apical surgery is due to slippage of the retractor. Furthermore, transient mental nerve paraesthesia can occur from the retractor causing damage to the nerve tissue at the site of the mental foramen. To prevent accidental damage a groove can be cut into the bone providing a secure anchor for the retractor.

Suction

A skilful and accurate suction technique is imperative to provide the clinician with a clear view of the surgical field. Surgical suctions tips have small diameter nozzles to allow precise placement without overly obscuring the operator's vision. Particular attention to detail within the surgical area is essential whilst simultaneously controlling saliva build up in the oral cavity.

Control of Bleeding

Adrenaline-containing local anaesthesia should be used unless contraindicated, as it improves visual acuity by its haemostatic nature. Placement of a cotton pledget soaked in 1 in 1000 adrenaline into the osteotomy can further aid haemostasis. Ferric sulphate, calcium sulphate, Surgicel and Gel Foam may also be used to enhance haemostasis but should all be thoroughly washed out prior to wound closure as they will inhibit clot formation and subsequent healing and may lead to increased postoperative pain.

Cortical Bone Removal and Curettage

A round surgical bur can be used to remove cortical bone allowing access to the root apex and surrounding periradicular tissues. The granulomatous lesion should

be carefully removed to avoid contamination of the specimen and then placed in formaldehyde ready for pathological testing.

Maxillary Sinus Protection

When treating upper posterior teeth, on occasion the osteotomy will extend to and connect with the maxillary sinus. To prevent unwarranted materials and agents passing into the sinus it is advisable to block the entry point with a cotton pledget or with sterile gauze. The pledget should be large enough to fill the entire entry point and should be bound in floss for ease of retrieval. Other materials used for this purpose include iodine gauze strips.

Root End Resection, Preparation and Sealing

Root End Resection

Historically, the root end would have been resected with a bevelled preparation. This made access to the apices far easier for preparation and resealing. The drawback of the bevelled apical root end preparation was that it exposed a high number of dentinal tubules. As the main cause of failure of root end surgery is egress of bacteria from the root canal system, keeping exposure of dentinal tubules apically to a minimum is desirable.

Using a long tapered diamond bur the root end should be resected horizontal to the long axis of the tooth so keeping the number of dentinal tubules exposed to a minimum. At least 3 mm of the root end should be removed to ensure the majority of accessory and lateral canals; apical deltas and ramifications are included in the resected root end. The root end is normally gradually shaved or, less frequently sectioned at a predetermined point. A reverse exhaust handpiece is employed for this purpose to minimise the risk of a surgical emboli.

Root End Preparation

The apices of the root end should be stained with methylene blue dye and examined under high magnification for the presence of undiagnosed and unfilled canals, isthmuses, oval-shaped canals, fractures and cracks.

Historically, following a bevelled resection, the root end was prepared using small round burs that created a very shallow and poorly retentive preparation. They also carried a high risk of perforating the root lingually/palatally. Bur preparations have been superseded by preparations using ultrasonic microsurgical instruments. These allow for 3 mm deep parallel preparations to be carried out on horizontally prepared root ends with a high degree of accuracy, control and consistency.

Root End Sealing

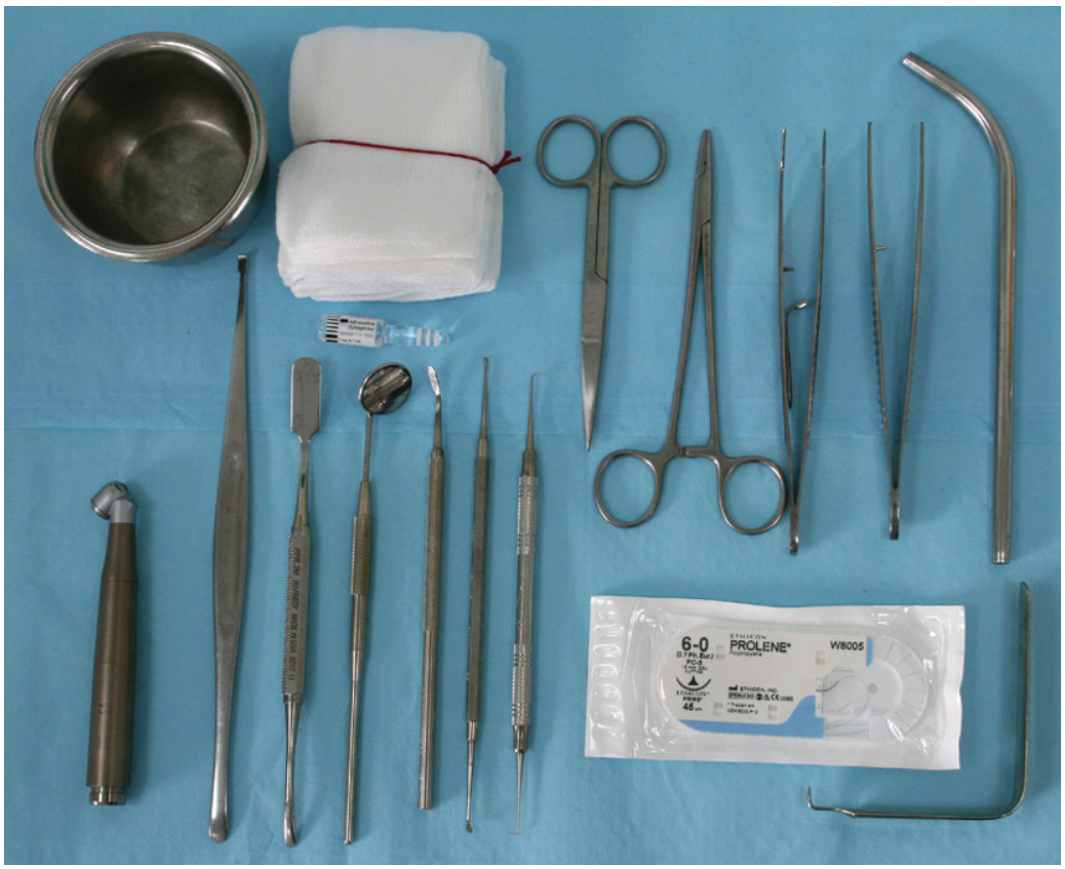
The root end should be sealed with a biocompatible material that will prevent the egress of bacteria to the apical tissues and allow healing of the periradicular tissues. Historically, amalgam has been used for this purpose but research has shown that amalgam provides a poor seal, is cytotoxic and is associated with a poor outcome. Amalgam has now been superseded by materials such as mineral trioxide aggregate (MTA). MTA is a biocompatible material, that has been shown to provide a good apical seal, and is associated with a high success rate (Chong and Pitt Ford, 2005). Furthermore, histological analysis has demonstrated this material to be bioinductive promoting the formation of cementum over the MTA. Alternatives to MTA that have proven track records include IRM, Super EBA and composite, e.g. Retroplast. Specially designed right-angled instruments are employed for insertion and packing of MTA, IRM and Super EBA into the prepared root end. The use of composite requires excellent moisture control and the root end should be prepared with a dish-shaped preparation. Composite is then built up to create a dome on the end of the root. Prior to reapproximation of the soft tissues the root end filling should be carefully examined to ensure an adequate seal has been achieved and a periapical radiograph of the tooth should be taken to assess the quality of the root end filling.

Reapproximation

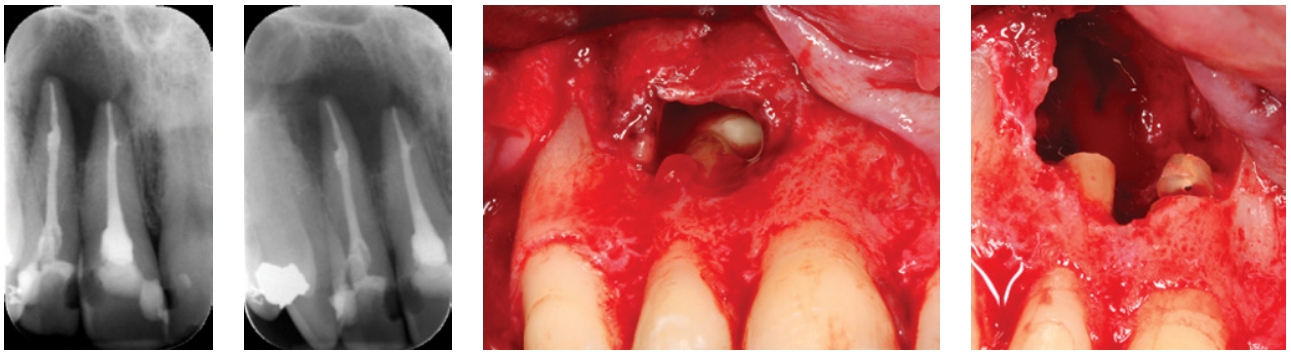
The site of the osteotomy should be washed and inspected to ensure no foreign materials are left behind. Agitation of the bone should be carried out if necessary to promote bleeding. Following this the flap can be repositioned and sutured into place. Monofilament sutures should be used as these are less plaque retentive than braided sutures and they allow for quicker healing. Gentle pressure can be applied to the flap to promote epithelialisation and healing.

Postoperative Instructions and Follow-Up Care

Patients should be provided with oral hygiene instruction and advised to use a chlorhexidine mouth rinse for 3–5 days following surgery. Sutures should be removed within 48–72 hours after which time patients can resume normal cleaning of the soft tissues. After 1 year the patient should be recalled for a review appointment at which point a periapical radiograph should be taken to objectively assess the outcome of the treatment. A photographic and radiographic sequence of the apicectomy of a maxillary central and lateral incisor is shown in Figure 12.10.

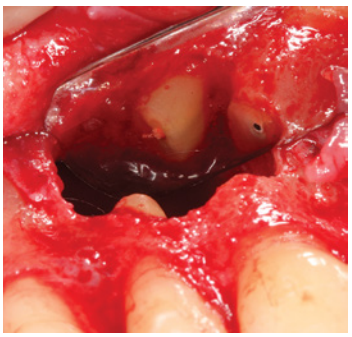


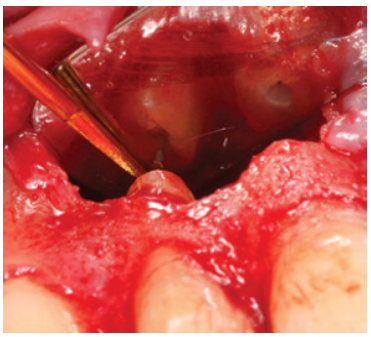
(a)

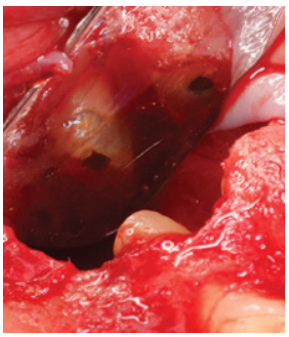


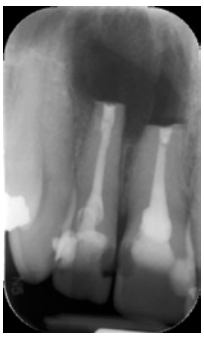
(b) (c) (d) (e)

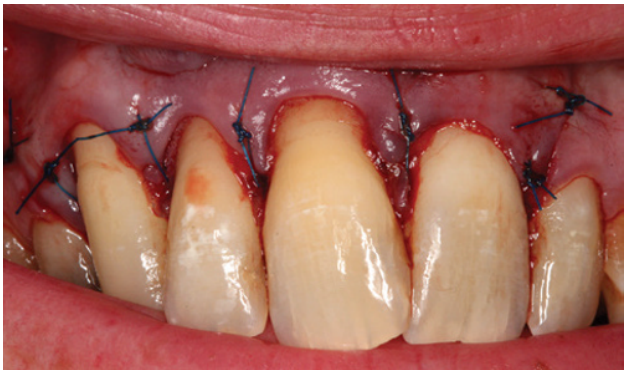
Figure 12.10 (a) Armamentarium for surgical endodontics. (b, c) The comparison between the postoperative and the 1 year review radiographs following endodontic retreatment shows an increase in the size of the apical radiolucency. Surgical endodontics is indicated. (d) Following flap elevation the apices are visualized. (e, f) The apices are resected. (g, h) Retrograde preparation with ultrasonic retrotips and retrograde obturation with MTA. (i) Postoperative radiograph. (j) Suture in place and (k) suture appearance 72 h later immediately prior to suture removal.


(f)


(g)


(h)


(i)


(j)

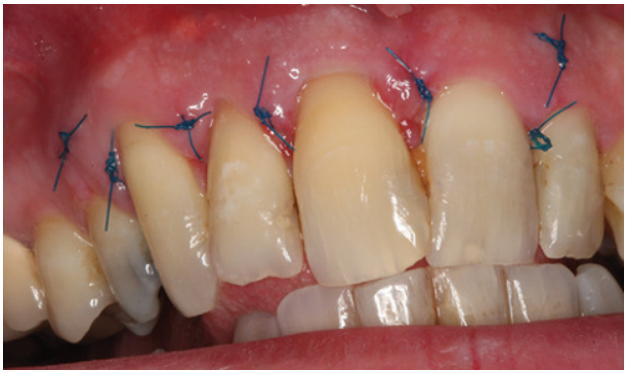

(k)

Figure 12.10 **(Cont'd)**

References

Chong, B.S., Pitt Ford, T.R. (2005) Root-end filling material: rationale and tissue response. Endodontic Topics 11:114–130.

Saunders, W.P., Saunders, E.M. (1994) Coronal leakage as a cause of failure in root canal therapy: a review. Dental Traumatology 10:105–108.

13

Procedures in Implant Dentistry

Richard Palmer

Introduction

Dental implants are used for the replacement of single teeth and to support fixed and removable dental prostheses replacing multiple teeth. They enjoy very high success rates and relatively few complications. Success criteria are focused on clinical/radiographic factors such as immobility, absence of radiolucencies and good maintenance of bone levels. Patient-based criteria such as absence of pain and nerve damage and provision of a functional and aesthetic prosthesis must be achieved to satisfy most patients.

Successful treatment is highly dependent upon effective levels of diagnosis, treatment planning and execution of the surgical and prosthodontic aspects of treatment, together with long-term maintenance care. It is imperative to consider all treatment options with the patient, and during detailed planning it may become apparent that an alternative solution is preferred. The advantages and disadvantages of the various options can be presented to the patient following careful clinical and radiographic examinations. The treatment plans should be outlined in writing. Written consent to the agreed treatment plan is essential.

Patients usually have high expectations of dental implants and it is therefore essential that their expectations are understood and that the clinician is confident that they can be met. Risk factors for implant failures and complications include by plaque-induced inflammation, a history of periodontitis, associated endodontic lesions, smoking and parafunction. One of the most important contraindications for implant treatment is the child who has not completed growth. The ankylosed implant can become increasingly in infraocclusion following growth and eruption of the adjacent teeth.

Clinical and Radiographic Examination and Planning

It is essential that patients undergo a thorough history and examination to determine their main complaints and to avoid missing important diagnoses that will have a bearing on their overall management, especially caries, endodontic problems and periodontal status. It is important to determine the reason for tooth loss and to manage all dental conditions as part of an overall treatment plan.

Where anterior tooth replacement is planned, the coverage of the anterior teeth and gingivae by the lips during normal function and smiling should be carefully assessed. An anterior prosthesis should provide good aesthetics and adequate lip support. The appearance of the planned restoration can be judged by providing a diagnostic set up or preferably a provisional prosthesis, for example a removable partial denture. This can serve as a model for a surgical guide to assist in the optimal placement of the implants, and as a transitional restoration during the treatment programme.

The height, width and contour of the edentulous ridge should be visually assessed and palpated to evaluate the soft tissue and underlying bone profile. Plain radiographs may provide sufficient information to assess available bone height but 3D tomography may be required to assess the ridge contour. The clinician needs to gather sufficient information to determine whether there is sufficient bone for implant placement or whether the patient needs to be advised that bone augmentation is required.

The distance between the edentulous ridge and the opposing dentition should be measured to ensure that there is adequate room for the implant prosthesis. The length of the edentulous space should be measured and related to the diagnostic set-up or denture and radiographs.

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

In edentulous ridges bound by teeth, the proximity and angulation of adjacent teeth must be evaluated. The occlusion should be carefully assessed, in particular in all excursive movements. It may be helpful to examine the occlusion with the existing prosthesis or the provisional prosthesis to assess the type of loading to which the implant restoration will be subjected. The overall aim is to provide an adequate number of implants within sound bone beneath the proposed location of the replacement teeth.

Study casts allow detailed measurements to be made. Also, the proposed replacement teeth can be positioned on the casts by the technician using either denture teeth or teeth carved in wax. The diagnostic set-up therefore helps to determine the number and position of the teeth to be replaced and their occlusal relationship with the opposing dentition.

The most convenient radiographic examination is the dental panoramic tomogram. Periapical radiographs using a paralleling technique are often adequate for evaluation in single tooth replacement and should be considered for all adjacent/opposing teeth that are heavily restored, with known or suspected endodontic problems and teeth with moderate to advanced periodontitis. Tomographic examinations to give cross-sectional and three-dimensional images have become more common with the introduction of cone beam CT. Radiographic stents with radioapaque teeth or markers are usually worn by the patient to relate proposed tooth position to the location of the underlying bone. The stents can subsequently be used to produce guides to assist in correct placement of the implants at surgery. All images should be of a known magnification so that accurate measurements can be taken. Computer-based image software programs are available that produce images of implants and their prosthodontic components which can then be imported into the CT image. This can be developed to very high levels of sophistication using a combination of radio-opaque diagnostic set-ups, CT scans and stereolithic modelling to produce surgical drill guides and premade prostheses.

Implant Placement

Implants should be placed using a careful aseptic surgical technique. Success is highly dependent upon a surgical technique which avoids heating the bone. Slow drilling speeds, the use of successive incrementally larger sharp drills and copious saline irrigation aim to keep the temperature below that at which bone tissue damage occurs (around 47 °C for 1 min). The most favourable quality of jaw bone for implant placement has a well formed cortex and densely trabeculated medullary spaces with a good blood supply. Bone which is predominantly cortical may offer good initial stability at implant placement but is more easily damaged by overheating during the drilling process.

The implants have to be placed at the correct positions, depths and angulations to allow fabrication of a functional and aesthetic prosthesis. Surgical guides can help considerably. Poorly positioned or angled implants will compromise the prosthodontic reconstruction. An adequate number of implants are required to support a given prosthesis and the distribution of load to the supporting bone can be spread by increasing the number and dimensions (diameter, surface topography, length) of the implants.

In contrast, it is equally important not to place too many implants in a given space such that they are too close together. This compromises the health of the intervening bone and soft tissue and construction of the prosthesis. It is generally recommended that a space of 3 mm is left between adjacent implants and at least 1 mm between an implant and an adjacent tooth. The average implant is approximately 4 mm in diameter and between 8 and 15 mm in length.

Implants should be selected to ensure good primary stability, measured by insertion torque or resonance frequency analysis. Implant length is also limited by the need to avoid damage to important anatomical structures, such as the inferior dental nerve. The assessment of length should allow an adequate safety margin, especially as most drills are designed to prepare the implant site slightly longer than the chosen implant.

In conventional protocols a cover screw or healing abutment is attached to the head of the implant following insertion of the implant. The mucoperiosteal flaps are closed with sutures and the implant left to heal for a period of 6–12 weeks. During this period, the implant remains unloaded and bone forms on the surface of the implant to provide a union termed osseointegration. Rapid treatment protocols are also used where the prosthesis is provided on the same day or within a few weeks. If the implant is loaded during this early period the amount of movement must be below 100 µm as fibrous encapsulation rather than osseointegration could occur.

The procedure guideline (Table 13.1) describes placement of a single implant using a conventional protocol.

Prosthodontic Treatment

Implant prosthodontics is very similar to conventional prosthodontics with the advantage of being able to use many precision-made components. The first phase of treatment is recording the position of the implants with an impression technique. This is done is in one of two ways:

1) A transfer coping is attached to the head of the implant and an impression taken of this and the

Table 13.1 Surgical placement of a single implant.

Preoperative Requirements	
Treatment plan	To check that preparatory treatment has been completed.
Signed consent	To ensure valid consent.
Radiographs	To provide information on available bone height, width of space at various levels, presence of important anatomical structures, position and angulation of adjacent tooth roots. 3D scans may be needed to give bone thickness if this was in doubt.
Study casts	May be required to check on diagnostic set-up and fit of surgical guide.
Surgical guide disinfected in chlorhexidine solution	Surgical guide helps in establishing mesiodistal and buccolingual positioning, angulation and vertical level of implant placement.
Straight handpiece and acrylic trimmer	To adjust surgical guide if required and temporary prosthesis at end of procedure.
The implant – planned design, length, diameter and appropriate alternative	Appropriate implant should have been ordered and checked against treatment plan. Shorter/longer/wider/narrower alternatives if any doubt about selection should be available.
Healing abutment or cover screw	To protect internal mechanism of the implant. Cover screw required for submerged surgery and healing abutment for non-submerged surgery.
Sterile surgical implant instruments	Complete set of instruments compatible with planned implant type. This may also include disposable sterile drills.
Sterile surgical kit	Basic surgical kit to elevate mucoperiosteal flaps and closure with sutures.
Sterile irrigation system	To keep drills irrigated during drilling process and avoid overheating of bone.
Sterile drapes	To maintain appropriate surgical environment covering patients' clothing and hair.
Analgesics	Either 1 g paracetamol or 400 mg ibuprofen given just before procedure to provide first line of analgesia when local anaesthesia wears off.
Antibiotics	Evidence that preoperative antibiotics may reduce early implant failure. However, failure rates are extremely low and evidence not particularly robust. Antibiotics more strongly indicated if systemic health problem with patient, e.g poorly controlled diabetes or procedure likely to be complicated by previous infection/need for grafting.
Chlorhexidine mouthwash	0.2% for 1 min to reduce bacteria in mouth. Some clinicians also use as circum-oral skin disinfection. More stringent barrier methods such as adhesive film dressings and covering of nose used in some countries.
Local anaesthesia	Usually containing adrenaline to produce more profound anaesthesia and haemostasis. Lignocaine commonly used. Articaine infiltration may be more effective in mandibular sites.
Surgical Procedure	
Incision made with number 15 blade	Normally mid crestal incision to provide good wound closure around healing abutment and adequate keratinised tissue buccally and lingually. Relieving incisions can be used to improve access – either extending around crevices of adjacent teeth or vertical relieving incision avoiding placement over adjacent prominent root surfaces.
Elevation of full thickness buccal and lingual flaps (Figure 13.1)	Cleanly under periosteum to minimise trauma and provide good visualisation of bone ridge, any concavities or important anatomical structures, e.g. mental nerve. Adequate visualisation of ridge profile should minimise chance of implant being placed in wrong position.
Drilling of site to accept implant using saline irrigation (Figure 13.2)	Drilling at low speeds (1500 rpm) with low pressure and clearing of swarf from drills to prevent overheating of bone (Figure 13.2(a)). More of a problem in dense bone. Depth of site established early in sequence. Position and angulation of site checked against surgical guide with guide pin placed in prepared hole (Figures 13.2(b), (c)).
Modification of position and angle of drilling	Drilling is in sequence as recommended by implant system. Correction and modification in early stages is very important to ensure optimum positioning. Diameter of site gradually increased with wider diameter drills to be just smaller in diameter than the planned implant.

(*Continued*)

Table 13.1 (Continued)

Surgical Procedure	
Preparation of coronal part of the site	Many implants have a head that is a different diameter or shape. A final drill is used to match this and finalise the vertical position of the head of the implant.
Irrigation of the site	To remove any loose bone fragments.
Check depth of site with measurement gauge	To check that planned implant can be inserted.
Mount implant on insertion device and maintain sterility of implant	Carefully connect implant to insertion device so that it can be inserted. The implant should not be touched during this procedure or allowed to touch any surface other than the osteotomy site that has been prepared in the bone.
Insertion of implant	Most implants are screwed into place (self-tapping) using slow revolutions of a handpiece or manual driver (under 30 rpm).
Implant placed to planned vertical level and torque level	At this point the insertion torque should have increased to at least 10 Ncm to give adequate primary stability. The torque can be adjusted on the drill set or insertion device. The vertical level of the implant is important to allow sufficient space for the abutment and prosthesis developing a good emergence profile.
Attachment of cover screw or healing abutment (Figure 13.3)	If there are doubts about primary stability of the implant the cautious clinician may attach a cover screw and bury the implant beneath the mucosa (submerged protocol) rather than proceed with planned healing abutment connection (non-submerged protocol).
Suturing of flap (Figure 13.4)	Normally interrupted sutures with 4'0' Vicryl or black silk.
Compression with damp gauze	To ensure good flap adaptation and haemostasis.
Adjustment of provisional prosthesis	To allow for change in shape of ridge, protrusion of healing abutment and postoperative swelling.
Postoperative Instructions Given	
	These include taking analgesics on 4–6 hourly basis for next 24/48 h, use of chlorhexidine mouth rinse 10 ml of 0.2% for 1 min twice daily, ice packs within next few hours to reduce swelling and instructions to use firm pressure with sterile gauze if bleeding is encountered.
Arrange follow-up appointment	To review patient in approximately 1 week to remove sutures, check healing and adjust prosthesis if necessary and to arrange further appointments for prosthodontic treatment.

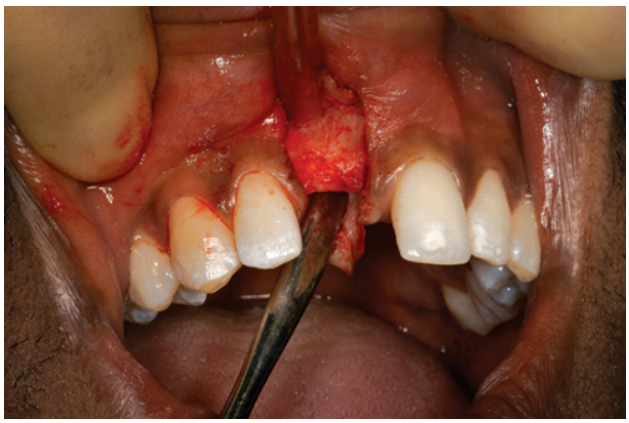


Figure 13.1 Elevation of full thickness buccal and lingual flaps.

adjacent ridge and teeth. An implant replica is attached to the transfer coping and a cast produced to select the abutment type and construct the prosthesis.

2) An appropriate abutment is chosen and attached to the implant. An abutment transfer coping is attached to the abutment and an impression taken of this and the adjacent ridge and teeth. An abutment replica is attached to the transfer coping and a cast produced to construct the prosthesis.

The procedure guideline (Table 13.2) will follow option 1 because this is the most common generic procedure and the only difference is the attachment of a preselected abutment to the implant prior to procedure 1.

Abutments are available in a variety of designs to allow removable prostheses and fixed prostheses that are either cemented or screw retained. Abutments are usually constructed in titanium, gold alloys or zirconium. The crowns and prostheses are made in combinations of materials including acrylic, composite, titanium, gold and porcelain.

Treatment follows conventional prosthodontic protocols, according to complexity of the case, and includes recording of the occlusion, trial fit of components and final fit of the prosthesis. A carefully planned functional occlusal loading will result in maintenance of osseointegration and marginal bone levels. In contrast, excessive loading may lead to bone loss and component failure. The lack of mobility in implant-supported fixed prostheses

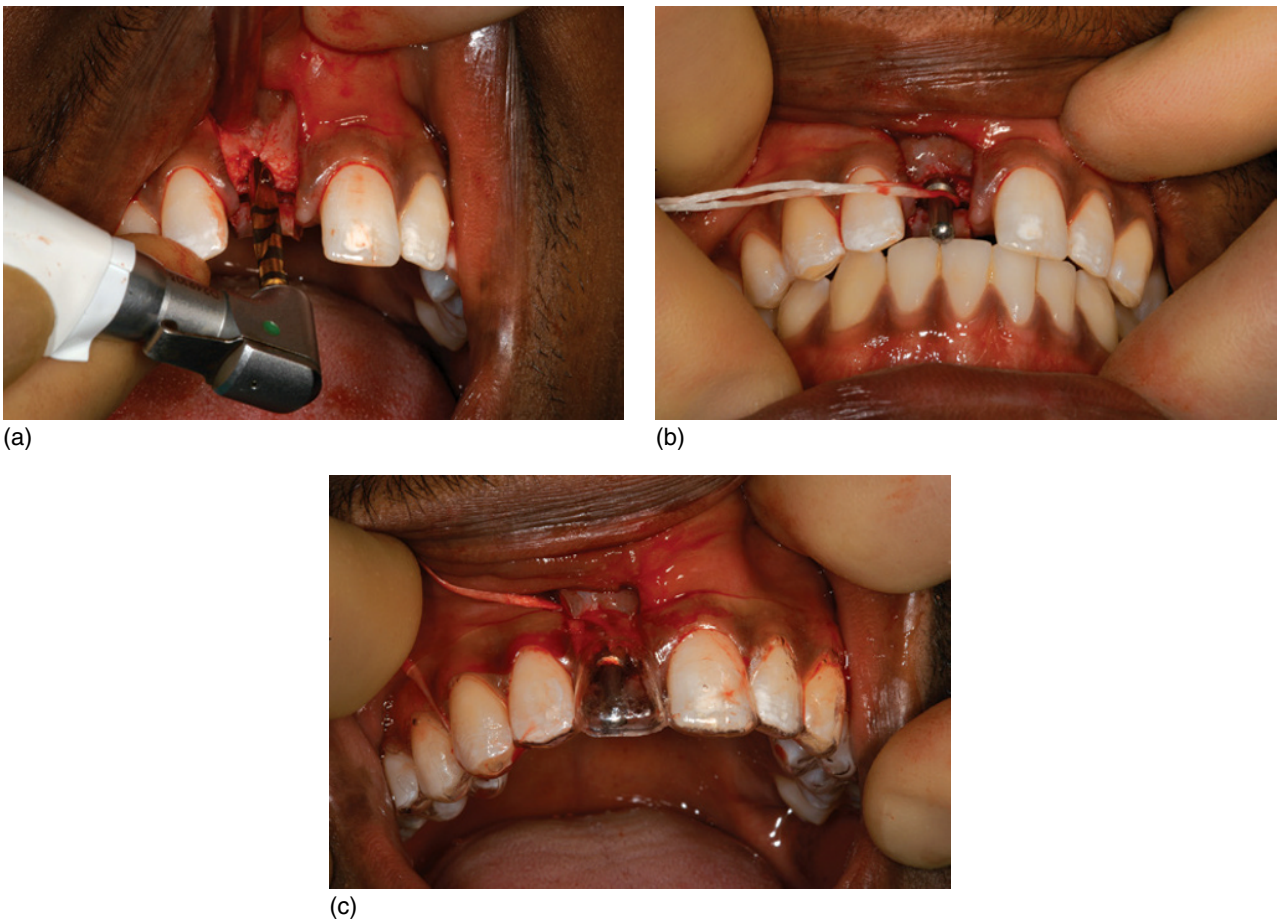


Figure 13.2 (a–c) Drilling of site to accept implant using saline irrigation, check angulation with guide pin (b) and stent (c).

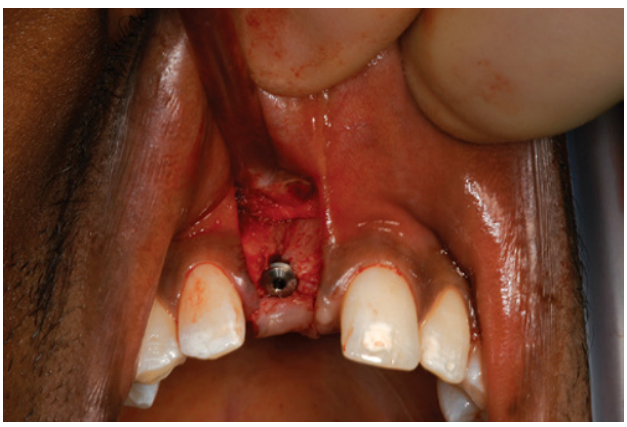


Figure 13.3 Attachment of cover screw or healing abutment.

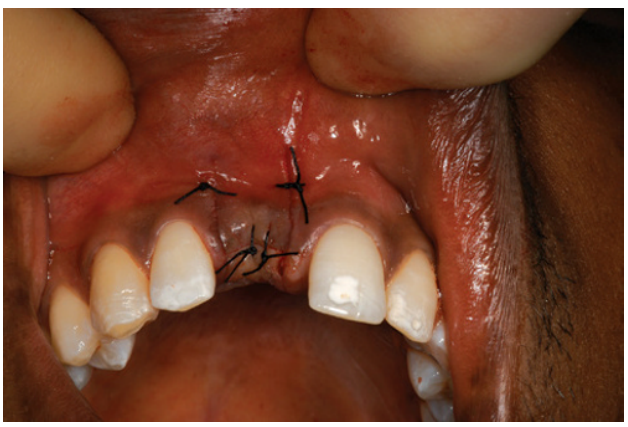


Figure 13.4 Suturing of flap.

requires provision of shallow cuspal inclines and careful distribution of loads in lateral excursions. With single tooth implant restorations, it is important to develop initial tooth contacts on the natural dentition and to carefully control guidance in lateral excursions on the implant restoration.

The procedure guideline (Table 13.3) describes fitting of a single cement retained crown.

Table 13.2 Recording an impression of an implant replacing a single tooth using an open tray technique and an indexed abutment/implant connection.

Preoperative Requirements	
Record of type of implant and healing abutment placed	To ensure that correct impression transfer coping is available.
Appropriate impression transfer coping	To fit the implant head and of sufficient length to protrude through a hole in impression tray.
Rigid plastic stock tray or custom impression tray and impression material	To record an impression with minimum chance of distortion.
Straight handpiece and acrylic trimmer	To adjust impression tray and make a hole in it to allow protrusion of the transfer coping.
Implant prosthodontic kit	Containing appropriate screwdrivers to remove and connect components.
Radiographic film and holder	To check fit of transfer coping in implant and to evaluate bone shape near implant head that may have a bearing on abutment selection.
Shade guide	To record shade of crown. This can be done at the start of the procedure or at the end.
Procedure	
Check health of peri-implant soft tissue	To make sure that it is not inflamed/swollen.
Check adjacent tooth surfaces are clean	To record accurate impression of adjacent tooth surfaces.
Remove healing abutment with appropriate screwdriver (Figure 13.5)	To gain access to implant head. If this is too uncomfortable then give small amount of local anaesthesia.
Connect transfer coping (Figure 13.6)	Carefully engage transfer coping onto/into implant head making sure there is no trapping of soft tissue and engagement is precise. Check there is no rotation. Make sure connection is screwed together adequately so that disengagement cannot occur.
Optional – radiograph assembly using holder and paralleling technique	*This is optional*. This is more important in implant systems that do not provide an obvious enough engagement mechanism between components – the radiograph can verify the fit and also provide evidence of any bone contours that may interfere with this.
Check fit of impression tray (Figure 13.7)	Check that transfer coping protrudes through or in the direction of hole in tray so that it can be unscrewed after impression material is set.
Record impression	Make sure site is clean and dry. Syringe material around transfer coping and adjacent teeth. Insert loaded tray and make sure that transfer coping is within hole in the tray. If impression material flows readily then the hole in the impression tray may need to have a wax lid to contain the material.
Check material is set, unscrew retaining pin in transfer coping and remove impression	Check impression has adequate detail and that transfer coping is firmly held within the material (Figure 13.8).
Replace healing abutment	So that access to the implant head is retained and soft tissue contour is maintained until the crown fit appointment.
Record impression of opposing dentition and disinfect both impressions	Prior to sending to laboratory.
Perform interocclusal record	If articulation of casts require it.
Check shade	Make sure patient is happy with shade. Consider more detailed shade taking with technician if appropriate.
Refit provisional prosthesis and make appointment for fit of crown	
Provide instructions to laboratory *Optional* – Some clinicians prefer to connect the implant replica to the impression transfer coping to make sure of proper engagement before the cast is poured in the laboratory	This will include details of make and type of implant, material and design of abutment and crown and whether this is to be cemented or screw retained.

Table 13.3 Fitting of a single tooth cemented implant crown on an indexed antirotational abutment.

Preoperative Requirements	
Record of previous appointments and instructions to laboratory	To ensure that correct abutment and crown has been fabricated.
The working cast, abutment and crown (Figure 13.9)	To evaluate shape, fit, margin location and contact points prior to fitting in patients' mouth.
Check rotational position of the abutment on the working cast (Figure 13.10)	So that this position is transferred to the implant in the patients' mouth. A transfer or positioning device may help to avoid errors.
Implant prosthodontic kit for system being used	Containing appropriate screwdrivers to remove and connect components.
Radiographic film and holder	To check fit of abutment and crown and to record baseline marginal bone levels.
Articulation paper, shim stock, handpiece and burs	To make any adjustments to the occlusal contacts.
Procedure	
Make sure abutment and crown are clean and disinfected	All prosthetic devices should be properly cleaned and disinfected prior to insertion in the patients' mouth.
Check health of peri-implant soft tissue	To make sure that it is not inflamed/swollen.
Check adjacent tooth surfaces are clean	To facilitate fitting and checking of abutment/crown.
Remove healing abutment with appropriate screw driver (Figure 13.11)	To gain access to implant head. If this is too uncomfortable then give small amount of local anaesthesia.
Connect abutment to the implant (Figure 13.12)	Carefully engage abutment onto/into implant head making sure there is no trapping of soft tissue and engagement is precise. A tight soft tissue cuff or deeply placed implant may make fitting of the abutment difficult. Some abutments may have a holder to help with this quite fiddly process. Check there is no rotation between components. Make sure connection is screwed together adequately so that disengagement cannot occur.
Try-in crown	Check marginal fit, contact points and appearance.
Check occlusal contacts	At this stage check that occlusal contacts are likely to be correct following cementation of the crown. If obviously wrong then check that abutment and crown are properly seated – if in doubt radiograph. If gross adjustment is required it may be a fault in the impression technique. Consider new impression or adjustment and refinish in laboratory prior to cementation.
Show patient the crown *in situ* in a mirror in good light	To make sure they are happy with the appearance before cementation.
Remove crown, tighten abutment screw to specified manufacturers torque using a torque wrench	To prevent possibility of future screw loosening.
Place small pledget of cotton wool over abutment screw head	To prevent cement entering screw head as this would prevent retightening of screw in future if this were required.
Clean and dry abutment and fitting surface of the crown	To ensure clean surfaces for cementation. Keep area free of saliva.
Mix cement according to manufacturers instructions and smear a small volume on the interior of the crown	To minimise extrusion of excess cement.
Insert crown and keep firm pressure until cement is set (Figure 13.13)	Firm pressure is required because soft tissue cuff around the crown may tend to prevent perfect seating.
Remove excess cement with probe and floss	To produce clean cement free margins that are not plaque retentive.
Radiograph assembly using holder and paralleling technique (Figure 13.14)	This is to check precise seating of the abutment and crown, absence of excess cement and position of bone levels for future comparison, i.e. baseline bone levels.
Check and adjust occlusal contacts	The single tooth implant crown with adjacent natural teeth should lightly hold shim stock when the patient bites together firmly. This is to allow some minor intrusion of the natural teeth on first contact before contact is made with the osseointegrated implant unit. Contacts in lateral excursions should be on adjacent natural teeth or light on the implant crown.
Smooth and polish any parts of the occlusal surface that have been adjusted	To make sure differential wear with opposing teeth is avoided.
Check patient is happy and comfortable. Give instructions in oral hygiene and care. Make arrangements to review if required in a few weeks and for an annual review.	The implant crown can generally be cleaned with the same methods as the patient used on the natural teeth. Screw-retained restorations are often reviewed with a few weeks to check that screws have maintained tightness at the appropriate torque. This cannot be done for cemented crowns.

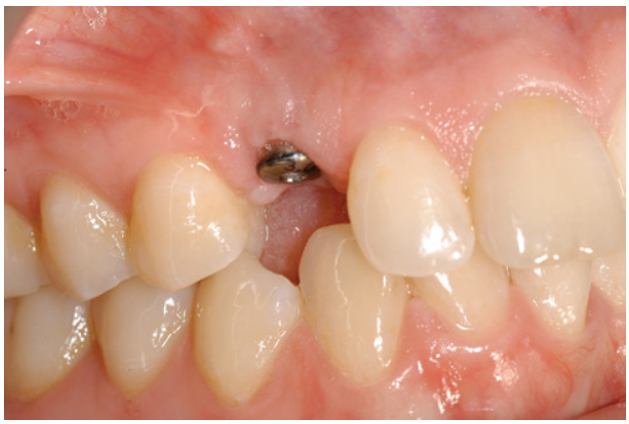


Figure 13.5 Remove healing abutment with appropriate screwdriver.

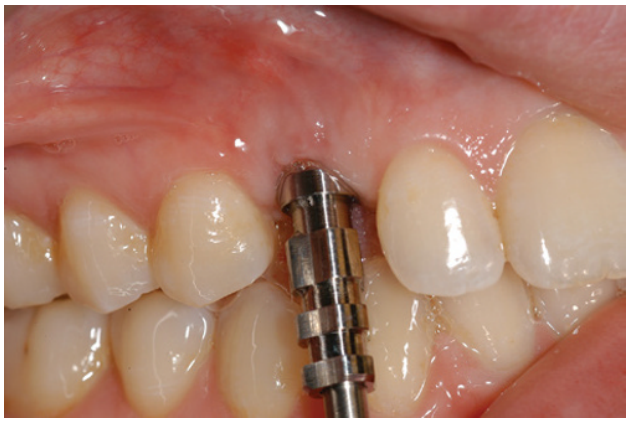


Figure 13.6 Connect transfer coping.

Figure 13.7 Check fit of impression tray.

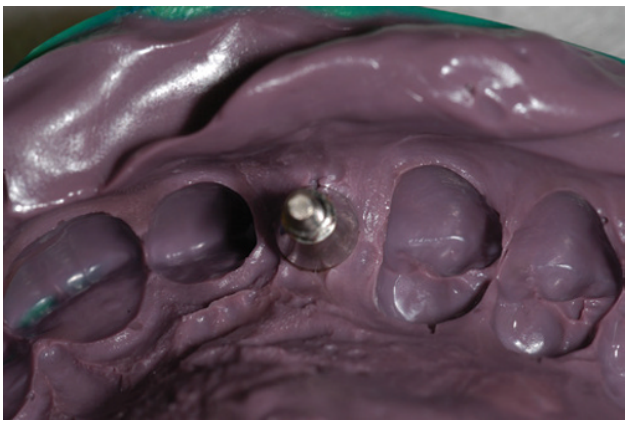


Figure 13.8 Check impression has adequate detail and that transfer coping is firmly held within the material.

Figure 13.9 The working cast, abutment and crown.

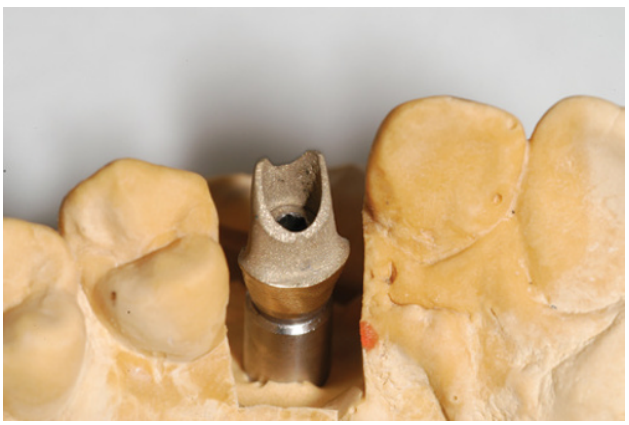


Figure 13.10 Check rotational position of the abutment on the working cast.

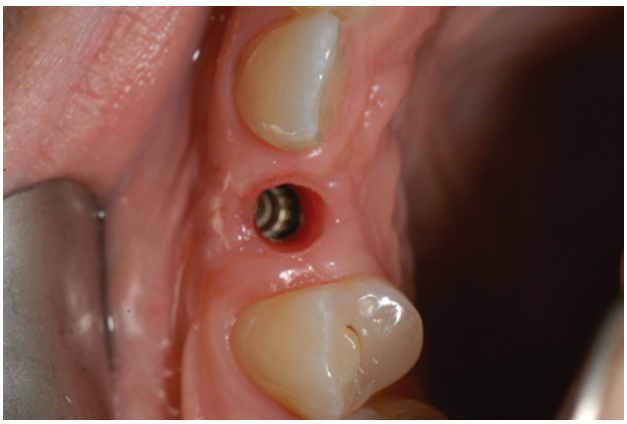


Figure 13.11 Remove healing abutment with appropriate screwdriver.

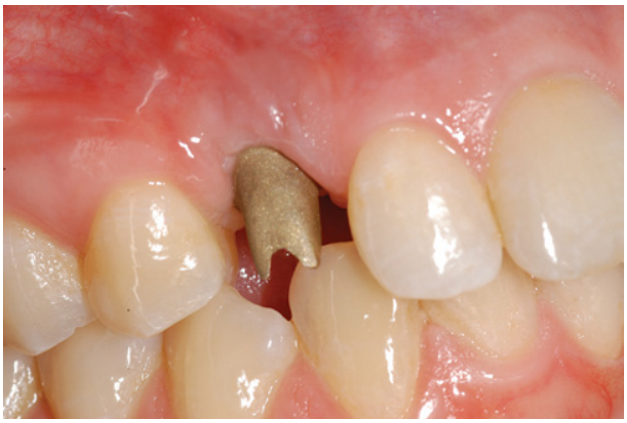


Figure 13.12 Connect abutment to the implant.

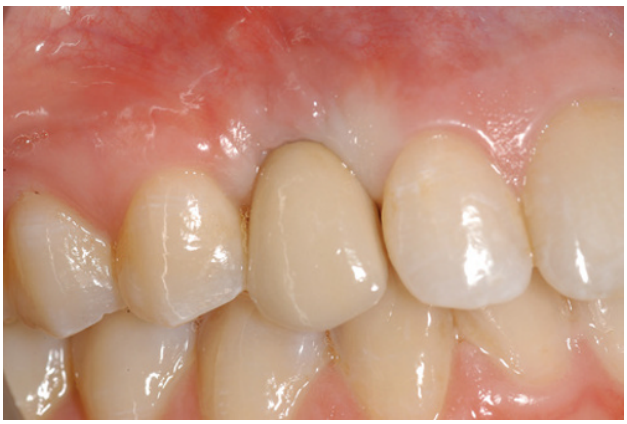


Figure 13.13 Insert crown and keep firm pressure until cement is set.

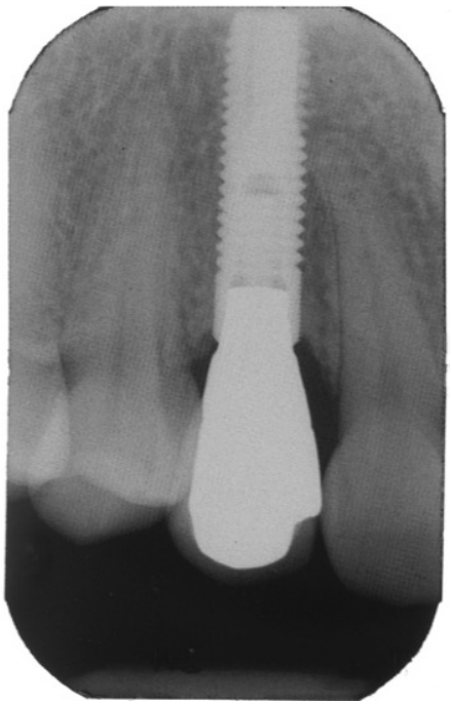


Figure 13.14 Radiograph assembly using holder and paralleling technique.

The procedure for fitting a screw-retained bridge (fixed dental prosthesis) is detailed in Table 13.4.

Re-Evaluation and Maintenance

It is generally recommended that patients are seen at least on an annual basis, but in many cases they will also require routine hygienist treatment at 3-, 4- or 6-monthly intervals according to individual requirements.

Any concerns, symptoms or signs should be noted. A soft tissue evaluation should look at the health of the surrounding peri-implant mucosa. Probing depths, clinical attachment loss and bleeding on probing can be recorded. The presence of inflammation of the soft tissue without bone loss is termed peri-implant mucositis. Inflammation with probing depths 5 mm or greater with bleeding or exudate and loss of bone is termed peri-implantitis. Both conditions require treatment. The former may respond to simple plaque control measures but the latter will require professional debridement of the affected implant surfaces using a non-surgical or open surgical approach. If this is not treated it could lead to progressive bone resorption and loss of the implant.

Table 13.4 Fitting of a screw retained bridge (fixed dental prosthesis) on two implants where definitive abutments are fitted at the same time.

Preoperative Requirements	
Record of previous appointments and instructions to laboratory	To ensure that correct abutments and bridge has been fabricated.
The working cast, abutments and bridge prosthesis with connecting screws	To evaluate shape, passive fit, margin location and contact points prior to fitting in patients' mouth. The bridge framework may have been tried in the mouth on a previous occasion but the addition of porcelain in the subsequent laboratory procedure may result in distortion.
Check passive fit of bridge on the abutments	A passive fit is essential to avoid creating undue forces and stress within the prosthesis. This can be done by checking the stability of the bridge on the abutments – it should be very stable and no rocking movement detected. One screw can be inserted and tightened. The fit of the bridge on the other abutment should remain perfect. The second screw can be inserted and tightened and this should present no difficulty.
Implant prosthodontic kit for system being used	Containing appropriate screw drivers to remove and connect components.
Radiographic film and holder	To check fit of abutments and bridge and to record baseline marginal bone levels.
Articulation paper, shim stock, handpiece and burs	To make any adjustments to the occlusal contacts.
Procedure	
Make sure abutments and bridge are clean and disinfected	All prosthetic devices should be properly cleaned and disinfected prior to insertion in the patients' mouth.
Check health of peri-implant soft tissue	To make sure that it is not inflamed/swollen.
Check adjacent tooth surfaces are clean	To facilitate fitting and checking of abutment/bridge.
Remove healing abutments with appropriate screwdriver	To gain access to implant heads. If this is too uncomfortable then give small amount of local anaesthesia.
Connect abutments to the implants	Carefully engage abutment onto/into implant head making sure there is no trapping of soft tissue and engagement is precise. A tight soft tissue cuff or deeply placed implant may make fitting of the abutments difficult. Some abutments may have a holder to help with this quite fiddly process. Check that abutments are fully seated. When sure that abutments are properly located tighten to torque level recommended by manufacturer.
Try-in bridge	Place bridge on abutments. The retaining screws should be inserted and screwed down one at a time to check passive fit as detailed above on the laboratory cast. Check marginal fit, contact points and appearance.
Check occlusal contacts	At this stage check that occlusal contacts are likely to be correct before final tightening of the screws. If obviously wrong then check that abutments and bridge are properly seated – if in doubt radiograph. If gross adjustment is required it may be a fault in the impression or laboratory technique (this is less likely if a try-in of the bridge framework on a previous visit was satisfactory). Consider new impression or adjustment and refinish in laboratory prior to fitting.
Show patient the bridge *in situ* in a mirror in good light	To make sure they are happy with the appearance before final tightening of screws.
Tighten retaining screws to specified manufacturers torque using a torque wrench	To prevent possibility of future screw loosening.
Clean and dry screw holes in bridge	To ensure clean surfaces for placement of restoration.
Place small pledget of cotton wool over screw heads	To stop restorative material entering screw head as this may need to be checked and tightened in the future.
Insert restorative material into screw holes	To seal screw holes and prevent food and debris getting into them. The restorative material could be temporary if it is planned to retighten screws within a few weeks or a more permanent tooth coloured light-cure composite.

Table 13.4 (Continued)

Procedure	
Radiograph bridge using holder and paralleling technique	This is to check precise seating of the abutments and bridge, and position of bone levels for future comparison, i.e. baseline bone levels.
Check and adjust occlusal contacts	The short span bridge with adjacent natural teeth should lightly hold shim stock when the patient bites together firmly. This is to allow some minor intrusion of the natural teeth on first contact before contact is made with the osseointegrated implant unit. Contacts in lateral excursions should be on adjacent natural teeth or light on the implant bridge.
Smooth and polish any parts of the occlusal surface that have been adjusted	To make sure differential wear with opposing teeth is avoided.
Check patient is happy and comfortable. Give instructions in oral hygiene and care. Make arrangements to review in a few weeks and for an annual review.	The implant bridge can generally be cleaned with the same methods as the patient used on the natural teeth and bridges. They will need small interdental brushes or floss threaders to clean under bridge pontics. Screw-retained restorations are often reviewed with a few weeks to check that screws have maintained tightness at the appropriate torque.

The prosthesis should be evaluated to check for any technical or mechanical complications. The most common is chipping of the crown structure. Evidence of mobility of a fixed crown or prosthesis could indicate failure of the cementation or loosening of the screws that connect the prosthesis to the abutment or the abutment to the implant. The screws will need to be retightened or the crown/abutment cleaned and re-cemented. Before this the prosthesis may need to be removed to check for any other complications. The occlusal contacts need to be checked and adjusted if required. In rare instances mobility may be associated with loosening of the implant due to bone loss and loss of osseointegration leading to implant failure.

Radiographic Evaluation

Baseline radiographs to show crestal bone levels and the state of the peri-implant bone should be taken as part of normal documentation at the time of fitting the final prosthesis. These should be repeated on an annual basis for the first 2–3 years to establish that the bone levels are stable. It should be remembered that some initial bone loss may occur during the first year of function with some implants, but that a steady state should then be established thereafter. The interval between radiographs may be extended if the bone appears stable over the first few years of function.

Conclusions

Dental implant treatment involves very careful clinical and radiographic evaluation, followed by detailed planning. Patients should be presented with the advantages and limitations of treatment alternatives. Provision of a successful implant prosthesis requires many skills including a surgical procedure to place the implant in the best possible position and prosthodontic techniques to provide an aesthetic and functional restoration in harmony with the rest of the dentition. Recognition of risk factors and long-term maintenance requirements are equally important.

14

Procedures in Oral Medicine

Michael Escudier and Saman Warnakulasuriya

Introduction

• A differential diagnosis is drawn by the clinician based on the history and an oral examination.	It consists of a list of possible diagnoses.
• A definitive diagnosis can be made for some oral conditions (Table 14.1) with pathognomonic clinical appearances.	Pathognomonic means characteristic for a particular disease.
• Other pathological conditions may present as lumps, ulcers, bullae, white, red or pigmented patches and require special investigations.	Bulla means a large vesicle, similar to a blister, containing serous or seropurulent fluid.
• The objective of the investigations is: – To establish a definitive diagnosis. – To inform the selection of an appropriate intervention. – To monitor the response to intervention.	The selection of the appropriate test is underpinned by the judgement and experience of the clinician.
• Investigations include: biopsy, imaging, haematological, serological or immunological investigations and culturing for microbes.	
• Any investigation is undertaken with the clear consent of the patient.	

Table 14.1 Conditions that may not require biopsy to confirm the diagnosis.

Condition	Description
Geographic tongue	A history of migration of patches and classical appearance of a depapillated patch(es) with a buff-coloured rim.
Frictional keratosis and linea alba buccalis	White patch along occlusal line; clear evidence of trauma to the site.
Leukoderma	Bilateral white/grey appearance of buccal mucosae that disappears on stretching.
Denture-induced stomatitis	Red patch covering denture-bearing zone.
An amalgam tattoo	Pigmented area in close contact with an amalgam restoration.
Papillitis; an enlarged lingual tonsil	Posteriorly located on lateral margin of tongue is an anatomical variation.
Central atrophy of tongue papillae (*median rhomboid glossitis)	A patch of depapillation of dorsal tongue.
Reticular lichen planus	Clinical appearance with striae is often sufficient to enable this diagnosis.

* This term is now obsolete.

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

Biopsy

- Failure to diagnose is a leading cause of dental malpractice litigation (Melrose, 2011).

- Biopsy is particularly indicated when the clinical appearance is indicative of a range of conditions.

Biopsy is the removal of a tissue sample for pathological examination.

- Biopsy facilitates light microscopic analysis by a histopathologist.

- Oral soft tissue lesions often require a biopsy to confirm the diagnosis.

Biopsy is also advisable for bone disorders which cannot be diagnosed by radiographic imaging alone.

Biopsy Techniques

- Several different techniques are available (Table 14.2).

A standard biopsy 'kit' for the incisional or excisional technique using a knife is shown in Figure 14.1.

- Biopsy kit: mirror, Mitchell's trimmer, blade handle, tissue forceps, needle holders, suture scissors, curved mosquitoes/clip, Lac and Kilner retractors, galipot, sterile gauze, sterile foil, sterile drape.
- Biopsy extras: 15 blade, 4-0 sutures, syringe handle, local anaesthetic cartridge, needle, biopsy specimen pot, suction tubing, suction tip.

- The technique should be appropriate for obtaining a tissue diagnosis with minimum discomfort and complications to the patient.

- Techniques available for biopsy of soft tissue lesions include:
  - Excisional.
  - Incisional.
  - Punch.
  - Brush.
  - Fine needle aspiration.

Table 14.2 Selection of biopsy techniques appropriate for the condition and underlying rationale.

Condition	Biopsy type	Rationale	Special considerations
Leukoplakia Erythroplakia	Incisional	• To exclude SCC • To exclude other conditions • To assess epithelial dysplasia • To stain for *Candida*	Representative sample. Ulcerated red areas – a separate biopsy.
Persistent new growth or ulcer	Incisional	To exclude/confirm SCC	Include normal marginal tissue Sufficiently deep up to muscle.
Polyps, warts, mucoceles	Excisional	Treat by excision	Any adjacent vital structures
Granulomas	Incisional	Diagnosis	Sufficiently deep as granulomatous areas are mostly deep seated.
Lumps on lip and palate	FNA preferred	Biopsy should be avoided to prevent spillage of tumour	Refer to specialist Head and Neck Unit.
Pigmented macules	Incisional or excisional	Exclude melanoma	If small may be excised. Avoid vital structures.
Vesicular-bullous	Punch	To determine intra-or subepithelial	• Perilesional tissue preferred. • Transport fresh or in Michel's medium.

SCC, squamous cell carcinoma.

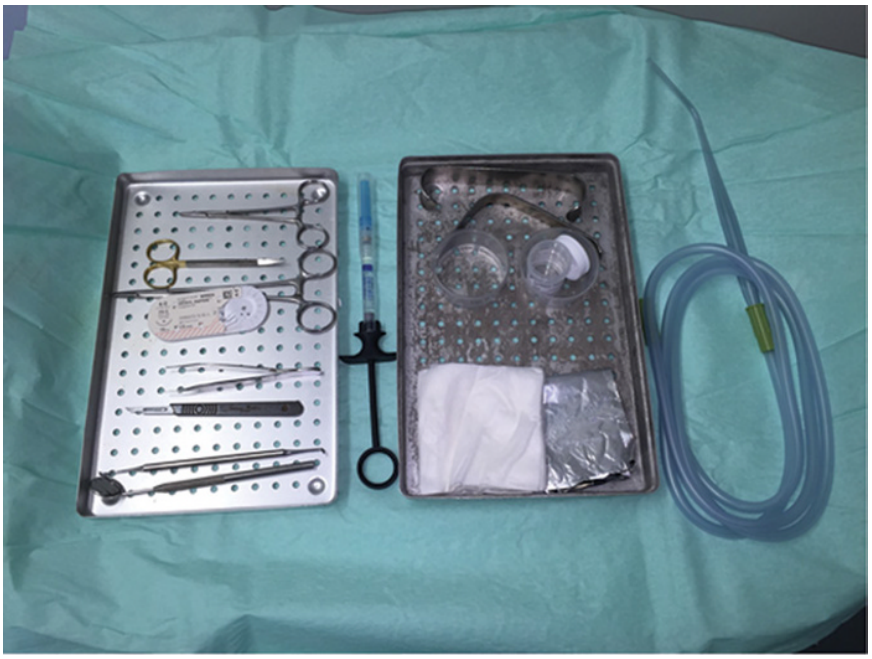


Figure 14.1 Standard biopsy kit.

Excisional Biopsy	
• Generally small lesions (e.g. <~2 cm at their widest diameter) may be excised thereby providing tissue for diagnosis as well as accomplishing the treatment at one visit.	Examples include: fibroepithelial polyps, benign squamous papillomas, mucoceles and denture-induced granulomas.
• An excised sample must always be transported to a pathology laboratory rather than be disposed of.	Why? At times, unexpected tissue diagnosis may occur requiring revision of the original clinical diagnosis.
• An excisional biopsy is not indicated when malignancy is suspected, however small the lesion.	Why? It may result in poor margin clearance, and obliterating the site of the primary lesion may make it difficult for a surgeon to operate at a later time.
Incisional Biopsy	
• Performed to sample a mucosal lesion that is large.	What shape is best? A wedge or an ellipse of tissue from the most representative area taking into consideration the optimal wound closure by suturing the defect.
• The sample is transported to the pathology laboratory to be analysed.	
• No clear contraindications to undertaking a biopsy in a surgical setting. However, there are some conditions where the decision to proceed with biopsy should be made with caution.	When? Bleeding diathesis secondary to anticoagulation, lesions located near vital structures that could be injured (e.g. near the submandibular duct orifice, near the mental nerve exiting at the foramen).
• Some lesions, e.g. suspected tumours of minor salivary glands of the palate and particularly of the upper lip should not be subjected to incisional biopsy unless such biopsies are performed by a specialist.	Why? To avoid any seeding of tumour cells which could adversely affect the future prognosis of the case (Kusukawa et al., 2000).
Site Selection	
• Critical to include the most representative part of a lesion, particularly if the affected area lacks a homogeneous appearance.	Why? In a mixed white/red patch consistent with the clinical diagnosis of erythroleukoplakia the red zone may demonstrate by histology a higher grade of dysplasia compared with white (simple keratoses) or even an early carcinoma.
• An incisional biopsy should always include a margin of normal tissue.	Why? A suspected squamous carcinoma where its rolled margin extends to 'normal' mucosa may show invading islands of malignancy that may be missed in the centre due to the friable nature of an invading carcinoma.

• If the disorder involves a large mucosal patch and there is a varied clinical appearance, more than one biopsy sample may be helpful for the pathologist to report upon.	In such cases a good choice is to use a punch biopsy to take at least two samples. The technique is described later.
• Incorrect sampling is often the reason for missing a malignancy or, for example, underdiagnosis of oral epithelial dysplasia.	Those with less experience should consult with a senior colleague before selecting the site from which an incisional biopsy is taken.
Biopsy Procedure and Technique	See Figure 14.2.
• Informed consent is essential prior to undertaking the procedure.	
• After giving an adequate local anaesthetic the patient should be reassured regarding pain control during the procedure.	Some anxious individuals may opt for intravenous sedation (Chapter 10) to comply with the procedure.
• Some operators prefer to remove tissue samples by laser.	Why? The main advantage is bloodless surgery and favourable wound healing. The CO_2 laser has been recommended to treat by excision benign oral lesions, e.g. fibromas, papillomas. However, when used for incisional biopsy of leukoplakia or erythroplakias thermal damage to margins may preclude valuable microscopic information and a pulsed char-free mode is recommended (Suter et al., 2010).
• Removal of sufficient tissue in terms of extent and depth is important.	Why? The pathologist requires a large enough specimen and small biopsies may shrink by a third when immersed in the fixative. The depth is important as superficial oral biopsy samples, particularly when lacking any connective tissue, cannot be interpreted when reporting, e.g granulomatous conditions: granulomas are found often deep in the lamina propria.
• Orientation of the biopsy with a stitch and a labelled diagram may help the pathologist to interpret its anatomical location.	
• Any blood exudate on the surface should be wiped by placing the sample on a wet gauze to reduce any blood contamination.	
• Issues pertaining to transport of specimens for immunological tests are described later.	
Labial Gland Biopsy	
• This procedure involves sampling minor salivary glands in the lower lip.	
• The three main indications for performing a labial gland biopsy are to: – Investigate xeostomia with a view to confirming Sjogren's syndrome. – Assess infiltrative diseases in connective tissue, e.g. sarcoidosis and amyloidosis. – Diagnose chronic graft versus host disease (cGVHD).	Rarely, IgG4-related disease may be confirmed on the basis of a labial salivary gland biopsy.
• The technique was originally described by Chisholm and Mason in 1968.	
• A systematic review (Colella et al., 2010) found 21 articles describing various surgical techniques for taking a lip biopsy and complications involved.	The most commonly used technique (Greenspan et al., 1974) involves a 1.5–2 cm linear incision in the normal lower lip mucosa parallel to the vermillion border, halfway between the vermillion border and the vestibule, and lateral to the midline. Four to six minor salivary glands are harvested and the wound sutured by primary closure with two or three interrupted resorbable sutures without overlapping the mucosal edges.
• Complications are seen in less than 10%, partial loss of sensation of the lip being the most commonly reported due to injury to the labial branch of the mental nerve.	
• Immediate postoperative complications are pain, lip swelling and bruising of mucosa or skin. Sampling errors may occur.	The resulting hypoaesthesia may take over a year to resolve.
• Lip biopsy is currently accepted as one of three minimum criteria in confirming Sjogren's syndrome in the presence of focal lymphocytic sialadenitis with a focus score >1 focus/4 mm^2 in labial salivary gland biopsy samples (Shiboski, Shiboski and Criswell, 2012).	

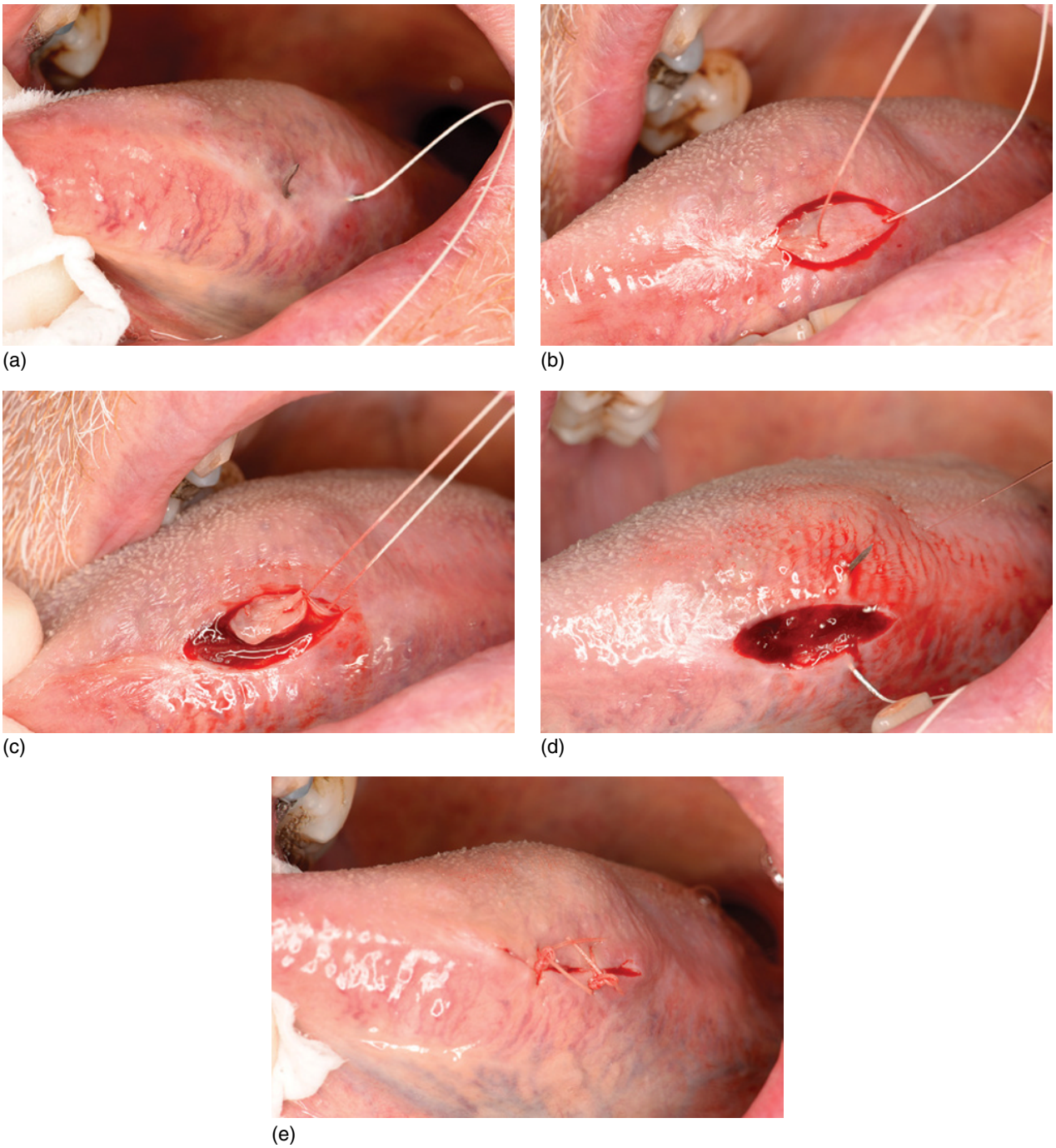


Figure 14.2 (a) Suture passes through proposed biopsy site. (b) Outline of biopsy. (c) Biopsy freed from underlying tissue. (d) Suture placed close to biopsy site. (e) Biopsy site closed.

Fine-Needle Aspiration Biopsy	
• Fine-needle aspiration biopsy (FNAB) provides a versatile technique in the initial diagnosis of lumps and tumour-like masses in sites, such as the breast, thyroid gland, and the prostate gland.	The benefit of the technique is that FNAB may avoid the complications incurred during open biopsy at these sites.
• Oral and paraoral lumps that could be investigated by FNAB include lumps suspected to be parotid adenomas to distinguish from chronic sialadenitis, palpable lymph nodes to exclude lymphomas, and swellings suspected of vascular origin to avoid bleeding complications.	Although FNAB is valuable in these circumstances, it is not as accurate as a tissue sample as architectural context is lost in a cytology preparation and it is not preferred for assessment of lesions accessible or considered safe to perform by a scalpel.

Punch Biopsy	
• Enables a small biopsy of oral mucosa of 3–6 mm diameter to be taken.	The technique is particularly useful for a palatal biopsy.
• After administration of local anaesthesia the punch is twisted vertically to a depth of about 3 mm and the base is severed with surgical scissors or a scalpel. A suture may be required to close the biopsy site.	
• A punch is a useful adjunct to obtain normal mucosa for direct immunofluorescence studies to diagnose vesicular–bullous disorders.	
• Intact epithelium and connective tissue are critical in evaluation of a specimen for direct immunofluorescence studies.	Biopsy of a fresh intact vesicle or bulla is difficult as it ruptures rapidly during a biopsy procedure. Therefore, the site of biopsy for a vesicular–bullous disease should be adjacent to a bulla/ulcer (perilesional) where epithelium is intact.
• The sample should be transported following quick freezing in liquid nitrogen or in the commercially available Michel's medium.	
• Biopsy of solid bony lesions may also be obtained by a trephine instrument.	
Brush Biopsy	
• A brush biopsy is designed to obtain complete transepithelial samples of mucosal lesions suspected of carcinoma or epithelial dysplasia.	It allows cytopathological examination to decide on the indication for a knife biopsy and is not an alternative to earlier referred sampling technique by incision biopsy.
• The circular end of the brush is placed over the mucosa, rotated 8–10 times while maintaining firm pressure to allow the brush to penetrate the full thickness of the epithelium until pin-point bleeding is apparent at the site.	
• The cellular material collected on the brush is transferred to a glass slide by smearing and then immersed in a fixative to avoid air drying.	
• Slides stained with the Papanicolaou method can be read by a cytopathologist to detect gross epithelial abnormalities (cellular atypia).	In the USA, the specimens are transferred to Oral CDx laboratories to obtain a computerised report on cellular atypia. A multicentre study in the USA reported good sensitivity of the technique (Sciubba, 1999).
Sentinel Node Biopsy	
• Sentinel node (SLN) biopsy facilitates the detection of lymph nodes potentially containing malignancy.	The first lymph node in a regional draining area that receives lymphatic flow from the tumour is designated the sentinel node.
• During the procedure the SLN is identified using radioactive colloid and a blue dye. This node is excised and examined by microscopy using serial sections. Tumour negative SLN precludes the presence of metastasis in regional nodes.	This procedure aims to avoid unnecessary treatment to the clinically negative neck by identifying the patients with occult neck disease.
• In a meta-analysis evaluating the diagnostic reliability of sentinel lymph node biopsy in patients with squamous cell carcinoma of the oral cavity the overall sensitivity in 631 tumours included in the study was 94% (95% CI 89–98 %).	Showed that SLN biopsy is a valid diagnostic technique to correctly stage regional metastases in patients with head and neck squamous cell carcinoma.
• An earlier review indicated 100% of oropharyngeal (n = 72), tumour sentinel lymph biopsy results correlated with subsequent neck dissections giving a negative predictive value of 100%.	

Chairside Diagnostic Tests for Mucosal Disease

- Adjuncts to conventional methods for the detection of oral cancer and precancer include:
  - Toluidine blue test.
  - Autofluorescence.
  - Chemiluminescence.

Toluidine Blue Test

- The use of toluidine blue dye as a mouthwash or topical application has been investigated as an aid to the diagnosis of oral cancer and potentially malignant lesions.

The World Dental Federation (FDI) Commission supports the use of toluidine blue in appropriately experienced hands while urging further research on its clinical utility in primary care settings. Although 100% of squamous cell carcinomas are dye positive, close to 75% of oral potentially malignant disorders may stain and in addition many benign conditions also show vital staining.

- With appropriate training, vital staining may assist in screening high-risk subjects and in helping to define the site for biopsy.
- For clinicians in primary care settings, specific training is required for correct application of the test and correct interpretation of the results.

The use of toluidine blue in expert and experienced hands is recommended:

- In the monitoring of suspicious lesions over time.
- In screening for oral mucosal malignancy and potentially malignant lesions in high-risk individuals and population groups.
- In the follow-up of patients already treated for upper aerodigestive tract cancer.
- In helping to determine an optimal site for biopsy when a suspicious lesion or condition is present.
- Intraoperatively during surgery of upper aerodigestive tract malignancy.

Optical Devices (Vizilite™ and Vizilite plus™, Microlux/DL™, VELscope)

- Light-based detection systems are based on the assumption that the structural and metabolic changes that take place in the mucosa during carcinogenesis give rise to distinct profiles of absorption and reflection when exposed to different wavelengths of light or energy.

Autofluorescence

- Visually Enhanced Lesion Scope (VELscope) is a handheld device that is based on the direct visualisation of tissue fluorescence.
- The clinician is able to detect through the scope any changes (or particularly loss) in fluorescence that occurs when abnormalities are present.

The principle behind the technique is that the presence of cellular alterations will change the concentrations of fluorophores, which affect the scattering and absorption of light in the tissue, thereby resulting in change in colour that can be observed visually.

- The VELscope handpiece emits a blue light into the oral cavity, which excites the tissue from the surface of the epithelium through to the basement membrane and into the stroma beneath, causing it to fluoresce.
- Typically, healthy tissue appears as a bright apple-green glow while suspicious regions are identified by a loss of fluorescence, which thus appear dark.

Though the sensitivity to detect any oral mucosal disorder is high the specificity to detect high risk lesions, e.g. dysplasia, is low (Awan, Morgan and Warnakulasuriya, 2011a).

Chemiluminescence

- Two handheld devices (ViziLite™ & MicroLux/DL™ system) are available for use in the oral cavity.

Chemiluminescence was originally developed for use in detecting abnormalities of the uterine cervix.

- The ViziLite system involves an oral rinse with 1% acetic acid solution for 1 min to help remove surface debris and slightly desiccate the oral mucosa. This is followed by direct visual examination of the oral cavity using the chemiluminescent blue–white light stick with an average wavelength of 490–510 nm. Normal cells absorb the illumination and appear lightly bluish, whereas abnormal cells having a higher nuclear-cytoplasmic ratio reflect the illumination and appear 'aceto-white' with brighter, sharper, more distinct margins. In the authors' experience the technique is useful to confirm oral leukoplakia but tends to give false negative results with red lesions (erythroplakia) (Awan et al., 2011b).

These devices function under the assumption that mucosal tissue undergoing abnormal metabolic or structural changes has different absorbance and reflectance profiles when exposed to various forms of light sources, as a result enhancing the identification of oral mucosal abnormalities.

The clear advantage of the optical tests is that it accelerates the decision to undertake a biopsy. Their utility in primary care is uncertain.

Salivary Flow

- Saliva is produced by the three paired major salivary glands (parotid, submandibular and sublingual) together with the many minor salivary glands throughout the oropharynx.

The total daily production of saliva is around 500 ml with the rate of production around 0.35 ml/min at rest which increases to 2.0 ml/min during eating and falling to 0.1 ml/min during sleep (Dawes, 1972).

- In addition to its role in digestion and taste, saliva produces a film which coats the teeth and mucosa and helps to cleanse and lubricate the oral cavity (Falcão et al., 2013).

The buffers within it also help to maintain optimal pH for the action of salivary amylase and to help maintain the structure of the teeth (Falcão et al., 2013).

- Saliva also prevents desiccation of the oral mucosa and acts as a barrier to microbes (Altarawneh et al., 2013) both physically and through its antimicrobial activity. As a result, if salivary flow falls, there are several complications, one of which will be a feeling of a dry mouth.

Assessment of Salivary Flow

Clinical Examination

- The Challacombe dry mouth scale may be helpful in assessing the degree of oral dryness with a resultant score of 7 or more indicating the need for onward referral and further assessment.

Challacombe dry mouth scale (one point for each feature to a maximum of 10):
- Mirror sticks to one buccal mucosa.
- Mirror sticks to both buccal mucosa.
- Mirror sticks to tongue.
- Saliva frothy.
- No saliva pooling in floor of mouth.
- Tongue shows loss of papillae.
- Altered (smooth) gingival architecture.
- Glassy appearance to oral mucosa.
- Cervical caries (more than two teeth).
- Tongue highly fissured.
- Tongue lobulated.
- Debris on palate.

Quantification

- A reasonable indication of salivary function may be obtained by measuring the resting (unstimulated) salivary flow over a period of 10 min.

This will be reduced in the presence of xerostomic medications or underlying conditions and a value below 0.2 ml/min requires further investigation and below 0.1 ml/min is indicative of an underlying condition or disease process (Atkinson, 1993).

- The stimulated parotid flow rate may also be determined.

Equipment and materials (Figure 14.3):
- 2% citric acid solution.
- 100 ml screw-top tubes/Universal (preweighed) labelled for collection from the right or left parotids – NB, if preweighed without label must not weigh post collection with label.
- 10 ml Luer-lock syringe (syringe used to create suction).
- 2.5 ml syringe (used to draw up 2 ml citric acid).
- Artery clip (for use with the syringe used to create suction).

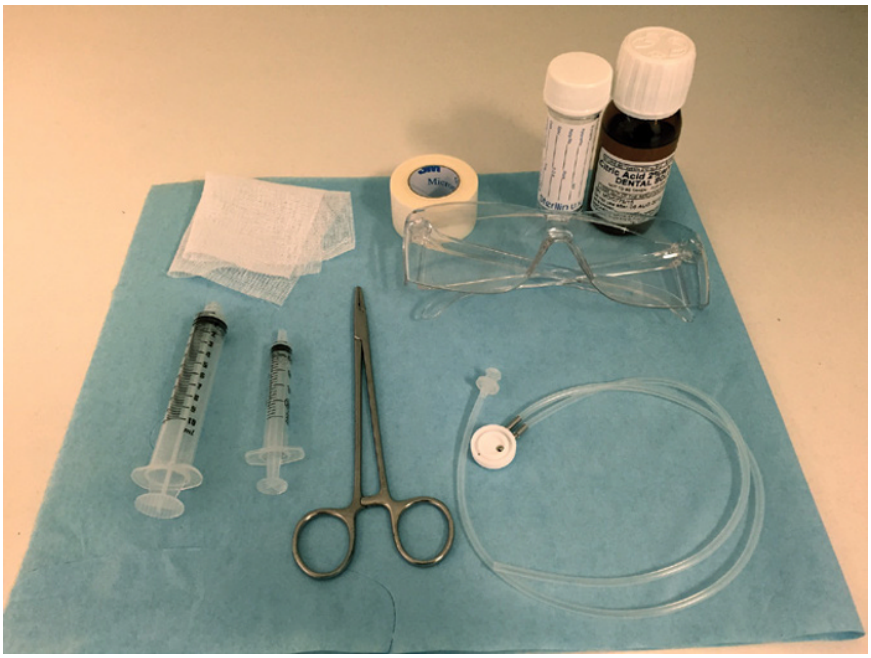


Figure 14.3 Stimulated parotid collection and flow rate. Materials: 2% citric acid solution; 100 ml screw-top tubes/universal (preweighed) labelled for collection from the right or left parotids – NB, if preweighed without label, do not weigh postcollection with label; 10 ml Luer-lock syringe (syringe used to create suction); 2.5 ml syringe (used to draw up 2 ml citric acid; artery clip (for use with the syringe used to create suction); parotid suction cup and tubing with syringe connector on tubing leaving the outer rim; two plastic cups (one for H_2O for patient to rinse after collection and one to hold 'spare' 10 ml citric acid; glasses for the patient; bib for the patient; timer or clock.

	• Parotid suction cup and tubing with syringe connector on tubing leaving the outer rim. • Plastic cup x 2 (one for H_2O for patient to rinse after collection and one to hold 'spare' 10 ml citric acid). • Glasses for the patient. • Bib for the patient. • Timer or clock.
• The orifice of the parotid duct is located bilaterally on the buccal mucosa opposite the upper second molar tooth.	If you have difficult visualising the orifice, dry the area with gauze.
• The parotid collector is placed on the mucosa so that the inner ring surrounds the duct orifice and is held in position by suction from the outer ring, created by suction obtained by pulling back on the syringe and allowing the pressure to come to equilibrium. An artery clip is attached to the tubing going from the collector to the syringe to 'lock-in' the air in the tubing.	The syringe can then be rested on the patient's chest/shoulder and secured with tape. The patient should avoid unnecessary movement of their head or jaw to prevent dislodging the saliva collection cup.
• Saliva from the parotid gland may flow passively into the inner ring and through the attached tubing.	If no saliva is seen after a 2–3 min waiting period, the salivary collection apparatus is removed to ensure correct placement over the duct orifice (an impression of two concentric circles on the buccal mucosa with the parotid orifice observed in the middle of the inner circle verifies correct placement).
• Fill a 2.5 ml syringe with 2 ml of 2% citric acid and drip one to two drops onto the tongue every 30–60 s. The 2 ml should be dispensed evenly over 10 min.	
• Stop collecting after 10 min and gently remove the suction cup by releasing the clip.	Take care to collect any residual saliva in the tubing: this is best done by holding the suction cup over the collecting universal whilst the universal is still taped to the patient's chest/shoulder.
• Place the top on the universal container and screw up tightly so that no saliva will leak out during transport.	
• The flow rate can then be assessed.	Neither the unstimulated whole nor the stimulated parotid flow are particularly reliable and hence both should only be viewed as indicative rather than diagnostic.

Ophthalmological Assessment

• Some patients, such as those with Sjogren's syndrome may complain of dry eyes. In such cases a number of specific tests may be of assistance in determining the severity of the effect. The most commonly used tests are: – Schirmer's. – Tear film break-up time. – Rose Bengal staining.	Together these provide good sensitivity in determining the severity of dry eyes (Paschides et al., 1989; Vitali, Moutsopoulos and Bombardieri, 1994; Gomes et al., 2012).
Schirmer's Test	
• A small strip of filter paper is placed inside the lower eyelid (conjunctival sac) of both eyes.	This test measures basic tear function.
• The eyes are then closed for 5 min before removing the paper and measuring the amount of moisture.	
• A healthy adult will normally moisten 15 mm of each paper strip whilst age-related reduction in lacrimation may mean that older patients are closer to 10 mm. In people with Sjogren's syndrome this may be less than 5 mm in 5 min.	The following is a guide as to usual wetting seen, after 5 min, in association with the varying degrees of hypolacrimation: • Normal: ≥15 mm. • Mild: 14–9 mm. • Moderate: 8–4 mm. • Severe: <4 mm.
Tear Break-Up Time (TBUT)	
• Sodium fluorescein dye is introduced to the eye and the tear film observed using a slit lamp whilst the patient avoids blinking until tiny dry spots develop.	
• The longer it takes, the more stable the tear film, whilst a short TBUT is indicative of a poor tear film and highly likely to be associated with symptoms of dry eyes.	In general: • Normal: >10 s. • Marginal: 5–10 s. • Low: <5 s.
Rose Bengal Staining	
• Rose Bengal stain is introduced into the eye to determine if there is uptake by the conjuctiva.	The possibility that this stain may damage the viability of human corneal epithelial cells has led some to suggest that lissamine green should be used in preference.

Candidal Assay

• This enables testing for the presence of *Candida* and other pathogens and may be undertaken using: – Salivary collected in a sterile container. – Salivary swab. – Smear. – Salivary imprint.	*Candida* originates from the Latin word candid, meaning white. The most common oral candidal species is *Candida albicans* which accounts for over 80% of all isolates. Others species increasingly encountered include: *C. glabrata*, *C. krusei*, *C. dubliniensis* and *C. tropicalis*. As the presence of *Candida* can be associated with a feeling of oral dryness candidal counts greater than 1700 colony forming units/ml are best treated with a standard antifungal regimen in the first instance and retested at the conclusion to confirm clearance.
Salivary Assay	
• The patient is asked to collect 1–2 ml of saliva in a sterile container.	Approximately 60% of the population carry *Candida* species as part of their normal oral flora.
• The sample is then sent to microbiology for: – Direct microscopy.	Direct microscopy enables detection of fungal morphological forms (budding yeast or hyphae) when the organism presents in high numbers and is therefore most probably causing disease.
– Culture.	Species identification requires other selective media or biochemical assays, e.g. Sabouraud's dextrose agar with (SABC) and without (SAB) chloramphenicol and CHROMagar-*Candida* is useful in differentiating. The latter is useful as different species produce different coloured colonies (especially *C. albicans* and *C. glabrata*).
– Sensitivity testing.	Why? The increase in resistance to common antifungal agents may require targeted therapy to achieve efficacy.

Concentrated Oral Rinse

- The patient holds 10 ml of sterile phosphate-buffered saline (0.01 M, pH 7.2) in the mouth for 1 min.
- The patient expectorates the solution into a sterile container for transfer to microbiology.
- The solution is concentrated (10-fold) by centrifugation and a known volume, usually 50 µl, inoculated on an agar medium using a spiral plating system.
- After 24–48 h incubation at 37 °C, growth is assessed by enumeration of colonies and expressed as candidal colony forming units/ml of rinse (Williams and Lewis, 2000).

Why? In patients with markedly dry mouths it may be difficult to obtain a salivary sample.

Salivary Swab

- A standard sterile cotton medical swab (Figure 14.4) is gently rubbed over the lesional tissue (Axel et al., 1985).
- The swab is then placed in transport medium.
- The sample is then forwarded to microbiology for culture and sensitivity testing.

Culture is undertaken as described previously.

Smear

- A metal spatula is used to remove a sample from the lesional site and spread out on a dry microscope slide (Figure 14.5).
- The slide is then fixed or sent dry to microbiology to be examined.
- The smear is stained either by the Gram stain or by the periodic acid–Schiff (PAS) technique.

Using these methods, candidal hyphae and yeasts appear either dark blue (Gram-stain) or red/purple (PAS).

Figure 14.4 Salivary swab.

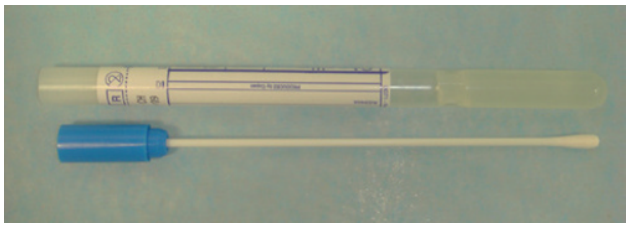
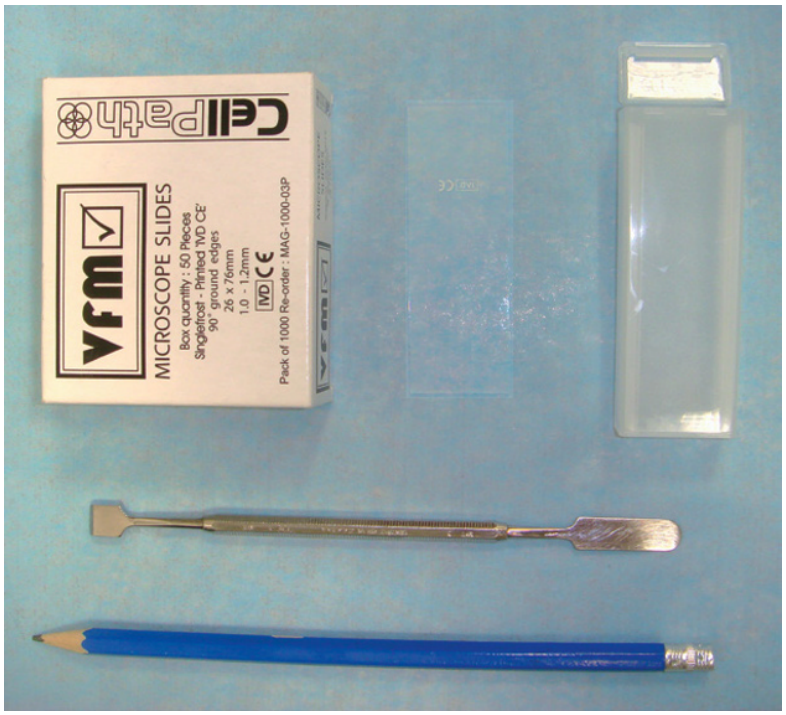


Figure 14.5 Smear equipment.



Salivary Imprint • The imprint method uses a sterile foam pad of known size (typically 2.5 cm^2), previously dipped in an appropriate liquid medium, such as Sabouraud's broth, immediately before use (Williams and Lewis, 2000).	
• The pad is then placed on the target site (mucosa or intraoral prosthesis) for 30 s and then transferred to an agar for culture.	Culture is undertaken as described previously.

Urinalysis

• This is a simple test which will identify overt pathological changes such as may be seen in diabetes.	The urine is usually assessed using commercially available 'dip-sticks'.

Venepuncture

• This is an essential skill as many conditions and diseases can be diagnosed using specific haematological (e.g. anaemia), serological (e.g. infections) or immunological (e.g. immunobullous) disease tests which require appropriate samples.	The necessary equipment is illustrated in Figure 14.6: • Blue or green butterfly needle. • Green vaccutainer adapter. • Disposable tourniquet. • Alcohol wipe. • Various blood bottles – as prescribed by EPR request. • Cotton wool. • Micropore or plaster.
• In many settings the request will be made electronically and patient-specific labels will be produced.	In some settings this will be in the form of a written request form.
• The operator should ensure that the requests and the labels match up.	
• The identity of the patient should be confirmed with their name and date of birth.	
• The necessary equipment (Figure 14.6) should be prepared on a tray.	

Figure 14.6 Venepuncture equipment. Set up: blue or green butterfly needle; green vaccutainer adapter; disposable tourniquet; alcohol wipe; various blood bottles – as prescribed by EPR request; cotton wool; micropore or plaster.

• Assess the patient for the best vein to use and ask if they ever have any issues or problems.	This will usually be located in the antecubital fossa, but it may also be necessary to use veins on the back of the hand.
• Place a tourniquet on the appropriate arm and wipe the area in which the venepuncture will be performed using an alcohol wipe.	This will usually be the non-dominant arm.
• Perform venepuncture, waiting for flashback in butterfly to confirm vein access.	
• Attach the relevant bottles, in turn, to the adapter and fill them to the appropriate level.	The optimal sample volume required will normally be indicated by a line on the bottle.
• Remove all bottles and the tourniquet, place cotton wool over the venepuncture site, remove the needle and apply pressure to achieve haemostasis.	Once haemostasis is achieved a sticking plaster may be applied, to address any capillary ooze, provided the patient does not report a sensitivity.
• Immediately dispose of sharps into a sharps bin.	
• Ensure the bottles are correctly identified either using the labels or by hand and place in a specimen bag.	
• Complete the patient's notes to identify that blood has been taken.	

Allergy Testing

• The most common dentally relevant allergens include: – Local anaesthetics. – Drugs (including toothpaste and mouthwash). – Latex. – Dental materials.	Allergy is defined as an immunologically mediated sensitivity. It is characterised by: • A specific immune response to the allergen. • Not being dose dependent. A change to the reaction on subsequent exposure.
• The commonest specific investigations associated with these sensitivities are: – Local anaesthetic allergy testing. – Cutaneous patch testing.	
Local Anaesthetic Allergy Testing	
• Patients with a history of adverse reactions to a local anaesthetic are sometimes incorrectly labelled as 'allergic' (Simon, 1984). • The validity or otherwise of this can be confirmed by anaesthetic allergy testing. • This procedure may be performed safely and with good accuracy by a knowledgeable practitioner. • The aim is to find a local anaesthetic that can be used in the patient to provide safe and comfortable dental treatment (Patterson and Anderson, 1982).	True allergic reactions to local anaesthetics are rare, estimated at less than 1% of all adverse reactions (Bennett, 1984).
Patient Evaluation	
• A thorough history of the events surrounding the 'allergic reaction' should be taken.	What should be included?: • Name of the drug. • Amount administered. • Presence of any vasoconstrictor or other additive. • Medications taken at the time of reaction. • Details of the reaction. • Position of the patient in the dental chair. • Treatment given.
• Food allergies should be identified, when possible.	Why? Food products often contain sulphite preservatives; consequently, their ingestion may elicit an allergic reaction.
• Current medications and their dosages should be recorded.	Why? Co-existing medical conditions may have been the cause of the suspected 'allergic event', e.g. postural hypotension or hypoglycaemia secondary to diabetes.
• A review of systems should be undertaken.	

Patient Preparation and Management

- Informed consent should be obtained.
- Baseline measurement of blood pressure, pulse and respiration should be obtained.
- Intravenous access should be obtained using a 16- or 18-gauge cannula.

Why? To provide a route of administration for drug and fluid administration in the event of a reaction.

- A complete emergency kit including oxygen should be available.

Preparation of Test Solutions

- The recommended agents to establish a safe anaesthetic agent for future dental treatment are prepared.

Which anaesthetic agents are used?:

- Lignocaine hydrochloride 2% with 1:80 000 adrenaline.
- Lignocaine hydrochloride 2% plain.
- Prilocaine hydrochloride with octapressinn 1:200 000.
- Prilocaine hydrochloride 3% plain.
- Mepivicaine hydrochloride.
- Other, e.g. articaine.

- Local anaesthetic test solutions are prepared by drawing up the full dental cartridge selected agents into sterile 1 ml tuberculin syringes using a 25- or 27-gauge needle.
- The control (0.9% sodium chloride) and histamine syringes are similarly prepared.
- Any air is expressed from the syringe.
- Each syringe is labelled for identification.

Injection Procedure

- Specific injection areas (usually on the forearms) are marked approximately 3 cm apart and cleansed with a sterile alcohol swab and allowed to dry.
- The test agent should be unknown to the patient at the time of injection.
- The test is conducted in three stages:
- Skin prick (Figure 14.7).
- Intradermal.
- Intrabuccal.

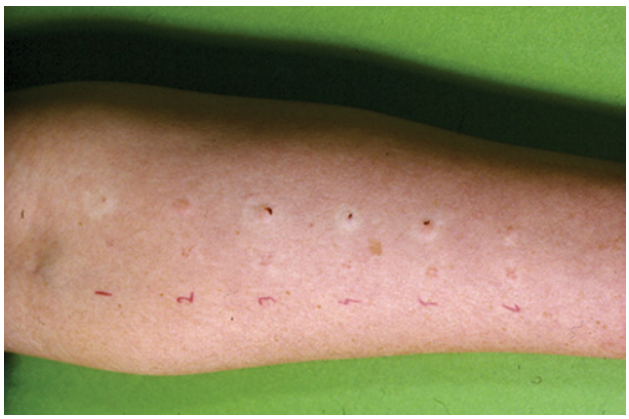


Figure 14.7 Skin-prick testing.

Skin-Prick Test

- For each agent in turn.
- Two-tenths of a millilitre of full strength agent is placed on the cleansed skin.
- A 30-gauge needle is used to superficially 'prick' the skin through the agent four times, making sure not to draw blood.
- A 10-min interval is allotted for evaluation before performing the intradermal injections.

The response is measured by the diameter of skin change or wheal, if present. A common guideline (Aldrete and Johnson, 1970) is:

- No visible change at injection site.
- +1–2 cm in diameter change, wheal or erythema.
- + + 2–3 cm in diameter change, wheal or erythema.
- +++ 3 cm or greater diameter wheal with erythema.

All observation should be compared with the control and recorded.

Intradermal Testing

- The needle tip is inserted, bevel up, just underneath the surface of the skin.
- 0.1 ml of the agent is injected.
- A 'bleb' should be formed if the injection is properly performed.
- A 15 minute interval is allotted for evaluation (as above) before performing the intrabuccal injection.

Intrabuccal Injection

- If no response occurs to the prior injections, a 1 ml injection of a single full strength anaesthetic is performed in the upper buccal sulcus.
- A 45 min interval is allotted for evaluation.
- The patient should be observed for 1–1.5 h after the last injection to determine that no delayed reaction will occur and to ensure the patient's safety.
- If a reaction occurs, the patient must be monitored and appropriately treated.

Cutaneous Patch Testing

- Skin patch testing may be useful in patients with suspected:
  - Lichenoid reactions related to dental materials.
  - Orofacial granulomatosis related to dietary or other allergens.

However, the value of extrapolating cutaneous patch testing results to the oral mucosa has been questioned
Why?

- A positive reaction (reported at 8–78.9%) confirms the diagnosis.
- Negative reactions guide the choice of an alternative material.

Why? Cinnamaldehyde and benzoic acid have been implicated in the aetiology of the condition.

Test Series

- Patients are tested against the European Series ensuring it contains the dental series, particularly those relating to amalgam (Figure 14.8).

The European Series is detailed in Table 14.3.
There is no worldwide agreement on the amalgam series but it generally consists of:

- 5% amalgam.
- 1% ammoniated mercury.

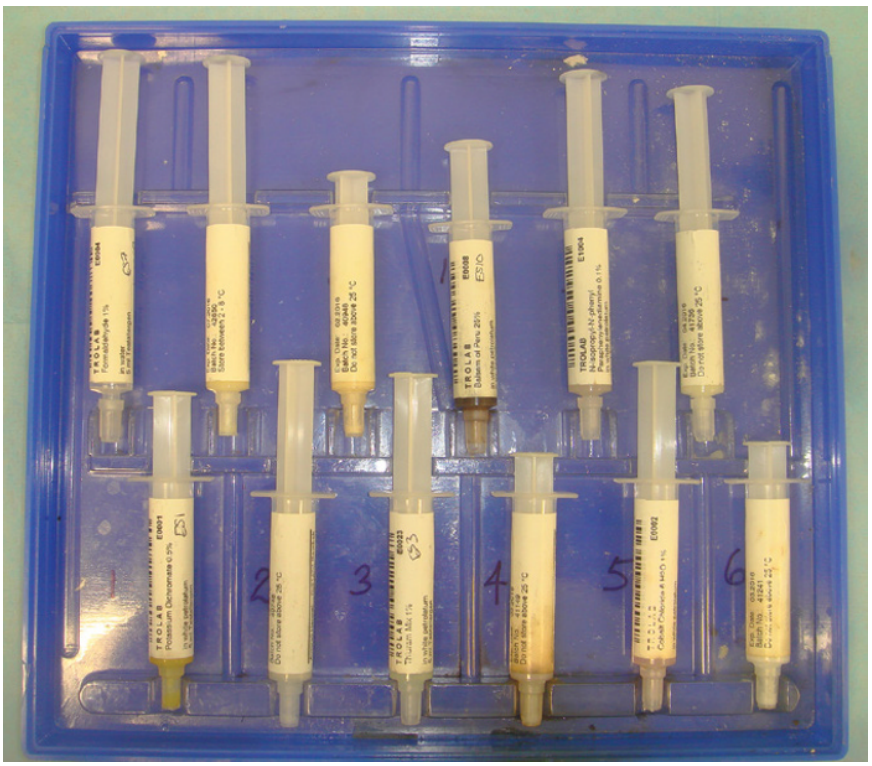


Figure 14.8 Patch testing reagents.

Table 14.3 The European baseline series with the addition of methylisothiazolinone 2000 ppm.

Compound	Concentration % (w/w) in petrolatum except for those in aqua[a]	Concentration in mg/cm^{2*}
Potassium dichromate	0.5	0.2
p-Phenylenediamine	1.0	0.4
Thiuram mix	1.0	0.4
TMTM	0.25	0.1
TMTD	0.25	0.1
TETD	0.25	0.1
PTD	0.25	0.1
Neomycin sulfate	20.0	8.0
Cobalt chloride	1.0	0.4
Benzocaine	5.0	2.0
Nickel sulfate	5.0	2.0
Clioquinol[b]	5.0	2.0
Colophonium[c]	20.0	8.0
Parabens	16.0	6.4
Methylparaben	4.0	1.6
Ethylparaben	4.0	1.6
Propylparaben	4.0	1.6
Butylparaben	4.0	1.6
N-Isopropyl-N-phenyl-4-phenylenediamine	0.1	0.04
Lanolin (wool alcohols)	30.0	12.0
Mercapto mix	2.0	0.8
N-cyclohexylbenzothiazyl sulfenamide Mercaptobenzothiazole	0.5	0.2
Dibenzothiazyl disulfide Morpholinylmercaptobenzothiazole	0.5	0.2
	0.5	0.2
	0.5	0.2
Epoxy resin	1.0	0.4
Myroxylon pereirae[d]	25.0	10.0
4-tert-Butylphenol formaldehyde resin (PTBP resin)	1.0	0.4
Mercaptobenzothiazole	2.0	0.8
Formaldehyde	2.0[a]	0.6
Fragrance mix I	8.0[e]	3.2
Cinnamyl alcohol	1.0	0.4
Cinnamal	1.0	0.4
Hydroxycitronellal	1.0	0.4
α-Amyl cinnamal	1.0	0.4
Geraniol	1.0	0.4
Eugenol	1.0	0.4
Isoeugenol	1.0	0.4
Evernia prunastri (oakmoss absolute)	1.0	0.4
Sesquiterpene lactone mix	0.1	0.04
Alantolactone	0.033	0.013
Dehydrocostus lactone and costunolide	0.067	0.027
Quaternium-15	1.0	0.4
Primin	0.01	0.004
Methylchloroisothiazolinone (150 ppm) and methylisothiazolinone (50 ppm)	0.02[a]	0.006
Budesonide	0.01	0.004
Tixocortol pivalate	0.1	0.04
Methyldibromo glutaronitrile	0.5	0.2

Table 14.3 (Continued)

Compound	Concentration % (w/w) in petrolatum except for those in aqua[a]	Concentration in mg/cm²*
Fragrance mix 2	14.0	5.6
Hydroxylisohexyl 3-cyclohexene	2.5	1.0
carboxaldehyde	1.0	0.4
Citral	2.5	1.0
Farnesol	2.5	1.0
Coumarin	0.5	0.2
Citronellol	5.0	2.0
α-hexyl cinnamal		
Hydroxyisohexyl 3-cyclohexene carboxaldehyde	5.0	2.0
Methylisothiazolinone	0.20[a]	0.06

PTD, dipentamethylenethiuram disulfide; TETD, tetraethylthiuram disulfide; TMTD, tetramethylthiuram disulfide; TMTM, tetramethylthiuram monosulfide.

* Calculations based on the use of the Finn Chamber® (diameter 0.8 cm) technique with application of 20 mg petrolatum preparation or where appropriate (in water) 15 ml aqueous test solution.

[a] In water.

[b] Also known as chinoform and vioform.

[c] Also known as colophony.

[d] Also known as Balsam of Peru.

[e] Emulsifier: sorbitan sesquioleate 5%.

Test Procedure	
• The patient should not take any cortisone or medications altering the immune system during the test, avoid taking showers and avoid exposure of the back to sunlight.	
• The test patches are applied, if possible, to the upper part of the patient's back.	The upper part of the arm can also be used.
• Mark, to the left of the tape, the first and the fifth chamber.	Why? It assists identification of the hapten when the tape has been removed.
• Patches are not applied to the midline and the scapula.	Test units should not be placed under a brassiere shoulder band as this can cause dislocation of the test units.
• When several test series are applied, two horizontal rows of 4–5 units per row can be applied across the back.	Test units should not be placed under a brassiere shoulder band as this can cause dislocation of the test units.
• The tape should be pressed with the palm of the hand for about 5 s.	Why? The pressure and heat will enhance adhesion.
• Unless the patient has very dry or oily skin there is no need to put on extra reinforcement tape to secure the patches.	If the patient's skin is oily it can be cleaned with some ethanol.
• Complete the patient record form.	Why? It facilitates keeping track of the patient's test results.
Reading the Results	
• Patch test results are usually read on day 2 after allowing initial skin irritation from the backing tape to subside (Figure 14.9).	The reactions are graded as: T: Macular reactions +: Papular reactions ++: Papulovesicular reactions in accordance with the International Contact Dermatitis Research Group criteria (Fregert, 1981).
• Re-reading may be necessary on day 3, particularly in those individuals with sensitive skin who may develop a weak erythema.	
• It may also be necessary to re-read the test at day 7 after test application for haptens that may show delayed reactions.	
• Patient information sheets are provided for all positive reactions.	Why? They explain where the substance can be found and if there are some known synonyms of the substance.

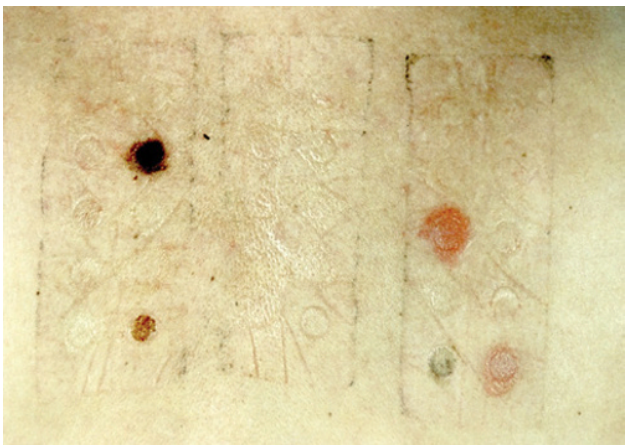


Figure 14.9 Cutaneous patch testing result.

References

Aldrete, J.A., Johnson, D.A. (1970) Evaluation of intracutaneous testing for investigation of allergy to local anesthetic agents. Anesthesia and Analgesis 49: 173–181.

Altarawneh, S., Bencharit, S., Mendoza, L., et al. (2013) Clinical and histological findings of denture stomatitis as related to intraoral colonization patterns of Candida albicans, salivary flow, and dry mouth. Journal of Prosthodontics 22:13–22.

Atkinson, J.C. (1993) The role of salivary measurements in the diagnosis of salivary autoimmune diseases. Annals of the New York Academy of Sciences 694:238–251.

Awan, K., Morgan, P., Warnakulasuriya, S. (2011) Evaluation of an autofluorscence based imaging system (VELscope^{TM}) in the detection of oral potentially malignant disorders and benign keratoses. Oral Oncology 47:274–277.

Awan, K., Morgan, P., Warnakulasuriya, S. (2011) Utility of chemiluminescence (ViziLite) in the detection of oral potentially malignant disorders and benign keratoses. Journal of Oral Pathology and Medicine 40:541–544.

Axéll, T., Simonsson, T., Birkhed, D., et al. (1985) Evaluation of a simplified diagnostic aid (Oricult-N) for detection of oral candidoses. Scandinavian Journal of Dental Research 93:52–55.

Bennett, C.R. (1984) Monheim's Local Anesthesia and Pain Control in Dental Practice, 7th edn. St Louis: Mosby; p. 225.

Chisholm, D.M., Mason, D.K. (1968) Labial salivary gland biopsy in Sjogren's disease. Journal of Clinical Pathology 21:656–660.

Colella, G., Cannavale, R., Vicidomini, A., Itro, A. (2010) Salivary gland biopsy: a comprehensive review of techniques and related complications. Rheumatology 49:2117–2121.

Dawes, C. (1972) Circadian rhythms in human salivary flow rate and composition. Journal of Physiology 220:529–545.

Falcão, D.P., da Mota, L.M., Pires, A.L., Bezerra, A.C. (2013) Sialometry: aspects of clinical interest. Revista Brasiliera de Reumatologia 53:525–531.

Fregert, S. (1981) Manual of Contact Dermatitis, 2nd edn. Copenhagen: Munksgaard; pp. 71–76.

Gomes, P.D., Juodzbalys, G., Fernandes, M.H., Guobis, Z. (2012) Diagnostic approaches to Sjögren's syndrome: a literature review and own clinical experience. Journal of Oral and Maxillofacial Research 3:e3. eCollection.

Greenspan, J.S., Daniels, T.E., Talal, N., Sylvester, R.A. (1974) The histopathology of Sjogren's syndrome in labial gland salivary biopsies. Oral Surgery 37:217–229.

Kusukawa, J., Suefuji, Y., Ryu, F., et al. (2000) Dissemination of cancer cells into circulation occurs by incisional biopsy of oral squamous cell carcinoma. Journal of Oral Pathology and Medicine 29:303–307.

Melrose, R.J. (2011) Failure to diagnose pathology: an avoidable complication in oral and maxillofacial surgery. Oral and Maxillofacial Surgical Clinics of North America 23:465–473.

Paschides, C.A., Kitsios, G., Karakostas, K.X., et al. (1989) Evaluation of tear break-up time, Schirmer's-I test and rose bengal staining as confirmatory tests for keratoconjunctivitis sicca. Clinical and Experimental Rheumatology 7:155–157.

Patterson, R., Anderson, J. (1982) Allergic reactions to drugs and biologic agents. Journal of the American Medical Association 248:2637–2645.

Sciubba, J.J. (1999) Improving detection of precancerous and cancerous oral lesions, computer-assisted analysis of the Oral Brush Biopsy. Journal of the American Dental Association 10:1445–1457.

Shiboski, S.C., Shiboski, C.H., Criswell, L., et al. (2012), American College of Rheumatology classification criteria for Sjögren's syndrome: a data-driven, expert consensus approach in the Sjögren's International

Collaborative Clinical Alliance cohort. Arthritis Care Research 64:475–487.
Simon, R.A. (1984) Adverse reactions to drug additives. Journal of Allergy and Clinical Immunology 74:623–630.
Suter, V., Altermatt, H.J., Sendi, P., et al. (2010) CO_2 and diode laser for excisional biopsies of oral mucosal lesions. Schweizer Monatsschrift fur Zahnmedezin 120:8.
Vitali, C., Moutsopoulos, H.M., Bombardieri, S. (1994) The European Community Study Group on diagnostic criteria for Sjögren's syndrome. Sensitivity and specificity of tests for ocular and oral involvement in Sjögren's syndrome. Annals of the Rheumatic Diseases 53:637–647.
Williams, D.W., Lewis, M.A.O. (2000) Isolation and identification of Candida from the oral cavity. Oral Diseases 6:3–11.

15

Procedures in Oral Surgery

Tara Renton

Introduction

Oral surgery is a dental speciality dealing with conditions of the face, jaws, neck and mouth. It provides diagnosis and treatment for conditions affecting these areas. The patient may be fit and well or have significant comorbidity including social and medical complexities, or have difficulty managing their anxiety and fear during the procedure. This chapter is divided into the following parts:

- Part 1: Medical complexities and their appropriate management, and the assessment of the patient for management by means of local anaesthesia (LA), conscious sedation or general anaesthesia (GA). Management of anxiolysis, both non-medical and medical, is covered in separate chapters. The additional clinical tests which may be required, depending on the condition of the patient, are summarised and the importance of valid consent is emphasized.
- Part 2: Dentoalveolar surgery, which may involve routine exodontias, or the surgical removal of one or more teeth.
- Part 3: Surgery indicated for impacted teeth or fractured roots. Surgical access is most commonly indicated for third molar (wisdom tooth) removal or coronectomy, where there is a high risk of nerve injury.
- Part 4: Management of acute and chronic orofacial infections using medical and surgical techniques.
- Part 5: Management of temporomandibular joint (TMJ) disorders, including dysfunction, arthritides and myalgia.
- Part 6: Prevention and management of complications related to surgery including pain, infection, nerve injury and other less common complications.

Oral surgery procedures may be routine and simple in uncomplicated patients, or complex, involving extended surgery in an exceedingly compromised (psychologically, socially or medically) patient with a high risk of complications.

Other procedures to be covered in related chapters include:

- Management of patients presenting with acute and chronic orofacial pain using medical, surgical and affective techniques (Chapter 9).
- Surgical management of patients requiring implant dentistry, as part of a multidisciplinary team approach to rehabilitation (Chapter 12).
- Management of anxiolysis by means of behavioural interventions (Chapter 4), and pharmacological techniques (Chapter 10).
- Management of antral pathology and grafting of the antral space, when required for implant placement (Chapter 12), and in the management of dentoalveolar fractures.
- Surgical procedures in acute dental traumatology and in the management of dentoalveolar fractures.
- Surgical management of periapical pathology as part of endodontic therapy (Chapter 16).

Procedures which are considered to fall out with the scope of this manual, include:

- Management of orofacial trauma.
- TMJ surgery.
- Surgical management of salivary gland disease.
- Management of benign cystic and solid lesions of the soft and hard tissues of the mouth and jaws requiring advanced surgical management.
- Maxillary antral procedures.
- Preprosthetic surgery.
- Complex dental implant surgery.
- Oral surgery for the orthodontic patient.
- Surgical management of neoplasia.

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

Part 1: Examination, Medical Complexities and Considerations, and Consent

To provide each patient with the most suitable treatment plan to address individual need, it is essential to discover and record as much information as possible about each patient's past experiences, attitudes, expectations, general and oral health, and wellbeing. Procedures for patient examination and assessment are considered in detail in Chapter 6. For oral surgery, the standard history and examination should be augmented by examinations (Table 15.1) and special tests (Table 15.2) of particular relevance to oral surgery and the medical condition of the patient categorised, according to the scheme of the American Society of Anaesthesiologists (Table 15.3). Decisions must be made about the management of medically compromised patients (Table 15.4). In addition, a decision needs to be made about the selection of the anaesthesia most appropriate for the proposed procedures (Figure 15.1).

Consent

The consent process as considered in Chapter 5 is a requirement prior to any surgical intervention. Consent, which should involve joint decision making with the patient, is a process whereby the patient is made aware of the risk–benefit of undertaking the surgical procedure. It is the surgeon's responsibility to ensure that the patient understands the alternative treatment options and their consequences. This two-way discussion and agreement also allows the surgeon to ensure that the patient's expectations are managed appropriately and to recognise if the patient has unrealistic expectations which may prevent surgery.

Table 15.1 Examinations of particular relevance to oral surgery.

Extraoral examination	
• Palpation and evaluation of TMJ and movements.	Jaw movement is important in relation to mouth opening (access for surgery) and in assessments of TMJ disorders (clicks, crepitus, deviations on opening, tenderness of joints and muscles).
• Palpation of lymph nodes.	Enlargement of lymph nodes may be related to infection or neoplasm.
• Assessment of the symmetry of the face.	Pathology (congenital, growth deformity, infection or neoplasm), trauma and neuropathy may be indicated by asymmetry of the face or mouth.
• Cranial nerve evaluation.	Cranial nerve evaluation is important in any patient presenting with neoplasia, pain or neuropathy.
• Palpation of the salivary glands.	In patients presenting with xerostomia or recurrent meal time syndrome the evaluation of salivary gland enlargement and possible obstructions is important.
Intraoral examination	
• Examination of the oral mucosa.	Conditions of the oral mucosa, which may present as some form of ulceration or changes in appearance and texture, may be local or indicative of an underlying systemic problem. The examination must include screening for oral cancer.
• Palpation of the alveolus.	If the alveolus or edentulous ridge is tender to digital palpation, this may infer localised infection or trauma. A swelling may be related to an unerupted tooth, cystic lesion or neoplasia.
• Bimanual palpation of salivary glands and any soft tissue mass to assess mobility, blanching and fluctuance.	
Condition of the dentition	
• Occlusion – Class I, II or III with or without an open or cross bite?	
• Unerupted or partially erupted teeth.	
• Heavily restored teeth.	
• Oral hygiene, presence of calculus, gingivitis and periodontitis.	
• Tooth wear – attrition, abrasion and erosion.	
• Evidence of parafunction.	
• Evidence of trauma.	

TMJ, temporomandibular joint.

Table 15.2 Specific tests of particular relevance to oral surgery procedures.

Procedure	Additional clinical examination	Haematological examination	Radiographic tests
Routine dental extraction		Only with relevant medical history.	Long cone periapical (Figure 15.2).
M3M extraction		Only with relevant medical history.	• Long cone periapical, if possible, or sectional dental panoramic tomogram (Figure 15.3). • If high risk M3M use cone beam CT scan.
Removal or exposure of an impacted tooth		Only with relevant medical history.	• Parallax views for impacted canines. • Low-dose cone beam CT scan may be indicated.
Management of infection	• Assess for spread of infections to local spaces. • Temperature to assess for pyrexia. • Culture and sensitivity testing of pus exudates to assist with selection of antibiotics.	To check for spreading infection (leukocytosis, bacteraemia).	• LCPA or sectional DPT to evaluate the presence of an abscess and or sequestrate. • Rarely PET scans are indicated when presented with difficult to diagnose chronic bone infections.
TMJ examination	Three-minute examination (Table 15.12).	If arthritides suspected or chronic pain.	• Sectional DPT. • Occasionally, MRI may be indicated if open or closed locking associated with disc displacement or rarely CT for condylar or base of skull pathology.
Evaluation of neuropathy, facial weakness or sensory neuropathy	Cranial nerve examination.	If systemic cause for neuropathy is suspected, for example diabetes.	
Salivary gland examination	Salivary pooling, evaluation of Wharton's and Stenson's ducts for clear salivary exudates and lack of pus. Palpation of glands (often bimanual with fingers intra- and extraorally).	Routine in patients presenting with dry mouth to exclude connective tissue disorders and Sjogren's syndrome.	Sialogram may be indicated if obstructive salivary gland disease is suspected.
Soft tissue lesion/mass examination	• Duration. • Site, size, shape, surface. • Consistency, contour, colour. • Mobility, tenderness, exudates. • Fine needle aspiration or core biopsy.	Only with relevant medical history.	Radiological guided fine needle aspiration may be indicated for deeper salivary or lymph node lesions.
Hard tissue lesion/mass examination	Aspiration of a cystic lesions to: • Elucidate any malignant cells with cytology. • Exclude a haemangiomatous lesion prior to surgical excision. • Assist in diagnosis of a lesion, for example, odontogenic keratocyst or ameloblastoma.	Only with relevant medical history. If lesion may be related to systemic disease including Paget's disease, fibrous dysplasia, giant cell lesions.	LCPA or sectional DPT depending on the size of the lesion. Additional cone beam CT or MRI scans may be required if lesion is large, expansive and involving soft tissues.

CT, computed tomography; DPT, dental panoramic tomogram; LCPA, long cone periapical radiograph; M3M, mandibular third molar; MRI, magnetic resonance imaging; PET, positron emission tomography.

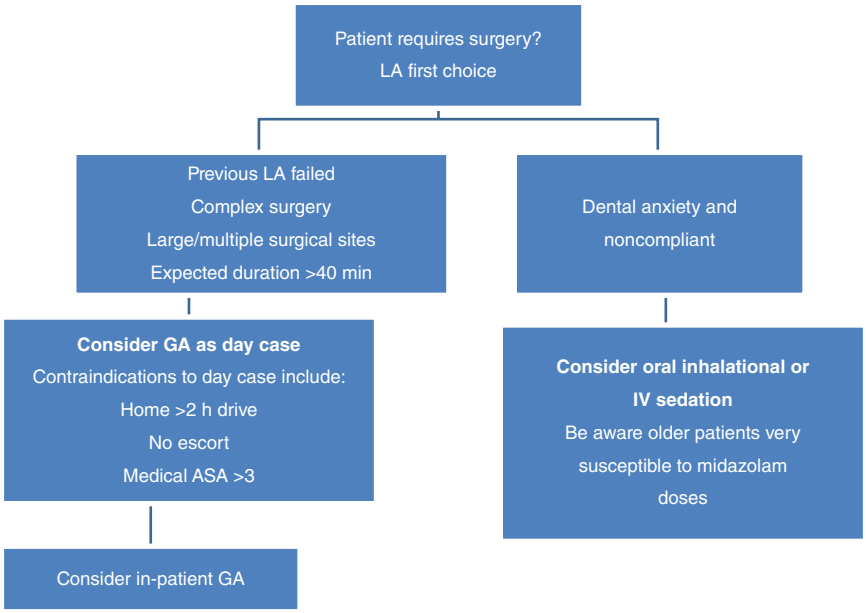


Figure 15.1 Algorithm for the selection of appropriate anaesthesia for oral surgery. ASA, American Society of Anesthesiologists. GA, general anaesthesia. IV, intravenous. LA, local anaesthesia.

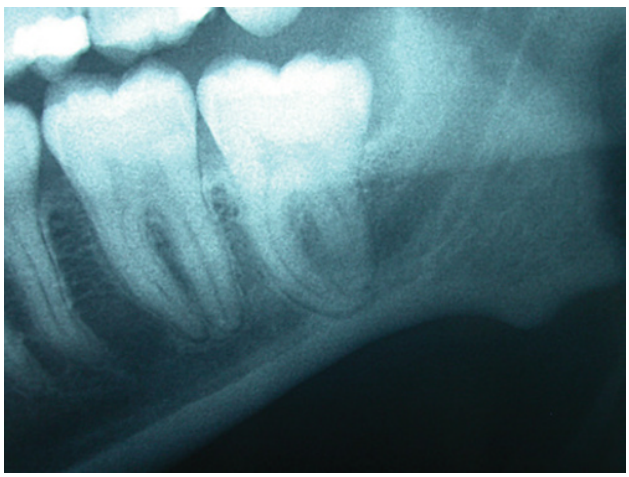


Figure 15.2 Dental panoramic tomogram of high-risk M3M showing roots crossing the inferior dental canal.

Part 2: Dentoalveolar Surgery – Routine Dental Extraction

Dental extraction or exodontia is the surgical process of removing teeth from the jaws. Erupted teeth can usually be extracted routinely without additional soft tissue or bone surgery, unlike partially erupted or impacted teeth (Tables 15.5 and 15.6).

Part 3: Surgery Indicated for Impacted Teeth or Fractured Roots

Surgical access is most commonly indicated for wisdom tooth–third molar removal, or coronectomy in situations in which there is a high risk of nerve injury. Surgical access may also be required for other impacted tooth removal, or exposure and orthodontic bonding (Tables 15.7, 15.8 and 15.9).

Part 4: Management of Acute and Chronic Orofacial Infections with Medical and or Surgical Techniques

Medical Techniques

Antimicrobial prescribing by dentists continues to increase despite significant reduction in other healthcare sectors (Palmer et al., 2000; Karki, Holyfield and Thomas, 2011).

Spreading infection (infection involving anatomical spaces locally, causing difficulty breathing and swallowing, and systemic spread resulting in pyrexia and malaise) is the sole indication for prescribing therapeutic antibiotics in dentistry. The cause should always be removed (usually the tooth or necrotic pulp) with drainage of pus if present. Signs of spreading infection include pain with increasing swelling, heat and redness of the area with:

- General malaise.
- Dehydration.
- Lymphadenopathy (of lymph nodes draining the infected area).
- Difficulty in swallowing, speaking or breathing may indicate sublingual, submandibular and/or parapharyngeal infection.
- Elevated body temperature (normal body temperature is 37 °C) – fever associated with dental infections is usually an elevation of 2–3 °C.

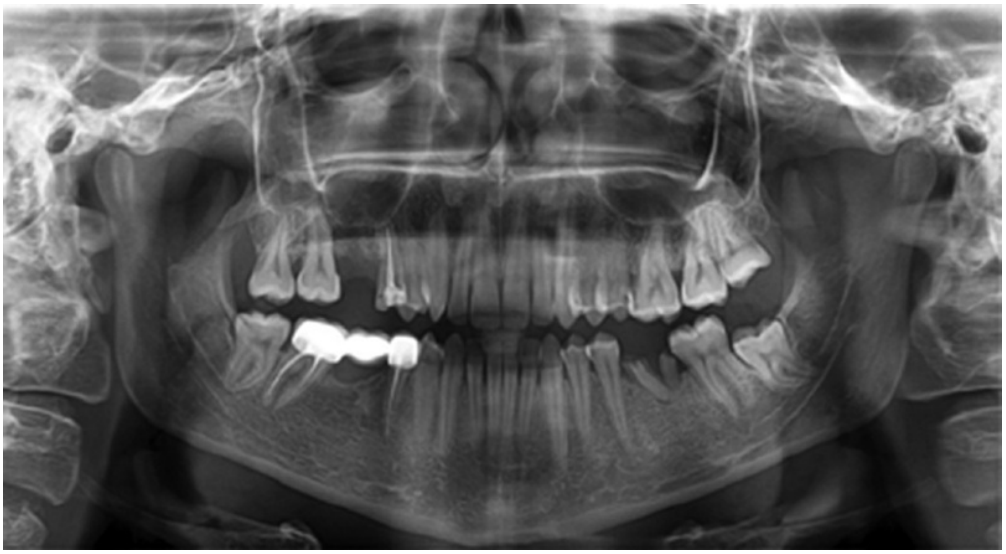


Figure 15.3 A DPT illustrating aspects of difficulties associated with dental extractions. The lower left third molar is vertically impacted and the roots are in close proximity to the inferior dental canal, with loss of the superior lamina dura of the canal. The apices of the roots of the upper right first molar roots are closely associated the maxillary sinus, risking an oroantral communication when extracted. The lower left first molar roots are grossly carious and retained, requiring surgical removal. Should the lower right third molar need extraction, avoid damaging the adjacent heavily restored second molar. Removal of the lower right second molar or premolar abutment would be complicated by the need to section the bridge.

Table 15.3 American Society of Anesthesiologists Health Categorisation.

Category
1. Fit and well patients requiring straightforward surgery who are expected to make a complete and uneventful recovery.
2. Patients with a medical condition which may complicate the delivery of care but is unlikely to affect outcome (e.g. hepatitis, coagulopathies, history of endocarditis, steroids, epilepsy, mental handicap).
3. Patients with medical condition(s), or past surgery, which may additionally compromise outcome (complicated surgery, uncontrolled diabetes, immunosuppression).
4. Patients in whom the complications of surgery may be severe with marked local or systemic complications (inherited clotting disorders, uncontrolled local or systemic disease) and/or require contemporaneous specialised medical therapy (severe immunosuppression, haemophillia).
5/6. Not relevant to surgical dentistry.

Prophylactic antibiotics are rarely indicated:

- NICE – antibiotics are not indicated for prevention of infective endocarditis.
- May be indicated during treatment of medication-related osteonecrosis of the jaw, osteoradionecrosis and osteomyelitis.
- The patient must be severely immunocompromised to warrant perioperative antibiotics for routine dentistry and/or oral surgery.
- Oral and maxillofacial surgery such as open reduction and internal fixation of a compound mandibular fracture, orthognathic surgery, head and neck surgery (clean and malignant, neck dissection), facial implant, and head and neck surgery (contaminated, clean contaminated) may require prophylactic antibiotics.
- Intraoral bone grafting.

Guidance for prescribing antimicrobials in dentistry include:

- Cochrane Database (2013).
- Dental Practitioners' Formulary in the British National Formulary.
- FGDP (2012).
- http://patient.info/health/infective-endocarditis-leaflet
- NICE (2008).
- NICE (2015).
- Scottish Dental Clinical Effectiveness Programme (2013).

Acute Infection

Persistent or repeated orofacial infection, including persistent or repeated dry socket, is always a matter of considerable concern (Tables 15.10 and 15.11)

Table 15.4 Management of medically compromised patients.

Medical condition	Issue related to oral surgery	Recommendations
Cardiovascular problems	Hypertension: • Bleeding. • Risk of myocardial infarction (MI) and stroke. Angina: • Angina attack. • Risk of MI. Recent MI	Hypertension: • <160/100 treat as normal. • >160/100 haemostatic agent postoperatively; IV sedation is preferable Angina: • Instruct patient to use nitrolingual spray preoperatively and ensure oxygen available MI: • Within 3 months – no elective treatment. • Within 6 months – no general anaesthesia – 50% increased risk of repeat MI.
Cardiac defects/ valve replacements/previous endocarditis/hypertrophic cardiomyopathy	Need for antibiotic cover.	• No antibiotic cover. • Maintain good oral hygiene. • Warn patient of risk of repeat infective endocarditis.
Liver disease	• Bleeding problems. • Impaired drug metabolism. • Cross-infection risk – hepatitis B, C,D,E. • May be immunocompromised.	Preoperatively: • Liaise with physician. • Liver profile, coagulation screen, FBC, APTT. • Caution with administration of local anaesthetic and sedation. • Drug prescription – check British National Formulary (BNF) Appendix 2 on liver disease. Postoperatively: • Haemostatic agent in socket. • Hepatitis B immunity, caution with hepatitis C patient cross-infection measures in place.
Kidney disease	• Bleeding tendency. • Drug prescription. • Dialysis patients. • May be immunocompromised.	Preoperatively: • Liaise with physician. • Renal profile, FBC, coagulation screen. • Check BNF Appendix 3 on renal impairment for caution with drug prescription. • Dialysed patients to be treated the day after dialysis • May require antibiotic cover. Postoperatively: • Haemostatic measures.
Diabetes	• Hypoglycaemic emergency. • Delayed healing and immunocompromised. • HbA1c prior to implant placement.	Preoperative: • Measure blood sugar level (<5.0 mmol – administer glucose orally). • Morning appointment. • HbA1c <6% Postoperative: • Antibiotics if poorly controlled or difficult surgical procedure.
Epilepsy	• Increased stress may cause seizure.	• Check frequency and presentation of seizures. • Intravenous sedation recommended due to anticonvulsant effects.

Table 15.4 (Continued)

Medical condition	Issue related to oral surgery	Recommendations
Disorders of haemostasis	• Increased risk of bleeding postoperatively.	Haemophilia A and B, Von Willebrand's disease: • Liaise with haematology physician/haemophilia centre. • Factor VIII levels between 50 and 75% required prior to treatment. • Desmopressin, tranexamic acid may be needed. • Treat in hospital – may require inpatient management. • Avoid inferior dental blocks whenever possible. Thrombocytopenia: Preoperative: • Liaise with haematology physician. • Platelet levels >80 × 10^9/ l treatment in a hospital setting. • <80 × 10^9/l platelet levels will require platelet transfusion. Postoperative: • Local haemostatic measures. • Platelets may be needed. • Desmopressin, tranexamic acid. • Avoid NSAIDs.
Anticoagulant therapy	• Increased risk of bleeding for patients – INR should be <4. • Increased risk of thromboembolic event. • Warfarin effect altered by antibiotics and NSAIDs.	Preoperative: • If INR >4 refer back to haematology clinic. • Dual antiplatelet therapy patients – refer for treatment in hospital. Postoperative: • Local haemostatic measures. • No NSAIDs.
HIV	• Viral load. • CD4 count – >200 cells/mm blood suitable for treatment. • Be aware of common oral manifestations: cervical lymphadenopathy, candidosis, hairy leukoplakia, herpes virus, papilloma virus, apthous ulcers, Kaposi's sarcoma and lymphoma. May require biopsy. • Neutropenia. • Bleeding tendency due to risk of thrombocytopenia. • IV sedation – benzodiazepine activity may be enhanced with HAART. • ART is treatment of people infected with HIV using anti-HIV drugs. The standard treatment consists of a combination of at least three drugs (often called 'highly active ART' or HAART) that suppress HIV replication.	Preoperative: • Viral load – <50 viral RNA copies/mm blood, low infectivity suitable for treatment. • CD4 count – >200 cells/mm blood suitable for treatment. • FBC, liver profile, coagulation screen. • Antibiotics if neutropenic and at risk of infection. Postoperative: • Antibiotics may be required if neutropenic. • Cross-infection risk low, but postexposure prophylaxis may be required for up to 4 weeks if exposure occurs.
Malignancy	• Malignant spread from organs may manifest in the head and neck region. • Haematological malignancy causes thrombocytopenia (decreased platelets), neutropenia (decreased neutrophils) and anaemia causing increased risk of bleeding and infection. • Patients with metastases from breast, prostate and multiple myeloma may be on oral or IV bisphosphonates.	Preoperative: • FBC, coagulation screen. • If platelets <80 × 10^9/l may need platelet transfusion. Postoperative: • Haemostatic measures. • Antibiotic therapy.

(*Continued*)

Table 15.4 (Continued)

Medical condition	Issue related to oral surgery	Recommendations
Chemotherapy	• Risk of bleeding due to thrombocytopenia. • Risk of infection due to neutropenia and immunosuppression. • Anaemia. • Patients on high dose steroids – dexamethasone, are at risk of adrenal crisis.	Preoperative: • If platelet <80 × 10^9/l, platelet transfusion required. • If neutrophils <1.5 × 10^9/l, antibiotic prophylaxis required. • If erythrocytes <8 × 10^9/l, special care with general anaesthesia and IV sedation. • Steroid cover – 25 mg IV hydrocortisone, if on high dose steroids.
Steroids	• Risk of Addisonian crisis. • May cause delayed healing.	Preoperative: • >7.5 mg prednisolone, or equivalent steroid cover required. Prior to procedures under local anaesthetic or IV sedation: • 25 mg hydrocortisone IV, or double dose of steroids on the day of surgery. For procedures under general anaesthesia: • Preoperative: 25–50 mg hydrocortisone IV. • Postoperative: 25–50 mg hydrocortisone IM every 6 h for 24 h. Antibiotics may be required.
Sedation	• Contraindicated in pregnancy and in patients with severe chronic obstructive pulmonary disease and allergy to benzodiazepines. • With caution in extremes of age and in patients with sickle cell disease, liver and renal disease, myasthenia gravis and psychiatric disease.	• Elderly – administer sedation slowly There is a correlation between age and midazolam dose, which decreases with increasing age. The initial bolus should be reduced in patients over 70 years (0.3 mg *not* 2 mg). • In patients with sickle cell disease, administration of sedation reduces oxygen levels and may result in a sickle crisis.

APTT, activated partial thromboplastin time; ART, antiretroviral therapy; FBC, full blood count; HAART, highly active antiretroviral therapy; HIV, human immunodeficiency virus; IM, intramuscular; INR, international normalised ratio; IV, intravenous; NSAIDs, non-steroidal anti-inflammatory drugs.

Table 15.5 Preoperative requirements for routine dental extractions.

Treatment plan	Check that preparatory treatment has been completed.
Signed consent	Confirm valid consent.
Radiographs	To provide information on available bone height, width of periodontium, root morphology, restorative condition of adjacent teeth, relationship of important anatomical structures, position and angulation of adjacent tooth roots.
Sterile surgical kit	Basic surgical kit to elevate mucoperiosteal flaps and close wound with sutures.
Sterile irrigation system	To keep drills irrigated during drilling procedures and avoid overheating of bone.
Sterile drapes	To maintain appropriate surgical environment, covering the patient's clothing and hair.
Chlorhexidine mouthwash	A preoperative rinse with 0.2% chlorhexidine for 1 min to reduce bacteria in mouth. Some clinicians also use 0.2% chlorhexidine as a circumoral skin disinfection. More stringent barrier methods, such as adhesive film dressings and covering of nose are used in some countries.
Local anaesthesia	Usually obtained using local anaesthetic solution containing adrenaline to produce more profound anaesthesia and haemostasis. Lignocaine commonly used. Articaine infiltration may be more effective in mandibular sites, but do not use for inferior dental blocks.

Table 15.6 Surgical procedure for routine dental extractions.

Position the patient appropriately	Once positioned appropriately (Figure 15.4), the patient should be given and asked to put on protective eye wear.
Use Luxator or elevator to mobilise tooth	Firm grip of an elevator or Luxator is required with forefinger protruding up the shaft to ensure minimal damage occurring, should the instrument dislodge and slip.
Once tooth is mobilised elevation of single rooted teeth may be possible with Warwick James or Couplands elevators	The key in application of forceps to a tooth during dental extraction is a very firm grip of the tooth in the forcep beaks, once pressure has been applied down the root length to gain a grip below the enamel–dentine junction. Once this grip is established, firm support to the patient's jaw is required to prevent discomfort and assist in providing resistance to the action of the active extracting hand (Figure 15.5) Application of forceps beaks to teeth, upper straights for upper incisors and canines, upper curved roots for premolars. Upper molar forceps for upper molars (beak to cheek).
Multiple-rooted teeth will require specific forceps application	Lower straight roots for incisors and canines, lower molars forceps for molars. Modified forceps such as cow horns may be used for lower molars. A strong downward pressure should be applied to expand the periodontal membrane. Various mobilisation techniques may be used: • Vertical axis rotation for single-rooted teeth. • Buccal/lingual–palatal rocking for single- and multiple-rooted teeth. Some operators advocate a 'figure of 8' movement for multiple-rooted molar teeth. Once mobility is gained the extraction can be completed with a slow, but firm buccal inclination of the tooth. Any resistance may be related to poor technique, adverse root morphology or dense bone. If this difficulty persists, or results in root fracture, further elevation with elevators, root sectioning or surgical access may be required.
Irrigation of the site	To remove any loose tissue tags and loose bone fragments.
Check socket	To check that no pieces of soft tissue or tooth bone fragments are retained and to inspect for continued haemorrhage.
Compression with damp gauze	To ensure good flap adaptation and haemostasis.
Give postoperative instructions, verbally and in writing	These include taking analgesics every 4–6 h for next 24/48 h, use of chlorhexidine mouth rinse –10 ml of 0.2% chlorhexidine mouthwash for 1 min twice daily, application of ice packs within next few hours to reduce swelling, and instructions to use firm pressure with sterile gauze if bleeding is encountered. Patient should be provided with contact details (name and phone number of the individual) to contact in the event of difficulties.
Homecheck: the patient should agree preoperatively to provide the practitioner with a contact telephone number, so that the practitioner can phone and speak to the patient 4–6 h postoperatively, when the local anaesthetic has worn off, or failing that the next day	Routine homecheck questions include: • Is analgesia required? • Any excessive pain or swelling? • Any paraesthesia? • Any continued or fresh bleeding? This provides an excellent assessment of the quality of service and audit data. An early follow-up appointment should be arranged if the patient is feeling compromised.
Review appointment	Review the patient approximately 1 week postoperatively to remove sutures, check healing and deal with any concerns the patient may have.

Figure 15.4 Correct positioning of the oral surgical patient.

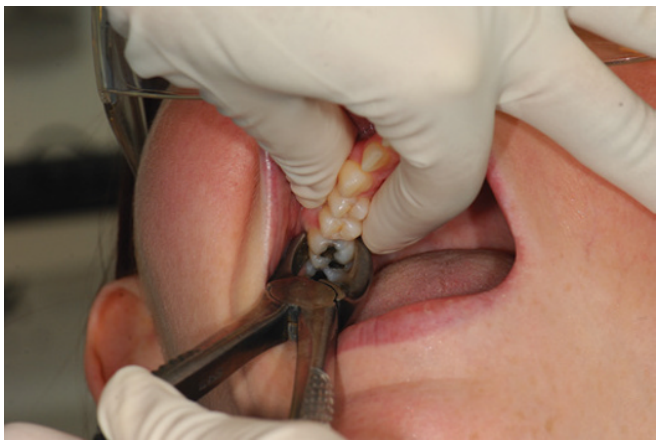


Figure 15.5 The appropriate grip and placement of forceps on a maxillary molar.

Table 15.7 Preoperative requirements for surgical removal of impacted teeth and retained and fractured roots.

Treatment plan	To check that preparatory treatment has been completed.
Signed consent	To confirm valid consent.
Radiographs	To provide information on available bone height, width of periodontium, root morphology, restorative condition of adjacent teeth, relationship of important anatomical structures, position and angulation of adjacent tooth roots.
Surgical guide disinfected in chlorhexidine solution	Surgical guides help in establishing mesiodistal and buccolingual positioning, angulation and vertical level of retained roots.
Sterile surgical dental extraction instruments	Complete set of instruments compatible with planned procedure (Figure 15.6).
Sterile surgical kit	Basic surgical kit to elevate mucoperiosteal flaps and close wound with sutures.
Sterile irrigation system	To keep drills irrigated during drilling procedures and avoid overheating of bone.
Sterile drapes	To maintain appropriate surgical environment covering patient's clothing and hair.
Antibiotics	Evidence that the preoperative administration of antibiotics may reduce postoperative infection is weak. Antibiotics may, however, be indicated if the patient has systemic health problems, for example poorly controlled diabetes, or the planned procedure is likely to be complicated by existing or previous infection.
Chlorhexidine mouthwash	A preoperative rinse with 0.2% chlorhexidine for 1 min to reduce bacteria in mouth. Some clinicians also use 0.2% chlorhexidine as a circumoral skin disinfection. More stringent barrier methods, such as adhesive film dressings and covering of nose are used in some countries.
Preoperative analgesics	There is no evidence for the use of preoperative analgesia. As lidocaine blocks last for up to 4 h, any preoperative analgesia will have no additional effect.
Local anaesthesia	Usually obtained using local anaesthetic solution containing adrenaline to produce more profound anaesthesia and hemostasis. Lignocaine commonly used. Articaine infiltration may be more effective in mandibular sites, but do not use for inferior dental blocks.

(Figure 15.10). It implies that there may be tooth fragments or bone sequestrate retained in the surgical site.

Part 5: Management of Patients with Temporomandibular Disorders, Including Dysfunction, Arthritides and Myalgia

Spontaneous pain from the temporomandibular region may be caused by three main conditions. The most common of these conditions is myalgia (muscle pain) commonly occurring in young adults in association with stress. Guidelines for management of temporomandibular disorders are published by the Royal College of Surgeons (2014). This section does not address traumatic conditions of the TMJ (condyle, condylar neck, ramus fractures, TMJ effusions) or other related soft tissue problems. Infection of the TMJ is extremely rare and confined usually to poorly managed otitis media in the developing world, often resulting in TMJ ankylosis. The Manchester Dental School three-minute TMJ examination is the most efficient way to assess patients with TMJ discomfort not caused by trauma, neoplasia or infection (Tables 15.12–15.15). The structure of the temporomandibular joint is shown in Figure 15.11.

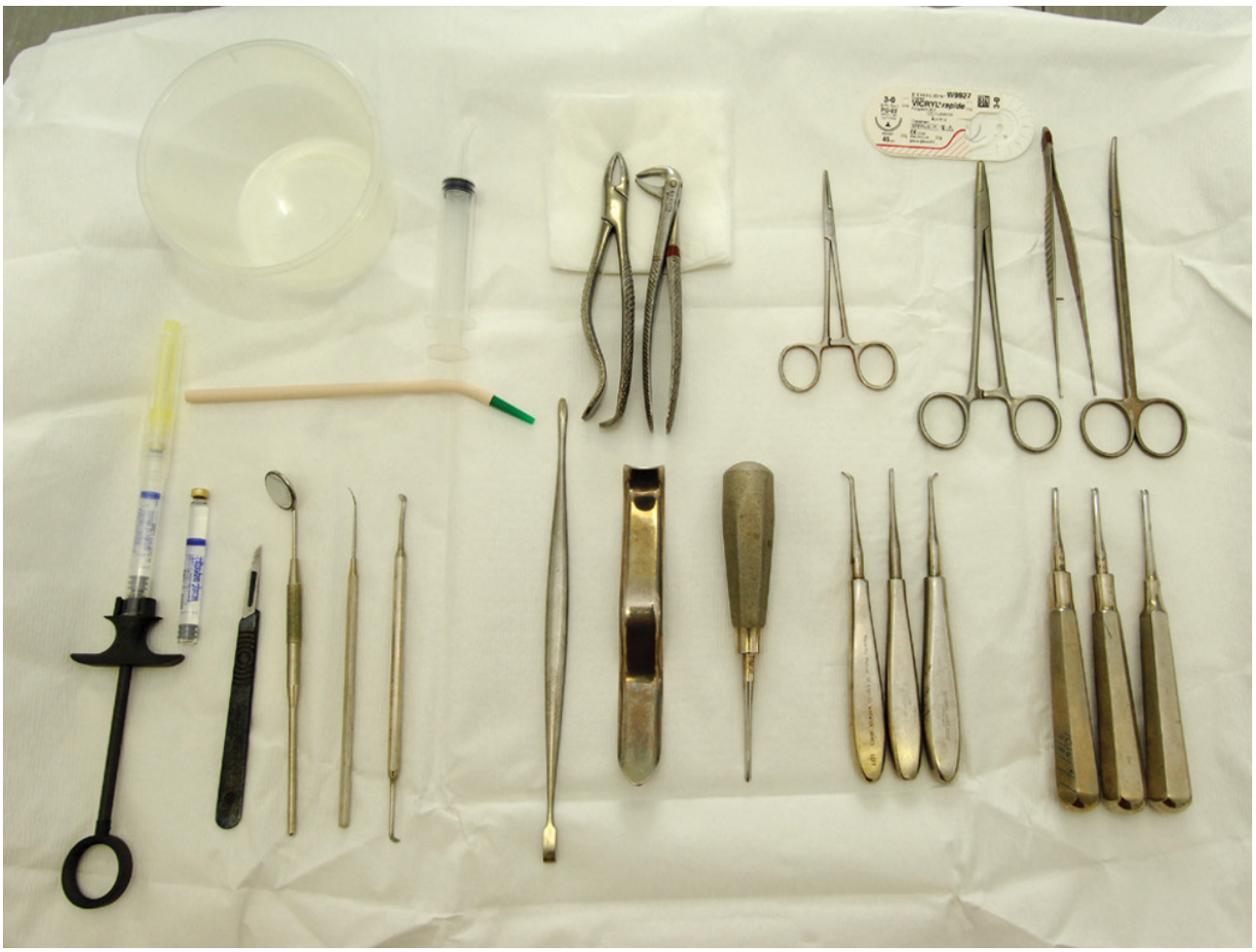


Figure 15.6 Oral surgery instruments.

Part 6: Prevention and Management of Complications Related to Oral Surgery

The patient must comprehend the potential risks associated with the surgery for which they have given consent. Many practitioners telephone patients the day after surgery to ensure that the patient is comfortable and exclude possible nerve injury. The complications related to extractions include:

- Extraction of the incorrect tooth.
- Sequelae:
  - Pain.
  - Swelling.
  - Trismus.
  - Sensitivity teeth.
  - Socket.
  - Bad breath.
- Complications:
  - Dry socket 5% – most common complication!
  - Lingual or inferior alveolar nerve injury (0.2% permanent, 2% temporary; high risk – 2% permanent, 20% temporary).

When complications arise, the patient must be informed in accordance with Duty of Candour. Some patient safety incidents will require specific and timely reporting

Wrong Site Surgery

The Revised Never Events Policy and Framework (2015) from NHS England modified the list of Never Events related to dentistry to the following three incidents:

- Wrong site surgery:
  - A surgical intervention performed on the wrong patient or the wrong site, including wrong tooth extraction of a permanent (adult) tooth even if re-implanted.
  - Interventions that are considered surgical but may be performed outside a surgical environment, e.g. wrong site block, and biopsy.

Table 15.8 Surgical procedure for impacted teeth and retained and fracture roots.

Position the patient appropriately	Once positioned appropriately (Figure 15.4), the patient should be given and asked to put on protective eye wear.
Use Luxator or elevator to mobilise retained or fractured root	Firm grip of an elevator or Luxator is required with forefinger protruding up the shaft to ensure minimal damage occurring, should the instrument dislodge and slip.
Once a retained or fractured root is mobilised, elevation may be possible using a Warwick James or Coupland elevator Impacted teeth and retained or fractured roots, with more than one apex, may require sectioning. This is preferable to raising a mucosal flap, which may cause additional pain and swelling for the patient.	Any resistance may be related to poor technique, adverse root morphology or dense bone. If this difficulty persists or results in fracture of the root, further elevation may be required, or possibly surgical access by means of a mucosal flap. Sectioning of a tooth or root is achieved using a fissure bur and surgical drill (Figure 15.7). During sectioning, the drill must remain within the tooth structure at all times to avoid unnecessary bone removal and damage to adjacent teeth. Once sectioned the tooth or root should be elevated using a Luxator or Warwick James elevator. Root fragments can be elevated using a root pick or Mitchell's trimmer, used in ways to avoid unnecessary bone removal wherever possible. If any root or root fragment remains resistant to elevation, relief of the adjacent gingivae may provide sufficient exposure of the buccal root surface to create an application point for further elevation. An application point may be formed using using a fissure bur.
Raising a two-sided buccal flap	If difficulties persist, a small two-sided buccal flap should provide sufficient access to deliver the retained or fractured root. The incision should be made with a number 15 blade. Normally, a mid-crestal incision will allow good wound closure. Relieving incisions improve access.
Buccal bone removal	Buccal bone should be removed with a fissure bur conservatively to gain sufficient access to create and use an application point for elevation of the root fragment. If the root is misshaped or ankylosed then further section of the root may be required.
Irrigation of the site	To remove any loose tissue tags and loose bone fragments.
Suturing of flap	Normally achieved using one or two interrupted sutures of 40 Vicryl.
Check socket	To check that no pieces of soft tissue or tooth bone fragments are retained and to inspect for continued haemorrhage.
Compression with damp gauze	To ensure good flap adaptation and haemostasis.
Give postoperative instructions, verbally and in writing	These include taking analgesics every 4–6 h for the next 24/48 h, use of chlorhexidine mouthrinse –10 ml of 0.2% chlorhexidine mouthwash for 1 min twice daily, application of ice packs within next few hours to reduce swelling, and instructions to use firm pressure with sterile gauze if bleeding is encountered. Patient should be provided with contact details (name and phone number of the individual) to contact in the event of difficulties.
Homecheck: the patient should agree preoperatively to provide the practitioner with a contact telephone number, so that the practitioner can phone and speak to the patient 4–6 h postoperatively, when the local anaesthetic has worn off, or failing that the next day	Routine homecheck questions include: • Is analgesia required? • Any excessive pain or swelling? • Any paraesthesia? • Any continued or fresh bleeding? This provides an excellent assessment of the quality of service and audit data. An early follow-up appointment should be arranged if the patient is feeling compromised.
Review appointment	Review the patient approximately 1 week postoperatively to remove sutures, check healing and deal with any concerns the patient may have.

- Wrong implant/incorrect placement of dental implant.
- Retained foreign body.

In accordance with the serious incident reporting framework, the incident should be reported on the providers' local risk management system (DATIX) and on Strategic Executive Information System (StEIS) within 48 h. Never Events must be reported to both StEIS and to the National Reporting and Learning System until a single system has been developed. These systems are not yet accessible via primary care. The Care Quality Commission (CQC) should be informed of serious events. These events are investigated, with an action plan developed and shared with the whole team, to improve the service and reduce the risk of a recurrence. The CQC may use information on Never Events to

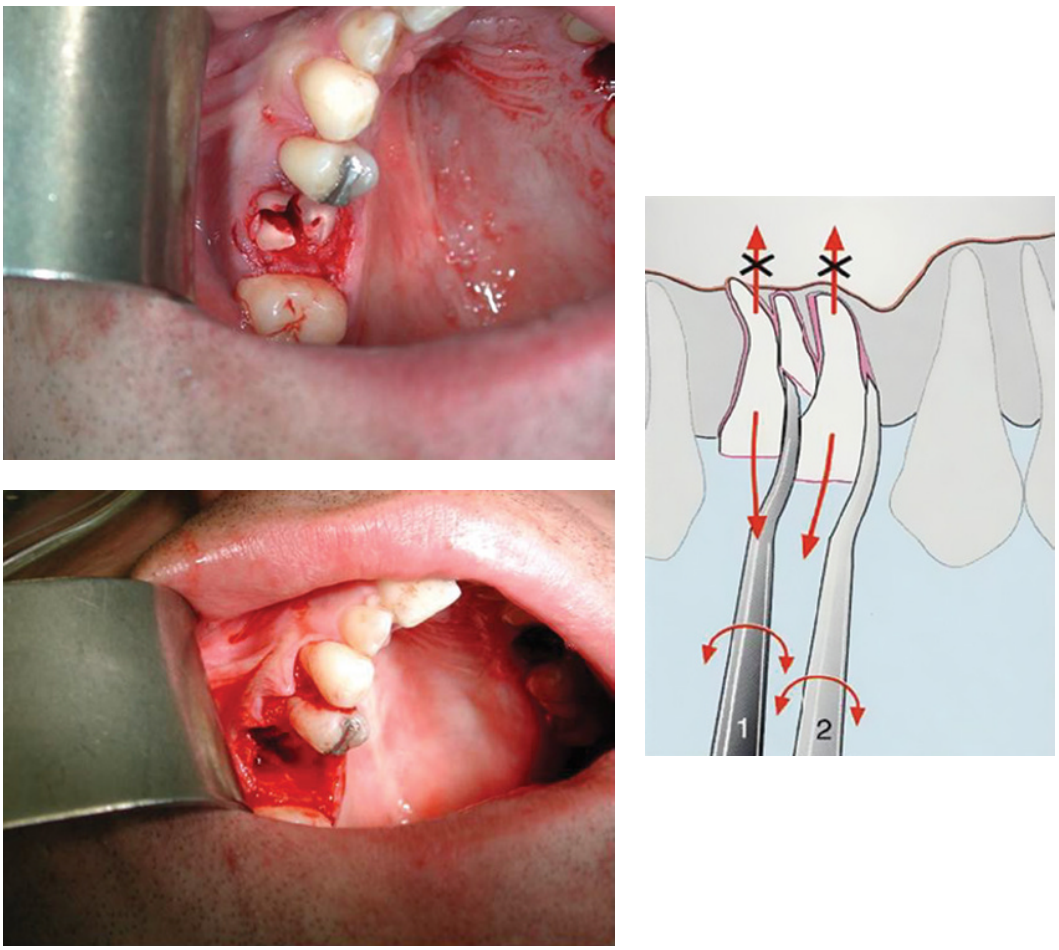


Figure 15.7 Section of multiple rooted teeth to minimise bone loss and complications.

inform their regulatory processes, alongside other indicators, and may take enforcement action

Haemorrhage

Haemorrhage is a normal reaction to physical trauma. All haemorrhage during and immediately following surgical extraction or soft tissue surgery should be managed with local primary closure or pressure. The patient should not be discharged until haemostasis is achieved and instructions on how to prevent onset of bleeding (avoidance of exercise, stress, very hot or cold foods or drinks soon after surgery) and control bleeding when it occurs (bite on pack for 5–10 min) have been given. Early postsurgical bleeding is related to poor initial haemorrhage control (insufficient sutures) or a bleeding dyscrasia (collagen vascular problem, platelet abnormal function or deficiency, or clotting deficiency (see Table 15.16)). Secondary haemorrhage (after 24 h) may be related to infection.

Dry Socket

Alveolitis or alveolitis osteitis is a complication of disintegration of the intra-alveolar blood clot, with an onset 2–4 days after extraction. Dry socket is a clinical diagnosis. The features include: severe postoperative pain surrounding the alveolus that increases in severity for a period from 3 days after extraction, followed by partial or total clot loss in the interior of the alveolus, with or without halitosis. Negative signs include: no lymphadenopathy, no inflammation and no pus. Radiographs and antibiotics are not indicated management as outlined in Table 15.17.

Persistent Pain and Nerve Injury

Some people who have a wisdom tooth removed suffer an injury to the trigeminal nerve which supplies sensation to the orofacial region. This can cause problems including neuropathic chronic pain, altered sensation

Table 15.9 Procedure for the coronectomy of the mandibular third molar.

Preoperative requirements	
Treatment plan	To check that preparatory treatment has been completed.
Signed consent	To confirm valid consent, having given specific warnings of: • 5% dry socket rate. • 2% risk of temporary lingual and inferior dental nerve injury. • 0.2% risk of permanent lingual and inferior dental nerve injury. If the tooth crosses the inferior dental canal, the risk of injury to the inferior dental nerve increases greatly. If it becomes necessary to remove the tooth, the risk increases to 20% temporary and 2% permanent nerve damage.
Radiographs	To provide information on available bone height, width of periodontium, root morphology, restorative condition of adjacent teeth, relationship of important anatomical structures, position and angulation of adjacent tooth roots (Figures 15.8(a),15.9(a), 15.8(b) and 15.9(b)). Cone beam CT screening may be indicated to evaluate the relationship of the tooth to the inferior dental canal. Ensure full assessment of the proximity of the roots to the inferior dental canal is undertaken.
Surgical guide disinfected in chlorhexidine solution	Surgical guides help in establishing mesiodistal and buccolingual positioning, angulation and vertical level of the third molar.
Sterile surgical dental extraction instruments	Complete set of instruments compatible with planned procedure (Figure 15.6).
Sterile surgical kit	Basic surgical kit to elevate mucoperiosteal flaps and close wound with sutures.
Sterile irrigation system	To keep drills irrigated during drilling procedures and avoid overheating of bone.
Sterile drapes	To maintain appropriate surgical environment covering patient's clothing and hair.
Antibiotics	Evidence that the preoperative administration of antibiotics may reduce postoperative infection is weak. Antibiotics may, however, be indicated if the patient has systemic health problems, for example poorly controlled diabetes, or the planned procedure is likely to be complicated by existing or previous infection.
Chlorhexidine mouthwash	A preoperative rinse with 0.2% chlorhexidine for 1 min to reduce bacteria in mouth. Some clinicians also use 0.2% chlorhexidine as a circumoral skin disinfection. More stringent barrier methods, such as adhesive film dressings and covering of nose are used in some countries.
Preoperative analgesics	There is no evidence for the use of preoperative analgesia. As lidocaine blocks last for up to 4 h, any preoperative analgesia will have no additional effect.
Local anaesthesia	Usually obtained using local anaesthetic solution containing adrenaline to produce more profound anaesthesia and haemostasis. Lignocaine commonly used. Articaine infiltration may be more effective in mandibular sites, but do not use for inferior dental blocks.
Operative procedure	
Position the patient appropriately	Once positioned appropriately (Figure 15.4), the patient should be given and asked to put on protective eye wear.
Incision	The incision should be made with a number 15 blade. Normally, a mid-crestal incision will allow good wound closure. Relieving incisions to form a triangular flap can be used to improve access, avoiding a vertical relieving incision or placement of the incision over adjacent prominent root surfaces or socket. By avoiding an envelope flap, minimal bone is exposed. Distal bone cannot be removed if not exposed, thus minimising the risk of damage to the lingual nerve during surgery (Figures 15.8(c) and 15.9(c)).
Buccal bone removal	Buccal bone should be removed conservatively, using a fissure bur, to gain sufficient access for an application point, allowing elevation of the coronal section of the molar (Figures 15.8(d) and 15.9(d)).

Table 15.9 (Continued)

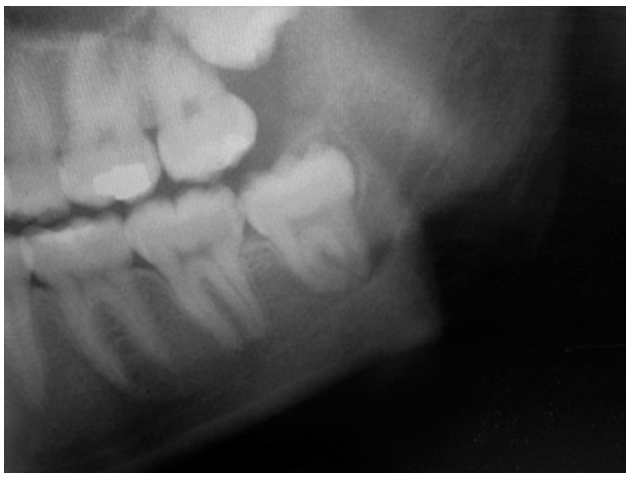
Coronectomy	The fissure bur should be 'sunk' into the pulp. The cut should go no deeper, but be 'lateralised' within the tooth structure, creating sufficient space to accommodate a straight Warwick James elevator to leverage off the coronal section of the tooth. After sectioning (Figures 15.8(e) and 15.9(e)), the crown should be elevated or removed with Fickling forceps. Occasionally, the crown may need additional sectioning to enable it to be elevated out of the small access provided by the triangular flap. When removing a third molar, the root should then be elevated (Figure 15.9(f)). In a coronectomy procedure, the cut surface of the sectioned crown should be inspected to ensure that all enamel has been removed (Figure 15.8(e)). Any retained enamel must be carefully removed with a rose head bur; care being taken to avoid lingual nerve damage. If the roots are mobilised at any time during the procedure, they must be removed. The patient must always be informed of this possibility. If extraction becomes necessary, great care must be taken to ensure minimal disturbance to the inferior dental nerve. Multiple sectioning of the root may be necessary.
Irrigation of the site	To remove any loose tissue tags and loose bone fragments.
Suturing of flap	Normally achieved using one or two interrupted sutures of 40 Vicryl.
Check socket	To check that no pieces of soft tissue or tooth bone fragments are retained and to inspect for continued haemorrhage.
Compression with damp gauze	To ensure good flap adaptation and haemostasis.
Give postoperative instructions, verbally and in writing	These include taking analgesics every 4–6 h for the next 24/48 h, use of chlorhexidine mouthrinse – 10 ml of 0.2% chlorhexidine mouthwash for 1 min twice daily, application of ice packs within next few hours to reduce swelling, and instructions to use firm pressure with sterile gauze if bleeding is encountered. Patient should be provided with contact details (name and phone number of the individual) to contact in the event of difficulties.
Homecheck: the patient should agree preoperatively to provide the practitioner with a contact telephone number, so that the practitioner can phone and speak to the patient 4–6 h postoperatively, when the local anaesthetic has worn off, or failing that the next day	Routine homecheck questions include: • Is analgesia required? • Any excessive pain or swelling? • Any paraesthesia? • Any continued or fresh bleeding? This provides an excellent assessment of the quality of service and audit data. An early follow-up appointment should be arranged if the patient is feeling compromised.
Review appointment	Review the patient approximately 1 week postoperatively to remove sutures, check healing and deal with any concerns the patient may have.

and numbness in the affected area. These symptoms usually last for a few weeks or months, although in some cases (0.02% for low risk and 2% for high risk wisdom teeth) it can be permanent if the nerve has been severely damaged. For some people these problems are constant, whereas for others they come and go. Nerve injury can interfere significantly with daily activities, for example making eating and drinking difficult and painful. The surgical procedure used should try to minimise the risk of nerve damage and the patient should be informed about the possible complications of wisdom tooth removal before the procedure.

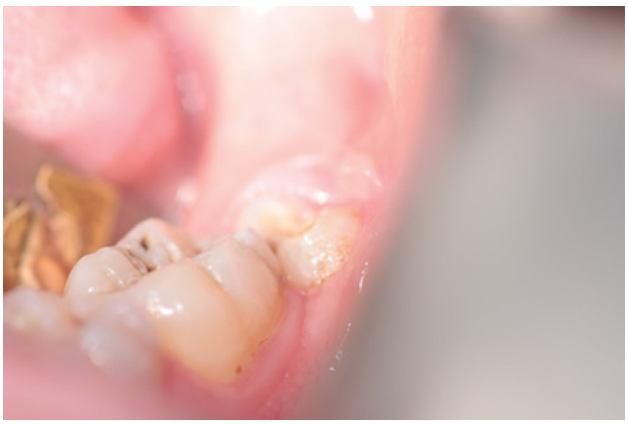
Various surgical and pharmacological treatments for nerve injury have been advocated in the literature with varying degrees of success. The management of the neurosensory deficits should include recognition of the mechanism and duration of the nerve injury and the patient's associated signs and symptoms (Table 15.18).

Initially, physiological and pharmacological non-surgical therapies are indicated following local anaesthetic, orthognathic and trauma-related nerve injuries as these in general are managed therapeutically. Early surgical evaluation and treatment may be required for known or suspected nerve injury. Management options for post-traumatic neuropathy will depend upon the mechanism, duration of injury and the patients' wishes. Management options include:

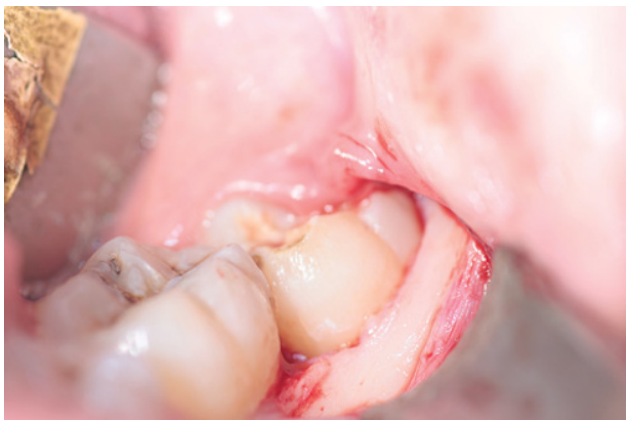
- Reassurance and review.
- Medical management.
- Counselling.
- Surgery (acute or late).



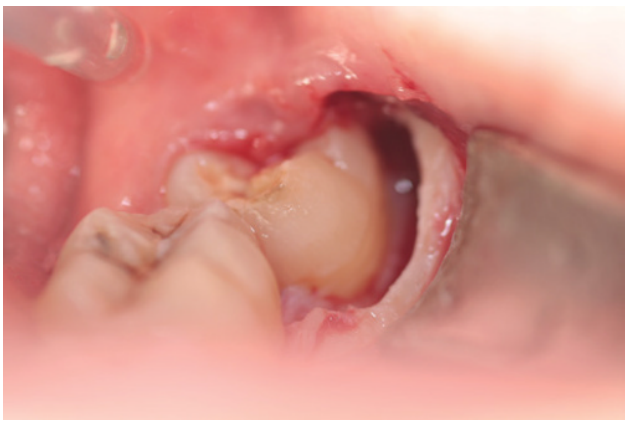
(a)



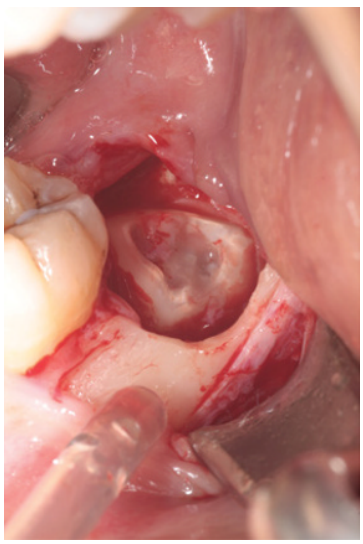
(b)



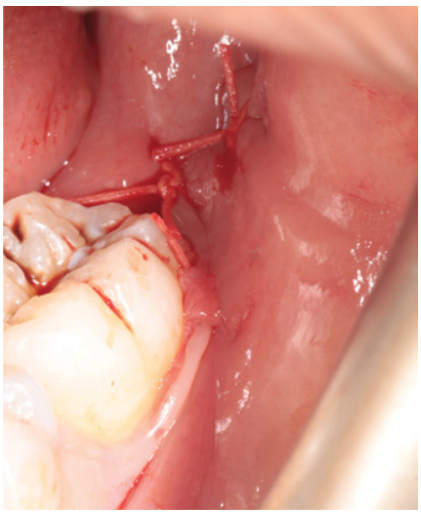
(c)



(d)



(e)



(f)

Figure 15.8 (a) Coronectomy preoperatively. Left dental panoramic tomogram of high-risk mandibular third molar. (b) Coronectomy preoperatively. Partially erupted mandibular third molar. (c) Coronectomy elevated small buccal triangular flap with bone exposure. (d) Coronectomy with buccal bone removal using fissure bur. (e) Coronectomy illustrating cut surface of retained roots with pulpal exposure and following wound toilet and irrigation. (f) Primary closure.

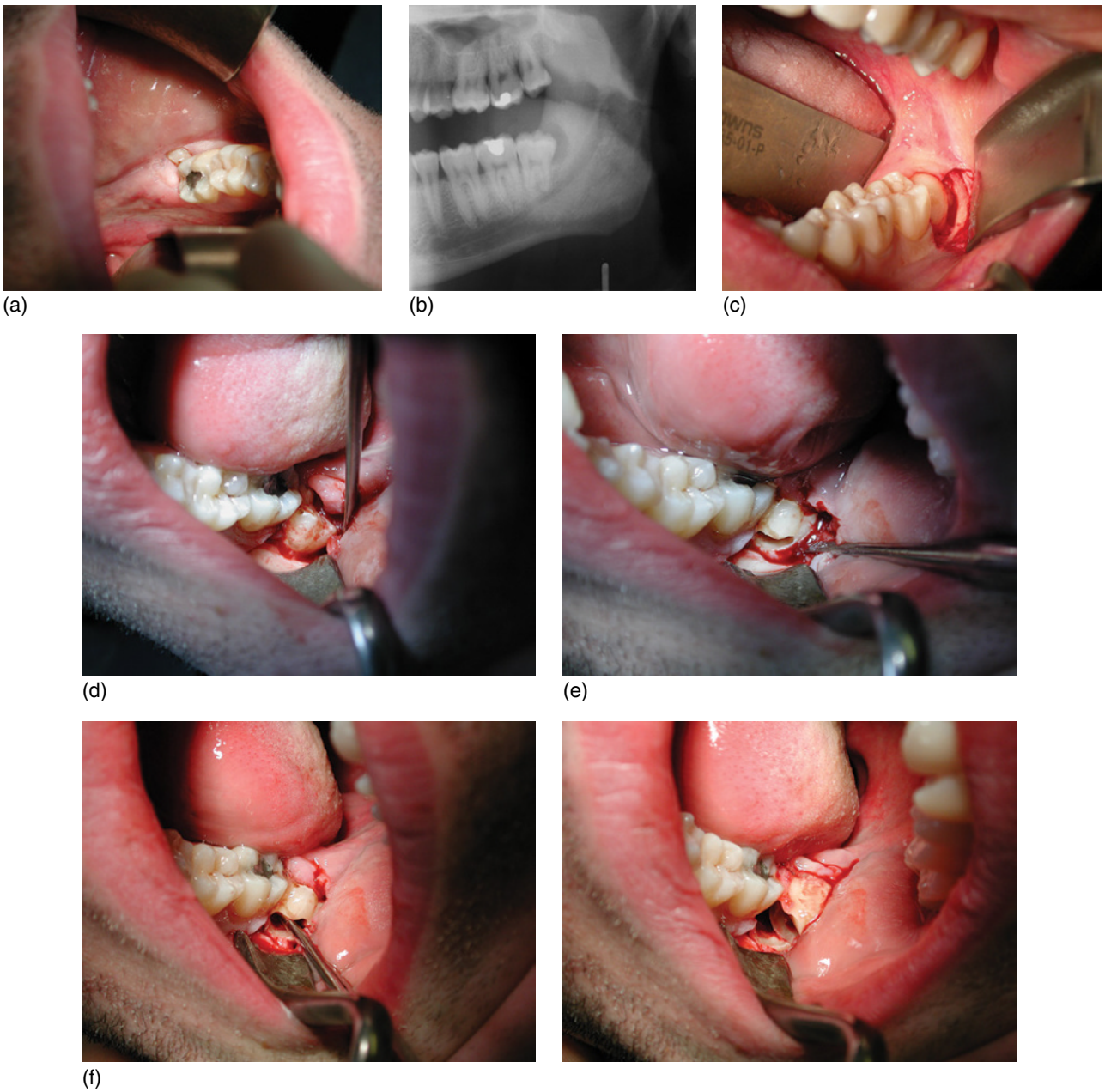


Figure 15.9 (a) Lower left third molar (LL8). (b) Preoperative orthopantomogram. (c) Minimal access buccal incision for section of third molars. (d) Buccal bone removal fissure bur. (e) Sectioning crown from root. (f) Elevator used for elevating crown. Now LL8 roots can be elevated.

Loss or Displacement of Tooth Fragment

All efforts should be undertaken to minimise inhalation or swallowing of dental instruments or teeth (Table 15.19). Rubber dams for example should be routinely used during endodontics, but are not suitable for exodontia. Throat sponges or packs can be used under general anaesthesia or sedation if the patient can tolerate them. Displacement of root fragments into adjacent anatomical areas is an uncommon complication of the removal of teeth. It must be recognised and the patient informed. Referral for confirmation of inhalation or ingestion of the tooth may be necessary.

Table 15.10 Management of acute orofacial infections.

Acute local infection	• Assess if patient is medically compromised. • Local lymphadenopathy may indicate local spread of infection. • Ensure patient's airway is not compromised and the patient is able to swallow. This will indicate the degree of tissue spaces involved (Figure 15.10).	• Identify cause of infection. • Remove carious tooth or partially erupted tooth associated with pericoronitis (Figure 15.5). • Drain pus, if there is a periodontal, periapical, or soft tissue abscess that failed to drain on removal of the tooth. • Antibiotics may be indicated. • Children may require admission (for intravenous antibiotics and fluids) given their high metabolic rate and tendency to rapid spread of dental infections.
Acute spreading infection	• Assess if patient is medically compromised. • Assess for pyrexia, using a tympanic digital thermometer. • Local lymphadenopathy may indicate local spread.	• If the patient's airway is compromised and/or the patient has difficulty swallowing, then the patient requires admission to hospital. • Removal of the cause of the infection is the first priority. If there is local spread of infection, achieving local analgesia may be difficult and may spread the infection further. A general anaesthetic may, therefore, be indicated for a relatively simple extraction. • Pus, which did not drain during the removal of the cause of the infection, must be surgically drained. • The classic incision is a submandibular extraoral incision to drain the submandibular and sublingual space. • Postsurgical rehabilitation should include prevention of further dental sepsis.

Table 15.11 Management of chronic orofacial infections.

Osteomyelitis	• Determine if patient is predisposed to chronic infection. • Site may or may not appear healed or inflamed, with or without tenderness. • Lymphadenopathy may or may not be present. • Erythrocyte sedimentation rate may be raised. • Signs and symptoms may be masked by existing or recent antibiotic therapy.	• Radiography does not always identify bone sequestra, but should indicate retained roots that require removal. • Jaw fracture should be excluded. • Early surgical site exploration under local anaesthetic should be undertaken if an infection persists for more than 2–3 weeks, or other worrying symptoms arise and persist. Neuropathy indicates an active spreading infection. • If pain or other symptoms and signs of infection persist after second surgery a 6-week course of clindamycin may be prescribed. The patient must be warned, however, of possible pseudomembranous colitis, and should be advised to take yoghurt during the course of antibiotics. • Continued review and repeat surgery, where indicated clinically, should be undertaken until the osteomyelitis has resolved. Analgesics and good oral hygiene should be instituted. • If pus is present and bone infection persist, a culture and sensitivity test may be indicated to exclude fungal and other rare orofacial infections.
Radiotherapy	• Risk of osteoradionecrosis. • Trismus, linked to endarteritis, can occur 3–6 months following completion of the therapy. • Pentoxyfilline with vitamin E may be of clinical benefit if osteoradionecrosis occurs. • Patients are at particular risk of osteoradionecrosis when: – Total radiation dose exceeded 60 Gy. – Dose fraction was large with a high number of fractions. – There is local trauma from a tooth extraction. – Periodontal disease or an ill-fitting prosthesis is present. – There is a history of immunodeficiency or malnourished.	Extractions should be undertaken, as indicated clinically, in a hospital environment up to 3 weeks prior to the start of the therapy. Preoperative: • Informed consent, including acceptance of the risk of osteoradionecrosis. • Antibiotic prophylaxis and use of 0.2% chlorhexidine gluconate mouthwash. Perioperative: • Atraumatic extraction using Luxators and periotomes. Postoperative: • Postoperative antibiotics should be prescribed. • Hyperbaric oxygen treatment may be recommended, although controversial. • Close postoperative follow-up.

Table 15.11 (Continued)

Bisphosphonates	• Risk of BRONJ. • Consider risk factors: – Dentoalveolar surgery. – Maxilla or mandible tori. – Type of bisphosphonate – intravenous or oral. Intravenous bisphosphonates are more potent than oral bisphosphonates – Time on bisphosphonates – more than 3 years carries an increased risk of developing BRONJ. – Periodontal disease, trauma from denture. – Systemic factors – diabetes, steroid therapy, immunosuppressant therapy. – Social factors – age(older patients) and smoking. – Genetic factors. • Drug 'holiday' has been suggested for 3 months prior to procedure. If on bisphosphonates for more than 3 years and serum CTX <150 pg/ml, the 'holiday' has to be physician approved	Prior to starting bisphosphonates patients should be sent for a dental assessment. Preoperative: • Informed consent. • **CTX** test as predictive of osteonecrosis of the jaw bone in patients exposed to **bisphosphonates**. During bone resorption, the dominant type 1 collagen is degraded. During this collagen breakdown, telopeptide (**CTX**) levels >150 pg/ml carry minimal risk of osteonecrosis – markers of bone turnover may be tested. However, the benefit of using this test lack evidence base. • Some centres prescribe prophylactic antibiotics. Perioperative: • Atraumatic extractions. Postoperative: • Antibiotics may be prescribed for multiple extractions or extensive surgery; recommendations vary – penicillin V, amoxicillin, clarithromycin, doxycycline and metronidazole have all been used. • Use of chlorhexidine mouthwash. • Review after 1 week. Treatment of BRONJ: • Treatment in hospital. • Asymptomatic exposed bone managed with chlorhexidine mouthwash four times a day. • Symptomatic exposed bone; penicillin V recommended. If patient allergic to penicillin, then metronidazole, clindamycin, doxycycline, erythromycin or levofloxacin may be used. • Invasive treatment not usually performed. • Mobile sequestrate should be removed without exposing any underlying bone.

BRONJ, bisphosphonate-related osteonecrosis of the jaw.
CTX, C-terminal telopeptide.

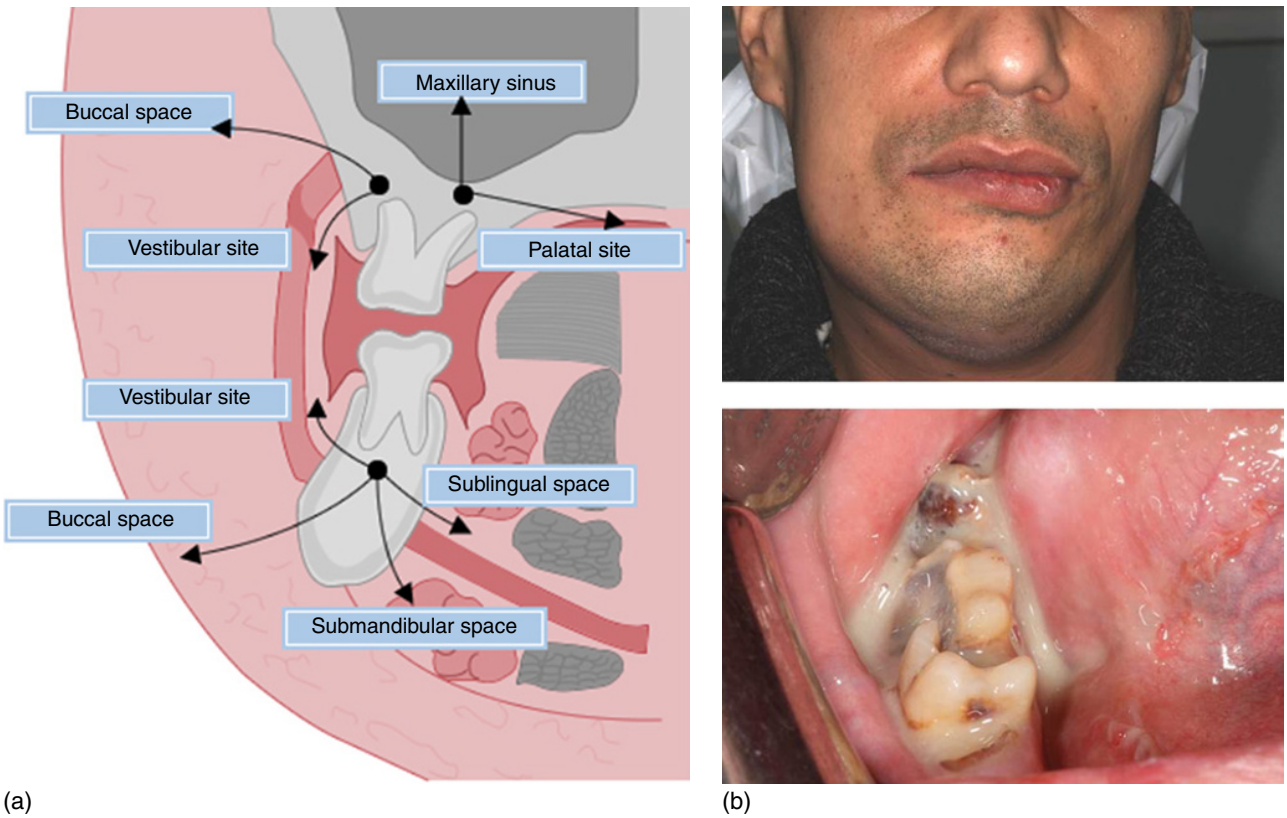
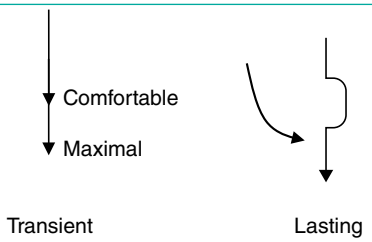


Figure 15.10 (a) Illustration of potential tissue spaces where odontogenic infections can spread. (b) A patient with acute spreading infection.

Table 15.12 Three-minute examination of the temporomandibular joint (courtesy of Dr Stephen Davies, Manchester University).

		Right	Left
Tender to palpation?	Lateral pole		
	Intra-auricularly		
Noises?	Clicks	Right Left Bilateral Soft Loud Consistent Intermittent Opening Closing Both Cycle: Early Mid Late Painful Painless Single Multiple	
	If patient has consistent clicks, do these clicks disappear when the patient opens from a protrusive mandibular position?		
	Crepitus	Right Left Bilateral Painful Painless	
Range of motion? (mm)	Lateral		
	Vertical		

Muscle tenderness

	Technique	Right	Left
Temporalis	Palpation		
Masseter	Palpation		

Occlusion record

Skeletal			
Angles			
Static occlusion	Does centric occlusion occur in centric relation?		
	If not – premature contact in centric relation? Roughly: Exactly: Direction of slide from centric relation to centric occlusion: Freedom in centric occlusion?:		
Dynamic occlusion		**Right**	**Left**
	Non-working side interferences?		
	Working side interferences?		
	Crossover position: Non-working side		
	Working side		
	Canine guidance?		
	Group function?		

Additional notes

Excessive tooth wear? Signs of attrition as a result of clenching or bruxist habits.
Cheek ridging/tongue scalloping? May be an indication of parafunction.
Evidence of tooth/restoration fracture? Parafunction may result in tooth or restoration fractures.

Table 15.13 Management of temporomandibular joint-related myalgia.

Diagnosis	
Preauricular pain	Signs may include: • May worsen on opening wide. • Worse during the first half of the day if bruxist. • Worse during the second half of the day if clencher. • Muscle tenderness (it is no longer recommended to examine the pterygoid muscles). • Joints tender to palpation. • Responds to over-the-counter analgesics (paracetamol and NSAIDs)
Evidence of parafunctional habits. Are the habits stress related?	• Muscle hypertrophy. • Attrition. • Atypical tooth wear. • Established gum chewing habit. • Posturing of the mandible.
Radiographs	• Pathology of joint evident in radiographs is very rare.
Signs of sinister disease RED FLAGS for neoplasia	• Painless trismus. • Patient over 50 years of age. • Prior carcinoma. • Worsening trismus despite therapy. • Lymphadenopathy. • Spontaneous neuropathy. • Asymmetry.
Management	
	• Exclude sinister disease. • Reassure patient that condition is self-limiting and will respond to reversible non-invasive management. • Cessate parafunctional habits, often associated with stress: discontinue gum chewing and institute relaxation classes. Recommend stress management techniques as often the parafunction is stress related. • Exercises and physiotherapy to discourage posturing of the mandible. • Analgesics as necessary. • Provision of hard, full occlusal coverage splint to reduce muscle activity. The patient should be encouraged to wear the splint as often and for as long as possible. • Avoid non-reversible therapies including occlusal readjustment.
Review	
	• Most (95%) patients will respond to non-interventional therapy. Non-responding patients should be reassured and encouraged to continue the treatment.

Table 15.14 Management of temporomandibular dysfunction.

Symptoms • Preauricular pain. • Recurrent clicking. • Jaw stiffness and intermittent trismus. • Open locking with reduction. • Closed locking with reduction. • Open locking without reduction. • Closed locking without reduction. • The latter conditions will present with a history of recurrent attendances to A&E for manipulation with or without sedation to reduce subluxation in association with disc displacement.	**Signs** • Clicking on opening and or closing (or both). • Deviation on opening and closing. • Reluctance to open wide for fear of locking. • Muscle tenderness. • Tenderness on palpation of joints.
Parafunctional habits Is the patent or their partner aware of bruxist tooth grinding activity which may occur during sleep? The patient may also have a clenching habit.	**Signs** • Muscle hypertrophy. • Attrition. • Atypical tooth wear. • Known gum chewing habit. • Posturing of mandible.

(*Continued*)

Table 15.14 (Continued)

Radiographs	
	• To reveal radiographically detectable pathology of joint – very rare. • A tomographic view (open and closed) may demonstrate disc displacement. • MRI may be of diagnostic value.
Signs of sinister disease	
	• Painless trismus. • Worsening trismus despite therapy. • Neuropathy. • Asymmetry.
Management	
	• Exclude sinister disease. • Reassure patient that condition is self-limiting and will respond to reversible non-invasive management. • Cessate parafunctional habits, often associated with stress: discontinue gum chewing and institute relaxation classes. • Exercises and physiotherapy to discourage posturing of the mandible. • Analgesics as necessary. • Provision of hard, full occlusal coverage splint to reduce muscle activity. The patient should be encouraged to wear the splint as often and for as long as possible.
Review	
	If recurrent locking without reduction occurs, a simple surgical procedure may be indicated; for example, meniscal placation, eminence enhancement or removal to stabilise the joint and prevent recurrent locking due to subluxation.

Table 15.15 Management of temporomandibular joint arthritides.

Diagnosis	**Signs**
• Preauricular pain. • Spontaneous unilateral or bilateral. • Associated with ongoing arthritides.	In older patients, signs may include: • Pain worsening on opening wide and resultant trismus. • Crepitis with movement. • Heat and redness over joints. • Tenderness on palpation of joints. • Responds to over the counter analgesics – paracetamol and NSAIDs. In younger patients, recent flu-related symptoms can be related to reactive arthritis, which usually affects many joints.
Radiographs	
	Required, if pathology of joint is suspected, despite being very rare.
Haematological investigations	
	• CRP may be elevated as a non-specific marker of inflammation in generalised arthritis. • Rh Factor and autoantibody screen for rheumatoid arthritis or Still's disease. About four out of five people with rheumatoid arthritis have positive tests for rheumatoid factor, but about one in 20 people without rheumatoid arthritis also have positive results. Only about half of all people with rheumatoid arthritis have a positive rheumatoid factor when the disease starts. • Another antibody test known as anti-CCP is also available. People who test positive for anti-CCP are very likely to develop rheumatoid arthritis. And people who test positive for both rheumatoid factor and anti-CCP may be more likely to have severe rheumatoid arthritis. • Uric acid levels if gout is suspected.

Table 15.15 (Continued)

Signs of sinister disease	• Painless trismus. • Worsening trismus despite therapy. • Neuropathy. • Asymmetry.
Management • Osteoarthritis anti-inflammatories. • If rheumatoid arthritis, refer to rheumatologist for full connective tissue disease screening. • If reactive arthritis, reassure patient and recommend analgesics as required. • Gout refer to rheumatologist for medical management.	• Exclude sinister disease. • Reassure patient that condition is self-limiting and will respond to reversible non-invasive management. • Cessate parafunctional habits, often associated with stress: discontinue gum chewing and institute relaxation classes. • Exercises and physiotherapy to discourage posturing of the mandible. • Analgesics as necessary. • Provision of hard, full occlusal coverage splint to reduce muscle activity. The patient should be encouraged to wear the splint as often and for as long as possible.
Review to assess improvement in symptoms	Review most likely for those patients attending a rheumatologist for the management of generalised specific arthritides.

CCP, cyclic citrullinated peptide; CRP, C-reactive protein; NSAIDs, non-steroidal anti-inflammatory drugs.

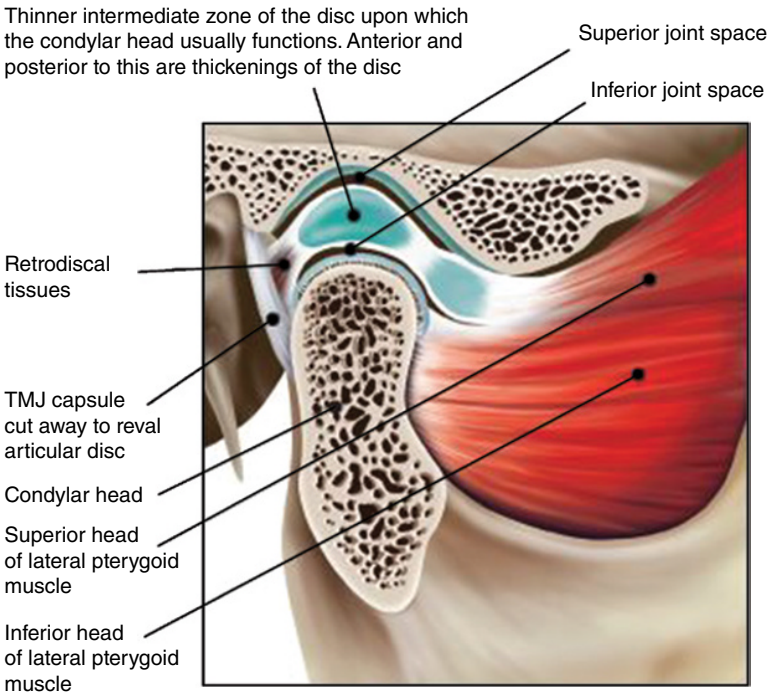


Figure 15.11 Temporomandibular joint (TMJ) structure. Courtesy of BDJ.

Table 15.16 Minimising risk and management of persistent postextraction haemorrhage.

No known haemorrhagic predisposition	Incomplete medical history, or failure of the patient to comply with postoperative instructions.	• Assess patient's level of consciousness and distress. • Examine socket for any clot formation (usually partial). • Under local anaesthesia, with adrenaline, evacuate clot and check for the presence of any bone and root fragments, which should be removed, squeeze socket to approximate fractured bone plates, place surgical pack (hydroxlysed cellulose or equivalent) and suture the wound. A buccal advancement flap may be required to provide primary closure. • Provide analgesia and antibiotics and review patient to remove sutures, check healing, and possibly haematologically assess the patient for bleeding dyscrasias.
Disorders of haemostasis	Increased risk of bleeding postoperatively.	*Haemophilia A, B, VonWillebrand's*: • Liaise with haematology physician/haemophilia centre. • Factor VIII levels between 50% and 75% required prior to treatment. • Topical desmopressin, tranexamic acid may be needed but lack evidence base. • Treat in hospital – inpatient management may be required. • Avoid ID blocks if possible. *Thrombocytopenia:* Preoperative • Liaise with haematology physician. • Platelet levels >80 × 109/l required – advisable to treat in hospital setting. • Platelet levels <80 × 109/l will require platelet transfusion. Postoperative • Local haemostatic measures. • Platelets may be needed. • Avoid NSAIDs.
Anticoagulant therapy	• Increased risk of bleeding for patients on: warfarin, heparin, aspirin, clopidogrel, dipyridamole, glycoprotein IIb/IIIa inhibitors. • Do not stop anticoagulant therapy as this will increase the risk of a thromboembolic event, unless advised by patient's physician. • Warfarin effect altered by antibiotics and NSAIDs.	Preoperative: • INR <4 OK for treatment, if >4 refer back to haematology clinic for adjustment. • Dual antiplatelet therapy treat in hospital. Postoperative: • Local haemostatic measures. • No NSAIDs.

INR, international normalised ratio; NSAIDs, non-steroidal anti-inflammatory drugs.

Oroantral Communication

It is suggested that up to 80% of maxillary posterior teeth extractions result in an immediate bony communication between the mouth and the maxillary antrum (oroantral communication (OAC)) but that most of these OACs are subclinical (Figure 15.12). There is a higher incidence of OAC with:

- Impacted maxillary third molars (greater surgical difficulty and proximity to sinus floor).
- Intraoperative root fractures.
- Fracture of maxillary tuberosity.
- Excessive use of force.

If a large OAC is identified, then it should be immediately repaired using a buccal advancement flap. Advise the patient to maintain good oral hygiene and use nasal decongestants. Review the patient to ensure the wound heals. If the wound breaks down, then a buccal fat pad may be indicated.

Jaw Fracture

Jaw fracture is an extremely rare complication of dental extraction and usually occurs in patients at high risk. Any surgeon routinely undertaking complex dentoalveolar surgery should be familiar with the management of dentoalveolar and mandibular fractures (Table 15.20).

Table 15.17 Management of dry socket.

Preoperative	
Confirmed history of dry socket	• Extraction in last 3–12 days. • More common in mandible than in maxilla. • Associated risk factors – contraceptive pill, diabetes mellitus, smoking, previous dry socket, surgical/difficult extraction. • Does not occur in children.
Clinical symptoms	• Severe intractable pain that does not respond to antibiotics or analgesics. • Onset within 3–10 days of extraction. • May have halitosis.
Clinical signs	• Empty socket possibly filled with food debris. • No inflammation. • No lymphadenopathy.
Operative procedure	
Check health of soft tissue.	To ascertain if there is associated infection.
Warn patient of some discomfort during irrigation of the socket. Local anaesthesia is not required.	Irrigate socket with saline several times to flush out and remove debris from the socket. Often, some bleeding occurs from the site.
Place resorbable bacteriostatic dressing into socket.	Use small pledget of alvogyl (iodoform on moss), Whiteheads varnish or iodoform paste (BIPP) as a lightly and loosely packed superficial dressing. This provides protection and allows the development of a clot and granulation tissue.
Review. One treatment usually suffices as washing out the food debris removes the cause of the problem and allows healing to take place.	Ideally the dressing should be washed out after 6–12 h. It is rare to have a recurrence of a dry socket. In the event of a recurrence, or if symptoms persist, it is important to exclude infection or osteomyelitis with the possible retention of bone sequestra or tooth fragments.

Table 15.18 Management of nerve injury complication in relation to dentistry.

Mechanism	Duration	Treatment
Known or suspected nerve section		Immediate exploration
TMS IANI – retained roots	<30 h	Immediate exploration
Implant	<30 h	Remove implant
Implant	>30 h	Treat patient therapeutically
Endodontic	<30 h	Remove tooth/overfill
Endodontic	>30 h	Treat patient therapeutically
TMS IANI – large neuropathic area, pain and disability	<3 months	Consider exploration
TMS LNI – large neuropathic area, pain and disability	<3 months	Consider exploration
TMS IANI – large neuropathic area, pain and disability	>6 months	Treat patient therapeutically
TMS LNI – large neuropathic area, pain and disability	>6 months	Treat patient therapeutically
LA, fracture, orthognathic, other surgery		Treat patient therapeutically

IANI, inferior alveolar nerve injury; LNI, lingual nerve injury; TMS, third molar surgery; LA, local anaesthesia.

Table 15.19 Diagnosis and management of lost or displaced tooth or restoration.

Confirm loss of tooth or tooth fragment: • Check mouth. • Systematic examination of the mouth. • Did patient cough during loss of tooth? • Do they remember swallowing the tooth or fragment?	If unable to find tooth fragment: • Inform patient and reassure. • Arrange referral for chest radiograph.
Tooth in chest: patient may be symptomless or suffer some loss of breath.	If tooth present in chest (likely to be right main bronchus) arrangements for referral to cardiothoracic specialist for bronchoscopy removal of tooth or fragment. Patient will need to be reassured, give consent and be placed on antibiotics to prevent pneumonia.
Tooth in stomach.	Reassure patient and encourage to continue eating as normal and to check stools for evacuation of tooth.

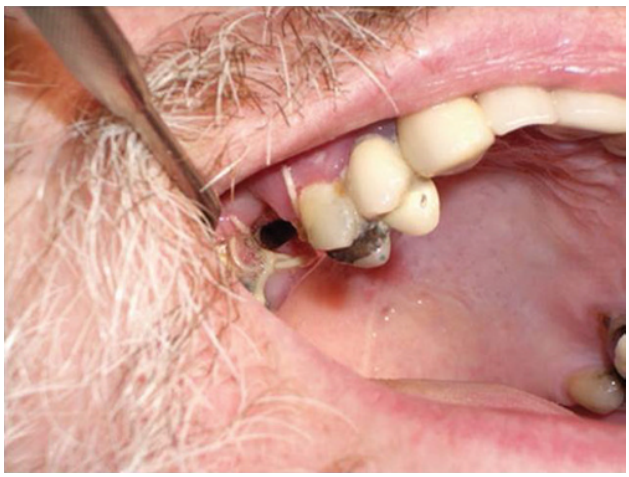


Figure 15.12 Oroantral communication.

Table 15.20 Diagnosis and management of jaw fracture related to dental extraction.

Confirm diagnosis: • Explore tooth socket. • Likely to have been high risk for gnathic fracture (for example thin edentulous mandible, deeply impacted tooth or large erosive lesion).	• Raise larger local flap and confirm fracture. • Check mobility of fracture – if incomplete can reassure patient and treat conservatively (analgesia, antibiotics, soft diet). • If mobile then placement of miniplates with microscrews is indicated (analgesia, antibiotics, soft diet).
• Report incident. • Review patient.	To confirm rehabilitation of the patient and healing of the fracture.

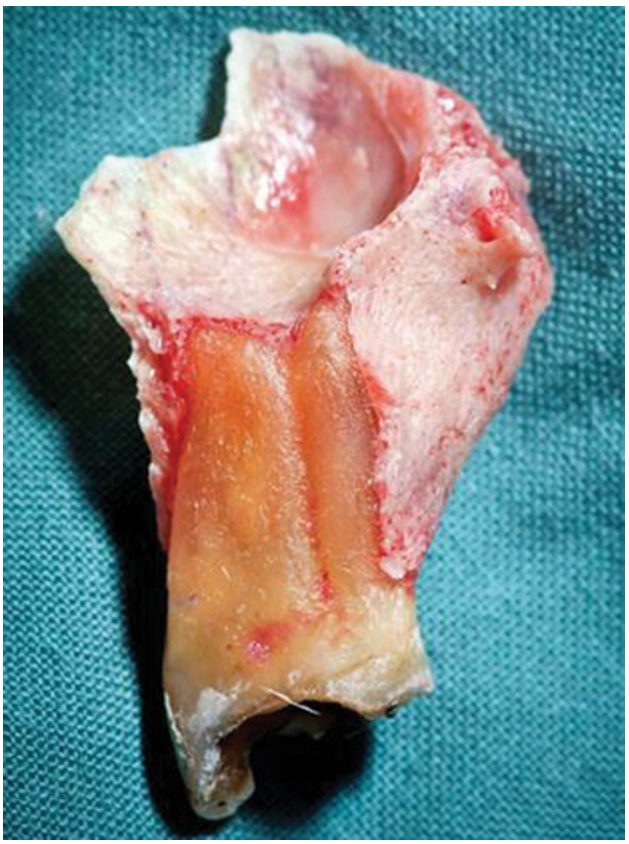


Figure 15.13 Tuberosity fracture.

Tuberosity fracture is very likely to occur in relation to a free-standing maxillary molar with antral cavity close to molar roots in older patients (Figure 15.13). Immediate recognition, removal and repair of the oroantral communication is recommended and the patient must be informed.

References

Cochrane Database (2013) Antibiotics for the prevention of bacterial endocarditis (severe infection or inflammation of the lining of the heart chambers) in dentistry. http://www.cochrane.org/CD003813/ORAL_antibiotics-for-the-prevention-of-bacterial-endocarditis-severe-infection-or-inflammation-of-the-lining-of-the-heart-chambers-in-dentistry (accessed 29th June 2017).

Dental Practitioners' Formulary in the British National Formulary. http://www.evidence.nhs.uk/formulary/bnf/current/guidance-on-prescribing/prescribing-in-dental-practice (accessed 29th June 2017).

FGDP (2012) Antimicrobial Prescribing for General Dental Practitioners. http://www.fgdp.org.uk/content/publications/antimicrobial-prescribing-for-general-dental-pract.ashx (accessed 29th June 2017).

Karki, A.J., Holyfield, G., Thomas, D. (2011) Dental prescribing in Wales and associated public health issues. British Dental Journal 210:E21.

Meechan, J.G. (2011) The use of the mandibular infiltration anesthetic technique in adults. Journal of the American Dental Association 142(Suppl 3): 19S–24S.

NHS England (2015) Revised Never Events Policy and Framework. https://improvement.nhs.uk/uploads/documents/never-evnts-pol-framwrk.pdf (accessed 29th June 2017).

NICE (2008) Prophylaxis against infective endocarditis (updated July 2016). https://www.nice.org.uk/guidance/cg64 (accessed 29th June 2017).

NICE (2015) Antimicrobial stewardship: systems and processes for effective antimicrobial medicine use. https://www.nice.org.uk/guidance/ng15 (accessed 29th June 2017).

Palmer, N.A.O, Pealing, R., Ireland, R.S., Martin, M.V. (2000) A study of prophylactic antibiotic prescribing in National Health Service general dental practice in England. British Dental Journal 189:43–46.

Royal College of Surgeons (2014) Commissioning Guide: Temporomandibular Joint Disorders. London: Royal College of Surgeons.

Scottish Dental Clinical Effectiveness Programme (2013) Drug Prescribing for Dentistry: Dental Clinical Guidance, 2nd edn. http://www.sdcep.org.uk/wp-content/uploads/2013/03/Drug_Prescribing_for_Dentistry_2_Web.pdf (accessed 29th June 2017).

16

Procedures in Orthodontics

Martyn Cobourne

Introduction

It is important for the primary care practitioner to examine and diagnose occlusal problems in the developing dentition. This will provide a firm foundation for appropriate and timely referral to a specialist orthodontist. In addition, the local practitioner may be the first port-of-call for a patient with problems associated with their orthodontic appliance, and it is important for them to be able to manage these problems and provide appropriate advice. In many circumstances this will just require advice and reassurance until they can see their specialist; however, if the problem is acute and a source of pain and discomfort, then the practitioner should have sufficient knowledge to provide some relief. This chapter outlines the core principles associated with examination of the orthodontic patient and appropriate referral to a specialist. In addition, the management of orthodontic emergencies is also covered.

Orthodontic Examination

Equipment

- Dental mirror.
- Dental probe.
- Ruler.

Procedure	Rationale
Medical history	A comprehensive medical screening should be carried out as part of the orthodontic examination. This can be achieved with an anonymous patient questionnaire that is completed before the consultation. The following conditions should be noted: • Congenital heart defects. • Bleeding disorders. • Childhood malignancy. • Diabetes. • Immunosuppression. • Asthma. • Epilepsy. • Allergies. • Infectious disease. • Bisphosphonate use.
Extraoral examination	The face should be looked at in both the relaxed and animated states in a position of natural head posture (the position that the patient naturally carries their head). Frontal and profile views should be undertaken.
Frontal examination: vertical relationship	A normally proportioned face should subdivide vertically into approximately equal thirds: • Upper face (hairline to lower forehead). • Middle face (base of forehead to base of nose). • Lower face (base of nose to bottom of chin). The lower third can be further subdivided into equal thirds covering the upper lip, lower lip and chin.
Frontal examination: the lips	Lip competency should be evaluated: • Competent lips are together at rest. • Potentially competent lips are obstructed from contact, usually because of the position of the upper incisors. • Incompetent lips are unable to achieve an anterior oral seal.

(*Continued*)

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

Procedure	Rationale
Frontal examination: upper incisor show	Around 3–4 mm of upper incisor should be on show at rest, whilst around 75–100% of the crowns should be shown on smiling.
Frontal examination: transverse relationship	A normally proportioned face should subdivide transversely into equal fifths: • Ear to outer eye. • Eye. • Nose. • Eye. • Eye to outer ear. The position of the dental centrelines should be noted in relation to the facial midline and any significant mandibular asymmetry.
Profile examination: anterior-posterior jaw relationship	A virtual vertical line (zero meridian) is dropped from the forehead with the face in natural head position and the position of the maxilla and mandible assessed in relation to this line. In a class I case: • The upper lip should rest on this line. • The lower lip should be just behind this line. In a class 2 case: • The lower jaw is >4 mm behind the upper In a class 3 case: • The lower jaw is <2 mm ahead of the upper
Profile examination: vertical jaw relationship	Intersection of the maxillary–mandibular plane angle with the back of the skull should be assessed: • If it coincides with the occiput it is considered normal. • If it is beyond the occiput this is reduced. • If it is in front of the occiput this is increased. The frontal proportions of the face can also give a clue to the vertical jaw relationship. If the lower third of the face is proportionally larger than the other thirds, then the vertical jaw relationship is increased and vice versa.
Temporomandibular joints	The temporomandibular joints should be examined for any obvious pain on palpation, crepitus, deviation, clicking or limited opening.
Intraoral examination	The intraoral examination is concerned with the mandibular and maxillary dentitions in isolation and in occlusion. This should be done with the patient supine in the dental chair using a dental mirror. An overall assessment of dental health should be made, including oral hygiene, general dental condition to include any restorations, untreated caries, periodontal disease or previous dental trauma.
Dental arches	• Mixed or permanent dentition. • Teeth present clinically. • Presence of crowding or spacing in the labial and buccal segments (as a general rule: 0–4 mm of tooth displacement is mild, 5–8 mm is moderate and >9 mm is regarded as severe crowding). • Tooth rotations. • Position and inclination of the labial segment in relation to the dental base. • Presence and position of the maxillary canines. • Inclination of the permanent canines. • Depth of any curve of Spee or Wilson.
Static occlusion	The patient should be asked to occlude in the intercuspal position. The incisor relationship should be classified: • Class 1: the lower incisor edges occlude or lie below the cingulum plateau of the upper incisors. • Class 2: the lower incisor edges occlude or lie behind the cingulum plateau of the upper incisors: • Division 1: the overjet is increased with proclined or upright incisors. • Division 2: the upper incisors are retroclined. • Class 3: the lower incisor edges occlude or lie ahead of the cingulum plateau of the upper incisors. The overjet should be noted (normal, positive, negative) and measured. The overbite should be in the range of 2–4 mm (normal, positive, negative) and measured. It can be increased or decreased from these dimensions. If there is no vertical overlap it is described as open. • The overbite is complete if there is contact between the incisors or the incisors and opposing mucosa. • The overbite is incomplete if there is no contact between the incisors or the incisors and opposing mucosa. The maxillary and mandibular centrelines should be assessed in relation to the facial midline and to each other. The buccal segment relationship should be classified in relation to the first permanent molars and canines.

(*Continued*)

Procedure	Rationale
	For the molars • Class 1: the mesiobuccal cusp of the first permanent molar should occlude with the mesial buccal groove of the lower first molar. • Class 2: the mesiobuccal cusp of the first permanent molar is ahead of the mesial buccal groove of the lower first molar. • Class 3: the mesiobuccal cusp of the first permanent molar is behind the mesial buccal groove of the lower first molar. For the canines: • Class 1: the maxillary canine should occlude directly in the embrasure between mandibular canine and first premolar. • Class 2: the maxillary canine is in front of the embrasure between mandibular canine and first premolar. • Class 3: the maxillary canine is behind the embrasure between mandibular canine and first premolar. The severity of these relationships can be described in terms of tooth units (half or a full unit). The presence of any anterior cross bites; or posterior buccal or lingual cross bites should be noted for each quadrant.
Functional occlusion	Any discrepancy between intercuspal position and the retruded contact position should be noted. The presence of canine guidance or group function in lateral excursion should be noted.
Summary	A summary of the presenting features helps develop a list of problems.

Orthodontic Referral Criteria

Orthodontic treatment is commonly carried out in the late mixed and early permanent dentition. Appropriate referral to a specialist orthodontist is therefore important and it is the responsibility of the general dental practitioner to monitor development of the dentition in their patients. Orthodontic referrals should be made based upon clinical need at the appropriate time.

Orthodontic treatment is generally carried out in four principle domains within the UK:	
Hospital orthodontic service	A consultant-led service providing treatment for complex malocclusions requiring multidisciplinary input or patients with medical problems: • Orthodontics and orthognathic surgery. • Orthodontics and restorative dentistry. • Orthodontics and oral surgery. • Complex malocclusions (IOTN 4+5 – see later). • Children with physical or mental handicap or underlying medical disorders. • Cleft lip and palate or other craniofacial anomalies.
Community orthodontic service	A specialist orthodontic service providing treatment for complex malocclusions (IOTN 4+5) and patients with medical and social problems.
Specialist orthodontic practitioners in primary care	A specialist orthodontic service providing the majority of orthodontic treatment for children and adolescents (IOTN 3.6–5 – see below).
General dental practitioners with a special interest in orthodontics	Routine orthodontic treatment for children and adolescents (with specialist treatment plan).
Routine orthodontic referrals	
Early loss of primary teeth	The early loss of primary teeth due to caries or trauma can have implications for space distribution in the mixed dentition. The orthodontist may be required to provide advice on balancing and compensating extractions: • A balancing extraction is the removal of a tooth from the opposite side of the same dental arch, which aims to preserve the centreline by maintaining arch symmetry. • A compensating extraction is the removal of a tooth from the opposite quadrant to maintain the buccal occlusion.

Failure of permanent tooth eruption	Any significant asymmetric eruption patterns (>6 months) warrants orthodontic referral: • The maxillary central incisor is prone to eruption failure secondary to the presence of a supernumerary tooth in the anterior maxilla. • The maxillary first permanent molars can sometimes become impacted against the distal aspect of the upper second deciduous molars. • The maxillary permanent canine is also susceptible to deviation from the normal eruptive path and impaction. These teeth should be palpable in the buccal sulcus by the age of 10–12 years and if they are not, this warrants orthodontic referral. • The mandibular canine can also fail to erupt and occasionally become horizontally displaced within the mandible.
Increased overjet	The presence of an increased overjet (>6 mm) should normally be referred in the mixed dentition phase, ideally before the pubertal growth spurt.
Anterior or posterior cross bites	The presence of an anterior or posterior cross bite associated with a mandibular displacement.
Crowding	The presence of dental crowding is also indicative of referral to an orthodontist: • Severe crowding in the mixed dentition can warrant early referral for an evaluation of the need for interceptive extractions. • Moderate crowding is often managed in the early permanent dentition.
Referral in the early mixed dentition	Although most malocclusions are corrected in the late mixed and early permanent dentitions there are some that should be considered for referral to an orthodontist in the early mixed dentition.
Significant maxillary or mandibular disproportion	The presence of a significant skeletal discrepancy may warrant early referral: • An increased overjet, particularly if it is associated with gross lip incompetence and marked maxillary protrusion can be a risk for incisor trauma. • An increased overjet associated with bullying and social isolation can also benefit from early intervention. • A significant reverse overjet associated with maxillary retrusion can respond well to protraction headgear and this is most effective before the age of 8 years.
Significant mandibular displacement	A significant mandibular displacement should also be corrected in the early mixed dentition, particularly if there is any evidence of localised recession or other occlusal and functional problems.
Cleft lip and palate	Individuals affected by cleft lip with or without cleft palate or isolated cleft palate should be managed in a specialist regional unit and should be referred accordingly if they are not under the care of one of these national units.
Adult referrals	Adult patients presenting with a malocclusion should be referred to an orthodontic specialist if they require treatment: • The presence of a significant skeletal discrepancy may warrant combined orthodontic and orthognathic treatment.
Index of Orthodontic Treatment Need The Index of Orthodontic Treatment Need (IOTN) is a validated and reproducible guide to treatment need that is currently used in the UK. The IOTN is composed of two parts: • Dental Health Component (DHC), which ranks cases from 1 to 5 based upon need for treatment. • Aesthetic Component (AC), which is ranked from 1 to 10.	
Dental Health Component	
Grade 1: no treatment need	Extremely minor malocclusions, including displacements <1 mm.
Grade 2: little need for treatment	2a: Increased overjet >3.5 mm but ≤6 mm (with competent lips). 2b: Reverse overjet greater than 0 mm but ≤1 mm. 2c: Anterior or posterior cross bite with ≤1 mm discrepancy between retruded contact position (RCP) and intercuspal position (ICP). 2d: Displacement of teeth >1 mm but ≤2 mm. 2e: Anterior or posterior open bite >1 mm but ≤2 mm 2f: Increased overbite ≥3.5 mm (without gingival contact) 2g: Prenormal or postnormal occlusions with no other anomalies (≤½ a unit of discrepancy).

Grade 3: borderline need for treatment	3a: Increased overjet >3.5 mm but ≤6 mm (incompetent lips). 3b: Reverse overjet greater than 1 mm but ≤3.5 mm. 3c: Anterior or posterior cross bites with >1 mm but ≤2 mm discrepancy between RCP and ICP. 3d: Displacement of teeth >2 mm but ≤4 mm. 3e: Lateral or anterior open bite >2 mm but ≤4 mm. 3f: Increased and incomplete overbite without gingival or palatal trauma.
Grade 4: treatment required	4a: Increased overjet >6 mm but ≤9 mm. 4b: Reverse overjet >3.5 mm with no masticatory or speech difficulties. 4c: Anterior or posterior cross bites with >2 mm discrepancy between RCP and ICP. 4d: Severe displacements of teeth >4 mm. 4e: Extreme lateral or anterior open bites >4 mm. 4f: Increased and complete overbite with gingival or palatal trauma. 4h: Less extensive hypodontia requiring prerestorative orthodontics or orthodontic space closure to obviate the need for a prosthesis. 4l: Posterior lingual cross bite with no functional occlusal contact in one or more buccal segments. 4m: Reverse overjet >1 mm but <3.5 mm with recorded masticatory and speech difficulties. 4t: Partially erupted teeth, tipped and impacted against adjacent teeth. 4x: Existing supernumerary teeth.
Grade 5: treatment required	5a: Increased overjet >9 mm. 5h: Extensive hypodontia with restorative implications (more than one tooth missing in any quadrant requiring prerestorative orthodontics). 5i: Impeded eruption of teeth (apart from third molars) due to crowding, displacement, the presence of supernumerary teeth, retained deciduous teeth and any pathological cause. 5m: Reverse overjet >3.5 mm with reported masticatory and speech difficulties. 5p: Defects of cleft lip and palate. 5s: Submerged deciduous teeth.
Aesthetic Component The aesthetic handicapping of the malocclusion based upon a series of 10 frontal colour photographs of the incisor occlusion. The score is based upon perceived aesthetic impairment due to the malocclusion.	In the presence of a malocclusion with an IOTN DHC of 3, it is currently suggested that an accompanying AC score of 6–10 justifies orthodontic treatment within the UK National Health Service (NHS). A malocclusion with IOTN DHC of 4 or 5 automatically qualifies for NHS treatment.

Orthodontic Emergencies

Equipment

Dental mirror.
Dental probe.
Light-wire pliers.
Heavy duty hard-wire cutters.
Weingart pliers.
Band-removing pliers.
Distal end-cutters.
Straight handpiece.
Acrylic bur.
Green stone.
Orthodontic wax.

Removable appliances	Removable appliances are used by orthodontists to achieve relatively simple tooth movements, often as an adjunct to fixed appliance treatment.
Appliance becomes loose	Most removable appliances can become loose during routine wear. This can be exacerbated in patients who habitually 'click' the appliance in and out during routine wear. • Most removable appliances are retained using Adams' cribs, which can be tightened using conventional wire-bending pliers (ideally Adams' pliers) by gently squeezing the interproximal bridge of the clasp. Occasionally, a crib will fracture. In these circumstances, the loss of a single crib should not compromise retention to the extent that the appliance cannot be worn, at least over the short term. • If the wire portion of the crib is protruding it can be cut with hard wire cutters and the remainder of the crib reactivated to provide some retention. • Alternatively, the whole crib can be cut off the appliance.

Fracture of the baseplate	Occasionally a portion of the baseplate can fracture. This can be smoothed with a conventional acrylic bur in a straight handpiece if it is sharp. • More significant fractures of the baseplate, which make an appliance impractical to wear, will require either a laboratory repair (with an impression of the appliance *in situ*) or a remake of the appliance from a new impression.
Distorted or fractured active components	Active components such as springs or labial bows can become distorted during use. These can often be bent back into a reasonable shape using conventional wire bending pliers. • More significant distortion or fracture will necessitate removal and a more extensive repair through the orthodontist.
Candida infections	Poor appliance hygiene and excessive wear can lead to infection through *Candida albicans*. This will produce a bright red area of inflammation corresponding to the dimensions of the baseplate. • Improved appliance hygiene will usually produce a rapid resolution. • More resistant infections will respond to a course of antifungal therapy.
Retainers	Retainers are commonly provided after the completion of orthodontic treatment to maintain tooth position (i) whilst the periodontal tissues complete the process of remodelling and (ii) and over the long term. Removable retainers are generally composed of wire and acrylic (Hawley type) or are vacuum-formed (Essix type). • Hawley type retainers can be affected by many of the problems associated with removable appliances. • Essix type retainers can cause localised trauma or ulceration and can be easily trimmed with scissors. Bonded retainers consist of multistranded stainless steel wires or fabricated chains bonded to the lingual surface of the anterior teeth with composite cement. • These retainers can fracture away from single or multiple teeth and are amenable to local repair with etch and composite in many cases. • More extensive damage may necessitate removal and replacement. It is important to remember that any significant fracture of a removable or bonded retainer will compromise their effectiveness at preventing unwanted tooth movement. In these circumstances, or if unwanted tooth movement has already occurred, patients should return to their orthodontist as soon as possible.
Functional appliances	Functional appliances are a group of largely removable appliances that are used to correct anterior-posterior jaw discrepancies in growing children. • Problems associated with removable functional appliances are usually related to ulceration in association with the increased extension of acrylic seen in these appliances. This can usually be eased with a simple acrylic bur in a slow handpiece. • Fractures and distortions of wirework can be managed as outlined for removable appliances.
Fixed functional appliances	A number of fixed functional appliances are also used. These generally consist of a metal tube or piston connecting the upper first molars to the lower anterior dentition to keep the mandible postured forward. • The most common problem is fracture of the piston or disengagement of the piston attachments from the teeth. • Problems with these appliances should be referred back to the prescribing orthodontist. If a patient is experiencing severe difficulties, the appliance should be removed as an emergency.
Fixed appliances	Fixed appliances are in common use today. The essential components of a fixed appliance include: • Brackets. • Bands. • Archwire. • Ligature wires. • Hooks. • Elastic bands and elastomeric chains. Patients can often experience pain and discomfort after the placement or adjustment of a fixed appliance. This can be associated with the teeth themselves, as they start to move or the soft tissues, particularly localised ulceration.
Orthodontic separators	Orthodontic separators are small elastomeric rings (or occasionally metal springs) that are inserted interproximally between molars or premolars to create space prior to banding. These can be lost or can slip beneath the contact point into the periodontal tissues: • If a slipped separator is causing gingival and periodontal inflammation, it can be removed with a dental probe. • In the event of the loss of a separator the patient should be advised to return to the orthodontist prior to their appointment for band fitting.

Orthodontic pain	General dental pain from a recently fitted or adjusted fixed appliance rarely continues beyond a few days and is efficiently managed with conventional anti-inflammatory analgesics.
Ulceration	• Localised ulceration affecting the lips, cheeks and tongue is also often time-limited but can be eased with over-the-counter topical anaesthetics or antiseptic mouthwash. • The application of soft orthodontic relief wax onto any area of the fixed appliance that is causing irritation can help prevent progressive ulceration.
Loose or fractured appliance	Components of the fixed appliance, particularly brackets, molar bands or palatal/lingual arches can become detached and loose. These problems can often be managed at the next routine orthodontic adjustment. • If loose components are causing problems they can be removed or secured with relief wax. • Loose molar bands should be removed if there is any risk of ingestion. They can be recemented with glass ionomer cement or left until the next routine appointment.
Lost ligatures or archwires	Occasionally auxillary ligatures or orthodontic archwires can become detached from the appliance. • Orthodontic ligatures can be replaced if they are not too distorted or removed and replaced at the next routine appointment. • Flexible archwires that come out of molar tubes can often be fed back in with orthodontic pliers. • If an archwire is loose and cannot be replaced it can be cut adjacent to the first area of attachment. Care should be taken not to leave any sharp protruding ends. In general, archwire problems should be managed by ensuring that no further trauma will occur and if necessary, this may require complete removal of the archwire.
Protruding archwires	This is a relatively common problem caused by active tooth movement during space closure, rotation of the archwire through the appliance during normal function or a previous failure to cut the archwire flush with the molar attachment. • Protruding archwires should ideally be cut with an orthodontic distal end-cutter and care should be taken to ensure that the cut end is retained and not ingested or inhaled by the patient. • If the archwire has rotated, it might be possible to feed it back into the correct position with orthodontic pliers. • Protruding wires can be bent distal to the molar attachment, although this might be difficult without an orthodontic tucker and/or if the wire is nickel titanium. Care should also be taken not to fracture bonded molar tubes when trying to bend a distal end. If none of these solutions are practicable, relief wax can be used on the protruding wire until the orthodontist can be seen.
Auxiliary arches	A number of auxiliary arches can be used in conjunction with fixed appliances, including transpalatal and Nance arches, quad helices and rapid maxillary expansion devices. These are often cemented onto the molar dentition with glass ionomer cement and can become detached. • General soft tissue trauma from these appliances can be managed with relief wax. • Any obvious sharp edges can be eased with a straight handpiece and green stone. • If the appliance is fractured or partially detached it should either be recemented with glass ionomer cement or removed to prevent the risk of ingestion or inhalation. These appliances can sometimes become embedded in the palatal mucosa. In these circumstances the embedded component should be bent away from the mucosa with orthodontic pliers or the appliance removed. In severe cases, some local anaesthetic might be required.
Headgear	Headgear is used to provide an external source of anchorage in conjunction with removable or fixed appliances. It generally consists of a metal intraoral detachable facebow and an external headgear to provide the extraoral force component. • At least two independent safety mechanisms are now recommended to be used with headgear: (i) a locking mechanism to prevent accidental detachment of the facebow and (ii) a snap-away headgear to prevent catapult injuries. • Patients experiencing any problems associated with headgear wear should be advised to stop and see their orthodontist at the earliest opportunity. If there is any suspicion of an eye injury resulting from orthodontic headgear, the patient should be immediately referred to a local accident and emergency department for a specialist opinion.

Further Reading

Orthodontic Examination

Cobourne, M.T., DiBiase, A.T. (2015) Handbook of Orthodontics, 2nd edn. Edinburgh: Elsevier Health Sciences.

Orthodontic Referral Criteria

Dowsing, P., Sandler, J. (2007) A guide to making appropriate orthodontic referrals. Dental Update 34(8):487–491.

Orthodontic Emergencies

Dowsing, P., Murray, A., Sandler, J. (2015) Emergencies in orthodontics. Part 1: Management of general orthodontic problems as well as common problems with fixed appliances. Dental Update 42(2):131–134, 137–140.

Dowsing, P., Murray, A., Sandler, J. (2015) Emergencies in orthodontics. Part 2: Management of removable appliances, functional appliances and other adjuncts to orthodontic treatment. Dental Update 42(3):221–224, 227–228.

Sodipo, I., Birdsall, J. (2016) Orthodontic first aid for general dental practitioners. Dental Update 43(5): 461–462, 465–466, 469–471.

17

Procedures in Paediatric Dentistry

Sanjeev Sood

Introduction

Paediatric dentistry relates to the care of young patients. It focuses on: preventive dental care; the diagnosis, treatment planning and delivery of care requiring non-pharmacological behaviour management; management of dental trauma and its consequences; the management of patients with special needs and children that are medically compromised; management of dental anxiety with the use of sedation techniques; and comprehensive oral care for patients under general anaesthesia.

> Children have a right to the enjoyment of the highest attainable standard of health, and to facilities for the treatment of illness and rehabilitation of health.
>
> *United Nations Convention on the Rights of the Child, Article 24*

Management of dental caries includes assessment of the child's caries risk, understanding of the disease process at an individual level, appropriate assessment of the disease process, managing where deemed suitable with targeted prevention and when necessary a restorative intervention. This chapter will focus on the restorative management of caries in the primary dentition as other chapters will cover the restorative management in the permanent dentition. Several of the techniques for restorative procedures in primary teeth are similar to those for the permanent dentition and these should always be kept in mind. The individual elements of the care plan are common to all forms of dentistry; however, it is of the utmost importance to treat the child and not the tooth.

There are a number of challenges that clinicians face when treating children. Despite these challenges, there are many reasons why time, effort and resources should be spent to manage this patient group successfully (Table 17.1).

The principle aims when providing dental care for paediatric patients include:

- Keeping the primary and permanent dentition free from dental disease.
- Applying targeted prevention plans based on the patient's caries risk status and using best available evidence and guidance.
- Reducing the risk of the child experiencing pain and anxiety due to dental disease or from treatment provided.
- Managing caries in the primary dentition at an early stage using the best techniques available ensuring that the teeth exfoliate at the natural time without causing pain.
- Instilling a positive dental attitude towards dental care now and for the future.

Table 17.1 Factors influencing the management of children in practice.

Issues that make treating children challenging	Reasons for treating children
• The child's behaviour. • Stages of development: – Behavioural – Dental • Shorter attention spans. • Differing tooth morphology. • Challenging operator access. • Choices of restorations. • Demanding parents. • Consent.	• Prevention. • Fostering good attitudes towards dentistry. • General health and wellbeing. • Relief of pain. • Prevent damage to the permanent dentition. • Prevent adverse consequences caused by premature tooth loss. • Treating children is a practice builder. • It is rewarding.

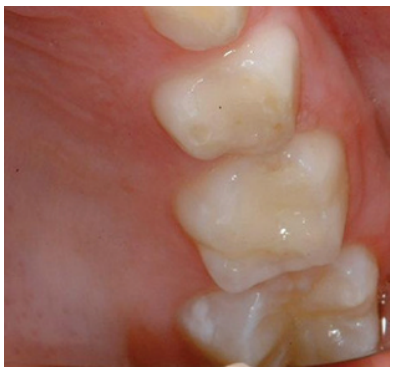
Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

Table 17.2 Possible adverse effects of dental neglect.

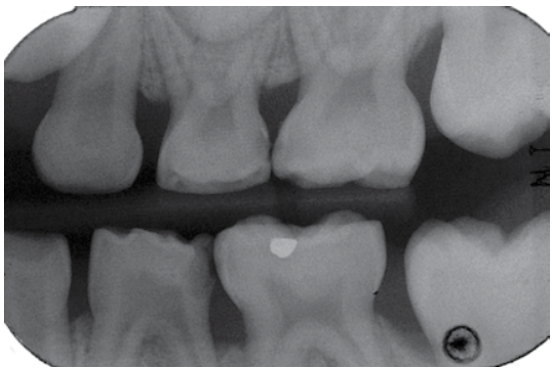
- Pain and sepsis.
- Greater risk of new carious lesions developing in both the primary and permanent dentition.
- Disruption to the quality of life.
- Missing school.
- Greater social impact on the family unit.
- Increased incidence of hospitalisation.

Untreated dental decay in children has a significant impact on their lives (Table 17.2).

The decision to restore carious primary teeth is complex. There are a number of factors that must be considered which are usually out of the control of the patient. The assessment of the patient should include a comprehensive clinical examination (extra- and intraoral), visual detection and radiographic evaluation of the carious lesions (Figure 17.1). Very young children and those who are anxious about dental treatment may find a full dental assessment frightening and may not cope with the full range of required diagnostic procedures. Behaviour management and modifications in approach, including a gradual introduction, should overcome these barriers. To make this decision several factors (Figure 17.2) must be considered.



(a)



(b)

Figure 17.1 (a) Clinical and (b) radiographic detection of caries. Note tooth 64 appears clinically sound; however, the bitewing radiograph shows the distal caries, together with an early enamel lesion in tooth 65.

Radiographic Assessment

There must be sound clinical indications to justify the exposure of children to x-rays to obtain dental radiographs, as they are particularly susceptible to the effects of ionising radiation. Careful clinical examination should indicate the most appropriate radiograph to confirm the diagnosis and previous radiographs should always be examined. The importance of radiographs in treatment cannot be overstated (Figure 17.3).

The benefits of bitewing radiographs include:

- Detection of caries that cannot otherwise be seen.
- The use of bitewing radiography, in addition to clinical examination, increases the number of interproximal lesions detected by a factor of between 2 and 8.
- Estimation of the extent of lesions.
- Monitoring of lesion progression (repeat radiographs, depending on the patient's caries risk status).

The frequency and recall with regards to radiographic exposure is dependent on the risk status of the child. For all high caries risk individuals, bitewing radiographs should be taken at the initial examination and at 6-monthly intervals until no new or active lesions are apparent and the individual has entered another risk category. A child with little or no caries activity does not require bitewing radiographs at every recall appointment. Children with low caries risk should be radiographed at approximately 12–18 month intervals in the primary dentition and at approximately 2-year intervals in the permanent dentition.

Once the decision has been made to restore a tooth, the operator must remember the differences in the anatomy of primary and permanent teeth. There are several key anatomical differences which affect disease progression, cavity design and restorative choices. Having knowledge of these will help with successful outcomes and reduce failure of the restorative care provided (Table 17.3).

Care Planning

The care plan for the patient will be determined by a number of the factors mentioned previously. The motivation of the child and parent, the extent of decay, the age of the child, the likely survival of the primary tooth, with any associated symptoms, will dictate your plan.

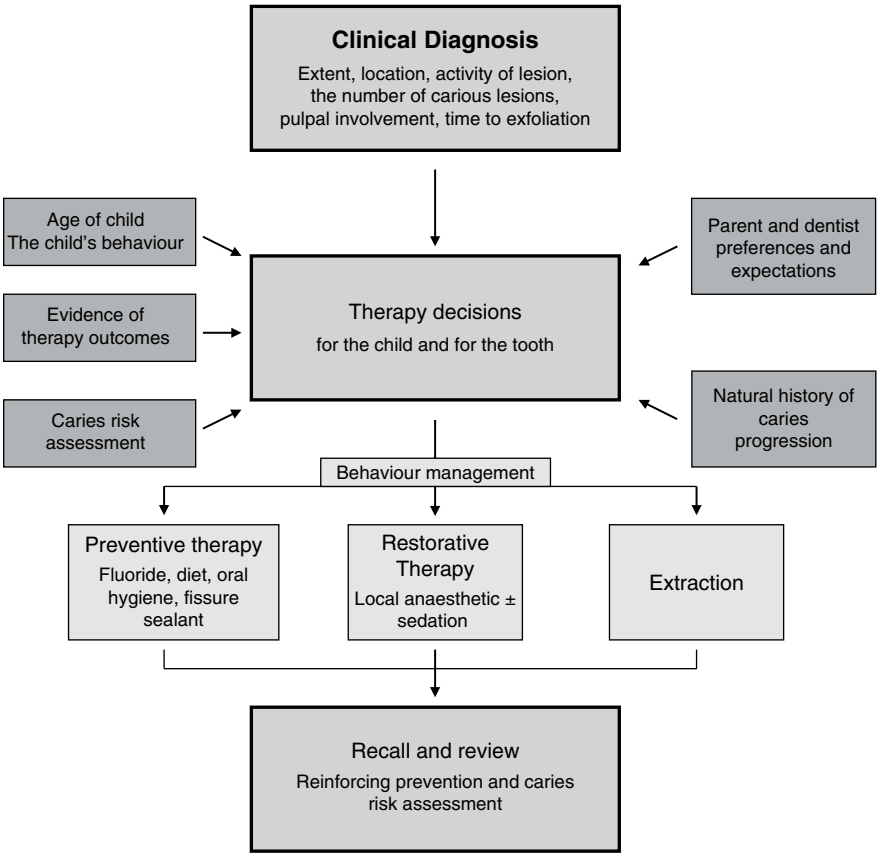


Figure 17.2 Flow chart for decision-making processes in paediatric patients.

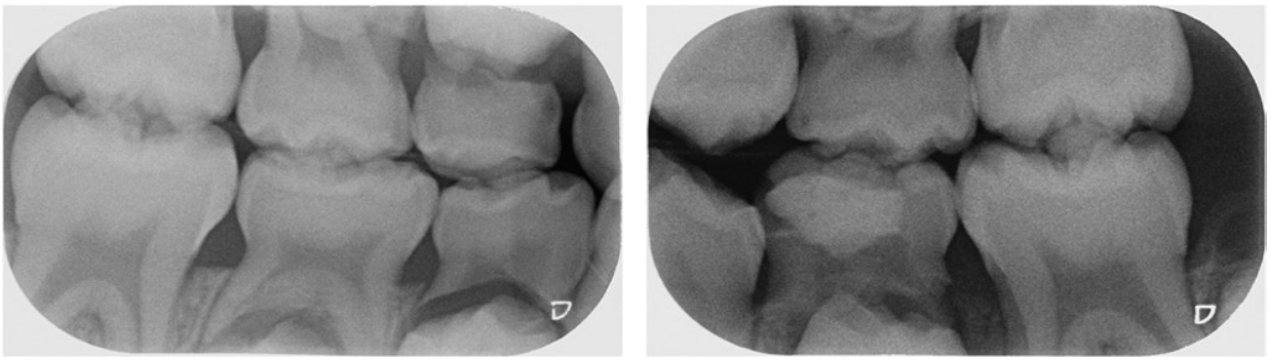


Figure 17.3 Grade 1 right and left bitewing radiographs in an 8-year-old.

With this information, a care plan and philosophy of preventative management can be formulated (Tables 17.4 and 17.5). It is essential for any restorative intervention that there is good pain control accompanied by good behaviour management (Table 17.6). Usually this involves quadrant dentistry, minimising the number of visits and the use of local anaesthetic, and building up treatment in stages of complexity while gaining the child's trust and confidence. This can be achieved by starting off with a simple procedure (e.g. fissure sealants) then moving onto move complex treatment (e.g. composite restorations) and if possible leaving extractions to the end.

Table 17.3 Primary tooth anatomy clinical implications.

Primary tooth anatomy	Implication
Thinner enamel and dentine	• Affects cavity design. • Less tooth structure for support. • Disease progression through the hard tissues is more rapid.
Larger pulps: **pulp chamber of primary teeth is relativity larger when compared** with **permanent teeth with the pulp horns being more superficial**	• Pulpal involvement in the caries process is more rapid. • Iatrogenic damage to the pulp during restorative procedures is more likely.
Broad contact 'areas'	• Detection of interproximal caries is more difficult in these areas. • Large stagnant areas with limited self-cleaning results in rapid progression of caries. • Adaption of the interproximal area for occlusal-proximal restorations requires modification.
Bulbous crowns	• Difficulty with matrix band adaptation and placement.
Narrower occlusal table: **convergence of the buccal and lingual walls results in a narrower occlusal table**	• Overpreparation of an occlusal cavity can lead to weakening of the cusps.
Altered angulation of the enamel prisms: **cervically, one-third** of **the enamel prisms are inclined in an occlusal direction**	• No need to bevel the gingival floor.
Thin pulpal floor and accessory canals	• Radiolucent areas and infection is usually present in the interfurcal area. • Clinically a sinus will be seen higher on the gingival margin.
Root form**: proportionally longer roots, more flared and flattened**	• Root canal therapy (RCT) difficult in primary teeth. • Fracture of roots during extractions more likely.
Developing successor	• During RCT and extractions, care must be taken not to damage the developing successor.

Table 17.4 High caries risk factors to assess when care planning your patients.

	Caries risk factors						
Risk category	**Clinical evidence**	**Dietary habits**	**Social history**	**Use of fluoride**	**Plaque control**	**Saliva**	**Medical history**
High Risk	New lesions Premature extractions Anterior caries or restoration Multiple restorations No fissure sealants Fixed appliance orthodontics Partial dentures	Frequent sugar intake	Social deprivation High caries in siblings Low knowledge of dental disease Irregular attendance Ready availability of snacks Low dental aspirations	Drinking water not fluoridated No fluoride supplements No fluoride toothpaste	Infrequent, ineffective cleaning Poor manual control	Low flow rate Low buffering capacity High *Streptococcus mutans* and lactobacillus counts	Medically compromised Physical disability Xerostomia Long term cariogenic medicine

Table 17.5 Prevention plans for delivering better oral health: summary guidance for primary care teams (2017). Reproduced with permission of Public Health England.

Prevention of caries in children age 0–6yrs

	Advice to be given	EB	Professional intervention	EB
Children aged up to 3 years	• Breast feeding provides the best nutrition for babies	I		
	• From 6 months of age infants should be introduced to drinking from a free-flow cup, and from age 1 year feeding from a bottle should be discouraged	II		
	• Sugar should not be added to weaning foods or drinks	V		
	• *Parents/carers should brush or supervise toothbrusing*	I		
	• As soon as teeth erupt in the mouth brush them twice daily with a fluoridated toothpaste	I		
	• Brush last thing at night and on one other occasion	III		
	• Use fluoridated toothpaste containing no less than 1000 pm fluoride	I		
	• It is good practice to use only a smear of toothpaste	GP		
	• The frequency and amount of sugary food and drinks should be reduced	III, I		
	• Sugar-free medicines should be recommended	III		
All children aged 3–6 years	• Brush at least twice daily, with a fluoridated toothpaste	I	• Apply fluoride varnish to teeth two times a year (2.2% NaF-)	I
	• Brush last thing at night and at least on one other occasion	III		
	• Brushing should be supervised by a parent/acrer	I		
	• Use fluoridated toothpaste containing more than 1000 ppm fluoride	I		
	• It is good practice to use onfy a pea size amount	GP		
	• Spit out after brushing and do not rinse, to maintain fluoride concentration levels	III		
	• The frequency and amount of sugary food and drinks should be reduced	III, I		
	• Sugar-free medicines should be recommended	III		
Children aged 0–6 giving concern [e.g., those likely to develop caries, those with special needs	All advice as above plus: • Use fluoridated toothpaste containing 1350-1500 ppm fluoride • It is good practioe to use only a smear or pea size amount • Where medication is given frequently or long term request thai it is sugar free, or used to minimise cariogenic effects	I GP GP	• Apply fluoride varnish to teeth two or more times. a year (2.2%NaF-) • Reduce recall interval • Investigate diet and assist adoption of good dietary practice in line with the eatwell plate • Where medication is given frequently or long term, liaise with medical practitioner to request it is sugar free, or used to minimise cariogenic effects	I V I GP

(*Continued*)

Table 17.5 (Continued)

Prevention of caries in children aged from 7 years and young adults

	Advice	EB	Professional intervention	EB
All patients	• Brush at least twice daily, with a fluoridated toothpaste	I	• Appy fluoride varnish to teeth two times a year (2.2% NaF-)	I
	• Brush last thing at night and at least on one other occasion	III, I		
	• Use fluoridated toothpaste (1350-1500 ppm fluoride)	I		
	• Spit out after brushing and do not rinse, to maintain fluoride concentration levels	III		
	• The frequency and amount of sugary food and drinks should be reduced	III, I		
Those giving concern to their dentist (e.g., those with obvious current active caries, those with ortho appliances, dry mouth, other predisposing factors, those with special needs)	All the above, plus: • Use a fluoride mouth rinse daily (0.05% NaF-) at a different time to brushing.	1	• Fissure seal permanent molars with resin sealant	I
			• Apply fluoride varnish to teeth two or more times a year (2.2% NaF-)	I
			• For those 8 years upwards with active caries prescribe daily fluoride rinse	I
			• For those 10+ years with active caries prescribe 2800 ppm fluoride toothpaste	I
			• For those 16+ years with active disease prescribe ether 2800 ppm or 5000 ppm fluoride toothpaste	I
			• Investigate diet and assist to adopt good dietary practice in line with the earwell plate	I

Table 17.6 Behaviour management techniques.

Tell-Show-Do
- A method of introducing dental equipment and procedures.

Acclimatisation
- The planned, sequential introduction of environment, people, instruments and procedures.

Systematic desensitisation
- This is based on the assumption that repeated nondistressing exposure to an anxiety-provoking stimulus will eventually reduce anxiety.

Positive reinforcement
- The presentation of a stimulus that will increase the likelihood of a behaviour being repeated.

Role modelling
- Children learn how to act by observing and imitating their peers.

Voice control
- Responding to the tone of voice rather than the actual words.

Enhancing control
- Giving the child control using a hand signal.

The care plan should be formulated in stages:

1) Elimination of pain.
2) Stabilisation.
3) Prevention.
4) Definitive restorative treatment.
5) Removal of non-restorable teeth.
6) Review.

Isolation

As with all forms of operative dentistry, particularly when restoring with moisture sensitive restorative materials, isolation is extremely important. Most specialists in paediatric dentistry use and teach the use of rubber dam isolation for restorative care. This is sometimes perceived negatively in general practice as the technique itself can be potentially difficult, acceptance from the

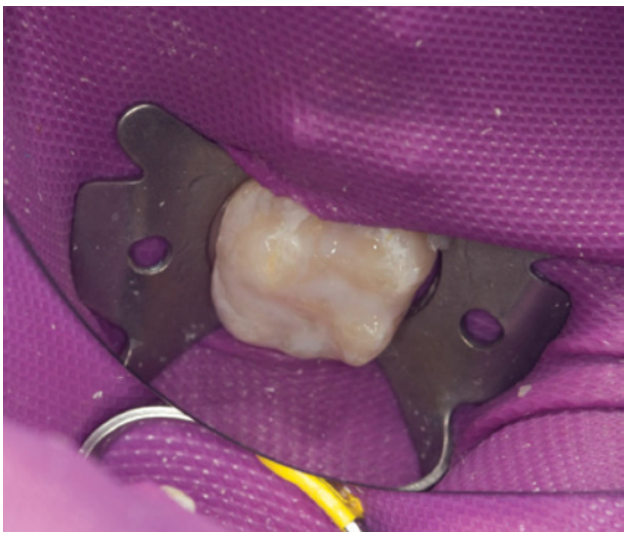


Figure 17.4 Individual tooth isolation of the first permanent molar allowing excellent visualisation and restoration of the tooth.

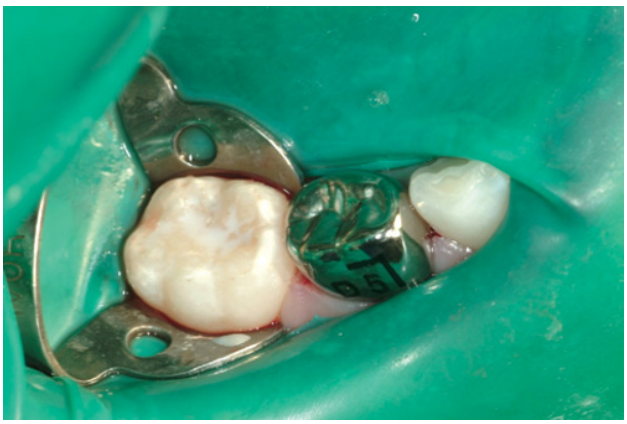


Figure 17.5 'Split dam' technique which allows quadrant dentistry to be carried out. Tooth 85 has been restored with composite and tooth 84 restored with a preformed metal crown in one visit.

child may be tricky, the operator may not feel confident with the application of a rubber dam and the time taken to place a rubber dam may be prohibitive. However, if you can manage the child confidently and are 'slick' in the use of a rubber dam (Figures 17.4 and 17.5), then the benefits outweigh the negative associations.

The benefits of a rubber dam include:

- Clean, dry, non-contaminated operating field.
- Retraction of soft tissues.
- Protection of soft tissues from iatrogenic damage.
- Protection of soft tissue from medicaments such as hypochlorite.
- Protection of the airway.
- Keeps the mouth open.
- Helps with behaviour management.
- Allows best use of the dental materials.

Fissure Sealants in First Permanent Molars

Fissure caries accounts for approximately 80–90% of all caries in permanent posterior teeth and 44% in primary teeth. Fissure sealant has been described as a material placed into the pits and fissures of caries-susceptible teeth that micromechanically bonds to the tooth preventing access by cariogenic bacteria to their source of nutrients, thus reducing the risk of caries in those susceptible sites. A Cochrane review calculated that placement of resin-based sealant in children and adolescents reduces caries incidence by 86% after one year and 57% at 48–54 months (Ahovuo-Saloranta et al., 2013). Sealants must be monitored for them to remain effective. Studies incorporating recall and maintenance have reported sealant success levels of 80–90% after 10 or more years.

Sealants should be placed on pit and fissure surfaces judged to be at risk for dental caries or surfaces that already exhibit incipient, non-cavitated carious lesions to inhibit lesion progression. This should be based on the caries risk of the patient. Sealant placement methods should include careful cleaning of the tooth surface. Resin-based sealants require placement in a moisture-controlled environment, often facilitated by a four-handed technique. If the area is compromised, the use of a bonding agent helps retention rates. Resin-based materials achieve better retention, and may be preferred, but glass ionomer sealants could be used as transitional sealants when moisture control is not possible.

Fissure sealant technique (Figure 17.6):

- Clean and dry tooth: using a slow speed handpiece and a prohy cup or brush. If required pumice slurry may also be used.
- Isolate tooth: cotton wool, dry tip, saliva ejector (rubber dam often not possible) (Figure 17.6(a)).
- Etch the tooth's surface (Figure 17.6(b)).
- Wash for 15 s.
- Dry for 15 s.
- Use a bonding agent if surface could potentially become contaminated with saliva (Figure 17.6(c)): light cure.
- Deposit resin: a small excavator or periodontal probe are useful (Figure 17.6(d)). Light cure.
- Check adhesion immediately and monitor in the future (Figure 17.6(e)).

Figure 17.6 Stages of fissure sealant application.

Restorations in Primary Teeth: Materials

There are many restorative materials that can be used in primary teeth with varying degrees of success. When choosing the type of material, the different factors that will affect the success rate of the material must be considered, e.g. isolation, behaviour of the child, parent preferences and the anatomy of the primary tooth. These factors and others mentioned previously will determine the success of your restorative care plan.

Amalgam

Amalgam has been the most commonly used restorative material in posterior teeth for over 150 years; however, its use is now in decline primarily due to the potential controversy surrounding perceived negative health effects of mercury, environmental concerns and the demand for aesthetic restorations.

Concerning safety of dental amalgam, a comprehensive review (European Commission, 2008) concluded that the appropriate use of dental amalgam does not pose a risk to patients or dental personnel. As to the clinical efficacy of amalgam, the majority of meta-analyses, evidence-based reviews, and randomised controlled trials report that the durability of dental amalgam is comparable to other restorative materials. Occlusal amalgam restorations in primary teeth have been found in a systematic review to have a success rate of 85–96% for up to 7 years. It concluded that in occlusal–proximal restorations in primary molars, amalgam should be expected to survive a minimum of 3–4 years and potentially in excess of 7 years (Canadian Agency for Drugs and Technologies in Health, 2012).

Composite

Composite resins are a popular and increasingly common choice of material in paediatric dentistry, giving good aesthetic results and bonding to remaining tooth tissues. As a result, reduced dependence on mechanical resistance and retention forms in cavity design results in conservative restorations. However, success rates with composites depend on the operator experience and restoration size, given that composites are more technique sensitive than

dental amalgam. Success is mainly related to moisture control, which can be challenging in paediatric patients.

There is good evidence, from meta-analyses of occlusal and occlusal–proximal composite restorations in paediatric patients, of success rates of about 90% after 10 years, with rubber dam use significantly increasing restoration longevity. The main reason for restoration failure was secondary caries.

Resin-Modified Glass-Ionomer Cements

There is evidence from a systematic review in favour of the use of glass-ionomer cements for occlusal restorations in primary teeth (Kielbassa et al., 2016). In addition, there is strong evidence that resin-modified glass-ionomer cements (RMGICs) are efficacious in the restoration of occlusal cavities. The retention of RMGIC restorations is increased by good isolation and the use of appropriate tissue conditioners.

Restorative Techniques: Occlusal and Occlusal–Proximal Cavities in Primary Teeth (Figure 17.7)

- Administer local anaesthetic.
- Place a rubber dam (if possible).
- Gain access with a high speed bur – establishing the outline of the cavity and allowing for caries removal.
- Use a large rose-headed bur to remove caries – being mindful of cavity depth and shape to avoid potential pulp exposure.
- For Class II cavities: must be mindful of the anatomy of the primary molar tooth.
- Isthmus:
  - With the box you require adequate depth without exposing the pulp (1.5–2.5 mm).
  - Adequate width without weakening the cusps (one-third to one-half distance between the cusps).

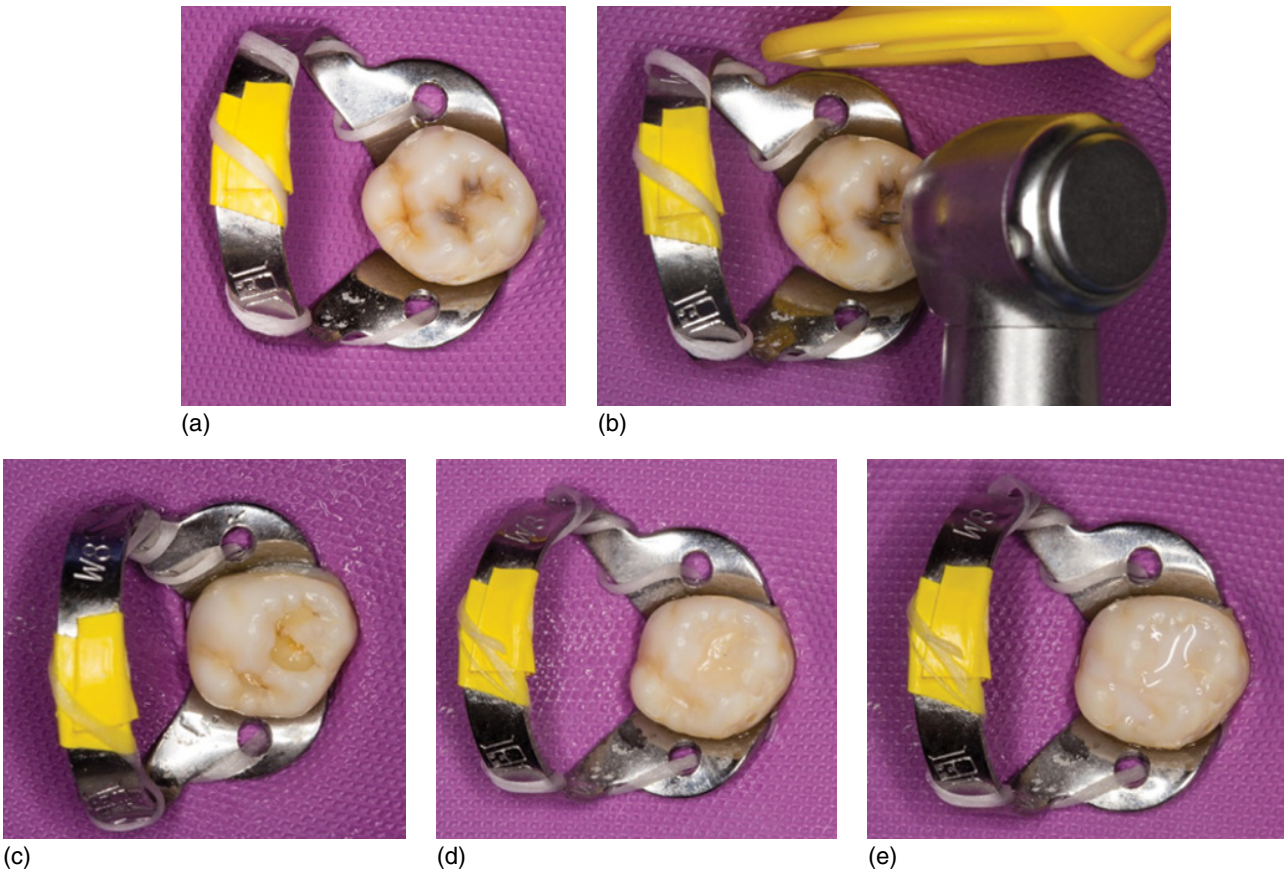


Figure 17.7 Occlusal composite restoration on tooth 55. (a) Rubber dam isolation. (b) Caries removal using a high speed air rotor and a 330 tungsten carbide bur. (c) Caries removed and the marginal ridge has remained intact. (d) Composite restoration in place. (e) Sealant placed over the occlusal surface.

- If possible, keep the enamel wall intact to help prevent damage to the adjacent tooth, this can be removed later with hand instruments.
- Establish the floor of the box, taking care not to extend beyond.
- Check walls are caries free.
- Place the restoration.

Preformed Metal Crowns

Preformed metal crowns (PMC) can be adapted to individual teeth and cemented with a luting agent. PMCs are flexible enough to allow trimming, crimping and shaping as required to achieve a good fit and using the buccal bulbosity of the primary molar to gain retention via the natural undercut. They have been used in paediatric dentistry for over 70 years with excellent success rates. PMCs have been found to have a success rate of more than 95% over 5 years. Evidence suggests that PMCs exhibit greater longevity than amalgam restorations, in particular occlusal–proximal amalgam restorations in primary molars. Once placed, PMCs rarely require replacement and as they cover the tooth, prevent other surfaces becoming carious (Innes et al., 2015).

There are many indications for the use of PMCs, including:

- Restoration of teeth with extensive caries, in particular multisurface restorations (Figure 17.8).
- Developmental defects, e.g. hypoplastic, hypomineralised primary or permanent teeth (Figure 17.9).
- Following primary pulp therapy, e.g. pulpotomy or pulpectomy (Figure 17.10).
- Treatment of children under sedation or general anaesthesia.
- Treatment of children at high risk of caries.
- Restoration of fractured teeth.
- Abutment for a space maintainer.
- Protection of teeth in patients with bruxism.

The 'Conventional' Technique

The 'traditional' or 'conventional' technique is the most commonly known to most practitioners. It has been taught for many years and has been used in most studies on PMC:

- Administer local anaesthetic.
- Place rubber dam (if accepted).
- Remove caries.
- Assess if there has been any pulpal involvement – manage appropriately.
- Cut a mesial slice and a distal slice using a fine-tapered diamond bur.
- Marginal ridge reduction – start from the occlusal and break the contact area. Produce a knife edge finish (wooden wedges can be used to protect the adjacent teeth): a shoulder preparation must be avoided or the crown will not seat.
- Reduce the occlusal surface by 1–2 mm following the contour of the occlusal surface.

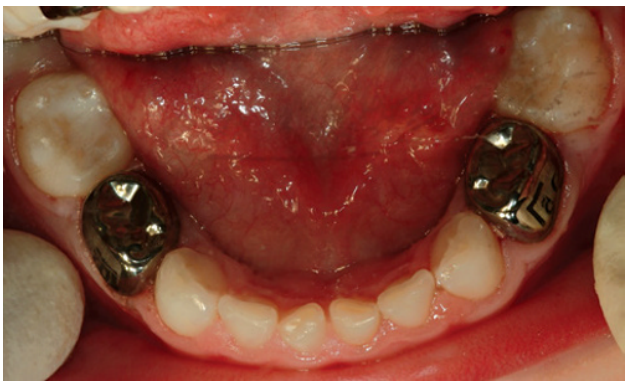


Figure 17.8 PMC placed on teeth 74 and 84 in a patient at high risk of caries.

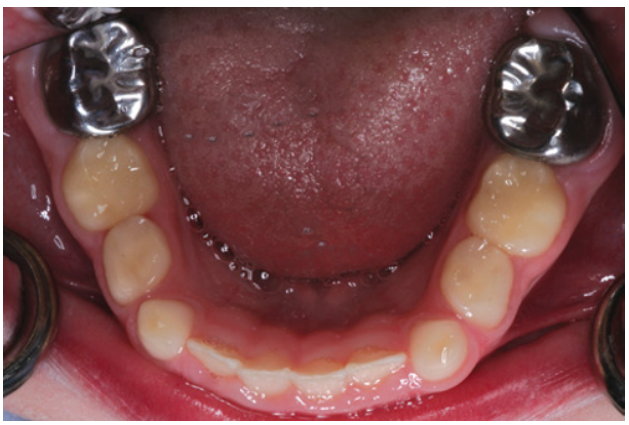


Figure 17.9 PMC placed on teeth 36 and 46 in a patient with hypoplastic amelogenesis imperfecta.

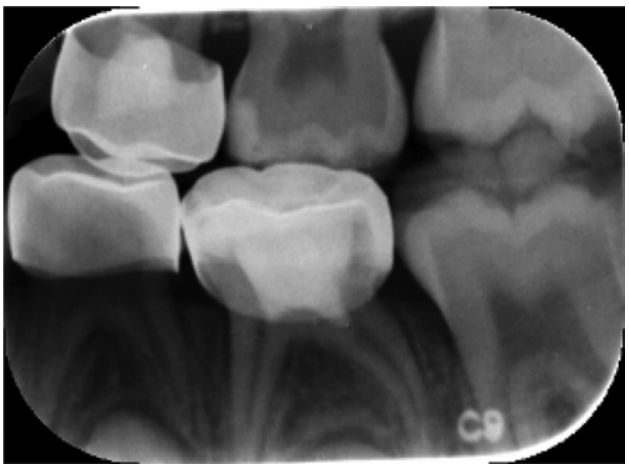


Figure 17.10 PMC placed post pulpotomy on tooth 64 and 75. In addition PMCs placed on tooth 74.

- Smooth any sharp line angles.
- Do not prepare the buccal surface as this is used to aid retention.
- Select the correct size of PMC.
- Seat the crown from a lingual to buccal direction.
- Place over tooth and see if a 'snap' can be heard in placement: if required the PMC can be adapted to create a 'snap' fit.
- Remove the PMC.
- Mix the luting agent (usually a glass-ionomer cement).
- Cement crown in place.
- Remove excess cement and clear contacts using floss.

The 'Hall' Technique

The 'Hall' technique is a method to manage carious primary molars without local anaesthesia, caries removal or any tooth preparation and sealing in residual caries. It was initially reported in the literature during an audit of child dental care in general practice in Scotland; a retrospective analysis of the outcomes for the teeth this practitioner had treated using PMCs demonstrated good success rates by placing these crowns over carious primary teeth with no preparation (Innes et al., 2006). The theory is to completely seal residual caries from the oral surroundings to alter the biofilms environment, eventually arresting the carious process. Clinical trials have shown the 'Hall' technique to be effective and acceptable to the majority of children, their parents and clinicians with 5-year survival rates of 92% (Innes, Evans and Hall, 2009). In addition, this technique avoids need for local anaesthesia and tooth preparation, thus decreasing the risk of iatrogenic damage to adjacent teeth.

This technique is not suitable for all children: careful patient selection is required. As part of the selection process a comprehensive history and clinical examination should be carried out. The main aim is to establish the vitality status of the pulp. This technique is suitable for teeth that display sign or symptoms of reversible pulpitis (Table 17.7). If there are signs or symptoms of irreversible pulpitis (Table 17.7) then the tooth should either be extracted or undergo pulpectomy.

Table 17.7 Signs and symptoms of reversible and irreversible pulpitis.

Reversible pulpitis	Irreversible pulpitis
Provoked pain of short duration: • Relieved with over-the-counter analgesics. • Triggered by stimuli and brushing. • Eased by removal of the stimulus.	Spontaneous unprovoked toothache, possibly accompanied by: • Sinus. • Excessive mobility not associated with trauma or exfoliation. • Furcation/apical radiolucency. • Radiographic evidence of internal/external resorption.

Procedure

- Select the tooth.
- Asymptomatic: no signs or symptoms of irreversible pulpitis (Figure 17.10).
- No space between E and D (Figure 17.11). Space formation: orthodontic separators require two visits. Placed for 3–5 days.
- Flossed between E and D to create space for the PMC (Figures 17.12 and 17.13).
- Ensure the airway is protected with gauze, have the patient sitting upright in the chair, and select the correct size of PMC (do not seat the crown through contacts prior to cementation as it may be tricky to remove).

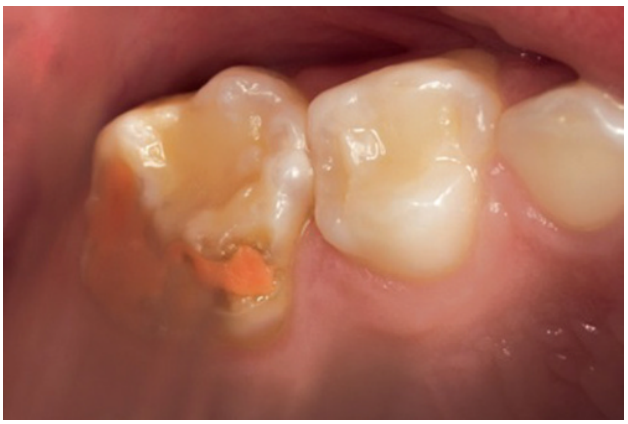


Figure 17.11 Hypoplastic primary molar (tooth 55).

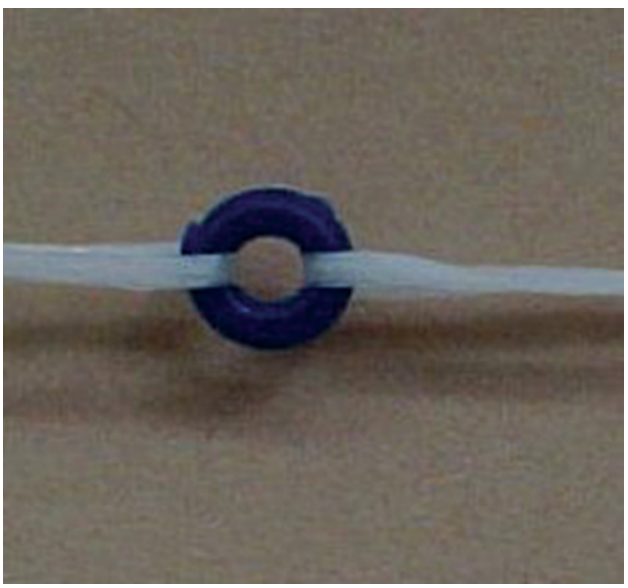


Figure 17.12 Orthodontic separator, placed with floss between the primary molars.

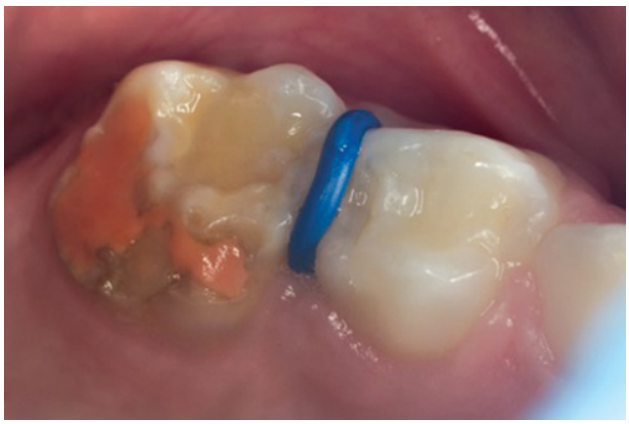


Figure 17.13 Orthodontic separator between teeth 55 and 54.

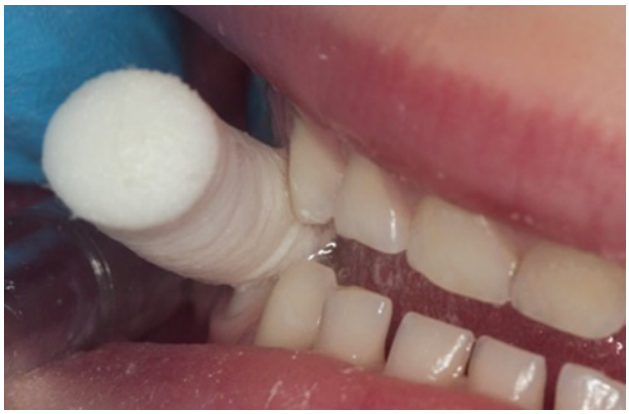


Figure 17.14 Child biting PMC into place.

- PMC (once appropriate size selected) is cemented with glass-ionomer cement and pressure (child biting a cotton wool roll, Figure 17.14). There should be some evidence of blanching around the gingivae (Figure 17.15).
- Finish: excess cement is flossed away (Figure 17.16). Occlusion will be high; advise parents this will settle within a week (Figure 17.17).

Pulp Therapy

The goal of pulp therapy in the primary dentition is to maintain the primary tooth in the dental arch until normal exfoliation without causing pain or swelling and allowing healing of the surrounding tissues. There should be no radiographic evidence of pathological external or internal root resorption, together with no harm to the developing permanent tooth. The indications and type of pulpal therapy carried out will depend on whether the pulp is vital or non-vital (Figure 17.18 and Table 17.5). Following on from clinical and radiographic diagnosis of the pulp and establishing if the pulp has the potential to

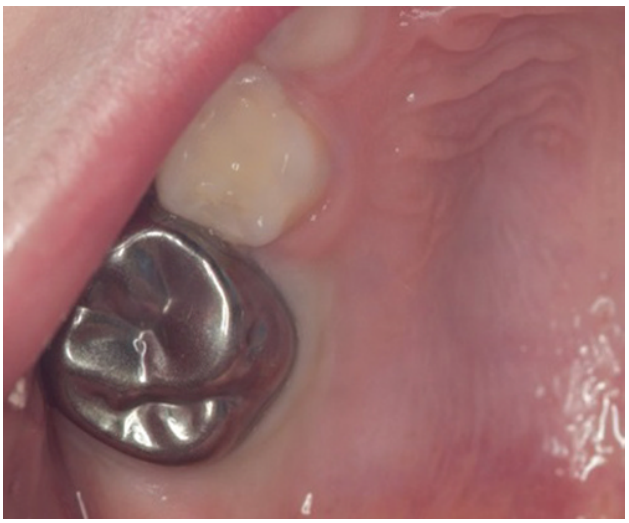


Figure 17.15 Blanching of gingiva around cemented PMC.

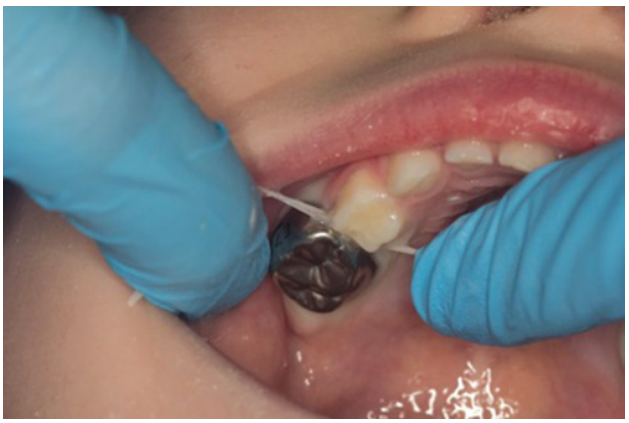


Figure 17.16 Flossing/removal of excess cement.

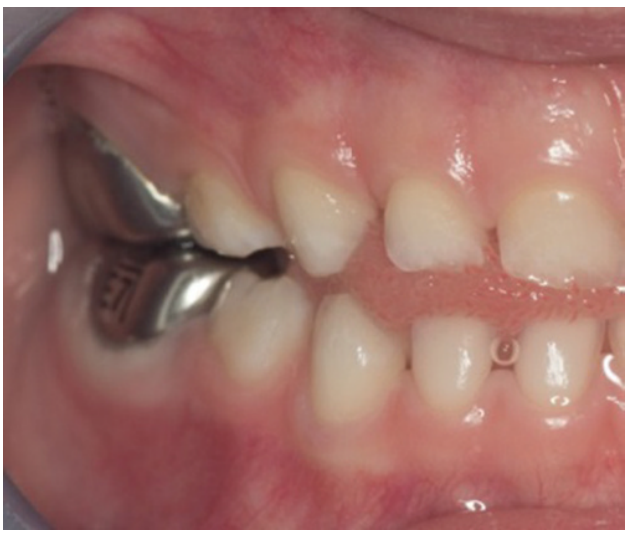


Figure 17.17 Occlusion high, post cementation of PMC.

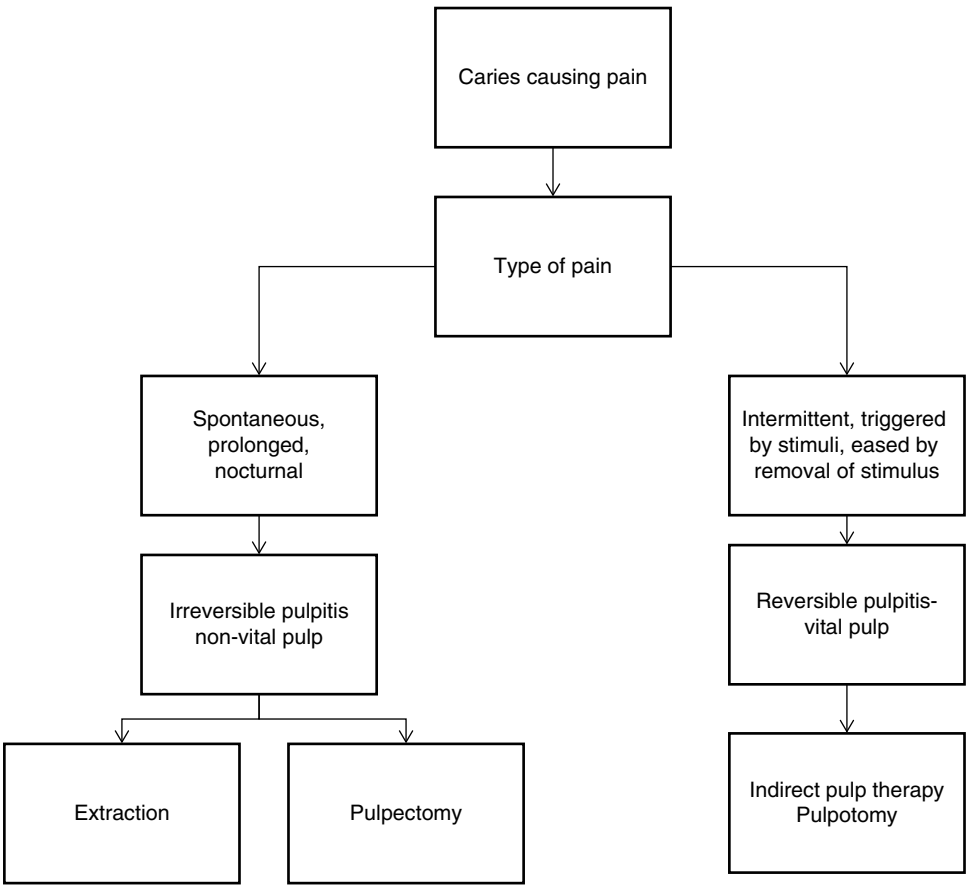


Figure 17.18 Flow diagram for the management of dental pain in paediatric patients.

heal (reversible pulpitis) or is incapable of healing (irreversible pulpitis), the management strategy for the tooth can be established.

The following should be considered prior to undertaking pulp therapy:

- Restorability of the tooth – if the tooth is unrestorable and it is not possible to achieve a good seal then it would not be appropriate to carry out this treatment.
- Tooth development – if the tooth is due to exfoliate, or there is significant root resorption, then the tooth would not be considered suitable.
- The patient's medical history – certain medical conditions contraindicate primary pulp therapy. For example, if the patient is medically compromised (significant cardiac disease) or immunosuppressed, then the risk associated with the development of infection outweighs the risk to the child's general health.
- The importance of the tooth – if the tooth needs to be maintained to avoid potential orthodontic problems, or the patient has hypodontia, it may be best to preserve the tooth.
- The urgency and amount of infection present – if following pulp therapy the infectious process cannot be arrested, bony healing cannot be achieved, there is pathological root resorption, or there is a significant facial swelling then extraction of the tooth may be in the best interests of the patient.
- Local anaesthesia and rubber dam placement – for successful outcomes local anaesthesia is required for pulp therapy in the primary dentition as well as rubber dam isolation. Therefore, the child must demonstrate good levels of cooperation as one of the criteria for pulp therapy.

Vital pulp therapy can be broken down into the following treatment options:

- Indirect pulp therapy.
- Direct pulp therapy.
- Pulpotomy.

Indirect Pulp Therapy

This is a procedure carried out in a tooth with caries close to the pulp, but not demonstrating signs or symptoms clinically or radiographically of irreversible pulpitis – the pulp has the potential to heal and the carious

process may be arrested. During the procedure caries may be left surrounding the pulp. The reason for this is if all the caries is removed then pulp may become exposed, resulting in the tooth requiring a pulpotomy. By leaving the caries in place to avoid pulp exposure, the affected area must then be covered with a material that will help promote pulpal healing. Usually a liner, such as a RMGI, glass-ionomer cement, dentine-bonding agent or a setting calcium hydroxide cement, is placed over the remaining caries to encourage healing and repair. If calcium hydroxide is used as the liner, then an additional material should be placed over it, as calcium hydroxide has a high solubility and a low compressive strength. The tooth is then restored with a material that seals the tooth from leakage usually by means of a PMC if there is a multisurface defect, or a composite resin if dealing with a single surface occlusal cavity. This would be considered the final restoration for the tooth, as there should be no indication to re-enter the tooth to remove the residual caries. Re-entry would cause additional tooth structure loss and the potential to increase the anxiety of the patient.If the tooth remains sealed the prognosis is good. Indirect pulp capping has been shown to have a higher success rate than pulpotomy in some long-term studies.

Direct Pulp Cap

This procedure is carried out when a pinpoint mechanical exposure of the pulp has occurred during cavity preparation or caries removal. A lining material, for example calcium hydroxide or mineral trioxide aggregate (MTA), which will encourage pulpal healing, is then placed directly over the exposure. As with indirect pulp therapy, the pulp must be considered to have the potential to heal. Unfortunately, due to the poor success rates in primary teeth, direct pulp capping of a carious pulp exposure is not recommended. Under such circumstances a pulpotomy should be considered the treatment of choice.

Pulpotomy

This is performed in a primary tooth with extensive caries, causing the pulp to demonstrate signs and symptoms of irreversible pulpitis, or when caries removal has resulted in a carious exposure of the pulp. During the procedure the coronal pulp is amputated, allowing the remaining vital radicular pulp tissue to heal (see later). There are a number of medicaments that have been recommended for use in primary teeth pulpotomies, but the best long-term success rates are associated with the use of 15.5% ferric sulphate or MTA. After the amputation and medicament placement, the coronal pulp chamber is filled with zinc oxide eugenol cement and the tooth is restored using a PMC as the seal is extremely important to best long-term outcomes. The radicular pulp should remain asymptomatic without clinical signs or symptoms of pain or swelling. In addition, radiographically there should be no evidence of pathological external or internal root resorption. An annual radiographic review of pulpotomised primary molars is recommended.

Pulpotomy Technique (Figure 17.19)

- Give local anaesthetic and place rubber dam.
- Remove the caries from the tooth and cut a large access cavity using a high speed handpiece: a 330 tungsten carbide bur is effective.
- Carefully remove the roof of the pulp chamber: this can be carried out using a slow-speed handpiece and a small and clean rose head bur (size 4).
- Remove the contents of the pulp chamber using a clean rose head bur in a slow-speed handpiece, or a clean sharp spoon excavator.
- Irrigate the pulp chamber with saline.
- Identify entrances to root canals:
  - Mandibular primary molars have just two canals (mesial and distal).
  - Maxillary primary molars have three canals (two buccal and one palatal).

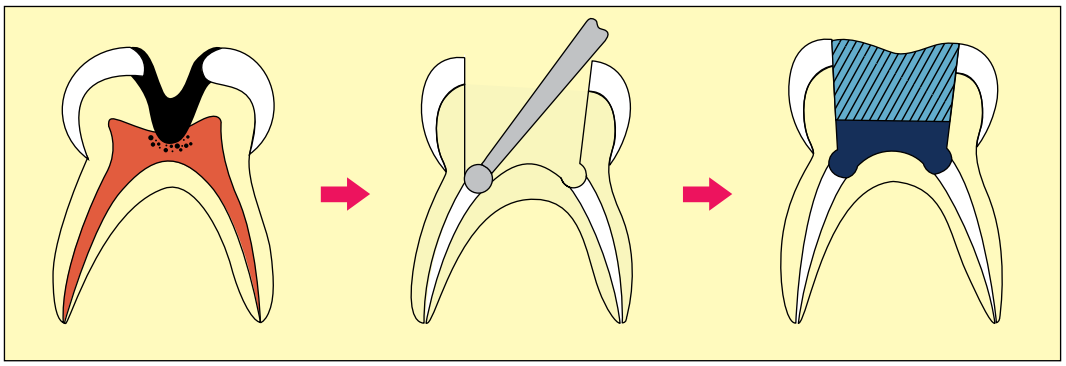


Figure 17.19 Diagrammatic stages in pulpotomy procedure.

- Achieve haemorrhage control by using a damp cotton pledget with pressure.
- Next place ferric sulphate into the pulp chamber on a cotton pledget or by means of burnishing using a microbrush for 15 s. If you are using MTA, place the MTA over the pulp stumps using the MTA or amalgam carrier.
- If ferric sulphate was placed using a cotton pledget, remove this and then place zinc oxide–eugenol cement in the pulp chamber filling the cavity.
- The tooth is then restored with a PMC.
- Postperatively you must advise the parent/carer that the tooth might be slightly tender when the local anaesthetic has worn off and that some over-the-counter analgesics may be required.

Non-vital pulp therapy comprises the following options:

- Pulpectomy.
- Extraction.

Pulpectomy

This is root canal therapy for pulp tissue in a primary tooth that is irreversibly infected or necrotic due to caries or, rarely, trauma. The root canals are debrided and shaped with hand files. Given typical root morphology, it is important not to overinstrument the tooth, as perforations can happen, and to use copious irrigation to clean the root canal system. If sodium hypochlorite is used care must be taken not to extrude this through the apex due to the potential tissue damage that could occur. After the canals are dried, a resorbable material such as non-reinforced zinc oxide–eugenol cement, iodoform-based paste or an iodoform and calcium hydroxide paste is used to fill the canals. The tooth then is restored with a PMC. Following treatment, symptoms should resolve within a few weeks and the infectious process should resolve radiographically in 6 months. There should be radiographic evidence of successful filling without gross overextension. In addition, the normal resorption process should occur allowing natural eruption of the permanent tooth.

Pulpectomy technique (Figure 17.20):

- Obtain a good preoperative periapical or vertical bite-wing radiograph showing the apex of the tooth.
- Give local anaesthetic and place the rubber dam.
- Remove the contents of the pulp chamber using a clean rose head bur in a slow-speed handpiece, or a clean sharp spoon excavator.

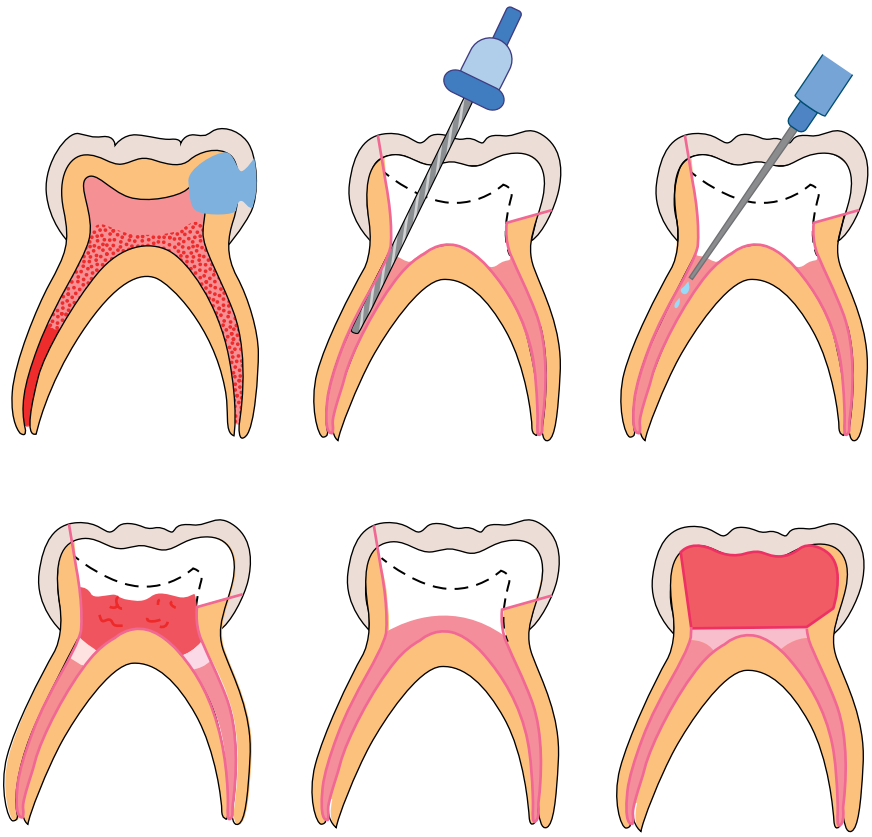


Figure 17.20 Diagrammatic representation of pulpectomy procedure for a primary molar.

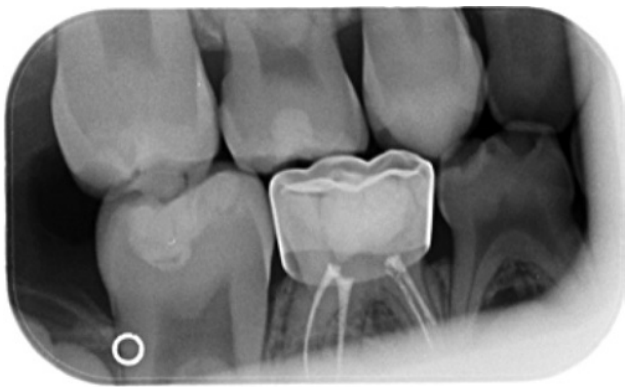


Figure 17.21 Radiograph following pulpectomy obturation of tooth 85. Preformed metal crown as final restoration.

- Irrigate the pulp chamber with saline.
- Identify entrances to root canals.
- Remove the necrotic tissue from the entrance to the root canals, using a straight probe.
- Irrigate the pulp chamber again with saline.
- Gently instrument the canals with files staying 2 mm away from the radiographic apex and not going beyond a size 35 file.
- Irrigate the pulp chamber again with saline. Dry pulp chamber with a cotton pledget and the canals using paper points.
- Place calcium hydroxide paste or plain zinc oxide–eugenol in the coronal section of canals using an applicator and then gently tapping with a large paper point.
- Place zinc oxide–eugenol cement in the pulp chamber, filling the cavity.
- The tooth is then restored with a PMC.
- Postoperatively you must advise the parent/carer that the tooth might be slightly tender when the local anaesthetic has worn off and that some over-the-counter analgesics may be required.
- If the tooth remains symptomatic, or a sinus is still present after 3 months, the tooth will require extraction.
- An annual radiographic review of the obturated tooth is recommended (Figure 17.21).

Anterior Restorations In Primary Teeth

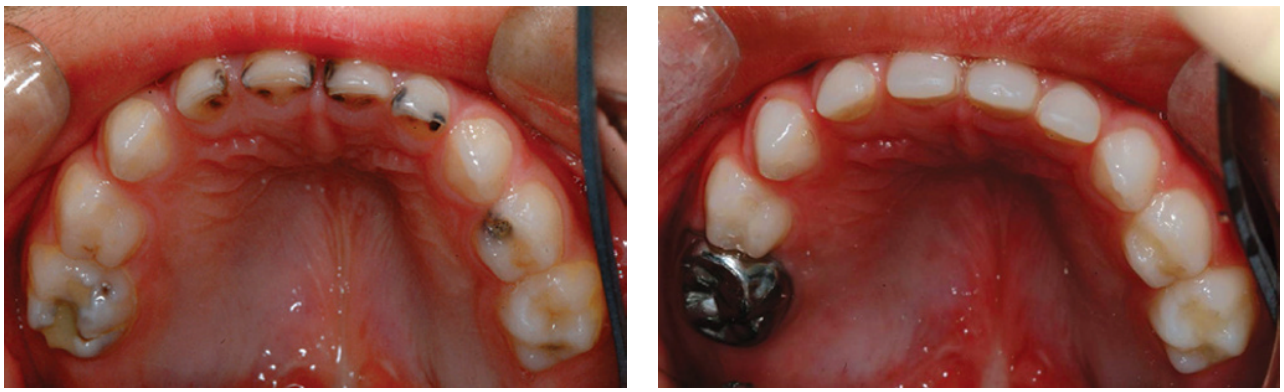
Dental caries in primary anterior teeth in children are a restorative challenge. The extent of the challenge is determined by:

- The behaviour of the child: caries of the anterior teeth tends to present in the preschool-aged child.
- The size of the teeth: deciduous anterior teeth are very small, with limited availability of enamel for bonding, and have relatively large pulps.

Resin-based restorations are appropriate for anterior teeth that can be isolated. Excellent aesthetic results are possible. By using a dovetail design the surface area for retention is increased. RMGICs have been recommended as they are less technique sensitive and there is the potential of fluoride release. In addition, the use of full coverage resin restorations is recommended in high risk individuals as the full tooth structure is protected (Figure 17.22).

Summary

Care planning for paediatric patients is challenging. Many factors must be taken into consideration when planning the ideal care package. As with any form of restorative dentistry no technique will be successful



(a) (b)

Figure 17.22 (a) Caries present in all four maxillary anterior teeth. (b) Restored with full coverage direct composite restorations.

without an effective preventative programme in place. There is an opportunity to establish good oral health practice at an early stage. With smart care planning and the appropriate use of dental materials in the correct situation, the dentistry provided should last the lifetime of the tooth without the need for repeated treatment. What is provided by dental care providers for paediatric patients will impact on their future care as adult patients.

References

Ahovuo-Saloranta, A., Forss, H., Walsh, T., et al. (2013) Sealants for preventing dental decay in permanent teeth. http://www.cochrane.org/CD001830/ORAL_sealants-for-preventing-dental-decay-in-the-permanent-teeth (accessed 21st July 2017).

Canadian Agency for Drugs and Technologies in Health (2012) Composite resin and amalgam dental filling materials: a review of safety, clinical effectiveness and cost-effectiveness. Ottawa: Canadian Agency for Drugs and Technologies in Health. http://www.cadth.ca/media/pdf/htis/june-2012/RC0358%20Dental%20amalgam%20Final.pdf (accessed 21st July 2017)

European Commission: Health and Consumer Protection Directorate-General (2008) Scientific Committee on Emerging and Newly Identified Health Risks. The Safety of Dental Amalgam and Alternative Dental Restoration Materials for Patients and Users. Brussels: European Commission: Health and Consumer Protection Directorate-General.

Innes, N.P.T., Evans, D.J.P., Hall N. (2009). The Hall Technique for managing carious primary molars. Dental Update 36:472–478.

Innes, N.P., Ricketts, D., Chong, L.Y., Keightley, A.J., Lamont, T., Santamaria, R.M. (2015) Preformed crowns for decayed primary molar teeth. CD005512. http://www.cochrane.org/CD005512/ORAL_preformed-crowns-managing-decayed-primary-molar-teeth-children (accessed 6th October 1017).

Innes, N.P.T., Stirrups, D.R., Evans, D.J.P., et al. (2006) A novel technique using preformed metal crowns for managing carious primary molars in general practice – a retrospective analysis. British Dental Journal 200(8):451–454.

Kielbassa, A.M., Glockner, G., Wolgin, M. Glockner, K. (2016) Systematic review of highly viscous glass-ionomer cement/resin coated restorations (Part 1): do they merge Minamata Convention and minimum intervention dentistry? Quintessence International 47:813–823.

Randall, R.C., Vrijhoef, M.M.A., Wilson, N.H.F. (2000) Efficacy of preformed metal crowns vs amalgam restorations. Journal of the American Dental Association, 131:337–343.

18

Procedures in Periodontics

Mark Ide and Claire McCarthy

Introduction

Periodontology is the art and science of maintaining the health of the tissues which support teeth and dental implants. It is not only critical to oral health, but also to general health and wellbeing.

Periodontal disease is a chronic problem. Initial therapy is often carried out simultaneously with other forms of dental treatment. The management will extend throughout a patient's life and will often be dependent for success on good patient compliance and thorough careful maintenance therapy by dental professionals. This should be continued even after successful completion of definitive restorative treatment (Figure 18.1).

Oral Hygiene Techniques

Brushing

Toothbrushing is still the most important method of plaque removal available but it will not remove plaque from fissures or the normal interdental area.

Brush Design

- Material: the preferred material is nylon. Nylon stiffness is more easily controlled because the diameter is more uniform.
- Design: toothbrushes are now produced in many designs. There is little clinical evidence to suggest the superiority of any one shape. Historically, it has always been suggested that the head should be trimmed flat and level and be multi-tufted, all tufts being of the same length. Serrated trim does not appear to be more effective. The ends of the filaments should be rounded.
- Length of head: most patients find a short head more suitable, but in clinical trials it is no more effective than a long head. A smaller head improves access to areas of the oral cavity. Larger brush heads are more difficult to manoeuvre in posterior areas. A length of 2.5 cm for adults and 1.5 cm for children is recommended.
- Stiffness: there is some conflict between the results of various tests on the plaque-removing ability of the different grades. It is generally recommended that patients use a soft–medium strength for adequate plaque removal. Hard bristles are not recommended as they may cause tooth abrasion especially where recession is present.

Frequency

Brushing twice a day is recommended and the most important time is at night, just before going to bed. This is an effective way of establishing a good oral hygiene routine.

Duration

There is a great individual variation in speed and efficiency. The criterion is to brush until all plaque is removed. A general rule is to brush for a minimum of 2 min, ideally 3 min to clean all surfaces effectively. Evidence indicates that patients rarely brush for this length of time and often spend less than 60 s.

Systematic Coverage

Brushing should be carried out in a systematic manner to ensure all surfaces are cleaned. Research shows that patients tend to spend longer brushing buccal surfaces. Far less emphasis is placed on cleaning the lingual and palatal surfaces of the teeth.

Techniques

A patient's brushing method should not be altered unless there is evidence of inefficiency or of damage to the tissues. If the plaque is removed without tissue damage, then the method is correct.

Basically, there are two movements: sweeping and penetrating. A reversal of direction of motion of the

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

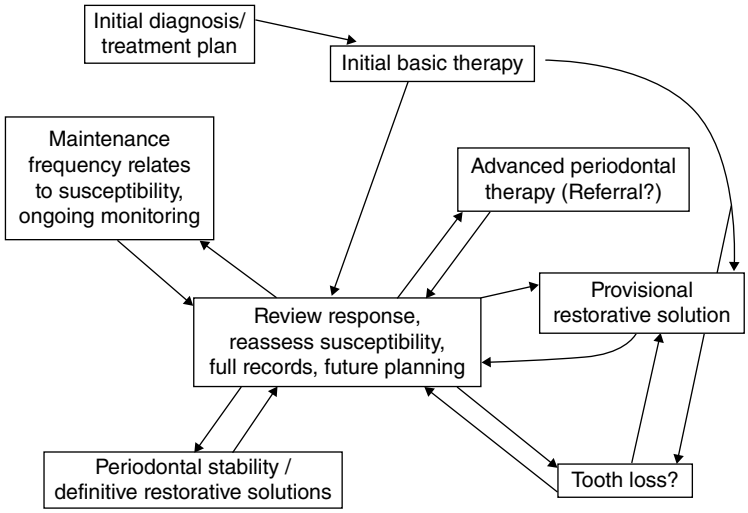


Figure 18.1 Care pathways in periodontal and restorative treatment.

Figure 18.2 Optimal angulation of toothbrush head to gingival crevice.

brush whilst under pressure results in a penetrating movement. Some penetration into the embrasures is always essential: penetration into the gingival crevice is also necessary on occasions. Many different techniques are described in the literature, but as stated above, if the plaque is removed then the technique is correct.

Modified Bass Technique The Modified Bass technique is the most widely accepted and used brushing technique. This method of brushing requires the tufts to be pointed apically at about 45 degrees and the ends pressed against the tooth and gingival margin to bring about adaption of the filaments to the complicated teeth–gum embrasures (Figure 18.2). The objective is to penetrate the gingival crevice. The brush is then vibrated or moved in small circles (mini scrub) so that the ends of the filaments move a little in relation to the adjacent surfaces. Because of the flexibility of the filaments, the amount of movement at their ends is relatively small compared with the movement of the brush. The brush is then moved to another place, but it need not be lifted from the teeth to do this. The patient should count the number of strokes on each surface to ensure sufficient time is dedicated to plaque removal.

Other Brushing Techniques

- Horizontal/scrub (mixed – sweeping, partly penetrating).
- Roll technique (sweeping).
- Charters (penetrating).
- Stillman (penetrating).

Manual Toothbrushing: Common Errors

- Not spending enough time or not brushing frequently enough.
- Leaving areas untouched – often lingual and palatal areas, because are they are difficult to access and cannot be seen.
- Applying excessive pressure that may cause the tufts to become distorted and cause tooth surface abrasion.
- Not applying bristles to the gingival margin.

Toothbrush replacement is recommended every 3 months, or sooner if the filaments lose their shape. This is referred to as splaying. Splayed filaments are ineffective, possibly damaging to the soft tissues and harbour bacteria.

Electric Toothbrushes

Electric toothbrushes provide limited benefit over a correctly used manual toothbrush, but there are added benefits for those with reduced manual dexterity. This group includes the elderly, physically disabled and those with arthritis in their hands and wrists. Care providers may also find electric toothbrushes easier to handle. Electric brushes can also be recommended to non-compliant

patients, as they are perceived as easier and faster than manual and may have a motivational element.

They are available in rechargeable and battery-operated varieties. The battery option can be cheaper, but possibly not as effective as the battery loses power and the brush gradually runs at a slower speed.

The correct electric brushing technique must be demonstrated to the patient, as it differs from the manual technique. It is important that the patient places the brush at the gingival margin for 3–5 s on each surface, and let the brush do the work. It helps with concentration if the patient counts the number of seconds spent on each site. The brush must not be moved as if it were a manual brush as this reduces its effectiveness. Patients should be advised to charge electric toothbrushes often (alternate days) and to replace brush heads every 3 months, or sooner if the bristles splay.

Electric toothbrushes have two modes of action.

Oscillating – Rotating

- The brush head utilises a side to side and rotating mechanical movement.
- Many brushes also pulsate with an in–out action to loosen the plaque, then oscillate to whisk it away.
- 7600 – 8800 rotations, 20 000 – 40 000 pulsations per minute.
- A variety of heads are available for different needs – interspace, orthodontic, flossing, tongue cleaner, whitening.

Sonic – Vibrating

- The brush head utilises a sweeping movement combined with high speed sonic vibrations.
- 21 000 – 31 000 vibrations per minute.
- Fluid forces created by the vibrations whip toothpaste and saliva into an oxygen-rich foamy cleanser, which removes plaque combined with the high-speed brushing action.
- Some patients may not tolerate the vibratory action of the brush.

Interdental Plaque Removal

Flossing

Floss is available in waxed or unwaxed versions. Waxed is said to be easier to use, if tight contacts exist between the teeth. In practice, there is little to choose between the two. It should be used in a vertical direction only and it is not advised in young patients. It may be used in conjunction with floss holders. Floss made of PTFE slides very easily between tight contacts. Patient adherence to flossing can be difficult to achieve as the technique is difficult to master and is perceived as time-consuming and arduous. Effective flossing requires excellent manual dexterity.

Dental Tape

Dental tape is like floss only wider. It is useful for cleaning, for example, bridge pontics and any tooth with adjacent gaps.

Specialised Floss

Superfloss is described as three flosses in one. It is marketed for use in patients with crowns, orthodontic appliances and bridgework. It has a stiffened end to thread between the teeth, a spongy portion to disrupt biofilm under pontics and fixed prostheses, under bridge pontics and around implants, and a floss section to clean in between other dentition.

Flossing Technique (Figure 18.3)

- Dispense 40 cm of floss.
- Wrap ends around middle fingers.
- Leave 10 cm in between hands.
- Use index fingers and thumbs to guide floss.

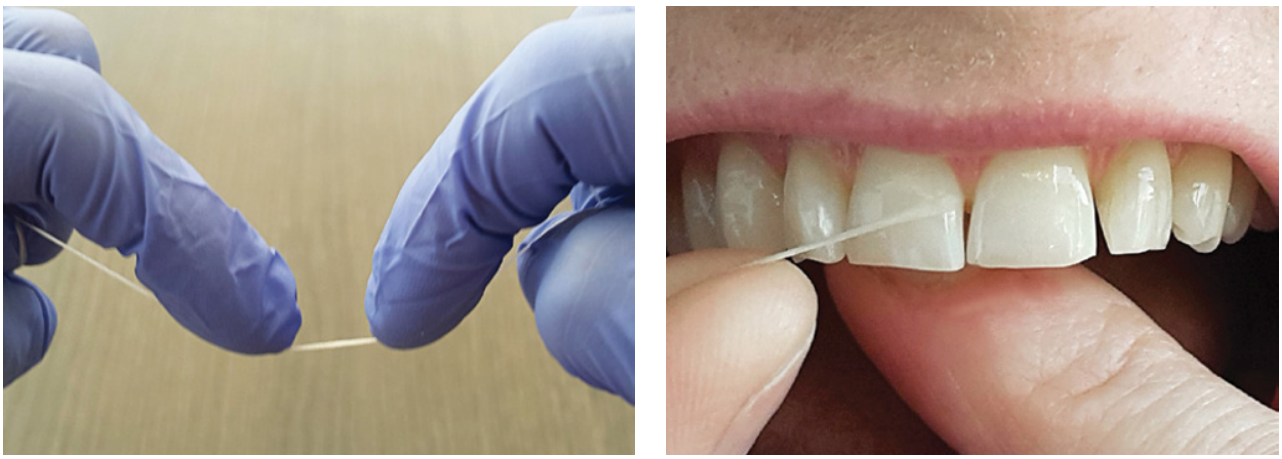


Figure 18.3 Flossing technique.

- Look in a mirror.
- Gentle side-to-side motion to get between contact point, taking care to avoid trauma or discomfort.
- Gently slide floss down the side of tooth into the sulcus.
- Applying pressure against the tooth, press floss from buccal and lingual aspects in a 'C' shape around the tooth.
- Keep pressure and contact with the tooth and move in a coronal direction removing plaque as you go.
- Insert floss back into the same space and repeat sequence on adjacent tooth.

Other Interdental Aids

Interdental Brushes

These are small brushes like bottlebrushes (Figure 18.4). They are available in many widths with either cylindrical or cone-shaped heads. They can be handheld, e.g. mini-interdental, or fitted into a handle. They are used to clean most interdental areas and wider spaces such as the interdental embrasures created postsurgically or small gaps occurring in tilted or irregular teeth. They are most suitable for patients with moderate to advanced periodontal destruction as they remove more plaque from large spaces when compared with floss. The brush dimension is selected based on the size of the interdental space and root morphology.

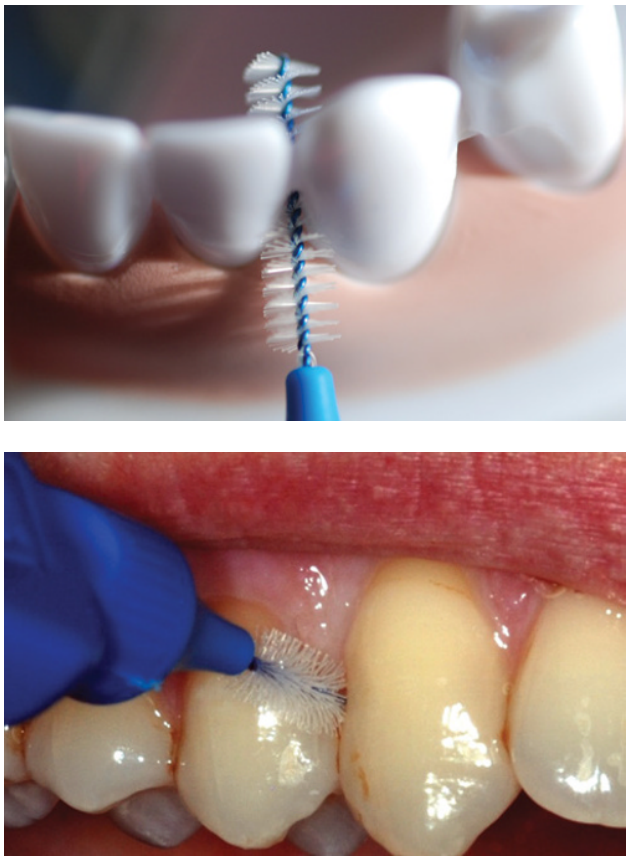


Figure 18.4 Use of interdental brushes.

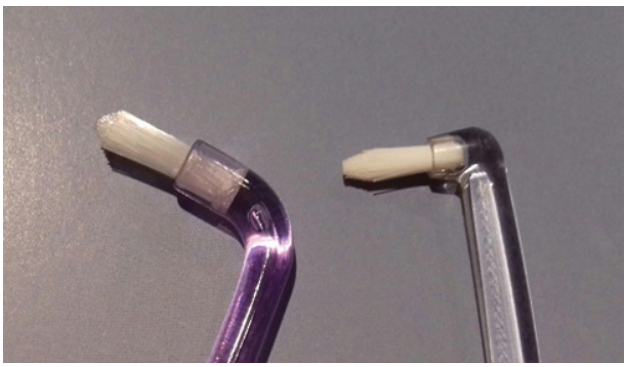


Figure 18.5 Monotip implant and 403A single tufted brush.

Single Tufted Brushes

Single tuft type brushes are manufactured with either a flat trim tuft or a pointed tuft (Figure 18.5). Single tufted brushes are used for plaque removal in furcation areas, around lone-standing teeth and areas of localised gingival recession. The monotip in Figure 18.5 may be adapted by simply bending the handle to the desired angulation. It is also recommended for use around single implant abutments and implant-supported prostheses.

Other Oral Hygiene Adjuncts

Chlorhexidine Gluconate

This can be used as a chemical adjunct for patients requiring treatment of acute gingival inflammation. It is available in mouth rinse and gel and considered the gold standard due to its robust substantivity. It is a bisbiguanide and has bacteriocidal and fungicidal properties. It is considered to be most effective in patients postsurgery or where oral hygiene measures are compromised. It decreases pellicle formation and alters bacterial attachment to tooth surfaces. The general advice is to use for a 2-week period and then cease usage. It is important to delay the use of dentifrices containing sodium lauryl sulphate after rinsing with chlorhexidine as it interferes with the plaque inhibition action. It is not suitable for widespread use but is helpful in the management of medically compromised patients who are predisposed to oral infection. It has side-effects such as staining and altered sense of taste hence long-term use is not recommended.

The WaterPik

This and other irrigation devices have not been shown to remove plaque and any improvement in the gingival tissues which occurs when they are used may be associated with the increased patient interest in oral hygiene which they produce. However, they may be of use in dislodging food debris from under bridge pontics as an adjunct to daily brushing and interdental cleaning.

Wood Points

They do not remove plaque but can be used to dislodge food debris. Patients who use wood points should be advised to change to the appropriate size interdental brush to remove plaque and food debris and, in turn, improve periodontal health.

Behavioural and Systemic Secondary Factors

The management of periodontal disease revolves around:

- Achieving good oral hygiene and patient concordance and attending professional intervention at agreed intervals.
- Accounting for, and wherever possible controlling or eliminating, other systemic or behavioural factors which have an adverse effect on periodontal health. There are a range of conditions and situations which may adversely affect treatment outcomes.

Smoking Cessation

Tobacco use has a detrimental effect on the periodontium. It is one of the most significant risk factors in the development and progression of periodontal disease. Smokers are more likely to present with periodontal destruction when compared with non-smokers and the increased risk of periodontal disease is around six times higher. Studies show that smokers tend to have a poorer response to periodontal treatment despite good plaque control. Studies have also shown that smokers spend less time on oral hygiene measures than non-smokers and therefore have more plaque and calculus. Clinical signs may also be masked in smokers and gingival bleeding is often reduced. This is a result of vasoconstriction of the blood vessels and increased keratinisation common in smokers. Smoking cessation should be included in all treatment planning and clinicians should take an active role in implementing this in the management of every patient. Clinicians should offer advice and support and educate about the effects of smoking on the periodontium and treatment outcomes. Research has shown that patients who stop smoking will show a marked improvement in their periodontal status within 3 years of quitting.

Management of smokers should include:

- Taking a detailed smoking history.
- Educating about the effects of smoking on the periodontal tissues.
- Advising about the impact of continuing to smoke on treatment outcomes.
- Establishing if the patient is ready to quit smoking.
- Setting achievable goals for subsequent visits.
- Referral to a 'stop smoking service'.
- Being supportive and non-judgemental.
- Educating the patient on plaque control, diet and caries.
- Delaying complex treatment until the patient has reduced or quit smoking.

Diabetic Control

Periodontal disease develops more quickly, at a younger age, and to a more severe level and a wider extent in people who have diabetes that is poorly controlled. Poor metabolic control can impact on host responses in the periodontium. This association is not general knowledge amongst all branches of the medical profession, and it may be very important for the dental practitioner to inform and liaise with the patient's general medical practitioner and specialist metabolic team. Periodontal treatment is more successful if diabetic status is well controlled, indicated by a favourable glycosylated haemoglobin score (HbA1C) of 7.5% or less, and complex procedures are only advised where control is good. Active periodontal disease may have a big enough systemic inflammatory effect to in turn compromise ease of diabetic control, in the same way as other infections elsewhere in the body may.

Such individuals should be examined and assessed as for any other case. However, management of the diabetic patient requires special care:

- Letter to medical team and general medical practitioner: the dentist should contact the medical team involved with the patient, to determine how well controlled the patient is and if there are any other associated issues.
- The role of diabetes in the aetiology and progression of gum disease should be discussed at the first consultation, and the importance of good control stressed as an integral part of the management of gum disease. An indication of the patient's diabetic control should be obtained (and of their own awareness of their status) by enquiring as to their most recent test results, in terms of exact results, and targets that they are expected to achieve. This can be verified with the medical team.
- It is wise to check the status of diabetic control at every appointment. This emphasises the importance of this factor and ensures that the dentists can relate clinical changes to metabolic influences.

Impact of Other Systemic Factors

Infectious Disease

The use of universal cross-infection control procedures should mean that infectious diseases should have limited specific effects on periodontal procedures. However, patients with advanced HIV disease may present with necrotising periodontal diseases. These can be simply managed by non-surgical care as outlined below, but may require the use of adjunctive systemic metronidazole or antimicrobial mouthwashes containing chlorhexidine or povidone-iodine.

Allergy

There are no unique issues related to periodontology that have any greater impacts than for other aspects of operative dentistry. Agents potentially initiating allergic responses would most likely be gloves, local anaesthetics, and systemic and local antimicrobial agents. Allergies to components of toothpastes, mouthwashes and prophylaxis pastes such as detergents and flavourings have been reported, and these can be confirmed by specialised patch testing in suitably controlled hospital environments.

Mucosal Disease

A range of mucosal diseases may involve gingival and periodontal tissues. These may range from benign lesions to those resulting in severe local tissue damage and inflammation. Such changes can make oral hygiene very difficult for patients, with a corresponding increase in the frequency of maintenance care to achieve periodontal stability. Lesions may make mechanical oral hygiene very uncomfortable, and commonly used antimicrobial preparations such as mouthwashes may not be viable in their marketed forms due to extreme burning and other discomfort experienced by patients. It may be necessary to dilute these products with water before use, although this may have a corresponding adverse effect on their antimicrobial effectiveness.

Interactions With and Effects of Other Therapeutic Interventions

Anticoagulants

Anticoagulants may lead to prolonged delayed bleeding after periodontal surgery and occasionally after root surface instrumentation. Patients should be warned of this risk before treatment and appropriate advice given in advance. Routine guidance for surgery in patients taking anticoagulants applies, with an increased need for use of topical antifibrinolytic agents such as tranexamic acid mouthwashes where local measures are unlikely to be effective.

Bisphosphonates

Biphosphonates are widely used for a range of conditions ranging from osteoporosis to secondary bony malignancy, in varying doses and means of administration. All surgery, including periodontal surgery, should be performed with caution, although it appears that the risk of complications is lower with oral compared with intravenous medication.

Cardiac Surgery

Although there has been a shift in guidelines against antimicrobial prophylaxis for dental procedures, the advent of some modern devices such as the Amplatzer occluder (an umbrella shaped device delivered from within a vessel and opened up at placement within the heart for the closure of septal defects) may still require the dentist to liaise with cardiac surgeons and ensure that treatment is either delayed or associated with antimicrobial use for the time period before such devices are fully covered by endothelial cells after placement.

Contraceptive Pill

It has been suggested that long-term use of oral contraceptives may result in increased marginal bone loss. However, this has not been overwhelmingly confirmed and much data relates to older, higher dose versions of these therapies – similar effects may not occur with more modern regimes.

Radiotherapy

Patients undergoing radiotherapy may experience discomfort from oral mucositis, which may make oral hygiene procedures painful and difficult. This may require increased professional maintenance care during the active treatment phase. Whilst chemical antimicrobial adjuncts may be helpful, these may also be uncomfortable to use. Radiotherapy may have two long-term impacts on periodontal care. Firstly, there may be compromised local healing and an increased risk of osteoradionecrosis after surgery, especially if bone removal is carried out. Secondly, radiotherapy to the head and neck may result in xerostomia and associated increased plaque formation and marginal inflammation. There are minimal data associating xerostomia with marginal bone loss. In addition, the clinician must be aware of the possibility of secondary tumours presenting within gingival tissues: in cases of uncertainty it is wise to consider biopsy of suspicious lesions, in conjunction with specialists if needed.

Drug-Induced Gingival Enlargement

Various groups of drugs have been implicated as having a role in the aetiology of this problem. These include calcium channel blocking antihypertensives such as amlodipine, phenytoin (anticonvulsant) and ciclosporin (used

as an immunosuppressant and often in conjunction with antihypertensives). These are best managed by provision of periodontal therapy and good oral hygiene techniques before commencing medication, but many patients may start these drugs with suboptimal oral health. This can result in the need for further treatment. After treatment, these individuals should receive more frequent and comprehensive maintenance care. Management options include:

- Change medication: it is sometimes possible to arrange for the patient's general practitioners to change the problematic medication, especially if it is impairing appearance or oral health and impacting on quality of life. The dentist should correspond with medical colleagues.
- Non-surgical treatment: although enlarged gingival tissues may become quite fibrotic, it is possible to achieve some degree of resolution by non-surgical therapy, although this may need to be repeated several times to allow adequate time for a favourable tissue response, ideally in conjunction with a change in medication.
- Surgical treatment: failure of tissues to completely shrink after non-surgical treatment, or presentation with extreme tissue enlargement, may require a surgical approach, as outlined below.

Orthodontics

Pre-existing periodontal disease, and associated tooth movement, does not preclude subsequent orthodontics. It is important to establish periodontal health and good oral hygiene practices before commencing any orthodontic treatment. Failure to do this may result not only in an exacerbation of existing periodontal pathology but also increase the likelihood of enamel demineralisation and frank caries lesions. Orthodontic treatment would not proceed unless the patient can demonstrate good oral health with corresponding reductions in gingival inflammation, bleeding and pocket depths.

Maintenance therapy should be continued during orthodontic treatment. In the presence of fixed appliances good oral hygiene is even more difficult to achieve, and if the patient is periodontally susceptible, consideration should be given to running concurrent hygiene appointments with each orthodontic appointment.

Orthodontic treatment may lead to localised gingival recession, especially where the soft tissues are thin and teeth are moved labially out of the alveolar envelope. This is most likely if treatment has included arch expansion to create space. These problems can be managed, on completion of orthodontics, by mucogingival and grafting procedures.

Treatment Planning for Therapy

Patient History

Treatment planning relies on taking an accurate and appropriate history, as outlined in Chapter 6 of this manual. Special emphasis should be placed on:

- What are the patient's perceived problems and concerns?
- What do they want to achieve from treatment?
- Previous dental and periodontal treatment: what was done, when and by whom? Was local anaesthesia used?
- Causes and timing of previous tooth loss.
- Current oral hygiene practices.
- Potential risk factors.
- Family history of periodontal problems and early tooth loss.

This should be accompanied by a full restorative assessment, including special tests. Periodontal problems rarely occur in isolation and treatment often has other restorative implications.

Non-surgical periodontal treatment is generally carried out as part of first phase dental treatment, after pain relief, but as part of disease stabilisation before considering definitive restorative options. This may be in conjunction with extractions and provisional prostheses, with splinting of mobile teeth and possibly even use of failing teeth as provisional bridges after sectioning and root removal.

Periodontal treatment planning must consider the prognosis of teeth in terms of restorative and periodontal features. In addition, the value of teeth as potential long-term abutments should be considered, together with the impact of tooth retention on aesthetics, function and quality of life. This varies between individuals – some patients would rather have a predictable stable long-term solution involving a greater number of extractions, but others may prefer to retain as many teeth for as long as possible and accept some degree of mobility and aesthetic compromise. These decisions can only be made after a careful discussion with the patient and development of an understanding of their perceived problem and aims of treatment, in both the short- and longer term.

Diagnosis – Assessment and Reassessment

Diagnostic procedures include all routine clinical assessments common to all patients, as outlined in detail elsewhere. These may be carried out in the following order:

- Assessment of all mucosal and soft tissue surfaces.
- Awareness of pathology of gingival tissues: swelling, colour, consistency, epithelial integrity, tenderness, sinuses, abscesses, gingival recession.
- Restorative assessment: restorations, caries, fractures and cracks, endodontic status.

Periodontal Assessment

Routine periodontal screening involves the basic periodontal examination (BPE) using a WHO periodontal probe (Figure 18.6). This probe has a 0.5 mm diameter ball-shaped tip then a narrow shaft marked with a black band between 3.5 and 5.5 mm from the probe tip, and is used with an applied load of less than 25 g. This probe configuration is labelled CPITN-C if it has an additional black band between 8.5 and 11.5 mm, and is labelled CPITN-E if the second band is absent.

The assessment is carried out around all teeth, but summary scores are made for each sextant. The sextants contain either molars and premolars, or the canines and incisors. Each sextant must have at least two functioning teeth – if only one tooth is present it should be incorporated into the adjacent sextant.

Each sextant is scored with the worst tooth score for that sextant. These are defined as:

- Score 0: there are no pockets exceeding 3 mm (coloured band on probe is fully visible), no calculus or restoration overhangs present and no bleeding after probing.
- Score 1: there are no pockets exceeding 3 mm, no calculus or restoration overhangs present but bleeding is seen after probing.
- Score 2: there are no pockets exceeding 3 mm, but calculus, restoration overhangs or other local plaque retentive features are identified.
- Score 3: coloured area of probe is only partly visible (probing depth greater than 3 mm but less than 6 mm).
- Score 4: coloured area of probe is not visible (probing depth greater than 6 mm).

Score *: attachment loss of 7 + mm or furcation involvement present.

A patient with sextants scoring 4 or * should be investigated further.

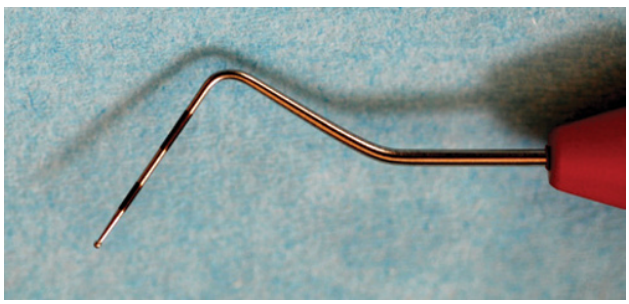


Figure 18.6 WHO probe used for basic periodontal examination assessments.

Complete periodontal assessment is likely to be needed in the case of:

- A BPE score of (possibly 3), 4 or *.
- As part of treatment planning for multidisciplinary restorative cases, or as a precursor to implant or adult orthodontic treatment, especially if the patient has a history of periodontitis.

Complete assessment includes, in addition to those procedures outlined above:

- Six-point assessment of probing depth and attachment level, as well as bleeding on probing.
- Clinical assessment of furcation involvement.
- Assessment of tooth mobility.
- Assessment of occlusion.
- Further detailed assessment of gingival recession may be required in some cases, for instance advanced gingival recession.
- Assessment of oral hygiene.

Six-Point Probing/Bleeding/Recession Assessment

Probes: the preferred probes for full pocket charting are one of the following:

- Williams probe: this blunt ended straight probe should have a diameter of around 0.5–0.7 mm and should have clear graduations scored and marked at 1, 2, 3, 5, 7, 8, 9 and 10 mm from the tip (Figure 18.7).
- UNC-15 probe: this blunt-ended straight probe should have a diameter of around 0.5–0.7 mm and should have clear graduations scored and marked every 1 mm, but with the spaces between 4 and 5 mm, 9 and 10 mm, and 14 and 15 mm marked as black bands (Figure 18.8).

Figure 18.7 Williams periodontal probe.

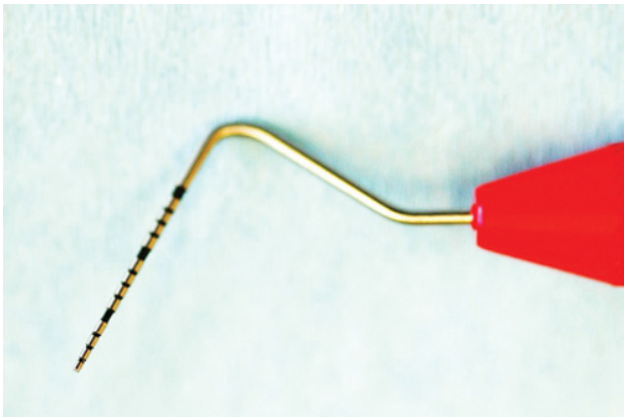


Figure 18.8 UNC15 periodontal probe.

Both probes are used in an identical manner, inserted gently into the pocket with a maximum load equivalent to 15 g, in a direction as parallel to the root surface as possible.

Probing method:

- Confirm which teeth are present with recording staff. Include implants.
- Agree location of starting point for charting procedure, e.g. distobuccal upper right last standing tooth. This may be determined by software package being used locally for recording clinical data digitally.
- Start charting, proceeding around arch towards midline (e.g. mesiobuccal upper right central incisor).
- On reaching midline, confirm this location with assistant to minimise risk or charting error. Then check back along previously probed sites and record presence/absence of bleeding at each.
- Continue around arch from midline, recording probing depths, and at end of arch (e.g. distobuccal upper left last standing tooth). Recheck these areas for bleeding.
- Repeat for other side of this quadrant.

Following assessment of probing depths and bleeding, gingival recession should be recorded in the same manner. This can be simply done using the periodontal probe to measure the distance in millimetres between the amelodentinal junction and the marginal gingiva. The presence of cervical restorations may make this difficult, and if no clear landmarks are present it may be wise to use the existing restoration margin for consistency over time.

The more sophisticated Miller classification for recession assessment is generally used as part of a periodontal or restorative assessment where gingival recession and/or aesthetics are possible issues, and where surgery is considered as a potential treatment option.

- Class 1: marginal tissue recession which does not extend to the mucogingival junction; no periodontal bone loss in the interdental area (Figure 18.9).
- Class 2: marginal tissue recession which extends to or beyond the mucogingival junction; no periodontal loss in the interdental area (Figure 18.10).
- Class 3: marginal tissue recession which extends to or beyond the mucogingival junction, bone or soft tissue loss in the interdental area or malpositioning of the teeth, preventing full root coverage (Figure 18.11).
- Class 4: marginal tissue recession which extends to or beyond the mucogingival junction, severe bone or soft tissue loss in the interdental area and/or malpositioning of teeth (Figure 18.12).

Furcations and Assessment of Disease Around Multirooted Teeth Furcations can be assessed using a routine periodontal probe, but the local anatomy can often make it difficult to accurately assess furcation involvements in this way. In such a case a Naber's furcation probe is helpful. This double-ended probe has curved ends

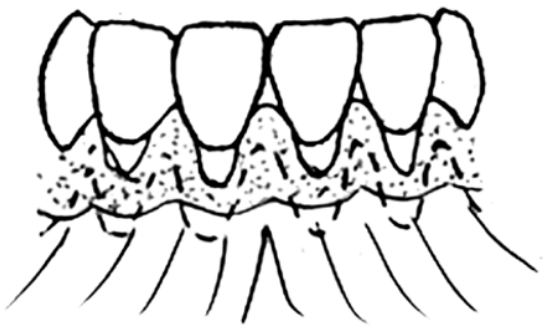


Figure 18.9 Miller Class 1 recession lesions, lower central incisors.

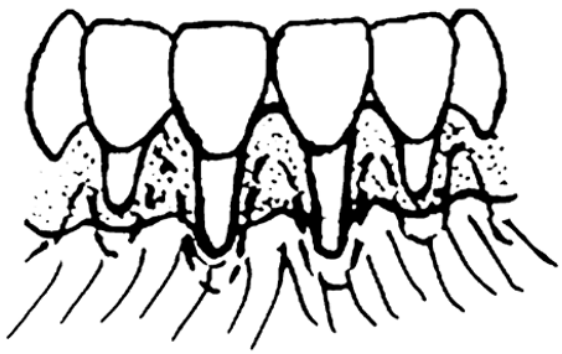


Figure 18.10 Miller Class 2 recession defects, lower central incisors. Class 1 defects, lower lateral incisors.

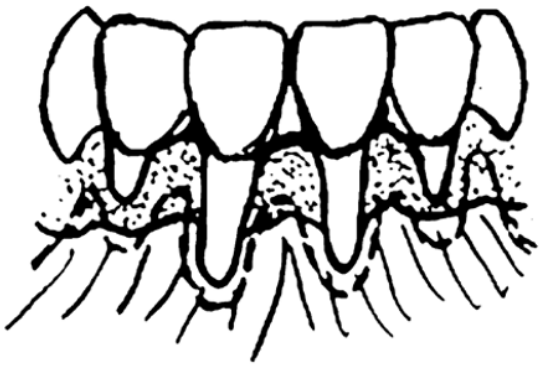


Figure 18.11 Miller Class 3 recession defects – loss of interdental bone, lower central incisors.

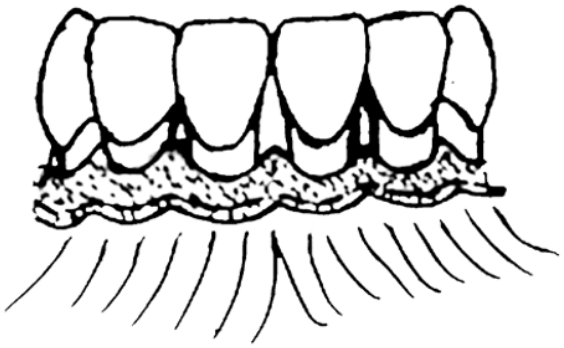


Figure 18.12 Miller Class 4 recession.

designed to enter furcations more readily, especially for upper molars. This assessment is carried out following probing depth and recession measurement.

Furcations are graded as:

- Grade 1: horizontal loss of tissue less than one-third of tooth width.
- Grade 2: horizontal loss of tissue more than one-third of tooth width but not extending the full tooth width
- Grade 3: horizontal loss of tissue extending the full tooth width 'through and through'.

There is also an optional Grade 4 classification, which refers to a through and through furcation where the furcation is open and accessible. In this system, a Grade 3 classification refers to a through and through furcation where the entrances are covered by marginal soft tissue but there is complete attachment loss.

Mobility Assessment Tooth mobility can have a variety of causes and it is important to identify and quantify mobility. This is normally achieved by attempting to move the tooth from side to side (normally buccolingually) and vertically, using either one to two single-ended instruments (i.e., mirror and probe) handles.

Mobility is graded:

- Grade 1: more than normal physiological tooth mobility (0.2 mm) but less than 1 mm movement in a horizontal direction.
- Grade 2: more than 1 mm movement in a horizontal direction but no vertical movement.
- Grade 3: vertical and horizontal tooth movement.

Oral Hygiene Assessment Oral hygiene can be assessed using a visible plaque score. However, this does not allow a tailored and detailed approach to oral hygiene instruction which has the best chance of achieving the optimal result. Oral hygiene scores are best left until after clinical examination, including probing, if disclosing agents are to be used, as they can change the appearance of marginal tissues.

The use of disclosing solutions is the preferred way of obtaining an accurate assessment of oral hygiene (Figure 18.13). There are several ways that this can be done. However, the use of disclosing solutions can be misleading in the presence of extrinsic staining and calcified deposits. It is most useful to assess ongoing oral hygiene after gross scaling to remove such deposits.

Disclosed plaque scoring methods include some very specialised techniques designed to identify small changes in the rate of plaque formation, and low levels of plaque formation. These are largely used in clinical research – whilst they are detailed, they are generally not practical for day-to-day practice.

A more practical approach is to use a four-point or six-point assessment of each tooth present, and to record the presence or absence of disclosed plaque at each site, generating a percentage plaque score (Figure 18.14).

Procedure:

- Explain nature and aim of procedure to patient. Confirm that it is likely that they may have some temporary

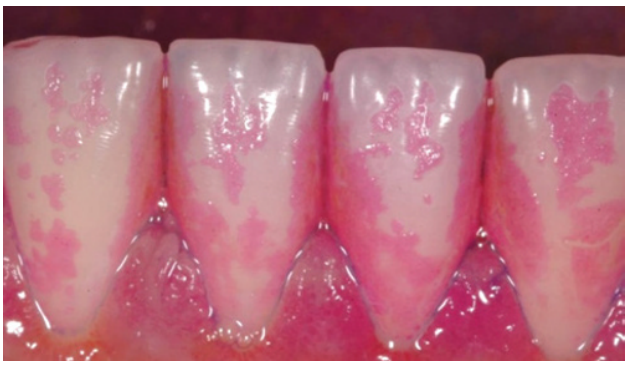


Figure 18.13 Disclosed plaque around lower incisors.

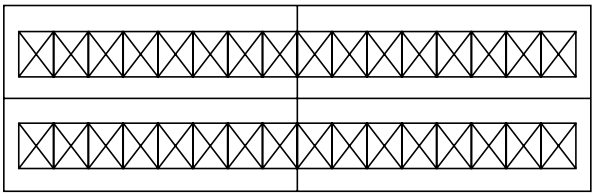


Figure 18.14 Grid used for clinical assessment of oral hygiene.

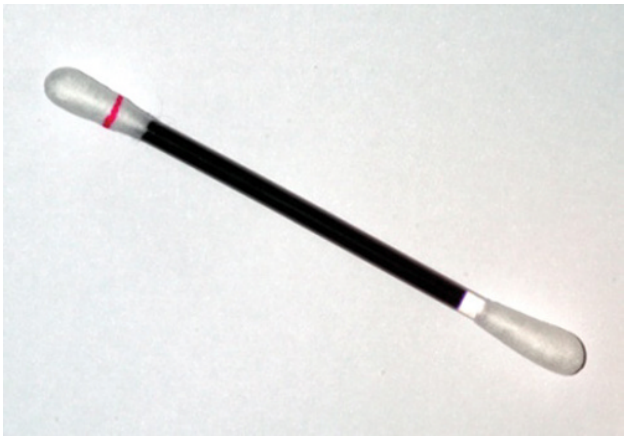


Figure 18.15 Disclosing solution application bud.

staining of dorsum of tongue after procedure, and that this will not be a problem for them for the rest of the day.

- Apply Vaseline barrier to lips to minimise lip discolouration by disclosing agent.
- Apply disclosing solution to teeth. This may be either using a disclosing tablet, chewed by the patient (followed by a rinse), applied using cotton wool pledgets around the gingival margins of all teeth, or using special premanufactured application buds (Figure 18.15).
- Record the presence or absence of plaque at each site, and calculate the percentage of all sites with plaque present. Discuss with thee patient, and use the chart to identify areas/sites where oral hygiene is inadequate (e.g. proximal sites), with suitable targeted advice for improvement. Patients should be given targets to help them improve their homecare routine. Ideally plaque scores should be less than 10% but a realistic goal would be <25%.

Calculation:

$$\frac{\text{number of sites with plaque}}{\text{total number of possible sites}} \times 100 = \%\ \text{plaque score}$$

Special Tests The use of radiographs, vitality testing and other special tests for periodontal purposes is described in Chapter 6.

Periodontal Reassessment

Reassessment is carried out 8–12 weeks after completion of non-surgical treatment, or 3–4 months after surgery. Treatment is successful if plaque and bleeding scores have been significantly reduced and pocket depths reduced. If this has been achieved patients can be transferred to maintenance care. However, it is possible that certain local areas may have anatomical features which compromise good response to initial therapy and ease of long-term maintenance, such as furcation involvements or infrabony pocketing with vertical bone loss. If this is the case and oral hygiene is at a sufficiently high level (not more than 10–15% of sites with plaque after disclosing) then surgical approaches can be considered.

Standard Stages in Reassessment

- Confirm patient's complaints, problems and changes since completion of treatment. This is an opportunity to deliver positive reinforcement messages related to reductions in bleeding, improved gingival tone and colour, fresher mouth and breath, or even reduced tooth mobility.
- Confirm medical status, and record any changes. Pay special attention to significant secondary factors such as smoking status and diabetic control if relevant.
- Carry out routine extraoral and intraoral mucosal examinations. Assess marginal gingival health inflammation – colour, contour, consistency of tissues.
- Record probing depths and recession for attachment level determination, tooth mobility and furcation involvements.
- Disclose patient and record plaque score.
- Carry out any other special investigations, i.e. vitality tests or radiographs, as indicated clinically.
- Determine changes in probing depth, bleeding and attachment levels, and relate to oral hygiene status. Make a judgement on host and site susceptibility for further disease progression or stability. Decide if:
  - Further non-surgical treatment is needed.
  - Other local factors need to be managed, for example, restorations.
  - Periodontal surgery is required.
  - The patient can proceed to a maintenance phase of treatment.
- Consider restorative and other treatment options.

Basic Non-Surgical Instrumentation

The aim of non-surgical periodontal instrumentation is to disrupt the bacterial biofilm and remove calculus deposits from supra- and subgingival surfaces. The term debridement is now widely used to describe this type of

treatment. Debridement means plaque biofilm and calculus removed from surfaces above and below the gingival margin without intentional removal of cementum. Recent findings show that biofilm is loosely adhered to root surfaces and the aggressive removal of calculus and cementum is no longer required to improve the clinical outcome. Subgingival instrumentation is referred to as root surface debridement (RSD).

Types of Instrumentation

Hand Instrumentation

Technique for Supragingival Calculus Deposits For calculus removal, it is vital to establish the correct angle between the instrument face and the tooth surface. The face-to-tooth angulation for calculus removal is an angle that is greater than 45°and less than 90°. The ideal angulation is between 80° and 90° where possible. The instrument of choice is a minisickle scaler (Figure 18.16). It is a universal instrument with two cutting edges and the face is offset at a 90° angle to the terminal shank. This makes it easier for placement and to achieve a blade to tooth angle of 90°. Supragingival debridement is the mechanical removal of bacterial plaque, its by-products, and plaque retentive factors (such as calculus) from the clinical crowns of the teeth. Supragingival calculus deposits are visible to the naked eye when dried with compressed air.

Technique for Root Surface Debridement The objective of RSD is to produce a biocompatible root surface by disrupting the plaque biofilm and removing calculus deposits within the periodontal pocket. It involves reducing the bacterial load in the pocket and creating a smoothened root surface while preserving cementum to promote tissue healing and reattachment.

The procedure should be undertaken in a methodical way, working around the mouth and around each tooth in a systematic manner (Figure 18.17). It is also important to select the correct instrument for the task you wish to carry out. Each stroke should be deliberate and effective. A firm finger rest (fulcrum) and a modified pen grasp is essential for controlled use of the instrument.

The movement of the instrument can be divided into two phases.

1) The exploratory stroke: this is used to determine the extent and location of the calculus deposits on the root surface (Figure 18.18). Tactile sensation is enhanced using a fine-tipped instrument held in a light modified pen grasp. A specially designed calculus detection instrument, the ODU 11/12 Explorer, will improve ability to locate fine calculus deposits by increasing tactile sensitivity to fingertips.
2) The calculus removal stroke:
   - The blade is positioned apically until the calculus is felt. Do not apply pressure at this stage.

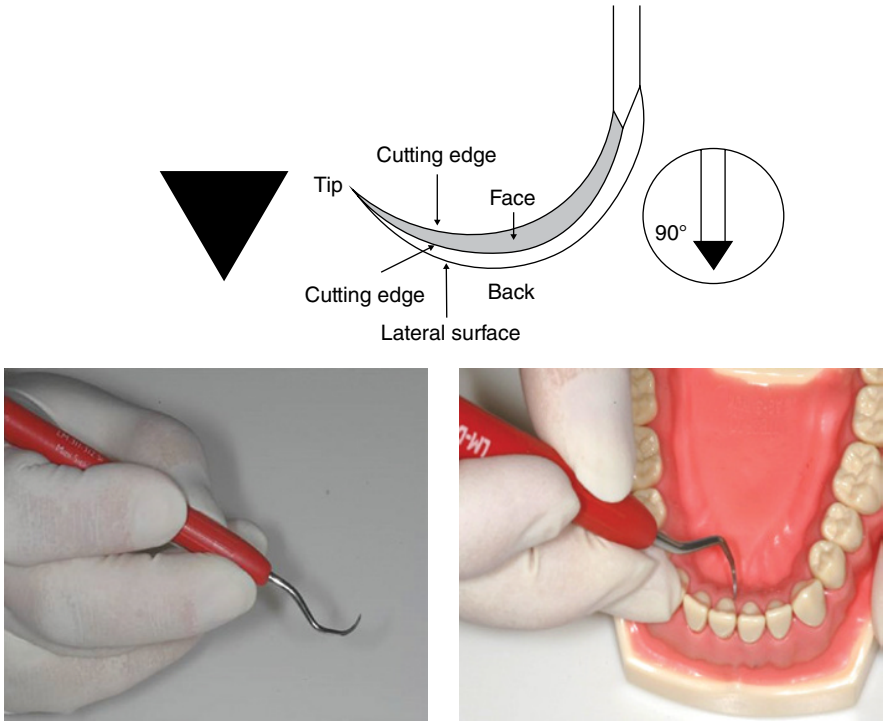


Figure 18.16 Features of sickle scaler, hand grip for and application of this instrument.

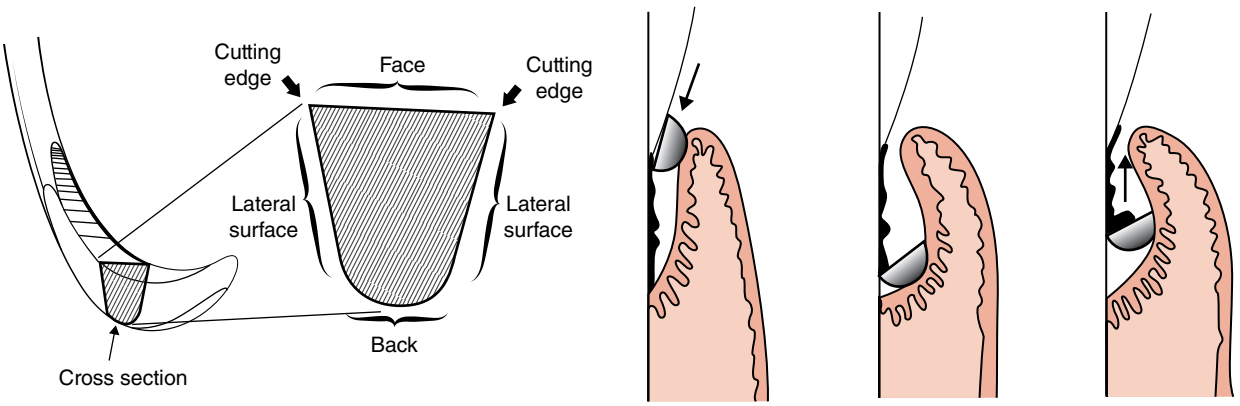


Figure 18.17 Features of universal curette and means of application to root surface.

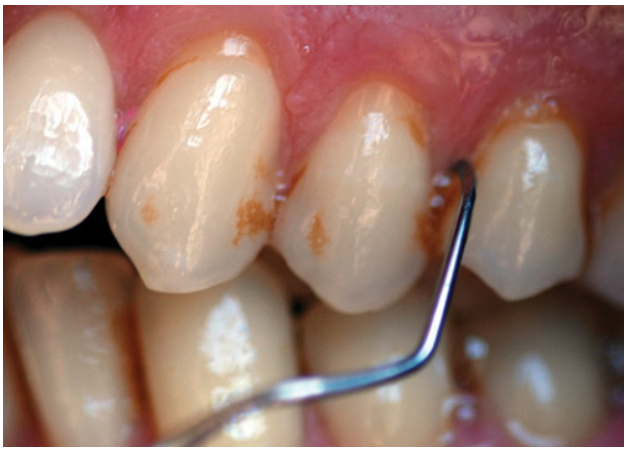


Figure 18.18 Clinical application to root surface.

- Slide the blade over the deposit until you feel that the instrument has passed it.
- Ensure the terminal shank is parallel with the long axis of the tooth to establish the correct angle of the cutting edge.
- Apply lateral pressure engage the cutting edge, and move in a coronal direction.
- Relax your muscles briefly and repeat the process on all sites as required.
- Use a variety of strokes moving the instrument in vertical, horizontal and oblique directions to ensure that every square millimetre of the root surface has been thoroughly debrided.

Lateral pressure is required to produce power to remove the calculus deposit. To achieve lateral pressure, the fulcrum finger must be straight to support the weight of the hand. Press the fulcrum finger firmly against the occlusal or incisal surface. Apply pressure inward against the instrument handle using the index finger and thumb. This will engage the cutting edge against the tooth surface. This pressure should be maintained throughout the working stroke to achieve calculus removal.

Powered Instrumentation

Powered scaling devices are composed of an electric power generator which delivers energy in the form of high frequency vibrations to a handpiece into which a variety of specially designed tips may be inserted. The rapid energy vibrations of a powered tip fracture calculus and clean the environment of the periodontal pocket. The power generator will transmit vibrations in the range of 25 000–29 000 cycles/s. True ultrasonic devices are only those which operate at frequencies above 20 kHz and in which the vibrations at the scaling tip are produced by either a magnetostrictive or piezoelectric system. The tips provided for use are either curette, chisel-shaped or probe-like. During development of the device, it was found that the tip should be blunted to minimise gouging of the tooth surfaces and therefore the older tips do tend to be slightly more bulky and blunt in contrast to the tips of hand instruments. Newer models of ultrasonic devices have much more slender tips to reach into pockets. The use of the two types of unit is similar.

Piezoelectric Debridement Systems Piezoelectric units use a quartz crystal mechanism. When an oscillating voltage is applied, the crystal oscillates from its rest position to produce a high frequency tip vibration. Less heat is produced than from the conventional magnetostrictive unit and therefore, less coolant is required.

Magnetostrictive Debridement Systems This comprises a working end coupled to a stack of ferromagnetic metal which acts to vibrate in a high frequency alternating

magnetic field generated by electrical current within the surrounding coil inside the handpiece.

Modes of Action

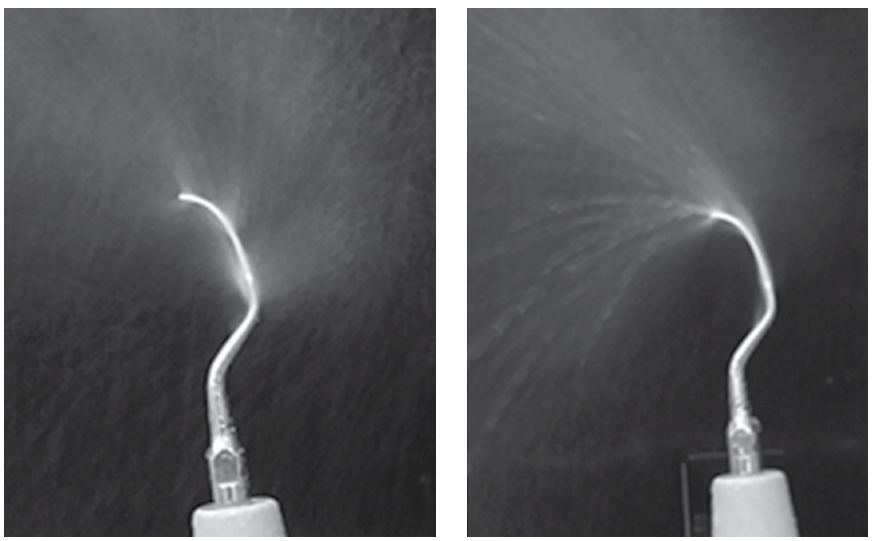
- Cavitation: tip produces spray with millions of bubbles that collapse, releasing energy that destroys bacteria by tearing bacterial cell walls and assists removal of plaque and endotoxins from the root surface.
- Acoustic turbulence/microstreaming: pressure produced within the confined space of a pocket by a continuous stream of fluid flowing over the evibrating instrument tip. There is an antimicrobial benefit as it disrupts and destroys subgingival pathogens due to the powerful swirling effect of fluid in the periodontal pocket space.
- Mechanical action: action of the vibrating tip removes calculus deposits as effectively as hand instrumentation. Several studies show that precision-thin tips produce better calculus removal and provide better access within periodontal pockets and are effective in Class II and III furcations when compared with hand instruments.
- Fluid lavage: flushing ability created by a continuous fluid stream within a pocket. Flushing action washes debris, bacteria and unattached plaque from the periodontal pocket improving vision during instrumentation. Fluid lavage has been shown to infiltrate the pocket to a depth that is equal to the depth reached by the ultrasonic tip.

Technique for Powered Devices

- Check that water is flowing through the handpiece first, then select tip and insert.
- Adjust instrument until a fine aerosol spray of water is emitted (Figure 18.19).
- Adjust power setting on low for plaque removal and medium to remove calculus. Medium is the maximum power that should be used. Ultrasonics should never be used on high power as it reduces effectiveness of the tip and may result in fracture of fine tips.
- The instrument should be held in a relaxed pen grasp supported by an intra- or extraoral finger rest. Lateral pressure should not be applied to the tip of ultrasonics as this reduces effectiveness.
- The tip should be inserted into the sulcus and held parallel to the long axis of the tooth, similar to the positioning of a periodontal probe. A 0° angulation is recommended for plaque removal and a 15° angulation for calculus deposits.
- The lateral, convex and concave surfaces of the end can be used to remove plaque and calculus. The tip itself should not be used and must not be applied perpendicular to the tooth as this will damage the surface causing grooving/pitting.
- Calculus deposits should be removed by starting at the most coronal edge and working down into the pocket in an apical direction.
- Continuous movement using very light pressure is important to ensure effective removal of deposits and avoid overheating.

Advantages of Ultrasonic Instrumentation

- An effective adjunct or alternative to hand instruments.
- Similar healing response.
- Reduced tissue trauma.
- Faster healing, less distention of pocket.
- Irrigational effect on anaerobic bacteria.
- Time saving of 20–50% (dependent on clinician).
- Clearing of debris, improved field of vision.
- Less operator fatigue – ergonomic.



(a) (b)

Figure 18.19 Effects of (a) incorrect versus (b) correct fluid flow and power setting on tip irrigation.

- Effective treatment of furcation-involved teeth.
- Technique easier to master but still requires considerable skill and attention to detail.
- Kinder to patient (depends on patient tolerance to noise, water, vibration): faster, shorter time in chair if phobic.
- Loss of tactile sensation can be overcome with experience, light grasp, modified pen grip, no applied force, fine tapered tip, and the use of an explorer 11/12 to check surfaces.

Contraindications for Ultrasonic Instrumentation

Powered devices should not be used on:

- Gold crowns.
- Porcelain.
- Areas of decalcification.
- Patients with dentine sensitivity.
- Patients with pacemakers (check manufacturers guidelines – piezoelectric instruments are thought to be generally safe to use).

Ultrasonic Debridement Strokes

Tapping motion:

- Tip positioned at uppermost edge of deposit and tilt working end to 15 degrees.
- Tip directed against deposit in a light tapping motion.
- Only gentle tapping pressure needed as firm pressure will reduce effectiveness of the instrument.
- Use vertical or oblique strokes holding the handpiece in a light pen grasp.
- Downward motion, starting at coronal point of calculus deposit and working towards the junctional epithelium.

Sweeping motion:

- Used for biofilm removal; position the working end parallel to the surface.
- Tip used in eraser-like motion in a light sweeping motion back and forth.
- Use short overlapping strokes to cover every square millimetre of the root surface.
- Light pressure and grasp will increase effectiveness of the ultrasonic instrument.
- Vertical, horizontal and oblique strokes.
- Begin at the gingival margin and work down to the base of the pocket.

Removal of Other Secondary Factors

Overhanging restorations or poorly contoured margins may contribute to plaque retention and cause loss of attachment. Restorations should be recontoured to allow for good plaque control and eliminate ledges where calculus may form. A high-speed handpiece with flame-shaped diamond burs are effective for reshaping and polishing old restorations. The clinician may also use a periodontal file or an ultrasonic instrument to polish rough amalgam restorations. Diamond-coated steel strips are effective for proximal polishing of amalgam restorations. Care should be taken in the placement of new restorations and margins should be kept supragingival where possible and follow the natural contour of the tooth. The patient's ability to perform oral hygiene measures should always be taken into consideration when placing a restoration.

Advanced Non-Surgical Instrumentation

Deep, Complex Sites

Deep, complex sites are common in patients with advanced periodontal destruction. Root morphology and reduced access into deep periodontal pockets are difficult to instrument well. For these more complex areas, site-specific instruments are recommended. Root surfaces may have developmental depressions and concavities that make thorough instrumentation hard to achieve. Furcation areas with narrow openings are difficult to reach and it may be quite a distance from the cemento-enamel junction (CEJ) to the entrance of the furcation. The distance from CEJ to the trifurcation in maxillary molars is approximately 3 mm mesially, 4 mm buccally and 5 mm distally. In mandibular molars, the distance to the roof of the furcation is 3 mm from the facial aspect and 4 mm on the lingual aspect. Bearing these factors in mind, a blended approach to non-surgical instrumentation is recommended. This involves using a combination of specially designed hand instruments and powered tips to thoroughly debride root surfaces so the benefit of both instruments will result in a good clinical response.

Design Features of Site-Specific Curettes

- Designed to reach the extreme base of inaccessible pockets without undue distension of gingival tissues.
- To remove every deposit of serumal calculus from the root surface.
- Long, curved, complex functional shanks to fit around the crown and into the periodontal pocket.
- Flexible shanks which allow clinicians to feel for subgingival deposits.
- Off-set blades which permit the cutting edge to be correctly angled against the root, while the opposite side is angled away from soft tissue wall of pocket.
- Shanks and working ends which are designed to adapt to the specific root surfaces.

Design Features of Working End

- Back and toe are round.
- Cross section is a semicircle.

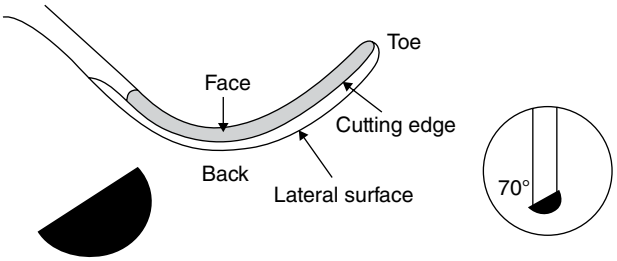


Figure 18.20 Design features of site-specific Gracey curette.

- One cutting edge/blade.
- Blade is off-set from the shank at 70°.
- Blade curves upward and to the side creating one cutting edge.

Site-Specific Curettes: Reduced Kit

The minimum number of instruments required to RSD the entire dentition using the site-specific Gracey range of instruments (Figure 18.20) is:

- 5/6 Anterior and premolar teeth – all surfaces.
- 9/10 Posterior teeth – buccal and lingual surfaces.
- 11/12 Posterior teeth – mesial surfaces of molars.
- 13/14 Posterior teeth – distal surfaces of molars.

The mini-Gracey series of instruments have a thinner blade for smoother insertion and a longer terminal shank than the standard design to clean deeper periodontal pockets, developmental grooves and narrow furcation areas. The 15/16 and 17/18 instruments are effective for interdental sites of molars as they have a more sharply angulated shank than in the standard 11/12 and 13/14 design.

A Blended Approach to Non-Surgical Periodontal Therapy

- Use a combination of both hand and ultrasonic instruments to debride root surfaces.
- Primary aim is to remove and disrupt subgingival biofilm and calculus.
- Correct selection of instruments: longer complex shank, small, sharp, thinner blades to reach into deep pockets in areas where access is limited.
- Ultrasonic instruments are most effective in furcation areas as they have a 360° of activity. Long, fine curved tips are specifically for these areas.
- Avoid fast, haphazard movements as this will reduce stroke effectiveness and result in operator fatigue.
- Use controlled, deliberate, intentional strokes working in a methodical manner around the dentition.
- Use an overlapping stroke pattern, with vertical, horizontal and oblique movements to cover the entire root surface.

Instrument Care

Many hand instruments require sharpening and this should be carried out regularly to ensure that cutting edges are sharp and effective. Sharp instruments mean:

- Fewer strokes.
- Reduced fatigue.
- Improved patient comfort.
- Reduced risk of burnishing calculus onto root surfaces.
- Smoother surfaces in faster time.
- Reduced risk to of trauma.

Blunt instruments mean reduced control during stroke production.

Furcation Files

Diamond-coated files are designed for cleaning deep concave sites in anatomically difficult areas such as furcations. They have a delicate, diamond-coated, round curved toe that permits adaptation in narrow deep concave surfaces. They clean and shape the concavity removing fine deposits and create a smooth surface.

Stain Removal and Polishing

Equipment required:

- Slow contra-angled handpiece.
- Disposable rubber cup.
- Medium polishing paste or toothpaste.
- Saliva ejector.
- Gauze.

Coronal Polishing Technique

- Position patient in a supine position. Chin up for maxillary teeth, chin down for mandibular teeth.
- Retract the patient's lips and cheeks and position a saliva ejector at the right-hand side of the mouth.
- Fill the rubber cup with paste and establish a fulcrum. Use a pen grasp to hold handpiece. Rest the handpiece in the v-shaped area of your hand between index finger and thumb.
- Hold the rubber cup so the rim is almost in contact with, but not touching the tooth surface. Activate the foot pedal and regulate the speed so the cup rotates at a slow, steady speed.
- Adapt the cup to the cervical-third of the crown, and apply just enough pressure to make the rim of the cup flare slightly. Take care when moving the cup into the sulcus.
- Using a dabbing motion, move the cup from the cervical-third of the crown toward the incisal edge. Use light intermittent pressure. Each surface should take 2–3 s to polish.

- Apply the cup to the interproximal surfaces as much as possible by repositioning the handpiece.
- Refill the cup frequently with paste. An empty cup will generate excessive heat and will not polish the tooth. Remove excess saliva from the cup as required using a paper towel or square of gauze.
- Allow the patient to rinse thoroughly to remove abrasive particles following the procedure.

Basic Surgical Treatment of Periodontitis

Reasons for Surgery

Surgery is a treatment option used most often to facilitate long-term maintenance of periodontally involved teeth. This is achieved partly by pocket elimination, exposing previously hidden diseased root surfaces, and partly by recontouring hard and soft tissues to aid access for self-performed and professional oral hygiene. Consequently, surgery is rarely carried out as a first line of treatment, but is reserved for sites which have not responded well to initial non-surgical therapy (often for anatomical reasons or the involvement of features such as furcations), despite control of other risk factors and the achievement of a good level of oral hygiene, evidenced by a low plaque score.

Preoperative Assessment

Assessment before surgery would normally involve:

- Completion of six-point probing chart of all teeth, recession charting and bleeding records.
- Assessment of plaque score.
- Assessment of tooth mobility and occlusion.
- Assessment or restorative prognosis of teeth to be treated and strategic value, including vitality testing if indicated.
- Recent periapical radiography of area to be treated.
- Confirmation of medical history and control of systemic risk factors.
- Assessment of patient's ability to cooperate and tolerate surgical treatment.
- Assessment of patient's ability to understand and to carry out appropriate postoperative care.

Indications for Surgery

Management of residual deep pockets after non-surgical treatment associated with:

- Furcation involvements.
- Infrabony pocketing/vertical bone defects.
- Iatrogenic factors such as root perforations.
- Crowding/unfavourable tooth position.

Adverse Factors and Contraindications

Surgery should be carried out with caution and not without documentation of the patient's understanding of success rate and risk of complications, especially in smokers.

Surgery should not be carried out in the presence of high plaque scores or for those with poorly controlled diabetes. Patients with a history of bisphosphonate medication may benefit from referral to a specialist centre.

Consent and Local Analgesia

Informed written consent must be obtained before carrying out periodontal surgery, as described in Chapter 5 of this manual. Local analgesia should be administered according to the location and innervations of the area under treatment. This normally involves:

- Maxillary sites: buccal and palatal infiltration analgesia for the areas to be treated, although in some situations buccal infiltration with articaine preparations may be adequate. Greater palatal and incisive nerve blocks may achieve a good outcome if it is necessary to anaesthetise all the palatal gingival marginal tissue.
- Posterior mandibular sites: administration of inferior dental and long buccal nerve blocks. It may be possible to rely solely on buccal articaine infiltrations but this technique is currently not widely practiced. Articaine should not be employed for nerve blocks due to the risk of possible nerve damage.
- Anterior mandibular sites: buccal and lingual infiltrations may provide adequate anaesthesia for localised surgery in these areas.

Conventional Surgical Approach: Procedure

- Ensure adequate local anaesthesia.
- Make initial outline incision. This is classically scalloped around the necks of teeth, moving away from the gingival margin by 1–2 mm as the incision moves around to the midlabial/midlingual, then returning to the gingival crevice as the incision approaches the proximal spaces. This is cut only to a depth of 1–2 mm. Outline incision classically involves teeth with periodontal problems and adjacent healthy tissue – flaps will be finished on healthy tissue. The papillae should still be on the flaps, and not excised.
- Decide on the need for vertical relieving incisions. These may be at one or both ends of the flap, and are utilised if good apical access is likely to be needed, or if

the flap is expected to be apically repositioned at the completion of the surgical procedure. As with all forms of oral surgery, incisions should be carefully placed considering local anatomical structures and aiming to maintain a good local blood supply to the flap.

- Return to outline incisions (often with a new sharp scalpel blade) and make thinning incision – follow outline of initial incision but ensure that the blade cuts down to sound bone. Aim to contact the bony alveolar crest, or the buccal aspect of this. If this is not achieved, flaps will be harder to elevate and removal of granulation tissue will be more difficult (Figure 18.21).
- Elevate flaps carefully, using routine surgical techniques. This should be easy. However, if flaps are tethered to underlying granulation tissue it may be necessary to carefully sharp dissect these apart. Flaps only should be raised far enough to allow access to diseased areas, i.e. usually to alveolar bone crest, or to allow repositioning of flap tissue in some forms of surgery. This minimises trauma to local bone and subsequent postsurgical loss of alveolar bone height. Even if working mostly on say the buccal side, it is still necessary to at least partly elevate the opposite (lingual) tissues, to achieve adequate access to surgically manage periodontitis and to avoid damaging the opposite (lingual) tissues.
- The flaps should have been elevated leaving behind a collar of gingival/granulation tissue around the necks of the teeth involved, by virtue of the thinning incision that was previously made. If this has not been fully made to bone, then it will be more difficult to easily raise the flaps. This tissue can now be removed using sharp curettes from around the teeth and from within any infrabony defects present (Figure 18.22).
- Having removed the excess soft tissue, the root surfaces can be inspected and any residual local factors (calculus, overhangs, cracks, furcations) can be managed. Root surfaces should be debrided of deposits, ideally using ultrasonic instruments. This often reveals further soft tissue remnants for removal.
- Inspect local bony anatomy and how flaps will be replaced on closure. It may be necessary to remove or thin bony ridges carefully, or to thin the underside of flaps and papillae (or both) carefully to allow flaps to be relocated to reduce the risk of postoperative pocketing, and to achieve a soft tissue contour that follows the underlying bony contour and which allows simple effective self-performed maintenance, e.g. using

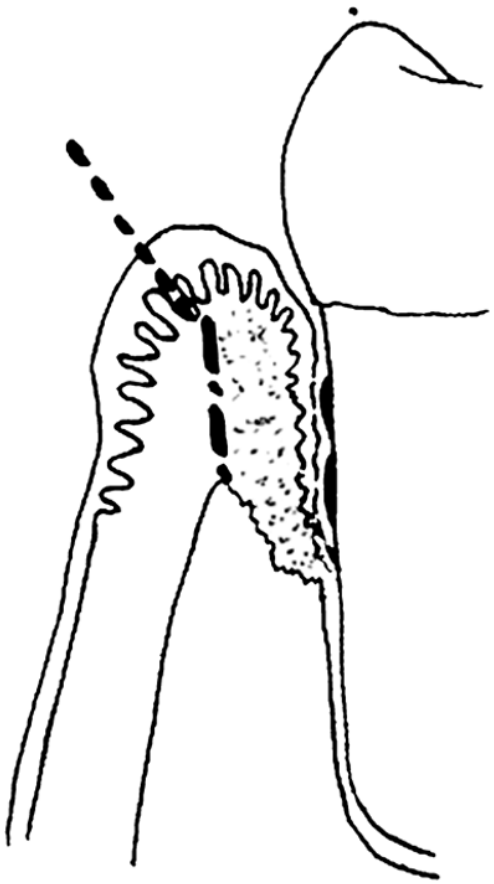


Figure 18.21 Primary (dashed line) and secondary (dotted/dashed line) incisions for periodontal access surgery in the management of pocketing with bone loss and root surface calculus.

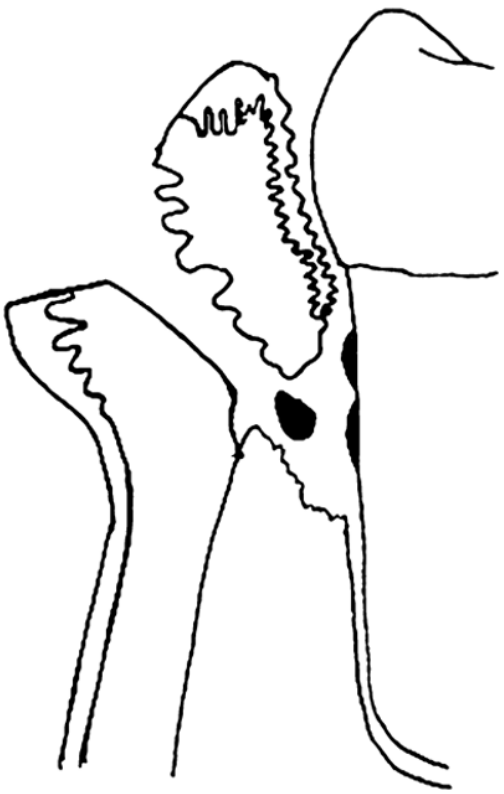


Figure 18.22 Removal of granulation tissue and root surface calculus using a curette, following flap elevation

proximal brushes, for the future (Figure 18.23). Hard tissue removal may be by rotary means (although this can be difficult close to teeth) or by using hand instruments such as chisels.

- Replace tissues and close flaps. Simple surgical procedures may be closed using simple interrupted sutures (ideally 4/0 or 5/0) between papillae, although vertical mattress sutures may also be used. In more sophisticated cases other suturing techniques may be indicated, but these are outside the realm of this text. Sutures should not be overtensioned. Sutures may be silk, vicryl or other resorbable, or PTFE. In areas of minimal access, 5/0 or 6/0 polypropylene ('Prolene') may be used.
- Compress tissues gently with gauze soaked in saline and confirm haemostasis.
- Give postoperative care and hygiene advice. Arrange for review and suture removal at 1 week.

Fibrous Ridges: Procedure

Thick fibrous gingival tissues adjacent to teeth with pocketing may not respond so well to non-surgical treatment. Thinning adjacent gingival tissue may be helpful for pocket elimination.

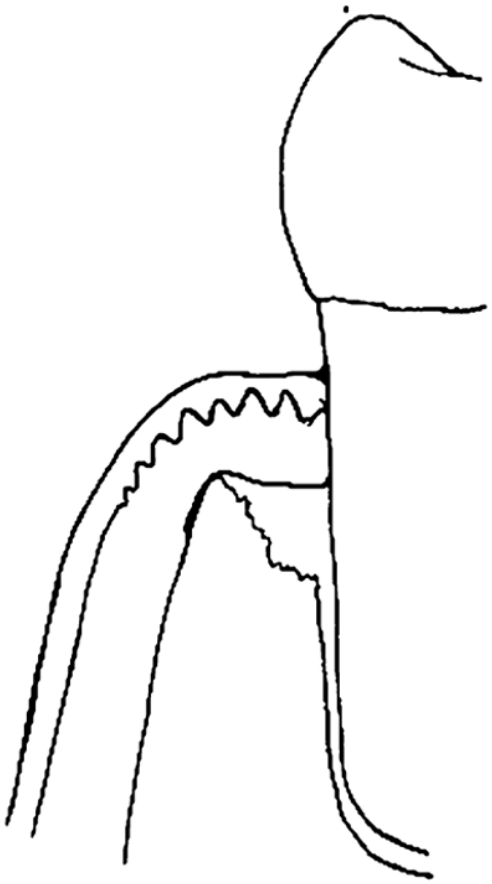


Figure 18.23 Relocation of flap in preparation for suturing.

- Ensure adequate local anaesthesia.
- Make a crestal incision away from the tooth in question (normally using a number 15 or 15c scalpel blade), ending with a T-shaped cut across the ridge if there are no other teeth involved. Extend incision around tooth. If planning generates significant gingival recession locally, consider scalloping incisions away from gingival margins on mid-buccal/mid-lingual aspects by 1–2 mm.
- Elevate buccal and lingual flaps to the extent of the relieving incision.
- Use a new, sharp 15/15c blade to thin out flaps (usually palatal, sometimes buccal) from underneath, removing wedge of fibrous connective tissue from beneath the flap. Aim to leave circa 2 mm thickness of intact connective tissue as a minimum beneath flap.
- Be wary of local anatomy during thinning procedure.
- Close flaps with interrupted or mattress sutures, 4/0–6/0 thickness.

Infrabony Defects

Infrabony defects may be managed either by attempts at regeneration to fill in the bony defect with new hard tissue, or by a resective approach, aiming to open out the defect and facilitate maintenance by exposing root surfaces (Figure 18.24).

The choice of approach is at least partly driven by the pattern of bony destruction present. Defects are classified according to the number of remaining walls present, so on a proximal molar root surface:

- A one-walled defect has neither buccal nor lingual bone present (Figure 18.25).
- A two-walled defect has either a buccal or lingual wall missing (Figure 18.26).
- A three-walled defect is completely contained, with intact buccal, lingual and proximal walls.

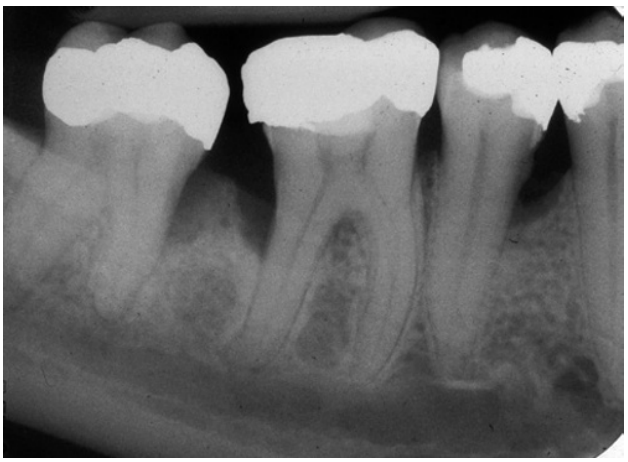


Figure 18.24 Periapical radiograph showing infrabony defects.

As the number of bony walls present and the depth of the infrabony defect increases, there is an increased tendency to consider regenerative, as opposed to resective, treatment options. Research suggests that more walls and steeper walled, narrower defects are more likely to generate bony infill. Regenerative procedures would normally be carried out by a specialist periodontist.

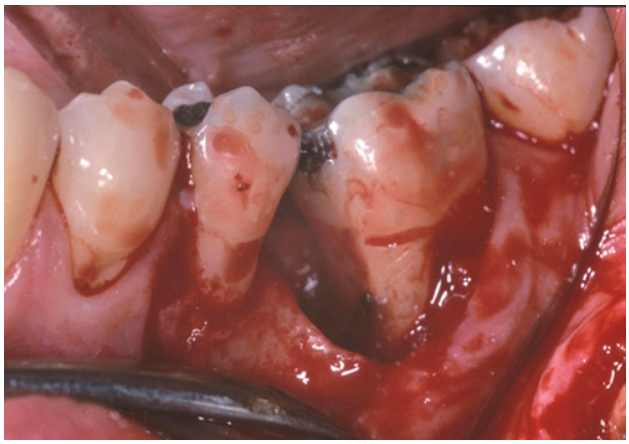


Figure 18.25 Proximal infrabony one-walled defect.

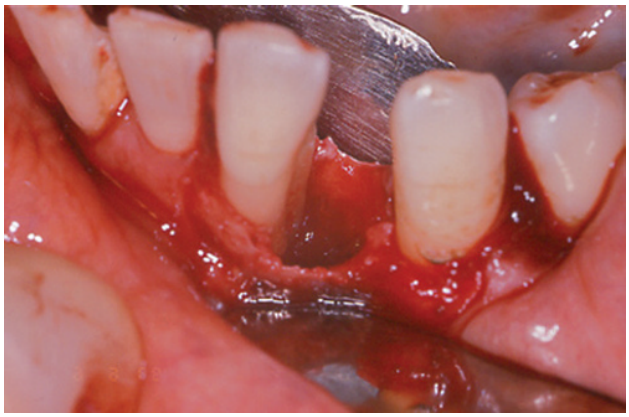


Figure 18.26 Proximal infrabony defect with two bony walls.

Advanced Surgical Treatment of Periodontitis

Root Resection and Division

This procedure can be useful for maintaining teeth which have advanced bone loss around one root, or some other problem such as an endodontic perforation, but good support on other roots (Figure 18.27). Preoperative assessment is as for other forms of surgery, but with extra emphasis on assessment of root and furcation morphology. In addition, this procedure must either be preceded, or rapidly followed, by root canal treatment, so the radiographic assessment must address these aspects also, either in terms of assessment of the current root filling, or ease of root treatment.

For root resection to be viable, the roots must not be fused at any point apical to the furcation.

Furcations: Procedure

This procedure is essentially identical to the conventional surgical approach outlined previously. However, after the granulation tissue has been removed, the relevant root can be sectioned off using a rotary instrument, often a high-speed handpiece with fine diamond-coated burs. After elevating the root fragment, the remaining tooth and furcation architecture is recontoured and smoothed to allow ease of maintenance postoperatively. Any exposed root canal filling material within the plane of section should be sealed with cement or bonded composite.

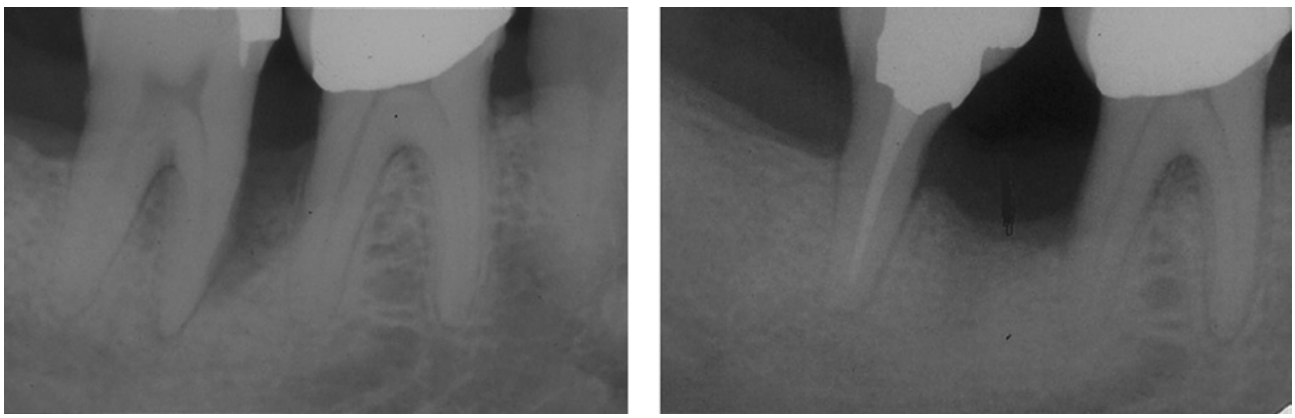


Figure 18.27 Radiographs showing root resection at lower right second molar to manage localised bone loss.

The area can then be sutured and allowed to heal – it may be necessary to recontour the tooth some weeks later as soft tissues remodel – this is easier if a postoperative radiograph has been taken.

Management of Gingival Recession

Gingival recession may be treated to deal with:

- Poor aesthetics (localised buccal recession or 'black triangles').
- Dentine sensitivity.
- Soft tissue changes compromising ease of oral hygiene.

The following techniques are typically carried out by a specialist periodontist:

- Pedicle grafts.
- Free gingival grafts.
- Connective tissue grafts.
- Growth factors and related techniques.

Gingival veneers are simple acrylic or other flexible prosthetic covers and can be a useful way to disguise 'black triangles' seen in Miller Class IV recession associated with horizontal alveolar bone loss (Figures 18.28 and 18.29).

Surgical Management of Gingival Overgrowth

External Bevel Approaches

The external bevel gingivectomy is the 'classical' approach for the treatment of gingival overgrowth. However, this procedure suffers some limitations:

- It does not effectively deal with infrabony defects or furcation involvements.
- It can involve exposure of a large area of connective tissue with healing by secondary intention.
- It can be associated with a loss of pigmentation where gingival tissues were naturally more pigmented preoperatively: this can have aesthetic implications.
- It relies on the ability to predict the location of the mucogingival junction accurately.

Procedure

- Ensure adequate local anaesthesia.
- Mark pocket depth/level of attachment on tissue surface for area to be treated.
- Make an incision around the neck of the tooth, in the gingival crevice, parallel to the long axis of the tooth, to separate gingiva from tooth surface.
- Trying to preserve attached gingiva, make a bevelled incision, angled coronally, aiming for the base of the pocket, from buccal and lingual, starting at the distal site and working mesially. This should remove a collar of tissue (Figure 18.30).
- Curette interproximally to remove tissue remnants.
- Instrument root surfaces.
- Use compression with a saline pack to help reduce postoperative bleeding.
- A periodontal dressing/pack is not always necessary.
- Routine postoperative care procedures apply.

Internal Bevel Approaches

An alternative approach is to use a modification of the conventional and fibrous ridge techniques described previously. This approach is probably more flexible and allows more control in tissue contouring, less risk of depigmentation, treatment of areas with infrabony defects and furcations, and avoidance of healing by secondary intention.

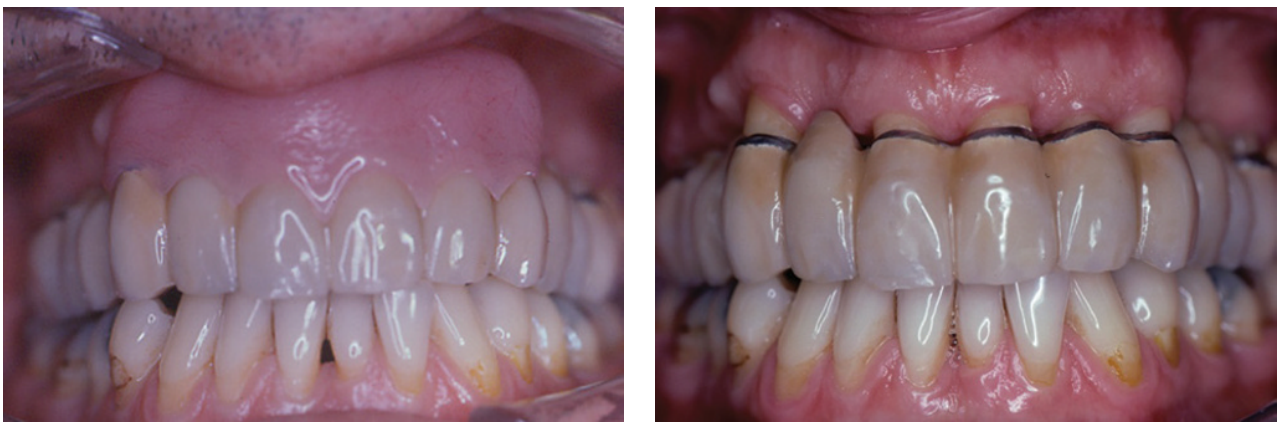


Figure 18.28 Conventional fixed prosthesis in patient with stabilised periodontitis, with and without acrylic gingival veneer.

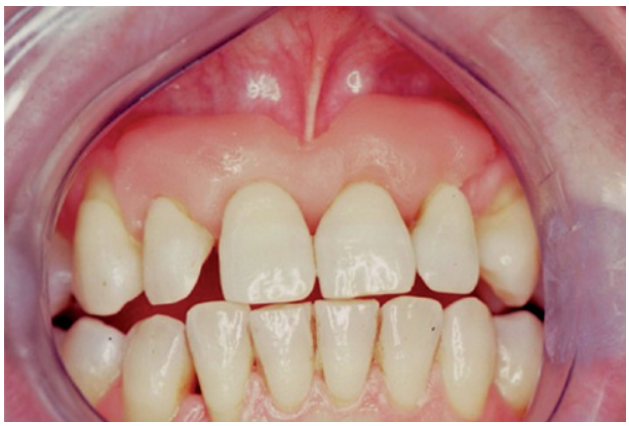


Figure 18.29 Soft silicone-based (Molloplast®-B) gingival veneer.

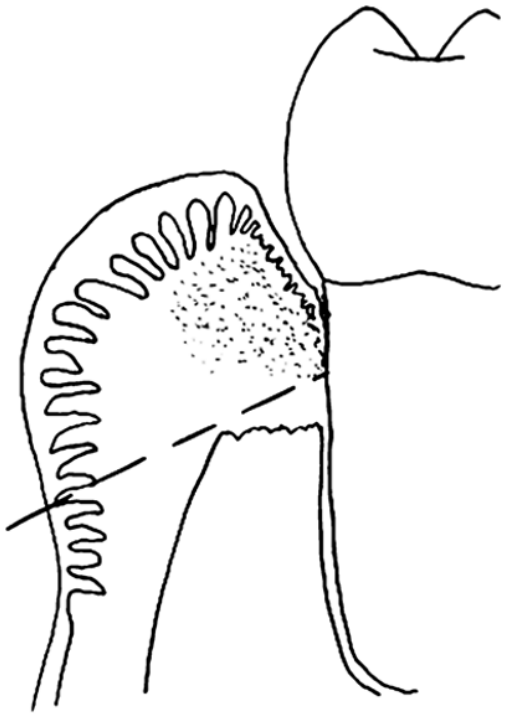


Figure 18.30 Angulation of incision (dashed line) made during external bevel gingivectomy.

Procedure

- Ensure adequate local anaesthesia.
- Mark pocket depth/level of attachment on tissue surface for area to be treated.
- Make initial outline incision. This is placed to mirror the markings of pocket depth, then returning to the gingival crevice as the incision approaches the proximal spaces. This is cut only to a depth of 1–2 mm. Outline incision classically involves teeth with periodontal problems and adjacent healthy tissue – flaps will be finished if possible on healthy tissue. The papillae should still be on the flaps, and not excised.
- Return to outline incisions (often with a new sharp scalpel blade) and make a thinning incision – follow the outline of the initial incision but ensure that the blade cuts down to sound bone. Aim to contact the bony alveolar crest, or buccal aspect of this. If this is not achieved, flaps will be harder to elevate and removal of granulation tissue will be more difficult. In addition, the aim of treatment here is to reduce bulky tissue from underneath the flap, the aim being to thin out the flap to 2–3 mm thickness.
- Elevate flaps carefully, using routine surgical techniques. This should be easy. However, if flaps are tethered to underlying granulation tissue it may be necessary to carefully sharp dissect these apart. Flaps only have to be raised far enough to allow access to diseased areas, i.e. usually to alveolar bone crest, or to allow repositioning of flap tissue in some forms of surgery. Even if working mostly on say the buccal side, it is still necessary to at least partly elevate the opposite (lingual) tissues, to achieve adequate access to surgically manage periodontitis and to avoid damaging the opposite (lingual) tissues.
- The flaps should have been elevated leaving behind a collar of gingival tissue/granulation tissue around the necks of the teeth involved, by the thinning incision that was previously made. If this has not been fully made to bone, then it will be more difficult to easily raise the flaps. This tissue can now be removed using sharp curettes from around the teeth and from within any infrabony defects present.
- Having removed the excess soft tissue, the root surfaces can be inspected and any residual local factors (calculus, overhangs, cracks, furcations) can be managed. Root surfaces should be debrided of deposits, ideally using ultrasonic instruments. This often reveals further soft tissue remnants for removal.
- Inspect local bony anatomy and how flaps will be replaced on closure. It may be necessary to remove or thin bony ridges carefully, or to further thin the underside of flaps and papillae (or both) carefully to allow flaps to be relocated to reduce the risk of post-operative pocketing, and to achieve a soft tissue contour that follows the underlying bony contour and which allows simple effective self-performed maintenance for the future. Hard tissue removal may be by rotary means (although this can be difficult close to teeth) or by using hand instruments such as chisels. If flaps do require further thinning, new sharp blades are needed to achieve the optimal result. Consider reshaping the new gingival marginal flap tissue to achieve a stable tension-free tissue replacement.

- Replace tissues and close flaps. Simple surgical procedures may be closed using simple interrupted sutures (ideally 4/0 or 5/0) between papillae, although vertical mattress sutures may also be used. In more sophisticated cases, other suturing techniques may be indicated, but these are outside the realm of this text. Sutures should not be overtensioned. Sutures may be silk, vicryl or other resorbable, or PTFE. In areas of minimal access, 5/0 or 6/0 polypropylene ('Prolene') may be used.
- Compress tissues gently with gauze soaked in saline and confirm haemostasis.
- Give postoperative care and hygiene advice, and arrange for review and suture removal at 1 week postoperatively.

Crown Lengthening

Indications

Crown lengthening is a procedure carried out to move the gingival margins of teeth into a more apical position. This may be a valid treatment option in several situations, listed below. In general, it should be carried out by an experienced surgeon or specialist. The procedure may involve either hard or soft tissue modification, or a combination of these. Regardless of the rationale, the operator should aim to achieve a pleasing aesthetic result that works in harmony with the rest of the mouth and the facial anatomy. Crown lengthening procedures may be considered for:

- Short clinical crowns/excessive gingival display due to gingival enlargement or altered passive eruption.
- Short clinical crowns following trauma or tooth surface loss, either for aesthetics, to facilitate restorations, or both.
- Achieving gingival symmetry after operative interventions and healing in aesthetic zones.
- Obtaining access for operative treatment such as subgingival caries and subgingival crown margins, or access to subgingival fractures or root perforations.

It is essential that any potential patient be fully worked-up for these procedures. Full restorative clinical examination should include determination of occlusal vertical dimension if restorations of short teeth are planned: this may impact on the exact degree of tissue change needed. Likewise, radiographs are vital to confirm the restorative status of potential sites and bone availability. Finally, a full aesthetic appraisal should be carried out regarding the present and proposed position of gingival margins. It is critical for there to be good communication between the surgeon and any referring dentist/prosthodontist.

Soft Tissue Modification: Procedure

This is a modification of the internal bevel gingivectomy approach outlined previously.

The main variations are that the outline incision should be placed at the desired final position of the gingival margin, and that vertical relieving incisions are more likely to be needed if flaps are to be apically positioned. In the presence of limited attached gingival width, apical positioning may be favoured over tissue resection.

The soft tissues should be elevated, excessive tissue removed and flaps thinned in the same way. This may be needed on buccal and palatal aspects of teeth, depending on the nature of the problem present. At this point, the relationship of the final gingival position to the current bone crest can be assessed. Ideally, they should be 2.5–3 mm apart all around each tooth being treated, with the soft tissue flap being no more than 3 mm thick.

Hard Tissue Modification: Procedure

If there is less than 2.5–3 mm between the bone crest and the proposed final gingival margin, then it will necessary to remove bone in the appropriate areas. This may be carried out with burs or using hand instruments such as chisels – the latter may give a more accurate result with less risk of tooth damage, but can be a slower procedure. Once the hard tissues have been adjusted, it should be possible to replace the flaps in the final desired position and to close with simple sutures.

Regenerative Techniques

These techniques are typically undertaken by specialist periodontists. They include:

- Growth factor techniques.
- Guided tissue regeneration.
- Tissue substitutes.

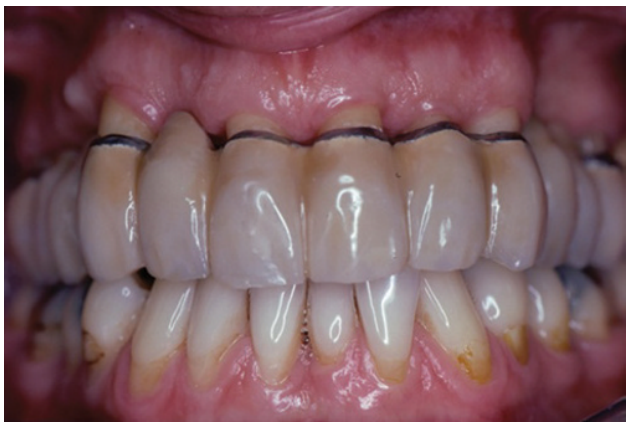
Management of Loose Teeth

Diagnosis

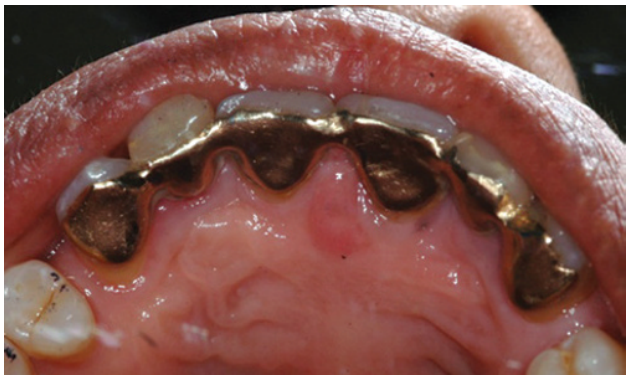
It is important to identify correctly the cause of looseness of a tooth – not all loose teeth have advanced periodontitis. Looseness may be the result of loss of root support following fracture or root resorption. It is, therefore, vital to carry out a full clinical examination and assessment to diagnose the cause of the looseness.

Treatment Options

- Occlusal adjustment.
- Extraction.
- Fixed splints: these are either conventional, linked crowns or linked resin-retained units (Figure 18.31).



(a)



(b)

Figure 18.31 (a) Conventional and (b) resin-retained fixed splints.

- Removable splint.
- Use of failing teeth as provisional bridges. Loose teeth that are provisionally splinted together can sometimes be converted to give effectively a provisional immediate replacement bridge when problems arise, by sectioning the root from the crown of the problematic tooth and elevating the root.

Postoperative Care and Maintenance

Postoperative maintenance has a major role in achieving successful surgical outcomes. For short-term care in the 1–2 weeks after surgery, oral hygiene is largely limited to chemical means such as chlorhexidine mouthwashes. However, after this point (at which time the tissues should be beginning to mature), the use of mechanical methods, suitably gently at first, should be developed. Patients may have enlarged interproximal spaces necessitating a review of the correct size of any interproximal brushes used by the patient, and the further recognition that these may get larger in the first months after surgery.

Plaque control should be reviewed at suture removal and at least at 1, and preferably 2 months after surgery. Surgical outcomes should be fully assessed at 3 months.

Further Reading

Eaton, K., Ower, P. (eds) (2015) Practical Periodontics. Edinburgh: Churchill Livingstone.

Hughes, F., Seymour, K., Turner, W. (2012) Clinical Problem Solving in Periodontology and Implantology. Edinburgh: Churchill Livingstone.

Lang, N, Lindhe, J. (eds) (2015) Clinical Periodontology and Implant Dentistry. 6th edn. Oxford: Wiley- Blackwell.

Palmer, R., Ide, M., Floyd, P.D. (2014) Clinical Guide to Periodontology. 3rd edn. London: BDJ Books.

The Good Practitioner's Guide, British Society of Periodontology, Version 3, 2016. Available from: https://www.bsperio.org.uk/publications/good_practitioners_guide_2016.pdf?v=3 (accessed 6th July 2017).

19

Procedures in Prosthodontics

Michael Fenlon

Crowns and Bridges

Crowns are fixed extracoronal restorations of individual teeth and bridges are fixed replacements for teeth. Crowns and bridges can be supported by natural teeth or by implants but for the purposes of undergraduate clinical practice, tooth-supported fixed restorations will only be considered here.

Crowns replace the outer part of a tooth and are primarily used to preserve the integrity of extensively restored or broken down teeth. They can be used to restore root canal treated teeth. However, when they are used to restore vital teeth, up to 20% of these may lose their vitality over the subsequent 5 years. Therefore, crown preparation should be prescribed cautiously, particularly for vital teeth in younger patients where tooth pulp size is at a maximum. The indications for crowns include:

- Protection of weakened tooth structure following root canal treatment.
- Support to weakened tooth structure following extensive coronal restorations, caries or tooth wear.
- Changes to shape and colour of teeth.
- Replacement of existing crowns.

Treatment Planning

Treatment planning is the cornerstone of successful restorative dentistry. The essential steps in treatment planning are:

- Thorough history.
- Careful examination.
- Appropriate special tests.
- Diagnosis.
- Prevention of further disease.
- Preliminary treatment – stabilisation of disease.
- Definitive treatment usually involving crowns and bridges.

For fixed prosthodontics, the standard history and examination should be augmented with specific examination of the partially dentate mouth and of teeth that may be crowned or used as bridge abutments (Table 19.1).

Any treatment plan should include prevention and treatment of existing conditions, including caries, periodontal problems and endodontic issues. The placement or replacement of fillings, posts, cores and other primary or foundation restorations must be successfully completed before commencing construction of crowns and bridges.

Procedure: Crown Preparation

Following treatment planning, radiographic examination, sensibility testing and the preoperative procedures detailed in Table 19.2, a polyvinylsiloxane (PVS) temporary crown matrix is required (Figure 19.1). In some cases, a diagnostic wax-up and thermoplastic former may be required if it is necessary to change tooth alignment, shape and/or occlusion.

The phases of tooth preparation will depend upon personal choice and training (Table 19.3).

During any tooth preparation, excessive cutting pressure should be avoided as this can result in rapid focal heating of tooth structure, causing pulpal damage which may be irreversible. Tooth cutting should be done with controlled, light, constantly changing contact between tooth and bur, thus allowing maximum cooling effect while minimising frictional heating. Some authors decry the use of depth orientation grooves, citing the risk of overheating the base of grooves during preparation. An alternative to using depth orientation grooves is the use of polyvinylsiloxane (PVS, addition-cured) silicone putty overcasts of the tooth/teeth to be prepared and the neighbouring teeth. A sausage of freshly mixed heavy-body PVS putty is pressed onto the teeth to be prepared and the neighbouring teeth, covering the crowns of the teeth and adjacent gingival tissues. When set, this is

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

Table 19.1 Oral examination of relevance to fixed prosthodontic.

Condition of soft tissues	
• Gingival biotype	Gingival biotype determines the thickness of the gingival margins and susceptibility to recession around restorations.
• Lip line	If the lip line is high crown margins and the interface between the crowns and the gingival will be visible, potentially compromising appearance.
• Basic periodontal examination (BPE)	Complex prosthodontics requires healthy periodontal supporting tissues. The BPE is a screening tool used to identify at-risk patients. When levels are recorded above 3, a full mouth periodontal examination is required.
Abutment considerations	
• Relationship of opposing teeth to proposed crowns and bridges	How do the opposing teeth meet? Will they meet the crowned tooth in maximum intercuspation, in lateral excursions, in protrusion? Is there enough space for a bridge pontic? Have the opposing teeth over erupted?
• Restorative status of abutment teeth	Crowns, fillings etc. Endodontically treated?
• Are the abutment teeth or opposing teeth worn?	Tooth wear can lead to short clinical crowns which reduce the amount of tooth tissue necessary for retention of crowns. Tooth wear can be caused by bruxism, a very unfavourable indicator for longevity of crowns and bridges.
• Orientation of the abutment teeth	Tilted or angled teeth need to be assessed particularly if bridges are planned. Consideration needs to be given to orthodontics or when bridges are possible, cantilever or fixed movable designs.
• Vitality testing	A positive response will improve the longevity and prognosis of any restoration. Loss of vitality and subsequent endodontics reduces the available tooth tissue. Teeth with extensive restorations and root-filled canals have a lower prognosis than vital teeth.
• Mobility of abutment teeth	Mobile teeth tend to have poor prognosis.
• Periodontal condition of abutment teeth, bleeding on probing, loss of attachment, 6-point pocket measurement	Abutment teeth should be periodontology healthy.

Table 19.2 Stages in crown or bridge construction.

Stage	Aims of stage	Materials and aids
Choose design of bridge	• Assess abutment teeth. • Extensively restored teeth – conventional bridges. • Unrestored teeth – minimal preparation bridges. • Choose design of bridge (cantilever, fixed/fixed or fixed/movable. • Consider diagnostic wax-up to help choose design.	
Primary impression stage	• Accurate study models of teeth and edentulous areas if pertinent to bridge design. • Not generally indicated for single crowns but if multiple crowns are planned, particularly for tooth wear study models are essential.	Alginate or polyvinylsiloxane (PVS) putty.
Temporary crown matrix	• Produce a PVS putty matrix or thermoplastic former for temporisation.	PVS putty.
Jaw relation record	• Only necessary if there is no definite position of maximum intercuspation. Wax squash bites should never be used. They are extremely inaccurate. • Cement temporary crown(s), check occlusion and adjust as necessary.	Use partial denture type wax rims if necessary. Temporary crown and bridge cement.
Fit stage	• Try-in. • Complete any necessary adjustments. • Cleaning and, where necessary, priming of the fit surface. • Cementation.	Fit checker. Articulating paper. Resin-based or glass-ionomer cement.

Figure 19.1 Prepreparation, single tooth, polyvinylsiloxane matrix for the construction of a temporary crown.

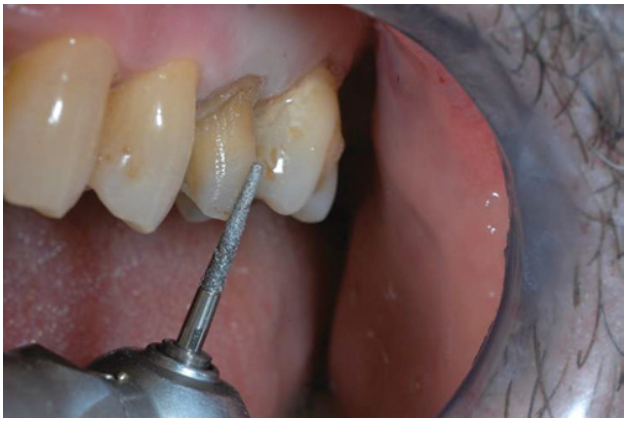


Figure 19.2 Buccal reduction in the preparation of a maxillary premolar for a full crown.

Table 19.3 Procedure for preparation for porcelain-fused to metal anterior and posterior crowns.

Incisal/occlusal reduction	Incisal/occlusal reduction: depth orientation grooves <2 mm deep.
Buccal/facial reduction	Buccal depth orientation grooves in three planes to facilitate curved facial reduction of 1 mm for porcelain and 0.5 mm for metal (Figure 19.2).
Buccal/facial shoulder	Shoulder, 1.5 mm wide, with well-defined margin to accommodate porcelain and metal alloy. Continue shoulder preparation interproximally, breaking contacts without damaging proximal surfaces of adjacent teeth. The vertical orientation of the bur should remain constant when forming the buccal and interproximal shoulder (1.5 mm wide). Most of the retention for the crown is derived from the proximal surfaces.
Proximal and palatal reduction	Complete axial reduction, including the palatal surface, using a chamfer bur if a metal surface is planned, with the chamfer finish line blending into the proximal shoulder line smoothly. Axial reduction of 1.5 mm using a flat-ended tapered bur, if porcelain fused to metal surface full coverage is planned. The shoulder finish line must be continuous around the tooth. The vertical orientation of the bur used for this should be the same as the orientation used for facial and proximal reduction.
Cingulum reduction	In anterior teeth use a round or (American) 'football' shaped bur to complete the preparation, reducing the cingulum by <1.5 mm, depending on the proposed design of the crown.

removed and trimmed. During preparation, the PVS overcast is sectioned with a scalpel and the space between the overcast and prepared teeth examined. The width and contour of this space represents the amount of tooth removed.

Management of Soft Tissues

Ideally all crowns and bridges should have supragingival finish lines with emergence and contour profiles similar to those of natural teeth. Such arrangements minimise damage to the soft tissues during preparation, possibly make the use of a retraction cord unnecessary, reduce the risk of postoperative gingival recession and increase the likelihood of a good clinical outcome, including the aesthetic qualities of the completed crown. However, many teeth to be crowned have existing restorations with subgingival margins that need to be included in the preparation. Wherever possible, subgingival preparations should be confined to critical aesthetic areas and where existing restorations already have subgingival finish lines.

In the aesthetic zone, subgingival preparations should be confined to <1 mm within the gingival crevice.

When undertaking subgingival preparation, it is essential to minimise damage to the soft tissues. It is advisable to use a flat plastic instrument to protect the tissues where there is a high risk of iatrogenic damage. If the soft tissues are traumatised, it is often impossible to achieve haemostasis adequate for impression taking on the same visit. In these circumstances, it may be necessary to temporise and record the definitive impression at a subsequent visit.

Temporary Crowns (Table 19.4)

Temporary crowns serve several important functions:

- Protection of exposed dentine: this prevents sensitivity for the patient and reduces the risk of pulpal death due to exposure of prepared dentine surfaces to the oral environment.
- Preservation of relative positions of prepared and proximal teeth ensures that the definitive crown should fit with firm proximal contacts.
- Prevention of overeruption of opposing teeth – if this happens there may be no space for the definitive crown.
- Restoration of appearance.
- An intraoral assessment of the design of the bridge or crown. Frequent debonding or fractures during the provisional stage will indicate changes are needed to the design of the restoration.

Impression Taking (Table 19.5)

Traditional crown and bridgework requires the recording of typically a PVS impression. With the advent of 'digital dentistry', impression taking is increasingly being replaced by digital impressioning using intraoral scanners.

Crown Cementation (Table 19.6)

To be able to deal with difficulties experienced during the cementation of crowns and bridges, clinicians need to have a good working knowledge of all relevant laboratory procedures.

Bridges

Bridges comprise retainers (the part of the bridge attached to abutment tooth/teeth) and pontics (the prosthetic replacement tooth attached to the retainer or retainers).

Table 19.4 Procedure for the construction of a temporary crown.

Prior to tooth preparations	Polyvinylsiloxane (PVS) matrix (Figure 19.1) formed, or thermoplastic blow-downs constructed in the laboratory, using the primary models. If the shape of a temporary crown is to be altered from that of the unprepared tooth, modifications can be made using a diagnostic wax-up on the primary model prior to overcast construction. This approach is essential if a temporary fixed bridge is planned.
Making a temporary crown with a PVS matrix	After preparations are complete, check that the PVS matrix fits well, examining where the cut surfaces of the overcast abuts the proximal teeth. Fill the indentation in the overcast representing the tooth to be temporised with a temporary crown and bridge material. Insert and seat firmly the filled matrix, checking that it is fully home. Excess material will be visible. Once the temporary crown and bridge material has set, remove the matrix, separate the matrix and the temporary crown, and check the crown for thickness and the absence of deficiencies. If the thickness of the crown is insufficient to function in clinical service or it includes deficiencies, then a remake may be indicated, possibly following further reduction of the tooth.
Adjusting a temporary crown	Trim marginal excess off the temporary crown until the margins match the margins of the prepared tooth, with neither horizontal nor vertical discrepancy between the margins of the crown and the margins of the preparation. The emergence profile and contour of the crown should be preserved during adjustments. The trimmed margins of the crown should be finished using an appropriate finishing system.
Trial insertion of temporary crown	Insert crown and check: • Marginal fit – horizontal and vertical – to ensure that adverse effects on gingival tissues are minimised. • Emergence profile – which should mimic the unprepared tooth – to ensure that adverse effects on gingival tissues are minimised. • Proximal contacts – these should be firm. This is important to prevent anteroposterior drifting which could interfere with the fit of the definitive crown and result in an open contact between the definitive crown and one or both of the adjacent teeth, resulting in food packing. • Occlusal contacts – these should be present but not high to prevent overeruption of opposing teeth, which would eliminate the space for the definitive crown. If the temporary crown is high, premature contacts should be identified using articulating paper and the crown adjusted to eliminate the prematurities while preserving the centric stops. This requires great care. Eccentric contacts, except on crowns on teeth responsible for guidance, should be eliminated.
Cementation of temporary crowns	Temporary crowns should be cemented with an appropriate provisional cement. If correctly seated during cementation the occlusion should not change. Nevertheless, the occlusion should be rechecked after cementation and any necessary adjustments made. All excess cement, particularly interproximal and subgingival cement, should be eliminated.

Table 19.5 Procedure for impression taking.

Checking fit of special/stock tray	Trays should fit comfortably over teeth. Adjust as necessary.
Gingival retraction, as indicated clinically	Retraction cord: either single stage or two stage. Place one thin and then one thick retraction cord around each subgingival preparation and leave for 5 min. Then thoroughly wet retraction cord, carefully remove the upper (thicker) cord, and carefully dry with air stream for 30 s.
Impression taking	Fill syringe with light-bodied impression material and load impression tray with either heavy-body putty (stock tray) or medium-bodied material (special tray), having placed adhesive on tray 5 min previously. Syringe impression material into gingival crevice. Air blow carefully with three-in-one syringe to encourage material into the depths of the gingival crevice. Inject remaining light-bodied material over the preparation and adjacent teeth. Insert the loaded impression tray, seat carefully and hold in a fixed position in the mouth. Allow the impression material to set. Remove the impression using a technique to minimise distortion.
Verification of impression	Carefully wash and dry impression. In good light, preferably using magnification, carefully check impression. There should be no defects or bubbles involving surfaces and margins of the prepared teeth, surfaces of teeth adjacent to prepared teeth and occlusal surfaces of all teeth. All margins should be recorded clearly, with a narrow 'skirt' of impression material extending beyond the finishing line of the preparation. Deficient impressions should be re-recorded. If in doubt, an impression may be cast to assess its sufficiency. Impressions should be disinfected prior to despatch to the laboratory, together with an opposing arch impression and a detailed laboratory prescription.

Table 19.6 Procedure for crown cementation.

Before the patient arrives	• Check fit of crown on the die. There should be no discernible discrepancy between the margins of the die and of the crown (Figure 19.3). • Check the die for damage or abrasion. If the die is damaged the crown may not fit the prepared tooth. • Check the proximal surfaces of adjacent teeth on the model for abrasion. If these surfaces have been damaged it may be impossible to seat the crown onto the prepared tooth without adjustment of the contact areas. • Check opposing teeth on opposing model. If these have been abraded during occlusal adjustment in the laboratory, the occlusion will be incorrect (high) clinically.
Checking fit of definitive crown	• Try to seat the definitive crown following removal of the temporary crown and all temporary cement. Ideally, the crown should seat fully with flush tight margins and good proximal contacts. • If the crown does not seat fully, use an appropriate 'fit-check' spray to check internal fit surface for blemishes and the proximal contacts. Carefully adjust as necessary. • Check margins for discrepancies. Negative horizontal defects – crown margin does not extend to the margin of the preparation – are an indication for a new impression and remake of the crown. Horizontal overhangs should be carefully adjusted until flush. Open margins may be caused by casting 'blebs' on the fitting surface or by an apical overextension of the margin of the crown. If such inaccuracies can be found and eliminated, resulting in tight margins, the crown may be suitable for cementation. If not, open margins are a strong indication for new impressions and remake of the crown. • Check emergence profile – the crown should not compress the gingival papilla. This happens when the diameter of the definitive crown rapidly expands from the margins rather than following the gradual expansion of diameter found in natural teeth.
Checking occlusion of definitive crown	• The crown should be seated fully and satisfactorily before the occlusion is considered. • Use articulating paper to identify contacts in maximum intercuspation. These should be no prematurity (high) contacts. If high contacts are present, these should be carefully adjusted until light contacts in maximum intercuspation remain. Contacts should *not* be eliminated. Where a crown opposes a partial denture tooth, the denture tooth should be preferentially adjusted. • Unless lateral guiding contacts have been planned, all contacts on crowns in lateral excursions (interferences) should be eliminated. Any margin or surfaces of a crown that has been adjusted should be polished until all visible evidence of adjustment has been eliminated.
Assessment of appearance	A good appearance meeting the patient's expectations is essential for success. Both the patient and the clinician should be happy with the appearance before cementation. If the metalwork fits well, but the shade or contour of the crown is unacceptable, it may be possible to have the ceramic part of the crown redone. Otherwise, new impressions and a remake may be indicated. *Do not cement crowns that the patient does not like or has uncertainties about.*
Cementation	• Preferably use encapsulated automated mix cements to eliminate human error in dispensing and mixing. Follow manufacturers' directions for use exactly. Small deviations may severely compromise the properties of a cement. Saliva contamination must be avoided. • Cement film should be as thin as possible, as the cement layer is the weak 'link' in the crown tooth interface. Crowns should be firmly loaded during cementation to seat completely and ensure a thin cement layer. • Carefully remove all excess set cement. • Check occlusion. Minimal or no adjustments should be necessary.
Review	It is good practice to review cemented crowns a week or so after placement. The review should verify that fit is acceptable, the occlusion is as intended, no excess cement has been overlooked, especially interproximally and subgingivally, and the patient is satisfied with the clinical outcome.

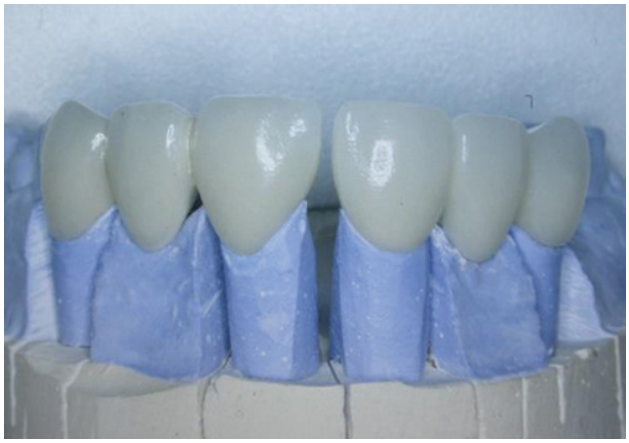


Figure 19.3 Do the crowns fit the dies?

Retainers can be:

- Conventional (the abutment is prepared for a crown and the retainer is a crown incorporated into the bridge structure).
- Minimal preparation (light preparation within enamel or no preparation) which rely primarily on resin-based adhesive cements for retention.

Bridge design, whether conventional or minimal preparation, may be:

- Cantilever: one retainer with one pontic attached.
- Fixed–fixed: one or more pontics with retainers at each end and sometimes between pontics.
- Fixed–movable: a pontic with a conventional retainer distally and a 'male' component mesially fitting into a slot in the distal of the medial retainer, where the long axes of the abutments is so divergent that parallel preparations would compromise the vitality of the abutment teeth.

Minimal Preparation Bridges

There is a genuine difference of opinion relating to preparations required for minimal preparation bridges. Some clinicians will do preparations as detailed in Table 19.7, others do no preparation whatsoever, and others pick and choose, depending on the circumstances and their personal preferences. The evidence for each approach is not strong and does not favour any specific approach.

Endodontically Treated Teeth

Teeth are weakened by endodontic therapy. Endodontically treated teeth are associated with a marked increase in the failure of bridges, so these teeth should, wherever possible, be avoided in the selection of bridge abutments. Endodontically treated teeth often require crowning because of the loss of tooth tissue associated with the reason for the root treatment (caries, trauma), endodontic access and preparation of the root canals. Root canals can be used to support a coronal restoration. Posts can be either cast or directly placed. Direct posts are made of either metal or fibre. The placement of posts and cores, in particular bonded posts and cores, requires fastidious moisture control and exact compliance with manufacturer's directions for use.

Table 19.7 Features of minimum preparation bridges.

Support	Presence of occlusal support – rests on posterior abutments and cingulum rests on posterior abutments. There is a difference of opinion between clinicians about the need for preparation with some preparing cingulum and occlusal rests similar to those required for cobalt chromium dentures, while others do no preparation.
Coverage	Cover should be maximised to maximise resin bonding. Axial preparation within enamel ensures maximum area for bonding, defines a single path of insertion, reduces bulbosity of the retaining wing, lowers survey line, and provides a finishing line which eases wax-up in the laboratory. Some clinicians feel that such preparations are unnecessary.
Wrap around	Ideally the retentive wing should wrap around the tooth by at least 180°. This can be done by extending the retentive wing from the embrasure close to the contact distant to the pontic all the way around to the pontic/facial line angle. Those clinicians in favour of preparation will prepare vertical parallel grooves in the distant embrasure and at the pontic/facial line angle. The grooves are tapering with parallel long axes, a maximum depth <1 mm and confined to enamel. They are said to give a single path of insertion and withdrawal, edge strength and clear finish lines for the laboratory.
Occlusion	Occlusion on pontics is confined to light centric stops only.

Crowns and Mandibular Incisors

Mandibular incisors are usually unsuitable for crowns because of their small size and tapering nature cervically. Therefore, every effort should be a made to avoid crowning mandibular incisors, many of which may be successfully restored using bonded composites, veneers or combinations of bonded composites and veneers.

Partial Dentures

Partial dentures are removable prostheses that replace some, but not all the teeth in a dental arch. Partially dentate patients comprise about 21% of the adult population

in the UK, and are mostly 55 years of age and older. While the edentulous proportion of the adult population has fallen from 37% in 1968 to less than 10% in the UK, the proportion of partially dentate patients is increasing with increasing longevity and individuals retaining more teeth into old age.

Partial dentures are associated with poor oral hygiene and increased levels of root and coronal caries, and with increased levels of at least gingivitis, particularly in the arch of teeth in which a partial denture is worn.

Treatment Planning

To provide each patient with the most suitable partial denture(s) to address individual needs, while minimising risk to the remaining dentition, a careful considered treatment plan should be formulated before any denture treatment is undertaken.

For partial denture prosthodontics, standard history and examination procedures should be augmented by a history and examination specific to the partially dentate mouth and existing dentures (Tables 19.8–19.10).

Diagnosis

It is essential to identify what is wrong with the existing dentures and the problems caused if mistakes and difficulties are not to be repeated.

Treatment Plan

The treatment plan should specify actions to manage any conditions that are treatable (e.g. caries, periodontal and endodontic problems) and the placement or replacement of restorations and crowns as indicated clinically to include the provision of necessary rest seats, guide planes and undercuts. All treatment involving abutment teeth should be completed before commencing construction of partial dentures.

Partial Denture Design

The design of partial dentures is the responsibility of the clinician. Responsibility cannot be passed on to the dental technologist. The stages of partial denture design, which all clinicians providing partial dentures should be familiar with, fall outside the remit of this manual. Cobalt chromium partial dentures have many advantages over acrylic partial dentures.

Table 19.8 Partial denture history.

Question	Relevance
Presenting complaint	If the presenting complaint relates to faults and deficiencies in partial dentures and these faults and deficiencies are not addressed, new dentures may fail for the same reasons.
Medical history relevant to wearing dentures:	
• Sjogren's, antihypertensives, antidepressants and drugs to control Parkinson's disease?	Reduced saliva impairs denture wear and increases caries rate.
• Neurological conditions including a history of CVA, Parkinson's disease, dementia?	Neurological conditions impair the oral control needed for the successful wearing of dentures.
• Diabetes mellitus?	Poor healing, reduced saliva and risk of oral infection including denture sore mouth.
• Dermatological and oral conditions that cause sore mouth?	Lichen planus, pemphigoid and oral ulceration inhibit denture wear.
• Use of bisphosphonate drugs?	Increased risk of bisphosphonate osteonecrosis with extractions.
• Excessive alcohol consumption, tobacco use and other oral cancer risk factors?	High oral cancer risk, together with increased risk of caries and periodontal disease.
Dental history:	
• When were teeth lost?	Ridge resorption related to time since extractions.
• Why were teeth lost?	Susceptibility to caries and periodontal disease?
Denture history:	
• Age of dentures and number of sets of partial dentures?	Frequent denture provision associated with reduced success – poor prognostic indicator.
• Where any partial dentures ever successful?	No successful dentures indicate very poor prognosis.
• Which dentures, if any, were successful?	No recent successful dentures indicate poor prognosis.

Table 19.9 Oral examination for partial denture provision.

Oral cancer examination.	Partial denture patients may have high oral cancer risk due to age and habits.
Condition of soft tissues:	
• Mucosal diseases and conditions present?	Chronic conditions of oral mucosa impair denture wear.
• Palpation of denture-bearing areas.	If ridge is tender to digital palpation, denture loading will cause discomfort.
Condition of the residual alveolar ridges:	
• Are dental remnants, denture-related pathologies present?	Should be eliminated before denture construction.
• Quality of residual alveolar ridges?	Poor ridge quality may impair support and stability of partial dentures.
• High frenae, prominent sharp bony ridges present?	Unfavourable for successful denture wearing – consider surgery.
• Interarch clearance, overeruption of opposing teeth?	Inadequate space for partial denture should be recognised at the outset.
• Presence of maxillary or mandibular tori.	Complicates partial denture design.
Condition of the abutment teeth:	
• Radiographs of abutment teeth.	Root length? Periapical condition? Endodontic status? Bone levels? Hidden caries?
• Restorative status of abutment teeth.	Crowns and restorations present.
• Vitality testing of abutment teeth.	Endodontically treated teeth have poor prognosis as abutments. Endodontic complications?
• Mobility of abutment teeth.	Mobile teeth have poor prognosis as abutments.
• Periodontal condition of abutment teeth – bleeding on probing, loss of attachment, 6-point pocket measurements?	Abutment teeth should be healthy.
• Position of abutments.	Kennedy classification.

Table 19.10 Intraoral examination of dentures.

Appearance: • Lip line? • Mid line? • Amount of tooth visible? • Match of natural and artificial teeth? • Visible clasps? • Black triangles? • Match of artificial and natural gingivae?	Patients primarily wear partial dentures for reasons of appearance. If the appearance produced by partial dentures is artificial-looking patients are rarely happy. Common faults include: denture teeth ill-matched to the remaining natural teeth, visible clasps, black triangles where blocked-out undercuts result in dead space between the denture and the remaining hard and soft tissues, differences in colour and contour of natural and artificial gingivae. Most of these difficulties are mitigated to a greater or lesser extent by a low lip line.
Retention and stability of partial dentures?: • Does the denture move on opening or moving the mouth? • Does the denture move on eating or biting? • Do clasps engage undercuts?	If yes, suggest: • Minimal retention. • Inadequate support or occlusal errors. • Poor denture design.
Occlusion: • Does maximum intercuspation of the natural teeth with the partial denture(s) in the mouth correspond with maximum intercuspation of the natural teeth without the partial denture(s)?	Incorrect jaw relation is the commonest cause of loose dentures and of denture discomfort.
Denture extension: • Do flanges fill the full height and width of labial and buccal sulci? • Does the mandibular partial denture, if it includes a distal extension, cover buccal shelves, retromolar pads and engage the retromylohyoid fossa?	
• Does the distal extension maxillary partial denture extend to the hamular notch, a displaceable but nonmobile part of the soft palate?	If not, this is evidence of underextension.
• Are buccal, labial flanges palpable through lips and cheeks?	If so, this is evidence of overextension.
Examination of dentures outside the mouth:	
• What are they made of?	Acrylic resin or cobalt chromium?
• Are clasps and occlusal rests present?	Indication of the sufficiency of the denture design.
• Are the denture teeth worn?	Indicates if the denture is routinely worn.
• Is the denture hygiene adequate?	If the denture is covered in deposits, hygiene must be addressed before making a new denture.

Alternatives to Partial Dentures

Alternatives to partial dentures, which includes no prosthesis if no benefit can result from provision of a prosthesis, should always be considered. These include bridgework or implant dentistry. All treatments have advantages and disadvantages which should be considered in the management of patients as individuals (patient-centred care).

Provision of Partial Dentures

The art and science of partial denture provision is complex (Tables 19.11–19.20).

Instructions for Wearing and Cleaning Partial Dentures

New dentures often cause some discomfort or sore spots. It is important that patients try to wear new partial dentures. If, however, the new dentures cause excessive discomfort, patients should note the discomfort experienced and go back to wearing the previous dentures.

Patients should wear the new partial dentures on the day of the review visit, unless causing excessive discomfort, allowing any areas of irritation to be discovered and suitably managed. Partial dentures should not be worn at night; however, many patients wear partial dentures at night whatever dental advice may be given.

Dentures should be cleaned by scrubbing with a soft bristle toothbrush, together with washing-up liquid, over a sink half filled with water. Toothpaste or denture cream should *not* be used as these are abrasive and damage denture surfaces. Dentures should be soaked in a proprietary denture cleaner for 30 min each day. If dentures are worn at night this procedure should be done in the evening and repeated in the morning.

Table 19.11 Stages in partial denture construction.

Stage	Aims of stage	Materials and appliances
Primary impression stage	To produce accurate primary models of teeth and edentulous areas. To produce wax occlusal rims for the preliminary jaw relation stage. To produce correctly extended special trays.	Polyvinylsiloxane (PVS) putty and/or alginate.
Preliminary jaw relation record stage	To articulate the primary models accurately. After having surveyed the primary models and examined the occlusion of these models, to formulate a design for the partial denture compatible with the occlusion and the wishes of the patient. The design should include plans for tooth preparation where indicated clinically.	Wax rims and either zinc oxide eugenol impression paste, modelling wax or PVS jaw relation registration material.
Secondary impression stage	To complete necessary tooth preparations. To produce accurate master models. To produce well-fitting, correctly extended denture bases.	Custom (special) tray. Light or medium body PVS or alginate. Tray modification materials: green stick or PVS.
Metal trial insertion stage	To fit the metal casting. To ensure that the metal casting does not interfere with the occlusion.	Fit-checker spray. Articulating paper.
Jaw relation record stage	To record the midline and level of occlusal plane by trimming the wax rim(s). To record the maxilla-mandibular jaw relationship in maximum intercuspation. To select tooth shade and mould.	Modelling wax rims on metal casting. Zinc oxide eugenol impression paste, modelling wax or PVS jaw relation registration material. Shade and mould guide.
Wax trial insertion stage	To verify the accuracy of the reproduction of maximum intercuspation. To determine if the patient's expectations of appearance have been addressed. Double-check base extension.	
Insertion stage	To verify the retention and stability of the denture(s). To verify accuracy of reproduction of maximum intercuspation. To adjust base extensions where necessary. To confirm that the patient's needs and expectations have been met. Denture hygiene instruction.	Fit checker. Pressure indicator paste. Articulating paper.
Review stage	To verify the retention and stability of the denture(s). To verify accuracy of reproduction of maximum intercuspation. To adjust base extensions where necessary. To confirm that the patient's needs and expectations have been met. Denture hygiene instruction.	Fit checker. Pressure indicator paste. Articulating paper.

Table 19.12 Partial dentures: first clinical stage – primary impressions.

Choosing impression stock trays	Trays should cover posterior teeth or retromolar pads in mandible and tuberosities in maxilla, if the molars are absent. Maxillary tray should be wide enough to fit outside tuberosities. Mandibular trays should be narrow enough to fit inside retromolar pads.
Modification of tray	Polyvinylsiloxane (PVS) adhesive. Place a walnut-sized bead of PVS impression putty in palate of the maxillary tray, in the edentulous areas of both trays and place in mouth. If the stock tray is very ill-fitting an overall impression with PVS putty is made.
Tray placement	Patients naturally open the mouth wide to 'help' the clinician. This, however, makes tray placement difficult, as the mouth should be half open for tray placement. As pressure from the lips tends to 'distalise' tray placement, trays should be pulled forward after insertion into the mouth before seating. This is to ensure that the anterior teeth are centred in the tray box section permitting the labial flange to be guided into the labial sulcus, having retracted the lip. Care should be taken not to trap the tongue on seating the lower tray.
Border moulding	Maxillary impression: purse lips, vigorous smile, lateral excursions of the mandible. Mandibular impression: purse lips, vigorous smile, eversion of lower lip, tongue licks behind upper lip, wide opening of the mouth.
Adjustment of impression putty	Remove 2–3 mm of PVS putty from all areas where putty touched teeth. Remove overextensions.
Alginate/alginate wash	Alginate adhesive. Place even layer of alginate over putty tray inserts and fill tray box sections. Place excess on borders. Place as above. Border mould as above.
Impression assessment	A good impression has correct extension, indicated by rolled borders, reproduces anatomical landmarks and has good surface detail.
Laboratory instructions	'Please cast impressions and make spaced perforated (for alginate)/spaced nonperforated (for PVS impression material) special trays. Please make wax rims for preliminary jaw relation record.'

Table 19.13 Partial dentures: second clinical stage – preliminary jaw relationship registration.

Checking fit of wax rims	Wax rims should fit into the edentulous areas without discomfort. Adjust as necessary.
Adjusting height of wax rims	Place one rim at a time in the mouth. Eliminate any contact between the wax rim and the opposing teeth. Repeat for the second rim, if there is one. Then insert both rims at the same time and eliminate any contact between the rims. Eliminating tooth to opposing wax rim contact is critical, as contact would cause the underlying soft tissues to be deformed during recording. As the soft tissues are represented by dental stone on the models, the different displaceabilities would render any record inaccurate.
Recording maximum intercuspation	Cut deep interlocking 'V'-shaped grooves into the occlusal surface of the wax rims. Insert wax rims in the mouth. Apply chosen recording material. Have patient close into maximum intercuspation. Remove rim(s) when recording material is set.
Verification of record	Check that none of the teeth have penetrated through the recording material into the opposing wax rim. Use the record and wax rims to hand articulate the primary models. Check that the teeth on the models meet in the same way as the natural teeth meet in maximum intercuspation. If in doubt re-record.

Partial Denture Review

The patient should return for first review 1 week after the dentures have been fitted. The review should include:

- Careful history to elicit problems.
- Careful examination of the soft tissues with particular reference to areas of discomfort described by the patient and areas of redness of soft tissues in proximity to the denture peripheries.
- Application of pressure indicator paste (PIP) to the peripheries of the dentures: insert, remove and adjust as necessary.
- A repeat of the insertion stage checks.
- An assessment of how well the patient is cleaning the dentures and the teeth. Offer oral and denture hygiene as necessary.
- The offer of another review appointment if there are any outstanding concerns.

Table 19.14 Partial dentures: third clinical stage – master impressions.

Tooth preparations	Guide planes can be prepared by removing bulbosity to create parallel-sided teeth. Preparation of occlusal rests – these should be saucer shaped, 3 mm across, 1 mm deep and be clear of the opposing occlusion. If possible, occlusal rest seats should be prepared in existing restorations. Preparation of cingulum rests – these should be crescent-shaped shelves, 4 mm across, up to 1 mm deep in enamel and be clear of the opposing occlusion. The floor of the rest should be at right angles to the long axis of the tooth. Rest seats should preferentially be placed in sound existing restorations. Creation of retentive undercuts can be achieved by adding composite to create a bulbosity on teeth. High survey lines can be lowered by reducing the contour of teeth, parallel to the path of insertion.
Checking fit of custom impression trays	Trays should cover all teeth, or, if distal extension saddles are planned, retromolar pads, buccal shelves, tuberosities, hamular notches and foveae palatinae. Trays should fit and engage sulci. Tray extension should be checked by visual examination of seated trays and palpation of borders. Obvious overextension should be reduced. Under extension should be addressed by the addition of green stick compound.
Master impressions	The appropriate adhesive for the impression material to be used is applied to the impression tray and left to dry for 5–10 min. An even, 5 mm thick layer of alginate or light or medium body polyvinylsiloxane impression material is applied over the fitting surface of the tray, extending over the borders onto the buccal and lingual surfaces. Trays are placed in accordance to the directions for tray placement in Table 19.5.
Impression assessment	A good impression has correct extension, indicated by rolled borders in the edentulous areas, good detail of teeth, reproduction of anatomical landmarks and has good surface detail. The purpose of master impressions is to produce an accurate likeness of the denture-bearing areas in the master model, permitting the production of an accurate casting.
Laboratory instructions	'Please cast impressions in improved die stone. Please cast cobalt chromium framework to design shown (provided a metal framework is required).' You may also request that wax rims for jaw relation recording are added to the casting. For acrylic dentures, wax rims only are required.

Table 19.15 Partial dentures: fourth clinical stage – metal framework trial insertion.

Checking the fit of the casting on the master model	Check that the design prescribed has been followed. Make sure the casting fits well on the master model. If there is rocking or a misfit the chances of success are remote. If the master model has broken abutment teeth or teeth that have been glued on the chances of success are remote. Check the master model for abrasions on the abutment teeth and guide planes. These indicate that the casting may be overextended and therefore very tight against natural teeth in these areas.
Fitting the casting in the mouth	Carefully insert the casting in the mouth. Do not use excessive seating force. If it slips into place the first stage is complete. If it jams or does not slide into place, a disclosing agent should be sprayed onto tooth contacting surfaces of the casting and it should be reinserted as far as it will go. It is removed and contacts, indicated by metal showing through the disclosing layer, are adjusted. This is repeated until the casting fits, or it becomes loose. If the casting rocks after adjustment, it is hopeless.
Trimming the casting out of occlusion	To establish even, simultaneous contact between maxillary and mandibular teeth in maximum intercuspation with casting in place. There should be no premature contacts between teeth and the metal framework. Any premature contacts should be found with articulating paper and eliminated.
Laboratory instructions	'Please add wax occlusion rims to casting for jaw relation record.'

Complete Dentures

Complete dentures are removable prostheses that replace the whole dentition. Edentulous patients comprise about 10% of the adult population in the UK, and are mostly over the age of 55. Edentulous patients often have feelings of guilt and inadequacy in relation to complete denture wearing and suffer marked disability in relation to chewing, even with correctly made, well-fitting dentures. As many edentulous patients have been without natural teeth for many years, increased residual alveolar ridge resorption minimises potential function of complete dentures. Where dentures are suboptimal, patients may additionally suffer disability in relation to speech, appearance and social embarrassment. Patients often are increasingly unwilling to accept the unavoidable disabilities imposed

Table 19.16 Partial dentures: fifth clinical stage – definitive jaw relation recording. This stage is often done at the end of the metal trial insertion stage, saving a patient appointment.

Trimming maxillary wax rim	Make sure the metal casting with its wax rim fits comfortably. If the metalwork previously fitted and now does not, look for the wax that is preventing fitting and eliminate it. Trim maxillary anterior rim if present to indicate mid line, height of incisors, maxillary occlusal plane and position of maxillary teeth to dental laboratory. Eliminate contacts between rims and opposing teeth. Scribe interlocking 'V'-shaped grooves in wax rim.
Recording position of maximum intercuspation[a]	Insert casting(s) with wax rims in the mouth. Apply chosen recording material. Have patient close into maximum intercuspation. Remove casting(s) and rim(s) when recording material has set.
Recording retruded jaw relationship[b]	To produce a definite record that relates maxillary to mandibular wax rims when the patient is in the retruded jaw relationship. This is only necessary when there is no occlusion between remaining maxillary and mandibular teeth. Refer to the method used for complete dentures explained later.
Choosing a tooth shade	To select a tooth shade that meets the patient's expectations. Choose shade under optimal conditions, good natural light or colour-corrected artificial light.
Choosing a tooth mould	To choose a tooth mould that meets the patient's expectations
Laboratory instructions	'Please articulate models using jaw relation record provided. Please set up teeth for wax trial insertion.' Special instructions – midline diastema, irregularities in the set-up, etc. Include shade and mould.

[a] Position of maximum intercuspation: this is the position where the opposing teeth interdigitate best.
[b] Retruded jaw relationship: this is the position where the condyles are in uppermost, midmost position in the glenoid fossa when the mandible is at the correct vertical dimension of occlusion. It is rarely coincident with the position of maximum intercuspation.

Table 19.17 Partial dentures: sixth clinical stage – trial insertion.

Examine the wax trial insertion before the patient arrives to identify potential problems	Is the set-up symmetrical and of a pleasant appearance? Have the rules for an aesthetic set-up been followed? Do the teeth meet evenly when hand articulated? Do the casting(s) fit well on the models? Do the teeth on the casts contact? Have the denture teeth been carefully adjusted to meet opposing natural teeth or have they been flattened?
Check appearance	Check that the mid lines coincide with the middle of the face. Check that the maxillary occlusal place is parallel to the interpupillary line laterally and the ala-tragal line antroposteriorly. Check the amount of maxillary and mandibular tooth showing at rest, speaking and smiling. Does the level of the artificial gingival margin coincide with the real gingival margin? Check lip support and prominence of upper teeth.
Checking jaw relationship	Make sure the casting(s) fit comfortably. Have the patient tap the upper and lower teeth together. Do they meet evenly or are there premature contacts on the denture teeth? If there are premature or open contacts between the denture teeth and natural teeth, the denture teeth should be removed and the maximum intercuspal position (MIP) should be re-recorded.
Check tooth position	Is there a cross bite? Except in Class III set-ups there should be no cross bites, unless teeth have drifted. Are the upper central incisors 8–10 mm anterior to the centre of the incisive papilla? If not the incisors are incorrectly placed – too anterior or too posterior? Is the upper lip well supported? Are the incisors vertical or slightly proclined? They should be slightly proclined.
Confirm the patient's acceptance of the appearance	The patient must be the final arbiter of appearance. Whatever the clinician may think about appearance, within the bounds of what is possible, the aim should be to achieve an appearance acceptable to the patient.

Table 19.18 Partial denture: addressing problems that arise at trial insertion.

Incorrect shade or mould	Ask laboratory to change shade and mould.
Incorrect position or appearance of maxillary anterior teeth	Move maxillary canine and incisor teeth (at the chair side) to correct height, angulations and antroposterior position. Even if the teeth are to be replaced with a different mould, this will make the task of resetting the new teeth easier.
Jaw relationship error	Remove denture teeth and build a wax rim just short of the opposing teeth and re-record MIP.

Table 19.19 Partial denture: seventh clinical stage – insertion.

Examine the dentures before the patient arrives to identify potential problems that may have arisen in the laboratory processing stage	Is the set-up the same as after the trial insertion? If not, may need to reset the teeth. Has acrylic found its way onto the surface of the metalwork? If so remove. Do the teeth meet evenly when dentures on models are hand articulated? If no, a laboratory error may have occurred. Are the teeth in the correct locations? If not, may need to reset the teeth. Is the acrylic forming the artificial labial gingivae lifelike? If not, may need to be recontoured. Is the polished surface rough? If so polish. Is the phonetic shelf present? If not, may need to be added. Is the acrylic sound? If not, the acrylic work may need to be replaced. Are the peripheries overextended/overpolished? If yes, will need to be adjusted and refinished. Are there sharp edges or blebs present? If yes, these must be removed. Is there an acrylic flash on the guide planes of the casting? If yes, remove. Do the denture teeth impinge on the model teeth? If so, adjust.
Initial denture insertion	Make sure the dentures can be inserted without discomfort. If not, use disclosing material and adjust carefully as necessary until the dentures can be inserted fully and removed without discomfort. Check the appearance using the same method used at the trial insertion stage.
Check denture retention	Retention: when pressed into place does the denture stay in place? If not the retention is poor. Clasps may need to be tightened.
Checking for correct extension	Correctly extended denture borders should fill the height, width and depth of the sulci. If the dentures cause a bulge of the cheeks or lips that can be felt or seen, the flanges are overextended. Pressure indicator paste can be applied to the flanges to check for overextension. Inspection may show over- or underextension in the areas around frenae, at the posterior border of the dentures, around the tuberosities, on the buccal shelves and in the postmylohyoid areas.
Check jaw relationship	Make sure the denture(s) fit comfortably. Check if the patient closes into maximum intercuspation. If the natural teeth are separated slightly the denture teeth may be adjusted using articulation paper. If the error is large the denture teeth may need to be removed and MIP re-recorded.
Check tooth position	Check appearance and tooth position. If these are unsatisfactory, it may be necessary to change the denture teeth.
Confirm the patient's acceptance of the appearance	Tooth position and appearance should have been agreed by the patient at the trial insertion so there should not be any change in the previously agreed appearance. If there is a problem at the insertion stage, you have a potentially serious problem.

Table 19.20 Partial dentures: addressing problems that arise at insertion stage.

Discomfort on insertion	Eliminate sharp edges. Remove overextensions disclosed using pressure indicator paste (PIP). Check that clasps do not impinge on soft tissues. If necessary, adjust clasps, or have them replaced with appropriately designed clasps.
Overextensions	Disclose all flanges with PIP, adjust where the PIP has been rubbed off.
Error in jaw relationship	Adjust small errors using articulating paper. If the error is large, grind off denture teeth, build a wax rim, re-record MIP.
Errors in tooth position	Remove teeth, reset artificial teeth in wax at the agreed, correct positions. Return to the laboratory for processing.

by wearing conventional complete dentures. Dental implant supported complete dentures can be far superior to conventional complete dentures.

Treatment Planning

To provide an edentulous patient with the complete dentures which meet their needs and expectations, it is essential to obtain as much information as possible about the patient's previous experience with dentures. For complete denture prosthodontics, standard history and examination procedures should be augmented with a history and examination specific to the edentulous mouth and existing complete dentures (Tables 19.21–19.23).

Table 19.21 Complete dentures history.

Question	Relevance
Presenting complaint	If the presenting complaint relates to faults and deficiencies in complete dentures and these faults and deficiencies are not addressed, new dentures may fail for the same reasons.
Medical history relevant to wearing dentures:	
• Sjögren's syndrome, antihypertensives, antidepressants and drugs to control Parkinson's disease?	Reduced saliva impairs denture wear and increases caries rate.
• Neurological conditions including a history of CVA, Parkinson's disease, dementia?	Neurological conditions impair the oral control needed for the successful wearing of dentures.
• Diabetes mellitus?	Poor healing, reduced saliva and risk of oral infection including denture sore mouth.
• Dermatological and oral conditions that cause sore mouth?	Lichen planus, pemphigoid and oral ulceration inhibit denture wear.
• Use of bisphosphonate drugs?	Increased risk of bisphosphonate osteonecrosis over mylohyoid ridges.
• Excessive alcohol consumption, tobacco use and other oral cancer risk factors?	High oral cancer risk.
Dental history:	
• When were teeth lost?	Ridge resorption related to time since extractions.
• Have dentures been worn since the teeth were lost?	Ridge resorption may be related to pattern of denture wearing.
• Which arch if either was rendered edentulous first?	Ridge resorption may be related to natural teeth having opposed a complete denture.
Denture history:	
• Age of dentures and number of sets of complete dentures?	Frequent denture provision associated with reduced success – poor prognostic indicator.
• Which dentures, if any, were successful?	No successful dentures indicate very poor prognosis. No recent successful dentures indicate poor prognosis.

Table 19.22 Oral examination specific to complete denture patients.

Oral cancer examination.	Complete denture patients have high oral cancer risk due to age and habits.
Condition of soft tissues:	
• Mucosal diseases and conditions present?	Chronic conditions of oral mucosa impair denture wear.
• Palpation of denture bearing areas.	If ridge is tender to digital palpation, denture load will cause discomfort.
Condition of the residual alveolar ridges:	
• Are dental remnants or denture-related pathology present?	Should be eliminated before denture construction.
• Height and width of maxillary residual alveolar ridge?	Poor ridge quality may impair support and stability of maxillary denture.
• Fibrous enlargement of maxillary tuberosities present?	Inadequate space for denture between tuberosity and retromolar pad.
• Height and width of mandibular residual alveolar ridge?	Flat ridge form impairs support and stability of mandibular denture. High elevated floor of the mouth may preclude lingual extension.
• The presence of fibrous replacement of bony ridges?	Displaceable ridges make very poor denture bearing tissues.
• Unroofing of ID canal or mental foramen – 'U-shaped foramen or 'tram track' ridge crest?	Poor prognosis as pain often results from mandibular denture wearing.
• High frenae, prominent sharp bony ridges?	Unfavourable for successful denture wear: consider surgery.

Table 19.23 Intraoral examination of complete dentures.

Appearance:	
• Size of maxillary teeth? Length? Width? Relationship to upper lip?	Patients primarily wear complete dentures for reasons of appearance. If the appearance produced by complete dentures is false-looking patients are rarely happy. Common faults include teeth that are too small, too white, set up too palatally, set with the midline of the denture not corresponding with the midline of the face, set up too regularly with centrals, laterals and canines at the same level, or set up with a slope laterally.
• Colour of maxillary teeth?	
• Prominence of maxillary teeth, lip support?	
• Symmetry? Is occlusal plane horizontal? Do midlines of face and denture correspond? Is tooth arrangement natural looking?	
Retention of maxillary complete denture:	
• Does the denture spontaneously fall on opening or moving the mouth?	Suggests minimal retention. Poor resistance to displacement suggests inadequate labial or buccal border seal.
• Resistance to the displacement when denture is grasped between thumb and forefinger in both canine areas and pulled downwards?	Poor resistance to displacement suggests inadequate posterior border extension and seal including extension and seal in the tuberosity sulcus.
• Resistance to displacement when denture is grasped by the central incisors and pulled downwards and forwards?	
• Resistance to displacement when denture is grasped in each canine area in turn and pulled laterally?	
• Denture falls saying 'A-A-A-A-A-A'?	
Stability and retention of mandibular dentures:	
• Does the denture spontaneously rise on opening the mouth?	Suggests tooth position or extension error.
• On opening, the denture is no longer displaced when the lower lip is pulled forward.	Suggests position of lower anterior teeth is incorrect – too far forward.
• On opening, the dentures displaced when the tongue is moved.	Suggests lingual overextension.
• Denture is only displaced on wide opening.	Suggests buccal overextension.
Occlusion:	
• Does maximum intercuspation correspond with retruded jaw relation? (To get patient to close in retruded jaw relation recline patient almost to horizontal, extend neck and have patient close slowly with tongue touching the posterior edge of the maxillary denture while holding the mandibular denture by its buccal flange in position with forefingers on the buccal extensions and thumbs under the mandible.)	Incorrect jaw relation is the commonest cause of loose dentures and denture discomfort.
Vertical dimension of occlusion (interocclusal clearance):	
• Minimum speaking space assessment – do denture teeth touch pronouncing '66' ('s' sounds are minimum speaking space sounds).	If teeth touch the interocclusal, clearance is inadequate. If RVD – OVD <2 mm the interocclusal clearance is inadequate; if RVD – OVD >4 mm the interocclusal clearance is excessive.
• Measure resting vertical dimension (RVD) and occlusal vertical dimension (OVD) using Willis gauge or dividers.	
Denture extension:	
• Does flange fill full height and width of labial and buccal sulci?	If not, this is evidence of underextension.
• Does mandibular denture cover buccal shelves, one-half to two-thirds of retromolar pads?	If not, this is evidence of underextension.
• Does maxillary denture extend to the hamular notch, to displaceable but nonmobile part of the soft palate?	If not, this is evidence of underextension.
• Are buccal, labial flanges palpable through lips and/or cheeks?	If so, this is evidence of overextension.
• Can the lateral aspect of the tuberosity be palpated with a finger in the tuberosity sulcus when the mouth is almost closed and the denture is in place?	If so, this is evidence of underextension of the denture flange in the tuberosity sulcus.
Examination of dentures outside the mouth:	
• Relationship of maxillary incisors to incisive papilla?	Facial aspect of central incisor should be 8–10 mm in front of the incisive papilla.
• Relationship of mandibular incisors to labial flange?	Incisors should be as far anterior as the correctly extended flange.
• Relationship of mandibular occlusal plane to anterior retromolar pad?	Molar teeth should be no higher than the lowest part of the retromolar pad.
• Definite maximum intercuspal position?	If absent, poorly set-up teeth in new dentures; tooth wear if old dentures.
• Rounded or knife-edged buccal, labial and lingual flanges?	Knife-edged flanges suggest under extension in width of flanges.

Special Tests

The only special test usually indicated for edentulous patients requiring conventional replacement complete dentures are sectional dental pantomograms, augmented with periapical views only where dental remnants are found or suspected.

Diagnosis

It is essential to identify what is wrong with the existing dentures and the problems caused if mistakes and difficulties are not to be repeated.

Treatment Plan

A treatment plan for complete dentures should include actions to manage any conditions that are treatable (e.g. denture-related stomatitis, denture-related ulceration), correct problems amenable to surgery (e.g. extracting tooth roots, removing denture granulomas) and rectify faults in existing dentures.

Provision of Complete Dentures

The successful provision of complete dentures is an acquired skill, requiring a detailed knowledge of relevant oral and dental science, together with the application of effective patient communication and management techniques (Tables 19.24–19.33).

Instructions for Wearing and Cleaning Complete Dentures

New dentures often cause some discomfort or sore spots. It is important that patients try to wear new dentures. If, however, they cause excessive discomfort patients should note the discomfort and go back to wearing previous dentures. Patients should wear the new dentures on the day of the review visit, assuming they do not cause excessive discomfort, so that any areas of irritation can be identified.

Table 19.24 Stages in compete denture construction.

Stage	Aims of stage	Materials and aids
• Primary impression stage	To produce correctly extended special trays.	Stock edentulous impression trays Polyvinylsiloxane (PVS) putty and/or alginate.
• Secondary impression stage	To produce well-fitting, correctly extended denture bases.	Custom (special) trays. Green stick compound and/or hard reline material to mould and refine special trays. Zinc oxide eugenol impression material or medium or light body PVS impression material.
• Jaw relation record stage	To check base extension. To determine vertical dimension of occlusion, anteroposterior tooth position, midline and level and orientation of occlusal plane. To record retruded jaw relationship. To choose tooth shade and mould.	Modelling wax, zinc oxide eugenol impression material or PVS occlusal registration recording material.
• Wax trial insertion stage	To verify vertical dimension of occlusion, accuracy of reproduction of retruded jaw relationship. To determine if the patient's expectations of appearance have been addressed. To address problems discovered at this stage.	
• Insertion stage	To verify retention, stability of denture bases. To verify vertical dimension of occlusion, accuracy of reproduction of retruded jaw relationship. To adjust base extension To address problems discovered at this stage.	Fit checker. Pressure indicator paste.
• Check record stage	To refine occlusion to ensure maximum intercuspation corresponds with retruded jaw relation. To develop balanced occlusion.	Modelling wax.
• Review stage.	To adjust base extension.	Fit checker. Pressure indicator paste.

Table 19.25 Complete denture: first clinical stage – primary impressions.

Choosing impression stock trays	Trays should cover retromolar pads/tuberosities. Maxillary tray should be wide enough to fit outside tuberosities. Mandibular trays should be narrow enough to fit inside retromolar pads.
Modification of tray	Apply polyvinylsiloxane (PVS) adhesive. Place walnut-sized bead of PVS impression putty in palate of tray, extend across posterior border and place in mouth. If the stock tray is very ill fitting an overall impression with PVS putty is recorded.
Tray placement	Patients naturally open the mouth to 'help' the dentist. This, however, makes tray placement difficult. The mouth should be half open for tray placement. As pressure from lips tends to 'distalise' tray placement, the clinician should consciously pull the impression trays forward after insertion into the mouth before seating. This is to ensure that the anterior ridge is centred in the tray box section permitting the labial flange to be guided into the labial sulcus, having retracted the lip.
Border moulding	Maxillary impression: purse lips, vigorous smile, lateral excursions of the mandible. Mandibular impression: purse lips, vigorous smile, eversion of lower lip, tongue licks behind upper lip, wide opening of the mouth.
Adjustment of impression putty	Remove 2–3 mm of PVS putty from all areas where the putty contacted soft tissues. Remove overextensions.
Alginate/alginate wash	Apply alginate adhesive. Place an even layer of alginate over the putty inserts and fill box sections. Apply excess on borders. Place as above. Border mould as above.
Impression assessment	A good impression has correct extension indicated by rolled borders, reproduces anatomical landmarks and has good surface detail (Figure 19.4).
Laboratory instructions	'Please cast impressions and make close fitting (for zinc oxide eugenol impression material)/spaced (for PVS impression material) nonperforated special trays.'

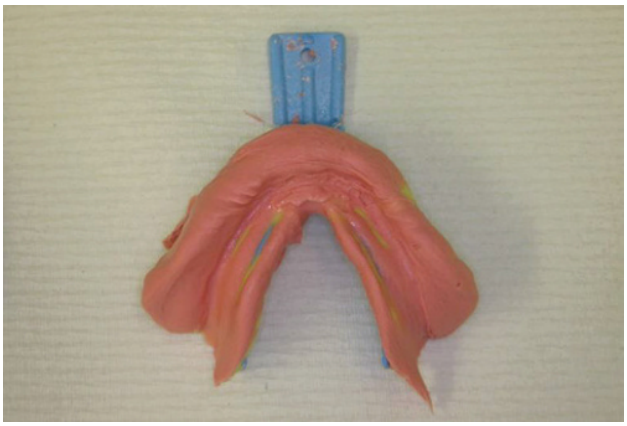


Figure 19.4 Complete dentures: an example of a satisfactory mandibular primary impression.

Dentures should preferably not be worn at night. However, many patients wear complete dentures at night whatever dental advice may be given. Dentures should be cleaned by scrubbing with washing up liquid using a soft-bristled toothbrush over a sink half-filled with water. Toothpaste or denture cream should *not* be used as these are abrasive and damage denture surfaces. Complete dentures should be soaked in a proprietary denture cleaner or sodium hypochlorite solution (Milton sterilising fluid mixed to the same concentration as for baby bottle disinfection) for 30 min each day and then carefully rinsed before insertion into the month. If dentures are worn at night this

Table 19.26 Complete dentures: second clinical stage – master impressions.

Checking fit of custom impression trays	Trays should fit and cover retromolar pads, buccal shelves tuberosities, hamular notches and foveae palatinae. Tray extension should be checked for extension by visual examination of seated trays and palpation of borders. Obvious overextension should be reduced and obvious underextension should be made up with chairside hard reline material or with green stick compound.
Modification of tray borders	Borders are modified using the border wash technique. Zinc oxide impression paste is mixed and placed along and over (<3 mm) the flange of the impression tray and across the posterior borders of the tray. The material should not extend onto the fitting surfaces or ridges. Alternatively, green stick compound can be used. Trays are placed and border moulded as detailed in Table 19.5.

(*Continued*)

Table 19.26 (Continued)

Examination of border wash or of impression of borders with green stick compound	Correct extension results in a rolled border. Under extension produces a knife edge border. Tray flanges show through in overextended areas. Overextensions are trimmed to the level shown by the curve of the potential rolled border interrupted by the prominent tray extension. The advantage of zinc oxide impression paste over other materials is that it can be added to and makes accurate impressions of both the height and width of sulci.
Master impressions	An even <3 mm layer of zinc oxide impression paste is applied across the fitting surface and over the borders of the tray. Trays are placed and border moulded as detailed in Table 19.5. Alternatively, a light- or medium-bodied polyvinylsiloxane can be used. This material is indicated for patients who are intolerant to zinc oxide impression paste.
Impression assessment	A good impression has correct extension indicated by rolled borders, reproduces anatomical landmarks and has good surface detail (Figures 19.5 and 19.6).
Laboratory instructions	'Please bead and box impressions. Please cast impressions and make permanent bases/wax bases/temporary bases and set up wax rims for jaw relation recording.'

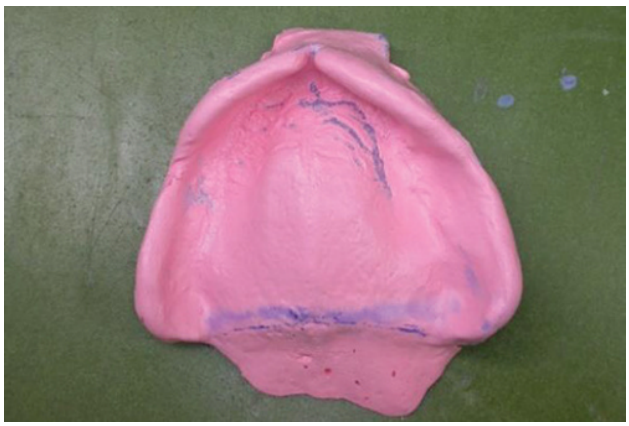


Figure 19.5 An example of a satisfactory zinc oxide master impression, reproducing a positive likeness of the maxillary denture-bearing area.

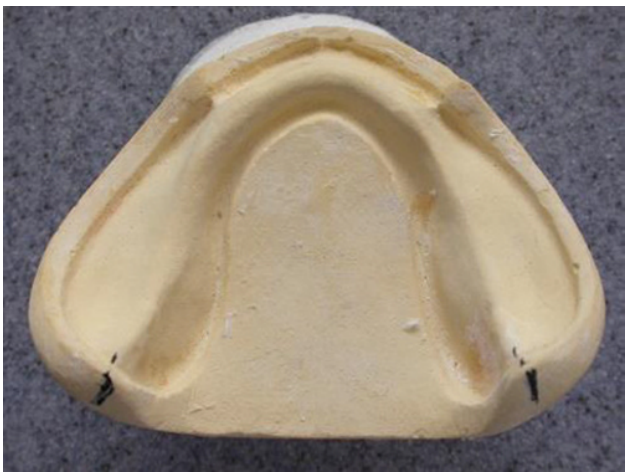


Figure 19.6 An example of a mandibular cast produced from a successful master impression.

Table 19.27 Complete dentures: third clinical stage – recording jaw relationship.

Trimming the maxillary wax rim	Make sure the bases fit comfortably. If they are uncomfortable at this stage, it is highly unlikely that the completed dentures will be comfortable. Aim: to indicate midline, height of incisors, maxillary occlusal plane and position of maxillary teeth to dental laboratory. Method: Trim labial and buccal extensions to about 9 mm anterior or lateral to the crest of the ridge. Trim anterior ridge height to show 1 mm of rim with lips apart at rest. Having established the anterior ridge height, trim or add to posterior rims to make them parallel to the interpupillary line when viewed from in front of the patient, and parallel to the ala-tragal line posteriorly. Mark the midline. The upper lip should look well supported with the philtrum and the vermilion border well defined without having the lips bulging.
Determining the vertical dimension of occlusion (VDO) to establish correct face height	Have the patient sit with the face vertical and the head unsupported by the dental chair. The patient is asked to let the lips touch gently. The distance from below the chin to the nose is measured with a Willis gauge. This is repeated after the patient licks the lips and swallows, and then after the patient says 'M'. These approaches should give broadly similar measurements. These measurements represent the resting vertical dimension (RVD). The occlusal vertical dimension (OVD – the occlusal height of the dentures) should be 2–4 mm less than the RVD. This is because dentate people have a small space between their teeth when at rest and when saying sounds with the letter 'S' in them – '66' and 'Mississippi' are widely used to test this minimum speaking space. See Table 19.28 for a comparison of methods to estimate VDO.
Trimming mandibular wax rim	To establish even simultaneous contact between maxillary and mandibular wax rims at the correct OVD in the retruded arc of closure. There should be no heel contacts as these will make any attempt to record retruded jaw relation unsuccessful.

Table 19.27 (Continued)

Recording retruded jaw relationship (RJR)[a]	To produce a definite record that relates maxillary to mandibular wax rims when the patient is in retruded jaw relationship.
Choosing a tooth shade.	To choose a tooth shade that meets the patient's expectations.
Choosing a tooth mould	To choose a tooth mould that meets the patient's expectations.
Facebow transfer	A facebow transfer may be done at this stage to relate the maxillary cast to the condylar hinge axis and the maxillary plane to enable correct orientation of the maxillary cast on the articulator.
Laboratory instructions.	'Please articulate models using jaw relation record provided. Please set up teeth for wax trial insertion.' Special instructions – midline diastema, irregularities in the set-up, etc. Include shade and mould.

[a] Retruded jaw relationship is the relationship of the mandible to the maxilla when the condyles are in the midmost, uppermost, anterior-most position on the glenoid fossa at the correct vertical dimension of occlusion. This position is recorded because it is the only reproducible position, edentulous patients having no dental reference points.

Table 19.28 Complete dentures: comparison of methods for estimating the vertical dimension of occlusion (VDO).

Method	Procedure	Strengths and weaknesses
Reproduce previous VDO	Measure VDO with existing complete denture in the mouth using either a Willis gauge or dividers.	Simple but unreliable, repeats errors of previous dentures. Use only if the old dentures have a satisfactory VDO.
Appearance	Trim maxillary wax rim to correct contour for optimum lip support and establish the occlusal plane. Trim lower rim height until the appearance of the lower face is optimised. Inability to approximate lips without mentalis activity indicates excessive VDO.	Depends on accurate trimming of maxillary rim. Requires experience for any chance of success, even then is unreliable; tends to give inadequate VDO.
Minimum speaking space method.	Maxillary rim is trimmed to correct contour. Mandibular rim is carefully trimmed to meet the maxillary rim evenly. Minimum speaking space sounds include 'S' sounds – there should be a space of about 1 mm between maxillary and mandibular rims pronouncing '66' or 'Mississippi'. Trim or add to mandibular rim until minimum speaking space is achieved.	Technique sensitive, difficult to do when wax rims are thick. Unreliable when denture bases are unretentive and unstable.
Resting vertical dimension (RVD) method	In dentate patients sitting upright, at rest, with the head unsupported and the maxillary plane horizontal, a space of 1–2 mm is normally found between the maxillary and mandibular teeth. This face height is called the RVD. In the edentulous patient, the maxillary wax rim is trimmed to correct profile, placed in the mouth and the RVD is measured. Patients may be encouraged into RVD by being asked to swallow or to say 'MMMM'. The occlusal vertical dimension is estimated at 2–4 mm less than the RVD.	Requires skill to use either dividers or Willis gauge reproducibly. RVD influenced by posture and the accuracy of trimming the maxillary wax rim.

Table 19.29 Complete dentures: choice of tooth shade and mould.

Method	Aim	Effect
Match mould and shade to existing denture	To copy the tooth size, shade and appearance of the existing denture.	Copying existing appearance is very effective, provided the patient is happy with the appearance of their existing dentures.
Place the shade guide under the upper lip to mimic the appearance of a central incisor	To judge or apply experience to select the shade that best matches the patient's appearance considering their age, complexion and general appearance. Shade selection should be done in north-facing, natural or diffuse colour-corrected light.	An estimate of the correct shade. This approach is very subjective. The patient should be consulted; indeed, shade selection should be a shared decision with the patient.
Tooth mould	A central incisor should, on average, be one quarter the width of the nose.	In older people the nose tends to be disproportionately large. If used as a guide it tends to give a mould that is too large for the older patient.

Table 19.30 Complete dentures: fourth clinical stage – trial insertion.

Examine the wax trial insertion (Figures 19.7 and 19.8) before the patient arrives to identify potential problems	Is the set-up symmetrical and of a pleasant appearance? Have the rules for an aesthetic set-up been followed? Do the midlines correspond? Do the teeth meet evenly when hand articulated? Do the bases fit well on the models? Do the heels contact? Are the teeth in the correct locations? Has the neutral zone been respected? Is the mandibular occlusal plane at the level of the anterior edge of the retromolar pad?
Trial insertion	Check that the midlines coincide with the middle of the face. Check that the maxillary occlusal place is parallel to the interpupillary line laterally and the ala-tragal line antroposteriorly. Check the amount of maxillary and mandibular tooth showing at rest, speaking and smiling. Check lip support and the prominence of upper anterior teeth.
Check jaw relationship	Make sure the bases fit comfortably. If they are uncomfortable at this stage, it is highly unlikely that the completed dentures will be comfortable. Practice having the patient close in retruded jaw relationship, using the method previously described, until this is easily and consistently achieved. Check that when the patient closes in the retruded arc of closure that the teeth are seen to meet evenly and simultaneously with no evidence of a slide into maximum intercuspation. If you see any slide or shift of the dentures whatsoever the jaw relationship is incorrect. If no slide is seen, repeat with the left and right first and second fingers gently supporting the maxillary and mandibular dentures on each side. If any slide or movement of the mandibular dentures is detected, the jaw relationship is incorrect.
Checking vertical dimension of occlusion	Have the patient count from 60 to 70. If you observe the maxillary and mandibular teeth contacting, there is no freeway space. With the patient sitting in a vertical position and the trial dentures in occlusion, check the vertical face height with a Willis gauge. This will give you the vertical dimension of occlusion. With only the maxillary trial denture in the mouth, using the method described for the previous stage, measure the resting vertical dimension. The occlusal vertical dimension should be 2–4 mm *less* than the vertical dimension of occlusion. If the lower molars are higher than the anterior edge of the retromolar pad the occlusal vertical dimension is probably too high.
Check tooth position	Is there a cross bite? Except in Class III set-ups there should be no cross bites. There should be no unilateral cross bites. Lower premolars and molars should be over the mandibular ridge. If not, they are not in the neutral zone, except where advanced resorption may have occurred. Are lower canines and incisors no more anterior than the correctly extended labial flange? If not, they are not in the neutral zone. Are the upper central incisors 8–10 mm anterior to the centre of the incisive papilla? If not the incisors are incorrectly placed – too anterior or too posterior. Is the upper lip well supported? Are the incisors vertical or slightly proclined? They should be slightly proclined.
Confirm the patient's acceptance of the appearance.	The patient must be the final arbiter of appearance. Whatever we may think about appearance, within the bounds of what is possible, we must try to achieve an appearance which satisfies the patient.

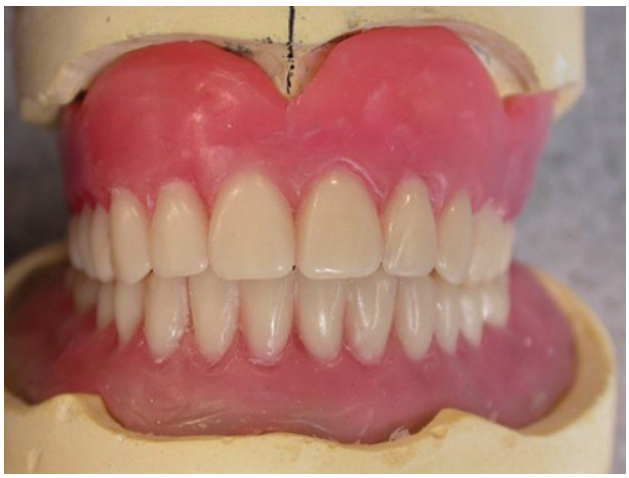


Figure 19.7 Frontal view of an example of a wax trial insertion complete denture.

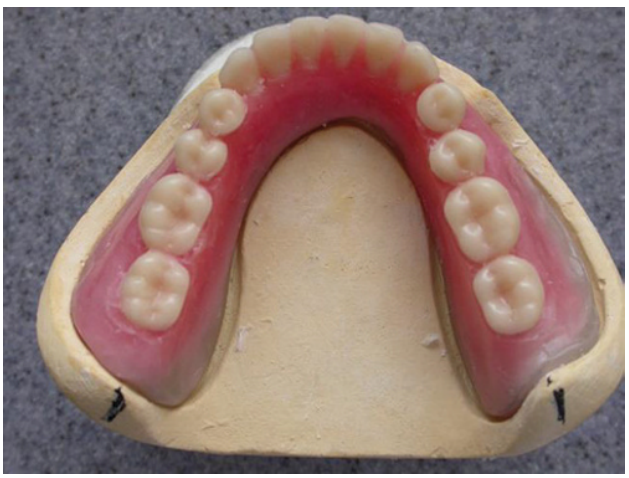


Figure 19.8 Occlusal view of an example of a lower wax trial insertion complete denture.

Table 19.31 Complete dentures: addressing problems that arise at trial insertion.

Incorrect shade or mould	Ask laboratory to change shade and mould.
Incorrect position or appearance of maxillary anterior teeth	Move maxillary canine and incisor teeth (at the chair side) to correct height, angulations and anteroposterior position. Even if the teeth are to be replaced with a different mould this will make the job of resetting the new teeth easier. If the upper occlusal plane is incorrect, remove posterior teeth and build a wax rim to the correct plane. If the jaw relation is correct this will indicate where the posterior teeth should be set. If it is incorrect this will aid in recording a correct retruded jaw relationship.
Error in jaw relationship	Remove lower posterior teeth and build a wax rim to meet the upper teeth or rim evenly at retruded jaw relationship. If any of the mandibular anterior teeth interfere with this process remove these also, then re-record retruded jaw relationship.
Error in vertical dimension of occlusion	Establish resting vertical dimension. If the error is within 2 mm of being correct ask the laboratory to correct the error. If the error is greater, re-record the retruded jaw relationship at the correct vertical dimension.
Check tooth position	Is there a cross bite? Except in Class III set-ups there should be no cross bites. There should be no unilateral cross bites. Lower premolars and molars should be over the mandibular ridge except in this area resorbed case. If not, they are not in the neutral zone. Are lower canines and incisors no more anterior than the correctly extended labial flange? If not, they are not in the neutral zone. Are the upper central incisors 8–10 mm anterior to the centre of the incisive papilla? If not the incisors are incorrectly placed – too anterior or too posterior. Is the upper lip well supported? Are the incisors vertical or slightly proclined? They should be slightly proclined.
Check the patient's opinion of the appearance	The patient must be the final arbiter of appearance. Whatever we may think about appearance, within the bounds of what is possible, we must try to achieve a satisfactory appearance for the patient by moving teeth, changing shade or mould or personalising the set-up.

Table 19.32 Complete dentures: fifth clinical stage – insertion.

Examine the dentures before the patient arrives to identify potential problems that may have arisen in the laboratory processing stage	Is the set-up the same as after the trial insertion? Do the teeth meet evenly when hand articulated? Do the heels contact? Are the teeth in the correct locations? Is the acrylic forming the artificial labial gingivae life-like? Is the polished surface rough? Is the phonetic shelf present? Is the base acrylic sound? Are the peripheries correctly extended/overpolished? Are there sharp edges or blebs present?
Initial denture insertion	Make sure the dentures can be inserted without discomfort. If not use pressure indicator paste and adjust as necessary until the dentures can be inserted and removed without discomfort. Check the appearance using the same method used at the trial insertion stage.
Checking the retention and stability of the maxillary denture	Retention: when pressed firmly into place does the denture stay in place? If not the retention is poor. If the denture is grasped in the premolar areas and pulled downwards firmly does it resist displacement? If not the retention is poor. If the anterior teeth are pulled forward, testing the posterior border seal, does the denture detach from the palate at the posterior border? Stability: if the denture is grasped in the premolar areas and pressure applied forwards, backwards and left and right laterally does it resist displacement? If not then stability is poor. Retention and stability in maxillary dentures should always be good, resisting displacement in all directions.
Check the retention and stability of the mandibular denture	Retention: when pressed firmly into place does the denture stay in place? If not the retention is poor. If the denture is grasped in the premolar areas and pulled upwards firmly does it resist displacement? If not the retention is poor. Stability: if the denture is grasped in the premolar areas and pressure applied forwards, backwards and left and right laterally does it resist displacement? If not, then stability is poor. Retention in mandibular dentures is often poor because the lingual tissues are mobile, breaking border seal.

(*Continued*)

Table 19.32 (Continued)

Checking for correct extension.	Many retention and stability problems are related to extension of the dentures. Correctly extended denture borders should fill the height, width and depth of the sulci. If the dentures cause a bulge of the cheeks or lips that can be felt or seen, the flanges are overextended. Pressure indicator paste can be applied to the flanges to check for overextension. Inspection may show over- or underextension in the areas around frenae, at the posterior border of the dentures, around the tuberosities, on the buccal shelves and in the postmylohyoid areas. If you can feel the hard palate or tuberosities behind the posterior border of a maxillary denture it is underextended. If the soft palate loses contact with the maxillary denture when the patient says 'AAA' the posterior border is overextended. If you can feel the lateral border of the tuberosity with the maxillary denture in place, it is underextended.
Check jaw relationship	Make sure the bases fit comfortably. If they are uncomfortable the patient will not reliably close into the retruded jaw relationship. Check if retruded jaw relationship corresponds with maximum intercuspation, using the method used at the trial insertion stage. Check if the vertical dimension of occlusion is correct, using the method used in the trial insertion stage. A correct jaw relationship is critical for success in the provision of complete dentures.
Check tooth position	Lower premolars and molars should be over the mandibular ridge, except in cases of severe ridge resorption. If not, they are not in the neutral zone. Are lower canines and incisors no more anterior than the correctly extended labial flange? If not, they are not in the neutral zone. If the mandibular teeth are not in the neutral zone the mandibular denture will rise up, demonstrating that the teeth are not in the neutral zone – provided any overextension has been eliminated first.
Confirm the patient's acceptance of the appearance	While the patient must be the final arbiter of appearance, tooth position and appearance should have been agreed by the patient at the trial insertion so there should not be any change in the previously agreed appearance. If there is a problem at insertion stage, you have a potentially serious problem. If teeth have to be removed at this stage, you may end up remaking the dentures. This emphasises the importance of making sure that the patient is satisfied with the appearance at the wax trial insertion stage.

Table 19.33 Complete dentures: addressing problems that may arise at the insertion stage.

Discomfort on insertion	Eliminate sharp edges. Remove overextensions disclosed using pressure indicator paste (PIP).
Overextensions	Disclose all flanges with PIP, adjust where the PIP has been rubbed off.
Underextensions	Local addition of chairside reline material. If underextension of the flanges is not confined to one area, consider rebase impression – zinc oxide eugenol impression paste in a thin layer in the base with the dentures in occlusion until the impression material sets. If the denture base has been ruined by overpolishing, consider starting again.
Incorrect position or appearance of maxillary teeth	Move maxillary canine and incisor teeth (at the chair side) to correct height, angulations and antroposterior position. Even if the teeth are to be replaced with a different mould this will make the job of resetting the new teeth easier. If the upper occlusal plane is incorrect, remove posterior teeth and build a wax rim to the correct plane. If the jaw relation is correct this will indicate where the posterior teeth should be set. If it is incorrect this will aid in recording a correct retruded jaw relationship.
Error in jaw relationship	If the error is less than half the width of a cusp, employ the check record procedure (see later). If the error is half the width of a cusp or greater, then remove lower posterior teeth and build a wax rim to meet the upper teeth evenly in the retruded jaw relationship. If any of the mandibular anterior teeth interfere with this process remove these also, re-record retruded jaw relationship.
Error in vertical dimension of occlusion	Establish resting vertical dimension (RVD). If the occlusal vertical dimension is 1–5 mm less than the RVD, continue and monitor at the next visit. If the difference between the occlusal vertical dimension and RVD is outside his range, re-record the retruded jaw relationship at the correct vertical dimension.
Errors in tooth position	Remove teeth, reset artificial teeth in wax at the agreed, correct positions. Return to the laboratory for processing.

procedure should be performed in the evening and repeated in the morning.

Review of Complete Dentures

The patient should return for initial review 1 week after the dentures have been fitted. This review should include:

- A careful history to elicit problems.
- Careful examination of the soft tissues with particular reference to areas of discomfort described by the patient and areas of redness of soft tissues in proximity to the denture peripheries.
- Review of the peripheries of the dentures with PIP to identify and remove any overextensions.
- A repeat of the insertion stage check.

20

Procedures in Special Care Dentistry

Carole Boyle, Mary Burke, Julie Edwards, Ellie Heidari, Joy Lewis, Sukina Moosajee and Najla Nizarali

Introduction

Special care dentistry (SCD) was defined in 2003 by the British Society for Disability and Oral Health as:

> That branch of Dentistry, which provides preventive and treatment oral care services for people who are unable to accept routine dental care because of some physical, intellectual, medical, emotional, sensory, mental or social impairment, or a combination of these factors. Special Care Dentistry is concerned with the improvement of oral health of individuals and groups in society who fall within these categories. It requires a holistic approach that is specialist led to meet the complex requirements of people with impairments.

SCD refers only to the treatment of adolescents and adults: children with special needs are the remit of paediatric dentistry

A wide range of patients with complex needs defines the speciality. The patterns of oral disease are similar to those of the general population, but people with special needs are less likely to receive restorative care and more likely to have extractions.

Practitioners will meet many patients with special needs who do not require referral to specialist services. Indeed, there are positive advantages for people with special needs to be treated in primary care with other members of their family close to home. The establishment of the speciality of Special Care Dentistry in 2008 lead to concerns that this may make primary care practitioners less likely to treat those with learning disabilities and encourage them to refer rather than treat. Such concerns were ill-founded. The aim of this chapter is to encourage the dental team to provide care for this group, who may be challenging but are also rewarding to treat.

The philosophy of SCD is to treat patients as individuals and to view them holistically; dental problems may be only a small part of person's healthcare needs. It may be necessary to work with a team of healthcare professionals to provide basic dental care. This can include medical and social care providers.

It is estimated that there are presently between 8.6 and 10.8 million people in the UK with a disability. With an ageing population, more of us will be affected by a disability or be caring for someone with an impairment. The Disability Partnership estimates this as 'one in four of us.'

Definition

The World Health Organization (WHO) International classification of impairments, disabilities and handicaps defines impairment and disability as follows:

> Any temporary or permanent loss or abnormality of a body structure or function, whether physiological or psychological. An impairment is a disturbance affecting functions that are essentially mental (memory, consciousness) or sensory, internal organs (heart, kidney), the head, the trunk or the limbs.

An alternative definition is: a restriction or inability to perform an activity in the manner or within the range considered normal for a human being, mostly resulting from impairment.

Access to Care

Access is often thought to be about just physical barriers, but should be considered in a wider perspective to include the attitudes of the dental team, communication difficulties and the health beliefs of the patient. Physical barriers and ways to overcome them are considered later in this chapter.

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

Attitudes

Attitudes of the dental team can be difficult to overcome. It has been shown that undergraduates who have experience with people with learning disabilities are more likely to feel comfortable treating them after graduation. Students who receive teaching in SCD can find it enjoyable, adding an extra dimension to their dental studies, allowing them to see patients as people not just a mouth. Teaching in SCD is also required for dental care professionals, allowing them to be more involved in providing oral health. Attitudes of the patient can be deeply held: they may have had bad experiences as a child or been made to feel unwelcome by previous dentists.

Assessment

In addition to the usual dental assessment considerations, the following factors are important for someone who requires SCD:

- Environment: dental surgeries can be intimidating for anxious patients. It may be better to take an initial history in the waiting room or in an office. For some patients, it may be easier to speak to the carers before attempting a dental examination. Alternatively, for someone with challenging behaviour, carry out an examination first, then allow the patient to leave. A history can then be taken and care planned with parents/carers without distractions.
- Technique: everyday techniques may be impossible to apply due to anxiety, challenging behaviour or physical impairment. Sometimes a toothbrush can be used rather than a mirror. Clinical holding may help to get a better look but sometimes a full examination and treatment planning can only take place under sedation or general anaesthesia.
- Radiographs: it may not be possible to gain cooperation for intraoral radiographs. Extraoral films such as lateral oblique views may be easier to obtain.
- Medical history: the medical history of patients requiring SCD may be complex. It may be helpful to provide a medical history form to be completed in advance. It can be useful to request that a list of medications is brought to appointments
- Other healthcare providers: it is important to find out about others involved in the patient's care and to liaise with them for clarification regarding aspects of the medical history. As dentists, we rely on the information given to us by our patients. Some people may be reluctant to disclose information, either due to embarrassment, or just because they do not see the relevance to dentistry.
- Attendance at other clinics or hospitals: if the patient has a complex medical history, probably they will attend multiple clinics in different hospitals. For example, renal dialysis may involve attendance on 3 or 4 days a week, limiting the options for dental appointments.
- Method of transport: it is important to find out how the patient travels to appointments. Hospital transport is notoriously unreliable, with patients arriving too early or too late. Relying on others for lifts can limit when patients can attend and using taxis can be expensive for frequent visits.
- Best time to attend: some patients prefer dental care in the morning, others in the afternoon. Patients may be reluctant to attend for dental care if they attend a day centre.
- Other investigations: it may be possible to combine dental care with other medical procedures, for example blood tests or hearing investigations.
- Length of appointments: some patients cope better with short appointments, perhaps because they have difficult in remaining still or keeping their mouth open for more than a short period. Others prefer longer appointments, and attend for fewer visits, if they have long distances to travel. It is important to discuss this at the assessment.
- Carers: if a patient attends with a carer, find out who they are and how well they know their client. Paid carers may have a close relationship, or have never met their client before. People with learning disabilities often will have a key worker and their contact details are useful for making appointments and organising consent.

Assessing special care patients can bring challenges. It is important for the dental team to be flexible and respond to the needs of individuals (patient-centred assessment).

Oral Health Promotion

Special care patients with physical and visual impairment may need additional support for oral hygiene procedures.

Prevention

Prevention is the key to good oral health. This can be achieved most effectively with a team approach involving the patient, dentist, the dental care professional and if appropriate, the carer

Recall

This should be individually tailored. The risk of developing oral diseases should be assessed. Consideration should be given to:

- The patient's medical treatment and medications, some of which may cause xerostomia or gingival hyperplasia.
- The patient's ability to maintain oral health.

- The use of fluoride supplements and oral hygiene aids.
- The patient's diet and any parafunctional activities.

Individual factors such as saliva quality and quantity have an impact on the oral health of SCD patients.

Diet

The dental team should encourage SCD patients to fill out a diet sheet, recording what they eat and drink daily. This allows analysis of the time, amount and frequency of sugar intake. Some patients are prescribed high calorie energy drinks. For example, older patients with weight loss, patients with involuntary movement, and head and neck oncology patients might be prescribed such drinks to gain or maintain weight. A multidisciplinary approach involving the dietician can be beneficial to the patient. SCD patients, in common with all patients, should be advised to limit sugar intake to meal times.

Aids

- Toothpaste: the minimum recommended fluoride content of toothpaste for adults is 1450 ppm. The 2800 ppm and 5000 ppm fluoride toothpastes can be prescribed for SCD patients at high risk of developing caries.
- Toothbrushes: toothbrushes may need to be modified, depending on the patient's impairment. Power toothbrushes may be advantageous for patients with reduced dexterity and may be preferred by carers.
- Interdental brushes: SCD patients and carers may find interdental brushes and dental floss difficult to use, but they should be recommended wherever practical.
- Fluoride rinses: it is recommended that fluoride rinses should be alcohol free. Rinses can be prescribed daily (0.05–0.10%) or weekly (0.2%), according to individual needs and cooperation. Some patients with oromotor function or dysphagia may be unable to rinse.
- Fluoride varnish (2.26%) can be applied at each recall.
- Fluoride gel (0.4% stannous fluoride) may be a useful alternative to fluoride varnish.
- Chlorhexidine solution: patients with poor plaque control may benefit from the prescription of 0.2% chlorhexidine solution which may be applied, possibly daily, by swabbing, rinsing or brushing. This may be useful for patients who are unable to expectorate. The disadvantages include bitter taste, alteration of taste and staining of teeth.
- Disclosing tablet or solution: disclosing tablets may help both patients and carers to improve plaque removal.
- Finger shields or mouth props for carers.

Impairment

Worldwide there are around 650 million disabled adults.

- Of the people with a physical impairment, approximately 65 million are wheelchair users. Others have upper and lower limb impairment, altered manual dexterity or require the use of walking aids. Arthritis is one the most common acquired causes of physical impairment, affecting a staggering 8 million people in the UK alone.
- Visual impairment affects 314 million people, of whom 45 million are blind.
- Two hundred and seventy-eight million people have moderate to profound hearing loss in both ears.
- Statistics on deafblind people are difficult to access worldwide. In the European Union, the deafblind population is estimated at 150 000.

Management

Good preparation allows for a smooth-running clinic and can alleviate anxiety both for the patients and the dental team. Prior to the dental appointment:

- It is good practice to ask the individual or carer what their preferred method of communication is. Avoid jargon and allow sufficient time for communication.
- Ask the patients about their impairment and ways to improve their access to the surgery, which should comply with disability and health and safety regulations.
- Some people may require domiciliary dental care (see domiciliary section). Treatment in the primary setting is the ideal, but domiciliary care or referral to a secondary or tertiary setting might be necessary.
- Ensure clear access all the way to the surgery. This is important for the safety of the patients who use walking sticks and wheelchairs.
- Only staff trained in manual handling should assist patient transfer to the dental chair. Injuries can easily happen to staff and patients if you are not familiar with handling patients
- Patient handling aids may be necessary:
  - Cushions for posture support.
  - Patient transfer boards and turntables.
  - A hoist.
- Other useful equipment:
  - Wheelchair recliner for wheelchair users who cannot be transferred to the dental chair.
  - Break leg chair: this makes it easier for the patient to transfer from a wheelchair to a dental chair and easier for those who use walking aids
  - Bariatric chair: this can carry people <700 kg in weight. The normal break leg chair can carry a maximum weight of 250 kg.

- Before reclining the patient, their medical history must be considered.
  There may be breathing issues, spinal problems or a risk of aspiration so they may not be able to be treated in a supine position. Ask the patient if they can sleep flat as this would give an idea on how far to recline the chair.
- If the patient has involuntary movements caused by conditions such as cerebral palsy or dystonia, sedation may be required. This may be the safest option for the patients and the operator.

Visual Impairment

Partially sighted people are unable to tell how many fingers are being held up at 6 m or less, even with glasses. Blind people may have some degree of vision (residual vision) but are unable to tell how many fingers are being held up at 3 m or less, even with glasses. Prior to the dental appointment:

- Leave a voicemail to confirm appointment time. Ask the patient about their preferred method of communication.
- Consider what appointment time would be the most appropriate.

  A blind person with a guide dog might not wish to travel in the rush hour.
  On the day of treatment:

- Offer to guide the patient by allowing them to take hold of your elbow.
  Some patients might prefer to be independent using a stick or other aid.
- Warn them if you are coming to any steps, tell them how many, and in which direction they run. This will help to reassure the patient, and reduced the risk of a stumble or falls.
- Be guide dog friendly. Ask the patient if they want the dog to come in to the surgery or to stay in the waiting room.
- Avoid bright backlighting as this interferes with residual vision.
- Information sheets should be in large print (font size >14). Ask the patient what font size they require.
- Some people might communicate via Braille and less commonly the Moon alphabet.

Hearing Impairment

There are four different levels of hearing impairment: mild, moderate, severe and profound. People with mild hearing impairment may have difficulty following speech, especially in noisy situations. If they have moderate hearing impairment, they will probably not be able to follow what you are saying without hearing aids. For people with severe hearing impairment and profound deafness, sign language is likely to be the preferred method of communication. Also, many people with hearing impairment can lip-read effectively. Prior to the dental appointment:

- It is good practice to ask the individual or carer what their preferred method of communication is. Avoid jargon and allow sufficient time for communication, which might include teleprinter, textphone or minicom.
- Ascertain the need for a language service provider such as 'Lipspeakers' or sign language interpreter.
- Consider what appointment time would be the most appropriate.
  A profoundly deaf person with a hearing dog might not wish to travel in the rush hour.

  On the day of treatment:

- Be hearing dog friendly. Ask the patient if they wish the dog to come in to the surgery or to stay in the waiting room.
- Have paper and pen available. This may be the preferred method of communication.
- Before commencing treatment inform the patient what the treatment will entail. The dental equipment might interfere with hearing aids and cause high-pitched whistling. Therefore, the patient may wish to turn off hearing aids
- When discussing the treatment sit in the front of the patient and do not wear a mask or a visor. When treating the patient wear a visor only.
  This will make it easier for the patient to lip-read.
- Minimise the background noise. For those with partial hearing this allows for clearer communication.
- Lower the pitch of your voice. Low tones can be heard more readily.
- Use gestures, for example thumbs up for asking if your patient is OK.
- If a sign language interpreter is present:
  - Ensure that you address the patient and not the interpreter.
  - Do not breach patient confidentiality.
  - Ask the patient's permission to discuss medical history and treatment details.

Deafblindness

Deafblind people have a combined sight and hearing impairment to varying degrees and may carry a white and red cane. People who are deafblind may use different modes of communication such as a deafblind interpreter,

the deafblind manual alphabet (for example Evans) and the block alphabet. Apply the procedures for individuals with hearing and visual impairment in the management of these patients.

Learning Disability

Learning disability is a significant impairment of intelligence and social functioning acquired in childhood. The World Health Organization defines learning disabilities as: 'A state of arrested or incomplete development of mind'. Learning disability is a diagnosis, but it is not a disease, nor is it a physical or mental illness. It can be acquired or have a genetic or congenital cause. Learning disability affects as many as 2.5% of a population; there are likely to be 1.5–2 million people with a learning disability in the UK. Males are more likely to be affected than females.

There are three criteria which need to be met before learning disabilities can be identified:

- Intellectual impairment.
- Social or adaptive dysfunction.
- Early onset – identified from birth; not occurring later because of injury or disease.

One way of measuring learning disability is using IQ (intelligence quotient). The average IQ in the general population is 100.

50–70 mild learning disability:

- Able to communicate.
- Limited written and reading skills.
- Can manage own self-care including toothbrushing.

35–50 moderate learning disability:

- Limited verbal communication.
- Unable to read or write.
- Needs assistance with self-care.

20–35 severe learning disability:

- Uses gestures/single words to communicate.
- Depends on others for self-care.

Below 20 profound learning disability:

- Dependent on others for all needs.

This assessment does not consider social functioning and the changes that can occur with maturity. It is important to assess the individual in their social context. For example, a person with a mild learning disability may be able to travel alone on public transport but if the train breaks down may not be able to find an alternative route home.

Causes of Learning Disability

Among people who have a mild learning disability, in 50% of cases no cause has been identified. In people with severe or profound learning disabilities, chromosomal abnormalities account for about 40% of cases, genetic factors account for 15% and acquired conditions a further 10%. Cases which are of unknown cause are fewer, but still high at around 25%.

Chromosomal and Genetic Causes

Fragile X Syndrome is the most common cause of inherited learning disability occurring in 1 in 4000 males and 1 in 6–8000 females. Boys are more severely affected and more likely to have significant learning disabilities than girls and a third of males are likely to be autistic.

Down's Syndrome is caused by a genetic abnormality: most commonly trisomy of chromosome 21. It results in a characteristic appearance with associated medical problems. The most significant of these is cardiac abnormalities, which can require surgery early in childhood.

Velo-Cardio-Facial Syndrome affects an estimated 1 in 3000–4000 births with a population prevalence of 1:2000. It is caused by small part of chromosome 22 missing at the q11 region. As the name suggests it is associated with cleft palate, congenital heart disease and a characteristic facial appearance, in addition to intellectual impairment.

Acquired Causes

Foetal alcohol syndrome: consumption of alcohol by pregnant women causes damage to the developing baby. This can result in stunted growth, characteristic facial features and delayed cognitive development.

Rubella infection in the first trimester of pregnancy can damage the foetus causing problems including deafness or even death. If the baby survives, it is likely to have retinopathy, cardiac malformations and learning disability. The incidence of infection has fallen dramatically in the UK due to an extensive vaccination programme.

Management

Communication

This is perhaps the biggest challenge: on first meeting, it is difficult to determine how much the patient can understand. It is better to overestimate someone's abilities than underestimate.

About 60% of people with learning disabilities have some skills in symbolic communication using pictures, signs or symbols. About 20% have no verbal communication skills but do demonstrate a willingness to communicate, expecting a response. For example, greet the patient

with a smile – even if they are non-verbal they will recognise welcoming body language. When taking a history from the parent/carer position yourself so you can maintain eye contact with the patient.

Communication Aids

Different people use different communication systems depending on the professional who has worked with them. Makaton, Signalong (signing and symbols use) and Widgit software (symbols for writing) are used by people with mild learning disabilities. People with more severe and complex needs may not be able to use any of the recognised means of communicating and will be dependent on others to interpret their needs and choices through observing and responding to their communicative behaviour.

Some health authorities have developed 'hospital passports' which are completed by the patient with their carers. This document sets out their likes, dislikes, preferred routines and communication method. The passports are probably more relevant to hospital admission but may provide some useful background information. For example, if the patient has a particular interest, this can be a starting point for conversation.

Associated Medical Conditions

- Epilepsy: this condition is more likely to occur in someone with a learning disability than in the general population. Its treatment and management are the same as in someone without a learning disability.
- Congenital heart disease: this is more common due to the association with Down's Syndrome and Velo-Cardio-Facial Syndrome. In the past, corrective cardiac surgery was less likely to be carried out on a person with a learning disability. Although this is no longer the case, heart disease is still the second most common cause of mortality as it is in the general population.
- Respiratory disease: respiratory disease has a much higher incidence in people with a learning disability than in the general population. This may be due to feeding, breathing and swallowing difficulties, epilepsy regurgitation and gastroesophageal reflux.
- Cancer: the incidence of death from cancer amongst people with a learning disability is lower than the general population. It is increasing rapidly as people with a learning disability live longer.
- Sensory impairments: around one-third of people with a learning disability experience visual impairment of vision and 40% have difficulties with hearing. Hearing problems may be due to impacted ear wax which can easily be treated and sight problems due to the difficulties in cooperating with sight tests.
- Mental health: reported rates of people with a learning disability who also have mental health problems vary widely, ranging from 10 to 39%, depending on the type of study and the methods used. Some conditions may be more prevalent than others in people with a learning disability, for example schizophrenia (between 1.3 and 3.7%), affective disorders (between 1.2 and 6%) and anxiety-related neurotic disorders (around 16.4%). Mental health problems can be due to a combination of biological, psychological, developmental and social factors.

Consent

This is covered in more detail in Chapter 5. An important principle is that no adult can consent on behalf of another adult and the ability to consent should be presumed.

Autistic Spectrum Disorder

Autism spectrum disorder (ASD) is a range of complex neurodevelopment disorders, characterised by:

- Social impairment.
- Verbal and non-verbal language impairment.
- Repetitive/stereotyped activities.

Autistic disorder, sometimes called autism or classical ASD, is the most severe form of ASD, while other conditions along the spectrum include a milder form (known as Asperger Syndrome), childhood disintegrative disorder and pervasive developmental disorder. Although ASD varies significantly in character and severity, it occurs in all ethnic and socioeconomic groups and affects every age group. The estimated incidence is 6:1000. Males are four times more likely to have an ASD than females. Only 30% of affected individuals with have an associated learning disability but all will have difficulty interacting with people around them.

Management

Prior to the dental appointment:

- It can be helpful if the dental team contacts the family/carers to find out more about the patient and their likes and dislikes. It may be helpful for them to visit the surgery before the first appointment to familiarise themselves with the setting and staff when no treatment is planned.
- The first appointment of the day is best to reduce stress. It is important not to keep the patient waiting.
- Visual supports: the parent/carer might want to take photographs of the surgery and the dental team. This can be made into book so the person knows the stages

of going to the dentist: what's coming next and when they will end.

During treatment:

- Routine is important: ideally the person should be seen by the same staff at the same time in the same room.
- Reduce background noise as this can be distracting or sound very loud to the patient. Only one person should speak at a time and you must warn the patient before you touch them.
- Use direct language: people with autism have a literal understanding. For example, do not say 'would you like to come into the surgery': they may answer no. Use short sentences and simple language.
- Time indicators allow the patient to know that there is a time limit on treatment: visual or auditory timers (e.g. sand timers, buzzers, watch alarms) allow them to monitor the length of the experience.

Treatment Options With time and patience, it may be possible to provide dental care under local anesthesia. More severely affected people will require sedation or general anesthesia.

Clinical Holding

Clinical holding is 'the use of physical holds (clinical holding), to assist or support a patient to receive dental care or treatment in situations where their behaviour may limit the ability of the dental team to effectively deliver treatment, or where the patient's behaviour may present a safety risk to themselves, members of the dental team or other accompanying persons' (British Society for Disability and Oral Health, 2009).

- Clinical holding can be used in several circumstances if assessment or a course of treatment cannot be carried out effectively or safely because of the behaviour of the patient.
- Clinical holding may be necessary in managing patients with learning disabilities, autistic spectrum disorder, dementia, mental health, neurodegenerative disease, involuntary movements and brain injuries.
- Clinical holding has been shown to allow the safe use of local anaesthetics and conscious sedation rather than resorting to general anaesthesia to carry out dental treatment for some patients.
- Clinical holding is not designed to enforce dental treatment but to aid it in certain circumstances.
- Clinical holding should be used as infrequently as possible; it should always be in the best interests of the patient.
- All members of the dental team should be trained in the effective and safe delivery of clinical holding.

Clinical holding should be discontinued:

- When the patient withdraws consent unless this would endanger them or others.
- In circumstances where patients show extreme distress and when a hold is causing pain or discomfort.
- In cases of respiratory or circulatory compromise, vomiting and seizures.

If the use of clinical holding is required, then:

- The method should be appropriate to the age, size, physical condition and sex of the patient.
- The minimum amount of force should be applied, for the shortest possible duration.
- Adequate numbers of trained and experienced staff should be present.
- No restrictive measures involving neck compression should be used.
- The patient's airway and head should be protected from obstruction and/or injury.

Consent

- A person with capacity to consent may require clinical holding to allow for safe and effective dental treatment. The process must be discussed in full. The patient has the right to withdraw their consent to clinical holding at any time.
- When an individual lacks the capacity to consent, clinical holding can be used if it is felt to be in the best interests of the patient and the least restrictive and detrimental course of action. All treatment should be carried out in accordance with the Mental Capacity Act Code of Practice.
- It is reasonable under common law to use clinical holding as an emergency measure, where the patient's behaviour represents an immediate or significant risk to themselves or others.
- Any decision to use clinical holding must be documented in the patient notes, including the length of time of the hold.

Cancer

Cancer describes malignant disease. Its impact is very wide ranging depending on site, disease progression and treatment.

- Annual incidence in the UK (2014) is over 356 000 and increasing (Table 20.1).
- It is predominantly a disease of older people.

Table 20.1 UK cancer incidence (Cancer Research UK, 2014).

Cancer	Incidence
Breast	55 222
Prostate	46 690
Lung	46 403
Bowel	41 265
Head and neck	11 449

- One in three people in the UK will have cancer at some stage.
- In the UK, breast, lung, colorectal and prostate cancer account for 50% of cancers.
- Oral cancer is the most common cancer in men in Sri Lanka, India, Pakistan and Bangladesh. In the UK, it is 3%.
- With an older population and improved survival there are more people living with cancer.

Cancers of the head and neck are particularly relevant for the dentist for early recognition and the side effects of treatment (Table 20.2).

Table 20.2 Referral guideline for oral/head and neck region cancer.

- Hoarseness lasting >3 weeks.
- Discomfort in throat for >3 weeks (especially in smoker or drinker).
- Dysphagia.
- Head and neck lumps for >3 weeks.
- Ulceration of oral mucosa persisting >3 weeks.
- Oral swellings persisting >3 weeks.
- All red or red and white patches of oral mucosa >3 weeks.
- Unexplained tooth mobility not associated with periodontal disease.

Treatment

Cancer treatment may be surgery, chemotherapy, radiotherapy, hormone therapy, or a combination of these. The choice depends on the cancer type, staging of disease (size and spread), patient performance status and patient choice. A multidisciplinary team is responsible for deciding the best treatment (Table 20.3).

A dental assessment is a recommended before cancer treatment. For head and neck cancer a dentist should be a member of the multidisciplinary team, to oversee dental care and advise on the complex dental issues that treatment causes.

Before Cancer Treatment

- Extraction of infected teeth, teeth with advanced periodontal disease or poor prognosis at least 10 days before treatment starts.
- Oral hygiene advice and scaling.
- Dietary advice and fluoride supplement appropriate to age.
- Restorative treatment; a temporary restoration if insufficient time. Smooth sharp teeth which may exacerbate mucositis.
- Ensure dentures are atraumatic to the mucosa and give instruction in denture hygiene.
- Orthodontic treatment is discontinued.

Table 20.3 Principle cancer treatment modalities – advantages and disadvantages.

Treatment	Indication/advantages	Contraindication/disadvantages
Surgery • Much improved with use of microvascular surgery for reconstruction.	• Small accessible tumours. • Resection of regional lymph nodes. • Debulking large tumours.	• Inaccessible tumours. • Organ preservation important, e.g. larynx. • Poor patient performance state. • Deformity with negative psychological and functional effects.
Radiotherapy • External beam. • Intensity modulated (focused to area). • Brachytherapy (internal).	• Inoperable cancers. • Adjunct to surgery and chemotherapy. • Whole body prior to bone marrow transplant. • Palliative treatment.	• Side effects: mucositis, skin burning, hair loss, bone necrosis. • Risk of radiation-induced cancer.
Chemotherapy • Kills rapidly dividing cells. • Newer targeted agents (biological therapy).	• Adjunct to surgery and radiotherapy.	• Side effects: bone marrow suppression, hair loss, mucositis, gastrointestinal ulceration, infertility.
Hormone therapy	• For hormone sensitive tumours, e.g. breast, prostate.	• Body changes due to hormone.

Table 20.4 Blood cellular levels – precautions for dental treatment.

Blood cell	Normal level	Requirements for treatment	Additional precautions
Platelets	$150–400 \times 10^9$/l	$>30 \times 10^9$ inferior dental block. $>50 \times 10^9$ simple single extraction. $>75 \times 10^9$ other surgery.	Local measures: Sutures, Surgicel® (Ethicon) after extractions. May need blood transfusion if too low.
Neutrophils	$2–7.5 \times 10^9$/l	$>1.5 \times 10^9$ routine management. $<1.5 \times 10^9$ antibiotic prophylaxis for extractions.	Avoid non-essential contacts to reduce cross infection.
Haemoglobin	Male 13.5–18 g/dl Female 11.5–16 g/dl	$>8 \times 10^9$ routine management. $<8 \times 10^9$ avoid general anaesthesia and sedation.	Care to avoid falling when anaemic.

- Primary teeth within 3 months of exfoliation should be extracted.
- Extract teeth with pericoronitis

During Cancer Treatment

Treatment should ideally be delayed until after active cancer therapy, as there may be a risk of infection and bleeding. Always consult with the oncologist.

- Treat symptomatically.
- Infection: a high dose intravenous antibiotic will probably be required.
- Extractions: the best time for improved white blood cells and platelets is usually between chemotherapy cycles. This must be checked with a full blood count (Table 20.4).

Some antibiotics interact with chemotherapy. Amoxicillin 1 g intravenously prior to extraction followed by 500 mg orally three times daily for 7 days, is generally recommended.

After Cancer Treatment

Once patients have recovered from cancer therapy, dental care may be carried out in the primary care setting without additional precautions. Most people who are cancer survivors live normal lives and do not require SCD.

Head and Neck Cancer

Cancer of the head and neck region and its treatment has a significant impact on oral care. Two-thirds of oral and oropharyngeal cancers present at late stage and require combined modality treatment.

Oral Side Effects of Radiotherapy

The side effects of radiotherapy have a substantial impact on the teeth and oral tissues (Table 20.5).

Radiotherapy is given daily for 4–6 weeks (total 45–70 Gy). The head is immobilised with an individually constructed radiotherapy mask (Figure 20.1). Over the last 20 years greater accuracy has been possible using computerised tomography (CT) scans to visualise the tumour and shape the beam. Intensity modulated radiotherapy allows better targeting to the tumour, sparing sensitive tissues such as the parotid glands and temporomandibular joint. This reduces xerostomia and trismus with improved quality of life.

Table 20.5 Oral side effects of radiotherapy.

Early	Longer term
Mucositis	Caries
Xerostomia	Periodontal disease
Tooth hypersensitivity	Osteoradionecrosis
Changes to oral flora	Dysphagia
Fungal infections	Hearing loss
Taste disturbance	
Trismus	In childhood:
	Impaired facial growth
	Dental abnormalities

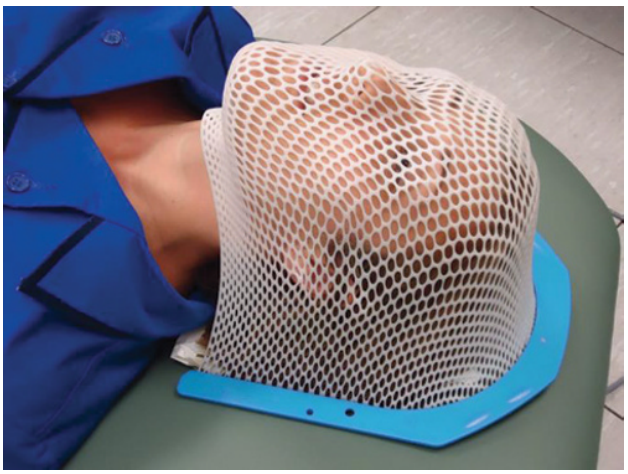


Figure 20.1 Radiotherapy mask.

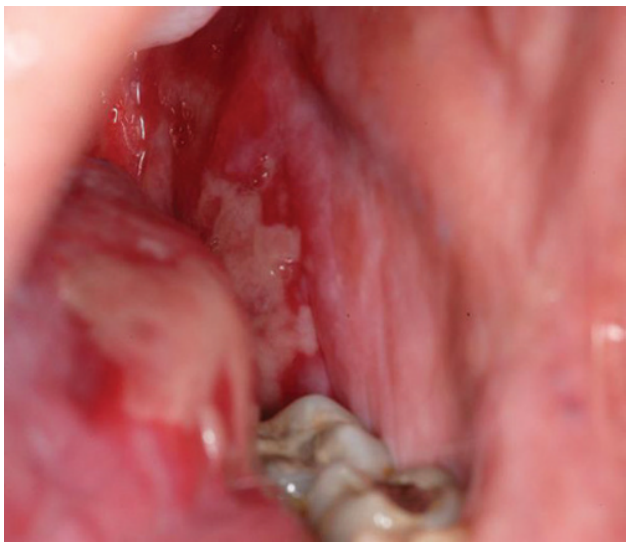


Figure 20.2 Mucositis.

Mucositis

- Erythema, ulceration of the mucosa, is intensely painful and very debilitating (Figure 20.2).
- May affect nutrition, cause sepsis and lead to hospitalisation.
- Occurs after about 2 weeks of radiotherapy and lasts 2–6 weeks after completion.
- Mucositis caused by chemotherapy develops after around 5–8 days and has a shorter duration.
- Oral hygiene is very painful; standard toothpastes and mouthwashes are often too strong tasting and people may discontinue oral care.

Saliva

- Function is reduced after only 2 days of radiotherapy and flow decreases by 50–60% during the first week.
- Consistency changes to frothy and thicker, sometimes with unpleasant mucous lumps.
- Recovery is slow, up to 2 years and incomplete.
- Xerostomia contributes to caries and changes in the oral flora.
- Hypersensitivity of teeth is a common side effect of radiotherapy and is most likely related to loss of saliva.
- Dry mouth can make eating, chewing, swallowing, maintenance of oral health as well as social functioning very difficult.
- Dry mouth is the most common complaint (95%) following radiation treatment for orofacial cancer.

Taste

- Taste alteration occurs in most people with head and neck cancer, especially after radiotherapy.
- There is considerable variation reported in the degree of taste alteration and which taste sensation is most affected and for how long.
- Taste loss or distortion commences after a threshold of 20 Gy and reaches its worst by 3–4 weeks. It improves over 6 months but may be persistent.
- Taste alteration affects the choice of food and desire for food and impacts on general health and maintaining weight.
- Taste distortion affects quality of life.

Trismus

- Trismus is generally defined as interincisal distance less than 20 mm.
- May result from muscle invasion by the tumor, effects of surgery or radiotherapy causing fibrosis of the masticatory muscles and tissue contraction.
- Trismus may develop towards the end of radiotherapy or during the months afterwards.
- Eating, oral hygiene, denture insertion and professional dental care is very difficult.
- People affected may not wish to eat socially and become increasingly isolated with decreased quality of life.

Caries

- 'Radiation caries' is rapidly developing and aggressive which appears after radiotherapy, often leading to tooth fracture (Figure 20.3).
- Its distribution is typically on incisal edges, cusp tips and smooth surfaces of teeth.
- It is believed to be an indirect effect of radiotherapy, related to reduced salivary flow and buffering capacity, frequent dietary sugar supplements, difficulty with oral hygiene and changes in the oral flora.

Periodontal Disease

- Periodontal disease may be exacerbated by oral flora changes, xerostomia and immune suppression.
- There is evidence of an increased rate of attachment loss and increased tooth mobility after radiotherapy, which appears to be a local effect on teeth in high radiation dose sites.

Oral Hygiene

- Oral hygiene is made temporarily difficult with painful mucositis.
- In the longer term, trismus can make it difficult or impossible to use a normal toothbrush.
- Surgery may result in paresthesia or anesthesia leading to mouth debris.
- Swallowing problems following surgery or radiotherapy affect oral clearance; rinsing or using mouthwashes may increase the risk of aspiration.

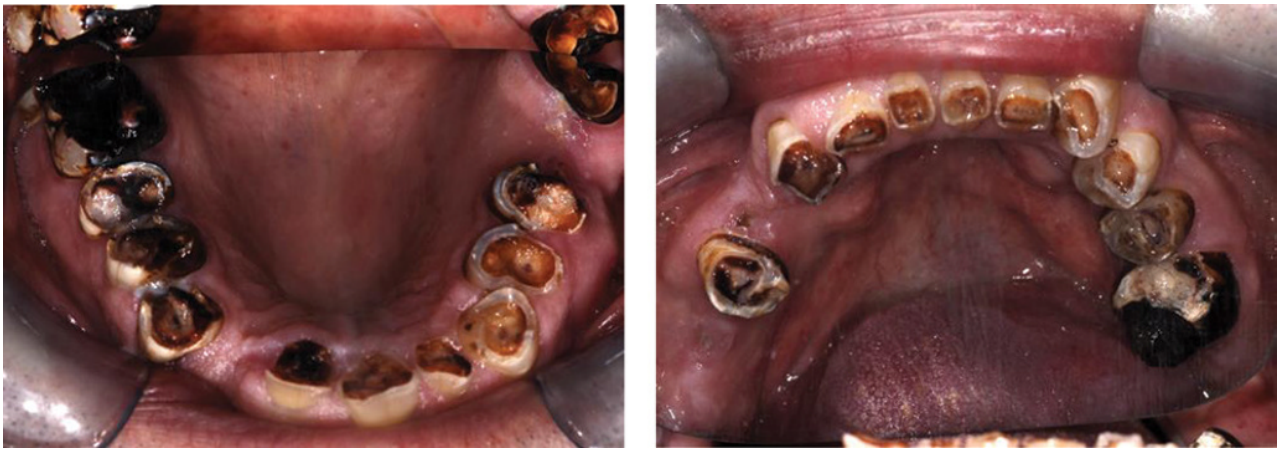


Figure 20.3 Radiation caries.

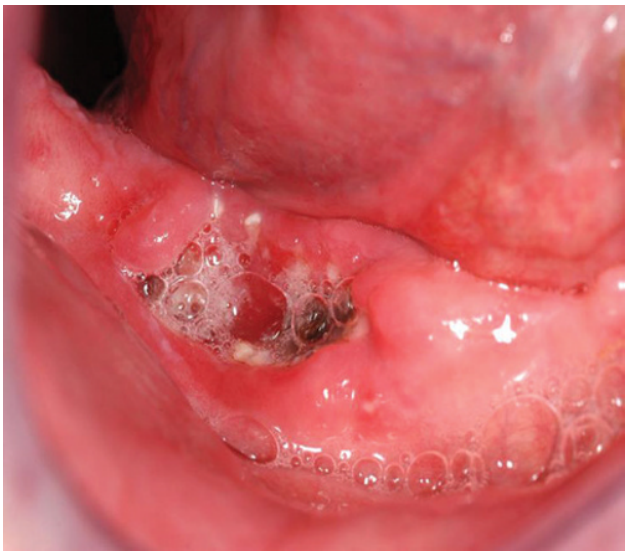


Figure 20.4 Osteoradionecrosis after lower molar extraction.

Osteoradionecrosis (ORN)

- ORN is a serious complication of radiotherapy. Current theory is of a fibronecrotic process of the bone and endothelial cells.
- It is exposed, devitalised bone present for over 3 months in an area that has been irradiated. The exposed bone looks yellow and is often rough and uncomfortable.
- It may cause pain, swelling, altered sensation, pus discharge, skin fistula and fracture (Figure 20.4).
- The greater the dose of radiotherapy, the greater the risk. It generally occurs in people who have been exposed to over 60 Gy; below 50 Gy it is uncommon.
- The risk for patients after radiotherapy is lifelong.
- The greatest risk factor is dental extractions. A retrospective study over 30 years found tooth extractions were responsible for 50% of cases. It may also develop spontaneously. Risk factors are shown in Table 20.6.

Table 20.6 Risk for osteoradionecrosis.

General factors	Dental factors
High dose radiotherapy	Extraction after radiotherapy
Chemotherapy combined with radiotherapy	Extractions prior to radiotherapy, especially if <10 days
Smoking	Denture trauma, especially over mylohyoid ridge
High alcohol	Implant placement
Reduced risk with intensity modulated radiotherapy	Biopsy
	Periodontal surgery
	Higher in mandibular molar area

Extractions Before Radiotherapy

Extractions may be recommended before radiotherapy to avoid ORN later. Considerations for extractions preradiotherapy:

- Teeth causing pain or with infection.
- Teeth with poor prognosis: periodontal pockets larger than 5 mm or restoration likely to fail.
- Molars teeth if trismus is likely to develop or long-term sugary food supplements are needed.
- Partially erupted third molars.
- Consider a shortened dental arch – most patients manage well. At the pretreatment visit, impressions may be taken to provide dressing plates or surgical obturators following maxillectomy. Outline prosthetic rehabilitation should be planned. Written information is important as it may be very difficult for patients to assimilate all the information at one time (available from Macmillan Cancer Support).

Continuing Care

Recalls should be three-monthly in the first year after radiotherapy and only less frequent once there is stabilisation of the diet and a satisfactory preventive regime (Table 20.7). Long-term maintenance should be

Table 20.7 Recommendations for oral care.

Condition	Recommendations
Mucositis	Maintain good oral hygiene. Use soft brush. Smooth sharp teeth and dentures. Avoid hard or spicy food and alcohol. Pain relief: Difflam (benzydamine hydrochloride mouthwash 15%). 2% lidocaine mouthwash. Systemic – non-steroidal anti-inflammatory agents. Chlorhexidine is not recommended.
Xerostomia	Stimulation by chewing sugar-free gum. Salivary stimulating tablets (SST, Medac). Replacement alternatives: Sips of water. A.S Saliva Orthana (A.S Pharma). Biotène Oralbalance Saliva Replacement Gel (GSK Consumer Healthcare). BioXtra (Molar). Dry lips and mucosa may be moistened with gel (e.g. Oralbalance).
Candida infection	Nystatin sugar-free oral suspension. Miconazole oral gel. Fluconazole 50 mg capsules or suspension. Dentures should be cleaned with a toothbrush and soaked in chlorhexidine.
Trismus	Exercises, early treatment minimises severity. Wooden spatula between upper and lower teeth, increasing in number. TheraBite® Jaw Motion Rehabilitation System™ (Atos Medical) Referral to physiotherapy.
Caries prevention	Use 5000 ppm fluoride toothpaste twice daily (Duraphat® 5000, Colgate-Palmolive). Alternative: 1% sodium fluoride gel or 0.4% stannous fluoride gel in custom-made trays for 10 min daily. Alcohol-free fluoride mouthrinse at least once daily (0.05% NaF). Fluoride varnish (2.2% fluoride) applied twice a year. Children and young adults should have fluoride appropriate to age.
Oral hygiene Denture hygiene	Twice daily brushing with a medium manual or electric brush, supplemental use of floss or interdental brushes. Soft brush (e.g. TePe Special Care Toothbrush) can be substituted if very sore. Dentures brushed and soaked in chlorhexidine mouthwash overnight. Dentures should not be worn at night; obturators should be cleaned and kept in. Chlorhexidine mouthwash (available 0.12–0.2%) is recommended if brushing is very limited, e.g. after surgery.

in primary care, with specialist support if advanced restorative treatment is required.

Extractions After Radiotherapy

Extractions in the irradiated area should be avoided and restorative treatment carried out wherever possible. The risk of ORN should be assessed and the patient informed. The following are recommended precautions:

- An experienced operator.
- Minimal trauma.
- Antibiotics: generally recommended, but with limited evidence.
- Review after 2 weeks and until epithelisation.
- If healing is delayed refer to an oral surgeon for further management.

Hyperbaric oxygen has been used in the past, but there is insufficient evidence to support its use for prophylaxis of ORN. Pentoxifylline and vitamin E have been used to treat advanced cases of ORN with promising results and they may be beneficial for prophylaxis before extractions. Dentists should be observant for areas of exposed bone in irradiated patients since early intervention of ORN improves outcome. Referral should be made to an oral surgeon.

Bisphosphonates

Bisphosphonates are an important class of drugs that are commonly used to affect bone turnover. They have a strong affinity for hydroxyapatite and are deposited in bone around the body including the mandible and maxilla.

Once deposited in bone they effectively strengthen it primarily by inhibiting osteoclast function, differentiation and migration. They also cause osteoclast early cell death (apoptosis). This breaks the normal cycle of remodelling of bone and results in increased bone density. Bisphosphonates have several uses in medicine. These are listed in Table 20.8.

The route and dose varies depending on the condition being treated and they can be given orally daily/weekly or intravenously every 4–6 weeks, yearly or sometimes one-off infusions. The procedures for treating patients with bisphosphonates are given in Tables 20.9–20.12.

In patients with cancer, bisphosphonates are principally used in the management and prevention of skeletal-related events associated with multiple myeloma or bone metastases from other cancers, commonly breast, prostate or lung.

Bisphosphonate Osteonecrosis of the Jaws

Bisphosphonate osteonecrosis of the jaws (BONJ) is a rare condition defined as exposed, avascular, non-healing bone in either the mandible or the maxilla that has been present for 8 weeks with no history of radiotherapy to the jaw (American Association of Oral and Maxillofacial Surgeons, 2006). BONJ is usually associated with trauma such as dental extractions, although it can occur spontaneously. The risk of BONJ is difficult to quantify, as there are many factors and comorbidities.

Bleeding Disorders

A bleeding disorder arises if any part of the haemostatic or clotting pathways is faulty; it can be acquired or inherited. Where a bleeding disorder is established or suspected, it may be necessary to liaise with the patient's general medical practitioner or hospital consultant to ensure the safe planning and delivery of dental treatment.

Acquired Bleeding Disorders

Acquired bleeding disorders are typically caused by anticoagulant therapy. Anticoagulants are most commonly used for the prevention and treatment of thromboembolism. Warfarin is the most commonly used oral anticoagulant. Its activity is monitored using the international normalised ratio (INR). Heparin inhibits activated clotting factors and decreases platelet aggregation. It is also mainly used for the prevention of thromboembolism and during renal dialysis. Antiplatelet agents inhibit platelet aggregation by blocking pathways of platelet activation and aggregation.

Table 20.8 Conditions that may be treated with bisphosphonates.

Osteoporosis
Prevention and treatment of steroid-induced osteoporosis
Cancer
Bone metastasis
Multiple myeloma
Hypercalcaemia of malignancy
Paget's disease of bone
Osteogenesis imperfecta
Fibrous dysplasia

Table 20.10 Procedures for patients starting oral bisphosphonates.

Procedure	Rationale
Patients should be encouraged to attend a dentist for a routine examination. Normal dental treatment should not be altered or withheld.	It is important to identify any treatment needed and allow a risk assessment for bisphosphonate osteonecrosis of the jaws to be made. The risk is low and cumulative for oral bisphosphonates.

Table 20.9 Procedures for all patients starting bisphosphonates.

Procedure	Rationale
Patients should be advised on reducing the frequency of sugars, on identifying hidden sugars and choosing healthy snacks.	To reduce the risk of caries.
Patients should use a toothpaste containing at least 1350 ppm fluoride. An alcohol-free fluoride mouthwash should be used at night after the teeth are clean. If the patient has xerostomia, Duraphat® (Colgate-Palmolive) 5000 ppm should be prescribed.	To reduce the risk of caries.
Patients should be instructed in the use of a manual or rotation oscillation toothbrush to reduce plaque and gingivitis scores. Teeth should be cleaned twice a day, including at night before going to bed.	To reduce the risk of caries and periodontal disease.
Floss or interdental brushes should be demonstrated and used daily.	To reduce the risk of caries and periodontal disease.
Patients should be encouraged to stop smoking.	This will reduce the risk of bisphosphonate osteonecrosis of the jaws, periodontal disease and other systemic illness.

Table 20.11 Procedures for patients starting intravenous bisphosphonates.

Procedure	Rationale
Patients should be prescreened by a dentist before bisphosphonate therapy commences.	For patients with cancer, intravenous bisphosphonates are much higher risk than oral medication. It is important to carry out all invasive dental treatment before patients start therapy.
Appropriate full mouth radiographs (e.g. dental panoramic tomogram) should be taken and each tooth assessed for caries, periodontal disease, retained roots and apical infection.	To identify treatment needed and reduce the need for future dental extractions.
Edentulous patients should be checked for poorly fitting dentures.	Trauma from dentures may cause bisphosphonate osteonecrosis of the jaws (BONJ).
Patients should have a caries and periodontal risk assessment with attention to carbohydrate frequency and oral hygiene status.	This will allow the longer-term prognosis of teeth to be considered.
A full medical history should be taken and the patients general medical practitioner or specialist should be contacted if there are concerns or further information required.	Some patients, for example those with prostate cancer and bony fractures, may only have a few months to live. Others may be having chemotherapy which would affect clotting or healing. It is important to consider the patients overall medical condition and prognosis when planning dental treatment. Quality of life may be more important than making the patient dentally fit.
All teeth of poor prognosis should be extracted prior to starting intravenous bisphosphonates.	To reduce the risk of tooth extraction and BONJ after intravenous therapy starts.
Patients should be made aware of the risk of BONJ and early symptoms.	BONJ can happen spontaneously and early presentation has a better outcome.
The benefits of bisphosphonates should be discussed.	Bisphosphonates are very successful in oncology management and patients should not be put off taking them due to the risk of BONJ.
Invasive dental treatment should be avoided including dental extractions, implant placement and periodontal surgery. Root treatment and sealing of unrestorable roots at gingival level should be considered as an alternative to extraction.	Dentoalveolar surgery carries a high risk of developing BONJ.

Table 20.12 Patients taking bisphosphonates requiring a tooth extraction.

Procedure	Rationale
All patients having a tooth extraction should be asked about conditions where bisphosphonates are commonly prescribed, such as osteoporosis. The patient's medication should be checked ideally from a pharmacy or doctor's note/letter.	Patients are sometimes unaware of the medication they take or think it unimportant that dentists know about bone medication. They may also have previous exposure but may still be at risk of bisphosphonate osteonecrosis of the jaws (BONJ) due to the long half-life of bisphosphonates.
The condition treated, type of bisphosphonate, route and duration of treatment should be assessed for risk of BONJ.	The risk of BONJ increases and may influence treatment decisions.
Informed consent should be gained by discussing the options and risks of treatment and alternatives.	Although the risk of BONJ may be low patients should be aware of the risk so that they can make an informed choice.
Local and national guidance should be checked for protocols on extractions in patients taking bisphosphonates.	There is currently limited evidence about BONJ and guidance is varied, for example providing antibiotic cover is advised by some and not others. It is important to check local guidance, protocols and new evidence as it becomes available.
High-risk patients receiving bisphosphonates may be more appropriately treated in a specialist centre and local acceptance criteria should be checked.	Specialist centres will have greater experience of high-risk patients.
Dentists should work within their skill and assess extractions for difficult surgical approaches. Referral for specialist advice or treatment should be sought if in doubt.	Teeth should be extracted as atraumatically as possible to help with soft-tissue healing. Primary closure may be helpful in situations where bone is likely to be exposed.
Healing should be reviewed regularly and a specialist opinion should be sought early if there is concern.	Small and early lesions are more successfully treated.

Inherited Bleeding Disorders

Von Willebrand's disease is a common inherited bleeding disorder caused by a genetic deficiency or defect in Von Willebrand's factor. Von Willebrand's disease presents with bleeding into mucous membranes, gingival bleeding, nose bleeds, prolonged bleeding and bruising after minimal trauma and menorrhagia in women. Bleeding into joints and muscles may occur with severe disease.

Haemophilia A is a congenital coagulation disorder resulting from a deficiency in clotting factor VIII. Haemophilia B is a congenital coagulation disorder resulting from a deficiency in clotting factor IX. The severity and clinical features of haemophilia A and B depend on the levels of factors VIII and IX. These include abnormal bleeding after haemostatic challenge in mild disease, to spontaneous bleeds into joints and muscles in severe disease.

Treatment Guidelines

- Routine conservative and restorative procedures requiring buccal, palatal, intrapapillary and intraligamental infiltrations, prosthodontic procedures and supragingival scaling may be carried out without measuring the INR, withdrawing heparin therapy or administering haemostatic cover for inherited bleeding disorders. Care must be taken not to instrument beyond the apex during endodontic treatment.
- The INR does need to be checked, heparin therapy withdrawn and haemostatic cover administered prior to extractions, surgical procedures, inferior alveolar block and lingual infiltration local anaesthetic injections, and deep periodontal scaling.
- A patient on warfarin with an INR below 4.0 can usually receive their dental treatment in primary care without altering their anticoagulant regime. For an INR result above 4.0, liaison with the clinician responsible for anticoagulation therapy is required.
- Withdrawal of heparin in conjunction with the clinician responsible for anticoagulation is usually adequate to reverse its anticoagulation effects.
- Patients taking a single antiplatelet drug can be managed routinely in primary care. Local measures are sufficient to manage any bleeding tendency associated with these drugs after surgical procedures.
- Referral to a specialist in special care dentistry is required for patients with acquired or inherited bleeding disorders with an erratic or fluctuant INR, inhibitors, liver impairment, a high alcohol intake, renal failure, thrombocytopenia, disorders of haemostasis, receiving cytotoxic chemotherapy or taking more than one antiplatelet drug.

Essential Equipment

- Local anaesthetic agent containing a vasoconstrictor (unless otherwise contra-indicated).
- Suture kit, including needle holders, scissors and tissue forceps (for surgical procedures).
- Resorbable sutures, e.g. 3.0 Vicryl Rapide (for surgical procedures).
- Resorbable haemostatic dressing, e.g. oxidised regenerated cellulose (e.g. Surgicel®), collagen sponge (e.g. Haemocollagen®) or resorbable gelatin sponge (e.g. Spongostan®) for extractions and surgical procedures.
- Gauze packs (for surgical procedures).

Pre-Procedure

Action	Rationale
Explain and discuss the procedure(s) and associated risks with the patient.	To ensure that the patient understands the procedure(s) and associated risks, and valid consent is obtained.
For patients on warfarin, liaise with the patient's general medical practitioner/anticoagulation clinic for the international normalised ratio to be measured 72/24 h prior to the planned procedure.	To ensure that the international normalised ratio is >4.0 prior to extractions, surgical procedures, inferior alveolar block and lingual infiltration local anaesthetic injections, and deep periodontal scaling.
For patients with inherited bleeding disorders, liaise with the patient's Comprehensive Care Centre/Haemophilia Centre informing them of the dental procedure(s) to be carried out, type of local anaesthetic injection and the date and time of the appointment.	To ensure that the appropriate haemostatic cover is prescribed and administered at an appropriate time prior to the dental appointment.
For patients with inherited bleeding disorders, plan dental treatment to minimise the number of treatment appointments requiring haemostatic cover.	To prevent the development of inhibitors, and reduce the theoretical risk of transfusion-transmitted infection.

Procedure

Action	Rationale
For patients on warfarin, confirm the international normalised ratio (INR) result and medical history with the patient.	To confirm that the INR is <4.0 and nothing has been taken that may affect the INR result (e.g. antibiotics, alcohol, St John's Wort, grapefruit juice).
For patients on heparin, confirm when the last dose of heparin was administered.	To ensure the effect of heparin on blood clotting is lost prior to commencing the dental procedure.
Confirm with the patient the procedure to be carried out and that haemostatic cover has been administered (if appropriate) and any products required post-treatment have been obtained.	To ensure that the appropriate haemostatic cover has been administered at an appropriate time prior to the dental appointment, and any products which may need to be administered post-treatment have been dispensed.
Carefully place suction tips, saliva ejectors and radiograph films. Carefully remove impressions. Use rubber dam to protect the oral mucosa.	To prevent injury to the oral mucosa during treatment and subsequent bleeding.
Carry out extractions with minimal trauma.	To prevent excessive bleeding from the bone and soft tissues.
Consider using a resorbable haemostatic dressing following extractions.	To provide a mechanical matrix to promote and stabilise clot formation.
Consider suturing extraction sockets with resorbable sutures.	To approximate gingival margins, achieve primary closure and prevent loss of the resorbable haemostatic dressing.
Ask the patient to sit up and bite on a damp gauze swab for at least 10 min	Pressure encourages formation of a stable blood clot.

Postprocedure

Action	Rationale
Give the patient thorough and detailed verbal and written postoperative (extraction) instructions.	To instruct the patient how to look after extraction sockets, promote healing and minimise postoperative complications.
Avoid the use of aspirin and non-steroidal anti-inflammatory drugs for postoperative analgesia.	Aspirin and non-steroidal anti-inflammatory drugs inhibit platelet function, which exacerbates the bleeding tendency.
Avoid prescription of macrolide antibiotics, azole antifungals and metronidazole for patients on warfarin.	These drugs interact with warfarin and can cause increased bleeding.
Give the patient verbal and written emergency contact details.	To ensure the patient can contact appropriate staff in the event of postoperative complications.
Ensure that the patient returns to the Comprehensive Care Centre/Haemophilia Centre if required.	Patients with severe inherited bleeding disorders or inhibitors may require prolonged monitoring or the administration of further haemostatic cover (Brewer, 2008).
Write thorough, contemporaneous notes detailing the procedure carried out.	This is a required for future reference and in the event of a postoperative complication occurring.

Problem-Solving

Problem	Cause	Prevention	Resolution
Failure to achieve postextraction haemostasis, resulting in postextraction haemorrhage.	Tear in the gingivae or other bleeding point.	Atraumatic extraction technique.	Inspect the bleeding site with good suction and light. Treat with local haemostatic measures (local anaesthesia with a vasoconstrictor, resorbable sutures, resorbable haemostatic dressing, damp gauze swab).

(*Continued*)

Problem	Cause	Prevention	Resolution
	Fibrinolysis. Local haemostatic measures fail to achieve haemostasis.	Consider preoperative use of tranexamic acid (in liaison with the patient's medical team).	Use tranexamic acid as a mouthwash, or to dampen the gauze swab.
	Inherited bleeding disorder. Local haemostatic measures fail to achieve haemostasis.	Careful preoperative treatment planning and use of haemostatic cover.	Contact the patient's Comprehensive Care Centre/Haemophila Centre regarding the use of extra factor concentrate and patient monitoring.
	Anticoagulant drug therapy. Local haemostatic measures fail to achieve haemostasis.	Preoperative INR check within 24–72 h of the appointment time. Check medical history prior to commencing the procedure. Appointment timing to ensure that the effects of heparin have worn off.	Contact the patient's anticoagulation clinic regarding checking the international normalised ratio and emergency management.
	Antiplatelet drug therapy.	Careful treatment planning. Atraumatic extraction technique.	Local haemostatic measures.
	Postoperative infection.	Careful, aseptic surgical technique. Consider the prescription of antibiotics following extractions in patients with inherited bleeding disorders to prevent a late bleed.	Local haemostatic measures and antibiotic therapy. If local measures fail to control haemostasis liaise with the relevant medical team.

Infection Control

The principles and practices of infection control in dentistry employed under the term 'standard (universal) infection control precautions' (Chapter 3) cover most oral healthcare interventions. However, there are some situations where standard precautions need to be supplemented with additional procedures because the patient poses a higher risk to staff or other patients around them.

Tuberculosis

Tuberculosis (TB) has a higher incidence in certain groups such as homeless people, people living with HIV and AIDS, intravenous recreational drug users and those that have suppressed or poorly functioning immune systems.

Procedures and Rationales

- A written TB plan should be an integral part of the infection control policy developed for dental settings.
- New employees should have evidence of either tuberculin skin testing or past immunisation.
- Preoperative questioning about general medical history and status should allow identification of those patients at risk or suspected of having TB.
- If TB is suspected, the patient should be given infection transmission advice and the relevant respiratory specialist should be informed by urgent patient referral.
- The patient should receive active instruction, and if necessary supplies of masks or tissues, to ensure they cover their mouth and nose when coughing.
- The patient must wash their hands after coughing whether tissues are used or not.
- If TB has already been diagnosed, information about the stage of treatment is required before any dental intervention is made.
- Avoid elective dental treatment until a respiratory physician certifies safety.
- Ideally all routine, elective dental care procedures should be delayed until the patient is declared not to be an infection risk.
- If emergency treatment is required, the least interventional option should be considered until infection risk is minimised, i.e. relief of pain and local sepsis in the first instance.
- For confirmed cases requiring interventional treatment, the patient should ideally wear a high-efficiency particulate air (HEPA) filter mask (often called respirator masks) when being transported through public or patient areas. Tissues and standard surgical masks are not effective at preventing transmission of TB.
- On arrival, the patient should be kept away from communal areas.
- Treatment may be carried out at the end of the treatment session.

- A 'negative pressure' atmosphere is preferred. The door to the treatment room should be kept closed, except for necessary access.
- Staff entry and exit should be kept to a minimum without comprising patient care.
- During dental procedures, all members of the dental team present must wear a HEPA mask.
- Disposable surgical gowns and full face visors must be worn.
- Use of aerosol-producing high-speed handpieces and ultrasonic scalers should be avoided as much as possible.
- Use high volume aspiration/suction. Suction units should be filtered and externally vented.
- The use of a rubber dam is highly recommended. It has been shown to reduce the amount of infected aerosol particles during treatment.
- The surgery should be cleaned as normal following the treatment episode. TBs is not known to be spread by contact with surfaces or equipment.

Standard decontamination and sterilisation procedures utilised in dentistry (washer disinfectors and steam autoclaves) are effective against *M. tuberculosis* Patients with multidrug resistant pulmonary TB pose a particular risk if dental treatment is required. Advice must be sought from a specialist infection control and/or respiratory/TB team in such instances. If staff show any symptoms up to 3 months following contact, then immediate referral to a specialist occupational health professional or a respiratory physician is required.

Pandemic Influenza

Highly contagious respiratory infections like pandemic influenza can be easily transmitted by aerosol-producing procedures such as dental treatment. Pandemic influenza can also be transmitted by contact. All the procedures described above for TB apply here but there are some considerations that may also be necessary in cases of pandemics where, unlike TB, large numbers of suspected cases are expected. All items such as magazines, books and soft toys should be removed from waiting rooms and communal areas.

For elective procedures, it is suggested that patients are contacted on the day of their appointment to check if they have become symptomatic for pandemic influenza. In such circumstances, all elective treatment should be cancelled until symptoms abate.

The standard order for the removal of personal protective equipment of **G**loves first, followed by **A**pron, followed by **M**ask and lastly **E**ye protection (G, A, M, E) is changed, with the HEPA filter mask (respirator) being retained until patients have left the treatment area.

Transmissible Spongiform Encephalopathies

Transmissible spongiform encephalopathies (TSE) are degenerative brain diseases seen in animals and humans caused by an infectious abnormal protein (prion) which is transmissible in several ways. In healthcare situations, the risk of iatrogenic transmission causing Creutzfeldt–Jakob Disease (CJD) relates to tissue or organ transplantation (e.g. corneal and dura mater grafts) and the use of growth hormone harvested/derived from cadaveric pituitary glands from patients infected with the variant prion or from instruments harbouring the protein. The prion protein has been shown to be difficult to remove from surgical instruments. Instruments used in TSE-positive cases need special consideration. There is no proven link between routine dental procedures and the transmission of CJD. However, risk groups include:

- Symptomatic patients: those with a clinical diagnosis of a prion disease or under investigation for a suspected prion disease.
- Asymptomatic but at risk (familial types): those who have had a blood relative affected by a familial form of prion disease.
- Asymptomatic at risk (iatrogenic types): those in known medical risk groups described below:
  - Recipients of human pituitary gland hormones (pre-1986).
  - Recipients of dura mater grafts (pre-1992).
  - Recipients of a blood transfusion or an organ from a donor that progressed to symptoms.

Procedures and Rationales

Most dental procedures are classified as low risk but all endodontic intracanal instruments (files, reamers, broaches) should be single-use.

Most general dental restorative, prosthodontic, oral surgical or periodontal procedures are classified as low risk procedures. Standard decontamination and sterilisation procedures are adequate for this group of dental procedures for all except symptomatic patients. In this group, the use of single-use instruments is recommended where technically possible.

Such procedures performed on patients suspected of having CJD or with a positive clinical diagnosis require specialist instrument decontamination and sterilisation advice and can require the destruction of instruments following the procedure.

General Anaesthesia

Previously, general anaesthesia (GA) was widely used to treat patients with special needs, but access to GA is becoming more difficult. Aside from access difficulties,

GA is not an ideal method of providing dental care, as treatment planning can be difficult when faced with a large treatment need and limited time and facilities to complete all dental treatment in one session.

Indications

The types of patients requiring dental care under GA fall into three categories:

1) Those who will not allow even an examination when awake and for whom sedation techniques have been unsuccessful. This group of patients poses challenges for the dental team who must devise a treatment plan in theatre. All equipment and materials which may be required must be available in theatre.
2) Those for whom sedation is partially successful making examination and cleaning possible, but not operative dentistry. This group can have sedation on a regular basis for recalls and oral hygiene measures, but will require GA for more advanced care.
3) Those for whom sedation does allow examination; however, either a requirement for a great deal of treatment or more difficult dentistry may be revealed, e.g. removal of wisdom teeth. For these patients, the initial examination under sedation helps the team to plan the treatment required and to discuss this with the carers. It allows efficient use of time in theatre.

Patient Assessment

The dentist who is to treat the patient should carry out the dental assessment.

- The patient's weight, height and blood pressure should be recorded as part of a general health assessment.
- Details of previous GA experiences should be recorded.
- If carers are doubtful regarding the patient's medical history, then further details should be sought from the patient's general medical practitioner.
- If radiographs can be taken preoperatively, this improves the accuracy of treatment planning.
- Consent should be obtained (see Chapter 5).

Requirements

Operating Theatre

Operating theatres are usually larger than dental surgeries and therefore space for equipment is not usually a problem. Radiographic facilities with fast processing of films or digital radiography should be available. All dental equipment needs to be brought to theatre and should be tested before the list begins. There should be two of everything, or at least easy access to back-up equipment in case of breakdown.

Staff Required

Dental GA requires a team approach:

- The dentist.
- The dental hygienist: to assist in cases of advanced periodontal disease, especially, if available, to see the patient and their carers pre- and postoperatively to motivate them in oral health measures.
- A radiographer: can help take dental radiographs in an unconscious supine patient.
- Dental nurses: in theatre, it improves the efficiency of the list if there are two dental nurses – one to act as a chairside assistant aspirating and retracting and the other to mix materials.
- The anesthetist.
- The anesthetic assistant.
- General nursing staff: for the care of the patient in recovery.

Treatment under GA

- Full examination: the first step is to carry out an examination of the oral cavity. To examine the teeth it may be necessary to use an ultrasonic scaler to remove plaque, calculus and food debris. The teeth should be charted and treatment required recorded.
- Radiographs: intraoral films are most useful. Lateral oblique films can be taken, but the radio-opaque thread in the throat pack may distort the view.
- Restorative treatment: it is easiest one side, upper and lower, at a time. Care must be taken when restoring large cavities in posterior teeth. If there is pulpal involvement, extraction is to be preferred to a direct or indirect pulp cap, given the risk of pulp death and infection in the future.
- Endodontic treatment: should only be considered for anterior teeth.
- Surgical treatment: this is usually carried out after the restorative care when it is known which teeth are restorable. Infiltration of local anaesthesia can help with haemostasis and postoperative pain.
- Recovery and discharge: it is the anaesthetist's responsibility to ensure recovery from anaesthesia, though this may be delegated to recovery staff. It is the dentist's responsibility to discharge the patients to the care of their family or carers and to give postoperative advice.

Conscious Sedation

Conscious sedation offers an alternative method of behaviour management to GA and intranasal sedation is particularly helpful in providing care for those with

challenging behaviour. Intravenous sedation can be used for people with learning difficulties if they can cooperate with placement of a cannula. Inhalational sedation is an extremely safe technique and can be used to treat adults and children with mild learning disabilities (see Chapter 10 for further details).

Oral Sedation

Oral sedation offers significant advantages in that it requires little patient cooperation. Peak plasma levels are generally achieved in 30 min so that dental treatment can usually start 15–20 min after administration.

Domiciliary Dental Care

As life expectancy increases so does the need for domiciliary dental care. The British Society for Disability and Oral Health (BSDH) has described a domiciliary oral health service as 'a service that reaches out to care for those who cannot reach a service themselves'. Domiciliary services can be provided in number of different locations, for instance day centres, residential and care homes, local hospitals and palliative care units.

Establishing Domiciliary Dental Care Services

- Liaise with partners in oral health, health and social care professionals, carers, care homes and the voluntary sector as well as commissioners. This will increase the dental team's knowledge of where the needs of domiciliary care are and perhaps ideas on how the team can adapt services accordingly.
- Establish an appropriate referral pathway. Only people who 'truly' have difficulty leaving their homes should be accepted for treatment.
- Assess the dental team's skill. A dental team fit to conduct domiciliary visits needs to have excellent team work, flexibility and the ability to work in different locations and circumstances. Other key skills are summarised by the BSDH acronym 'CAMPING': C, communication; A, assertiveness and anticipation; M, manual handling; P, planning and time management; I, improvisation; N, networking and liaison; G, gerontology (medical condition, associated problems and medical emergencies).
- Provision of initial training and continuous professional development training in the understanding, planning and delivery of all aspects of domiciliary care.
- Develop emergency and non-emergency visits procedural checklists.
- Acquire suitable equipment and instrumentation as recommended by the BSDH.
- Organise the domiciliary dental kit into general kit and sub-kits. The BSDH has provided a comprehensive list of useful items in each category.

Operational Arrangements

Preparation for a visit to a private residency:

- Contact the patient.
- Produce an environmental risk assessment which should include the following: the patient's details; medical history form; assessment of the patient's communication skills/needs; assessment of the patient's ability to give consent; details of parking availability and proximity; information on access to the premises, including details of stairs, lifts and lighting; a manual handling assessment; availability of services (electricity, running water, etc.); details of any hazards, pets and special circumstance; details of available aftercare support.

The environmental risk assessment form should be placed in the patient's notes and read before each domiciliary visit.

On the day of the visit:

- Contact the patient to confirm the appointment time.
- Carry a mobile phone and inform colleagues about details of the domiciliary visit (patient's detail, the anticipated return time, the main risks highlighted on the environmental risk assessment sheet) and have a chaperone.
- Introduce the dental team and carry visible official identification.
- If the patient's carer is present for support and consultation be cautious not to breach patient confidentiality.
- Take an up-to-date medical, dental and social history.
- Allow time to find a suitable working area and set up in the patient's home environment.
- Discuss the proposed treatment in the context of the overall care plan, bearing in mind the difficulty in positioning the patient and the time available.
- If dental treatment is provided, local policies for infection control will apply in the same way as for clinic-based procedures.
- Provide all necessary postoperative instruction, including advice on preventive measures.
- Ensure all equipment and instrumentation is safely packed up and removed from the premises.
- Complete the patient's clinical records and a report on the visit, highlighting any difficulties encountered.

Prison Dentistry

- The prison population is increasing.
- Most prisoners are adult males.
- There are different levels of security within prisons. In the UK, category A is the maximum security level, while D is the lowest level.
- Prisoners have high levels of mental illness and infectious diseases.
- Prison populations have high numbers of decayed and missing teeth.
- Periodontal disease is common amongst prisoners.
- Unhealthy eating, smoking, alcohol and drug abuse are contributing factors to neglected dentition amongst prisoners.

Provision of Prison Dental Services

- Gain an understanding of the judicial system, different types of prison establishments and prisoners. Gather information on the prison in which you are going to work.
- Local remand centres often have a high turnover of prisoners and can be overcrowded. This means that the dental team providing oral healthcare services may receive many request for emergency dental care for prisoners.
- Liaise with local commissioners, the prison governor and relevant healthcare managers about the dental contract and prison service specification. Explore the extent and limitation of the provision of dental services within that prison establishment.
- Liaise with the prison security department and other officers as appropriate.
- Obtain dental team security clearance.
- Organise a dental team induction and training programme to understand and be trained in, amongst other matters, procedures relating to access to the prison, personal identification and security, the security of instruments, equipment and drugs, and the management of the behaviour of prisoners. The National Association of Prison Dentistry (NAPDUK) is a valuable source of further information and relevant continuing professional development.
- A prison officer may need to be present in the surgery, depending on the category of the prison and the prisoner. Under such circumstances care must be taken to ensure patient confidentiality.
- It is costly and there are security issues when a patient is referred for secondary/tertiary care.

Dental Team Requirements

- Be accommodating and exercise good communication skills, while being firm, consistent and fair in the care of prisoners. This approach is necessary to meet the varied needs of prisoners, especially those who have learning difficulties and/or mental health problems.
- Planning and time management skills. Typically, the care of prisoners must work around prison routine.
- Interprofessional working. The care of prisoners is often best provided working in collaboration with other healthcare providers in the prison environment. Prisoners may exhibit abnormal behaviours, suffer unpredictable mood swings requiring assistance and be reluctant to comply with oral health advice such as smoking cessation.
- Specific skills. Knowledge of drug, alcohol and drug abuse, chronic systematic diseases, mental health problems, learning disability and infectious diseases. Understand the effects of rehabilitation and detoxification regimes on patients.
- Report writing for prison authorities and those who represent the rights of prisoners. Prisoners may be aware of their legal entitlements. The dental team must communicate effectively and appropriately with prisoners and their advocates. This can minimise complaints and other difficulties.
- Be able to identify and manage orofacial trauma, including untreated trauma, and self-harm-induced orofacial injuries.

Operational Arrangements

- Prepare environmental risk assessment of the dental surgery, decontamination facilities and security arrangements.
- Liaise with health and social care professionals within the prison establishment to, for example, identify and prioritise vulnerable prisoners for dental care.
- Be familiar with all relevant prison rules and procedures.
- Establish appropriate referral and urgent care pathways. A triage system might reduce treatment and reporting bias.
- Link dental records with inmate medical records. This will enable holistic care and provide the dental team with relevant information on the prisoner's medical status and history.
- Arrange referrals, as appropriate, when prisoners are realised back into the community.

Oral Health Promotion

- Ensure oral hygiene is included in all healthcare plans. Prisoners' oral health values, awareness and motivation may vary. Oral health may be a low priority for

many prisoners, especially for those involved in a detoxification programme.
- Use dental care professionals and other healthcare staff to reinforce regimes to promote oral health.
- Educate on risks of smoking, sugar intake and drug abuse.
- Ensure the availability of oral health kits to include high fluoride content toothpaste where indicated clinically.
- Encourage reduced sugar intake amongst prisoners, possibly through the promotion of healthy eating.

Further Reading

Introduction and Impairment

Boyle, C.A. (2005) Teaching undergraduates Special Care Dentistry. Journal of Oral Health and Disability 6(2).

Fiske, J., Dickinson, C., Boyle, C., Rafique, S., Burke, M. (2007) Special Care Dentistry. Quintessentials of Dental Practice. London: Quintessence Publishing.

Joint Advisory Committee for Special Care Dentistry (2003) A Case for Need: Proposal for a Speciality in Special Care Dentistry. London: Royal College of Surgeons of England.

National Autistic Society (2017) Dentist: preparing for a visit. http://www.autism.org.uk/living-with-autism/out-and-about/dentist-preparing-to-visit.aspx (accessed 22nd July 2017).

Owens, J., Dyer, T.A., Mistry, K. (2010) People with learning disabilities and specialist services. British Dental Journal 208:203–205.

Clinical Holding

British Society for Disability and Oral Health (2009) Guidelines for 'Clinical Holding' Skills for Dental Services for People Unable to Comply With Routine Oral Health Care. Stirling, C., West M., eds. London: British Society for Disability and Oral Health.

Kupietzky, A. (2004) Strap him down or knock him out: is conscious sedation with restraint an alternative to general anaesthesia? British Dental Journal 196:133–138.

Cancer

Cancer Research UK (2014) Cancer incidence statistics. http://www.cancerresearchuk.org/health-professional/cancer-statistics/incidence.

Jawad, H., Hodson, N., Nixon, P. (2015) A review of dental treatment of head and neck cancer patients, before, during and after radiotherapy: Part 1 & 2. British Dental Journal 218:65–68, 69–74.

Kumar, N., Brooke, A., Burke, M. et al. (2012) The oral management of oncology patients requiring radiotherapy, chemotherapy, and/or bone marrow transplantation. https://www.rcseng.ac.uk/dental-faculties/fds/publications-guidelines/clinical-guidelines/ (accessed 22nd July 2017).

Macmillan Cancer Support. Head and neck cancers http://www.macmillan.org.uk/information-and-support/head-and-neck-cancers (accessed 22nd July 2017).

Ray-Chaudhuri, A., Shah, K., Porter, R. (2013) The oral management of patients who have received radiotherapy to the head and neck region. British Dental Journal 214:387–393.

Scully, C., ed. (2010) Oral healthcare of people living with oral cancer. Oral Oncology 46:399–484.

Bisphosphonates

American Association of Oral and Maxillofacial Surgeons (2009) Position paper on bisphosphonate-related oteonecrosis of the jaws. 2009 update. http://www.aae.org/uploadedfiles/publications_and_research/endodontics_colleagues_for_excellence_newsletter/bonj_aaoms_statement.pdf (accessed 22nd July 2017).

Bleeding Disorders

Brewer, A., Correa, M.E. (2006) Guidelines for dental treatment of patients with inherited bleeding disorders. World Federation of Hemophilia Treatment of Hemophilia Monograph Series 40:1–8.

Brewer, A. (2008) Dental management of patients with inhibitors to factor VIII to factor IX. World Federation of Hemophilia Treatment of Hemophilia Monograph Series 45:1–4.

Infection Control

Cleveland, J.L., Robison, V.A., Panlilio, A.L. (2009) Tuberculosis epidemiology, diagnosis and infection control recommendations for dental settings. Journal of the American Dental Association 140: 1092–1099.

Department of Health (2013) Pandemic influenza: guidance on the delivery of and contract arrangements for primary care dentistry. https://www.gov.uk/guidance/pandemic-flu (accessed 22nd July 2017).

Scully, C., Smith, A.J., Bagg, J. (2008) CJD: Update for Dental Staff. Dental Update 35:294–302.

General Anaesthesia

British Society for Disability and Oral Health (2009) The Provision of Oral Health Care Under General Anaesthesia in Special Care Dentistry. A Professional Consensus Document. London: British Society for Disability and Oral Health.

Manley, M.C.G., Skelly, A.M., Hamilton, A.G. (2000) Dental treatment for people with challenging behaviour: general anaesthesia or sedation. British Dental Journal 188:358–360.

Domiciliary Dental Care

British Society for Disability and Oral Health (2009) Guidelines for the delivery of a domiciliary oral healthcare service. http://www.bsdh.org/documents/BSDH_Domiciliary_Guidelines_August_2009.pdf (accessed 22nd July 2017).

Prison Dentistry

National Association of Prison Dentistry. Dental Services Specification. http://www.napduk.org (accessed 22nd July 2017).

21

Procedures in the Management of Acute Dental Trauma

Serpil Djemal, Sanjeev Sood, Ravi Chauhan and Lakshmi Rasaratnam

Introduction

The prospect of managing acute dental trauma can be challenging and daunting for anyone. Achieving optimal outcomes relies on sound decision making from the outset, helping to avoid complications and chronic sequelae.

Although the damage caused directly by injury is beyond the control of the dentist, the provision of appropriate treatment both immediately and upon review improves the prognosis of teeth.

Dental trauma can affect anyone and at any time. The management of traumatised teeth can be complex, with potential implications lasting a lifetime for the tooth, the dentition and the patient, including a possible impact on quality of life.

As with all aspects of clinical practice, repetition and familiarity breed confidence, and occasional experience only may threaten competence. Fortunately, dental trauma tends not to be encountered as frequently as other problems. As a consequence, however, one of the challenges of managing acute dental trauma in primary dental care is maintaining competence. Like medical emergencies, initial management can have a large, if not huge influence on prognosis. It is important, therefore, for all members of the dental team to maintain up-to-date understanding of the basic principles of managing the acute presentations of dental trauma, together with the relevant skills.

When faced with the often unexpected challenge, there are a number of immediate questions:

- What do I ask the patient?
- What should I expect to learn from the history?
- How can I manage this injury?
- Do I have the time and the necessary equipment to manage this?
- Should I prescribe antibiotics?
- Is there anyone I can refer the patient to?
- When should I see the patient again?
- Where can I get more information?

This chapter aims to illustrate, in a step-by-step approach, the management of acute dental trauma to achieve the best possible outcomes.

What Do I Ask the Patient?

Dental trauma will usually present unpredictably during a busy day. The patient will often be anxious, in pain, possibly in shock, and keen to know if their injured tooth or teeth can be saved. As with everything in dentistry, the process of managing a problem that initially seems complicated begins with a detailed, focused history.

It is important to establish basic information as this will facilitate and guide your management. Questions to include are:

- Is the patient accompanied and, if so, did that person witness the trauma? It is especially important for paediatric patients to be accompanied, as there may be implications with respect to consent. Having a witness to the trauma may provide a more reliable account of the event than the traumatised patient is able to recall.
- When, where and how did the injury occur? Detailed answers to these questions, apart from aiding any future medicolegal investigations, may raise new questions, e.g. What has been the time lapse following the trauma – minutes, hours, days, or possibly even longer? Is there the possibility of soil or other contamination? Is a tetanus booster required?
- Was there loss of consciousness? If so, consideration must be given to the possibility of a serious head injury. If there is evidence of a serious head injury, the management of this injury must take precedence.

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

- Does the patient have a medical history which may complicate their management?
- Is there a previous history of trauma? The prognosis for traumatised teeth which have previously experienced trauma may be, at best, guarded.
- Are all tooth fragments accounted for, or is there the possibility of inhalation of a tooth fragment?
- Is there the possibility of non-accidental injury? Fifty to 70% of child abuse cases involve injuries to the head and neck region, and head and neck injuries, including dental trauma are common in cases of adult abuse involving physical violence.

A preprinted pro forma can be useful in these circumstances, as it acts as an aide-memoire (Table 21.1). As a result, the most appropriate and relevant questions will be asked in an appropriate order, facilitating an efficient, effective and comprehensive approach to the initial phase of the management.

The answers to the listed questions should provide the practitioner with the basic information required to inform the management of the trauma.

Patients who present with dental trauma may not have seen a dentist for some time, may be anxious about dentistry, or may not have had any previous dental treatment. All of these circumstances will undoubtedly compound the distress caused by the traumatic incident. In all cases, in particular those involving dental fear and anxiety, it is important to apply good behavioural management techniques to alleviate patient anxiety and to show empathy and understanding. In addition, any accompanying person(s) may be upset and agitated also, making it important, in the interest of the patient, to take full control of the situation.

Table 21.1 Questions that can be included in the pro forma.

Questions	Reasons for asking
Date of trauma	Will determine prognosis.
Time of trauma	May inform treatment.
What happened	To determine mechanism of injury.
Where did it happen	May require tetanus booster if it occurred around soil.
Loss of consciousness	Has the patient been cleared of head injuries?
Emergency treatment carried out elsewhere	To get a full picture of what has been carried out.
Medical history	May contraindicate certain treatment: • Immunocompromised. • Bisphosphonates/radiotherapy. • Allergies. • Bleeding conditions.
Smoking status	May compromise healing.
Bite disturbance	Will tell you that the tooth/teeth may not be in their correct position.

What Should I Expect to Learn from The History?

The clinical examination should be systematic, comprehensive and quick, adopting an easy-to-execute approach. The trauma management pro forma may be found to be useful in building the clinical picture.

Clinical Examination

A gentle assessment of the face, soft tissues and teeth should be carried out to minimise the patient's distress.

Most untreated injuries presenting in general dental practice will be relatively minor. Major soft tissue injuries or facial fractures would normally be managed in a maxillofacial unit. Soft tissue injuries, including lacerations (even if already sutured) should be noted and drawn on a facial diagram or photographed (Figure 21.1).

There are, however, occasions when more than an expeditious check of the facial skeleton is prudent if you have suspicions about further injuries, for example, bilateral circumorbital ecchymosis (black eyes) suggestive of a Le Fort II or III fracture, or unilateral ecchymosis and associated signs indicative of a zygomatic fracture. Palpation, to elucidate any step deformities, flattening of the cheek and any limitation of jaw movements, should be carried out (Figure 21.2) and a referral made if necessary.

A full charting of the teeth present, any mobility or displacement of teeth, changes in the gingival margin location (Figure 21.3) or changes in the occlusion (Figure 21.4) should also be noted.

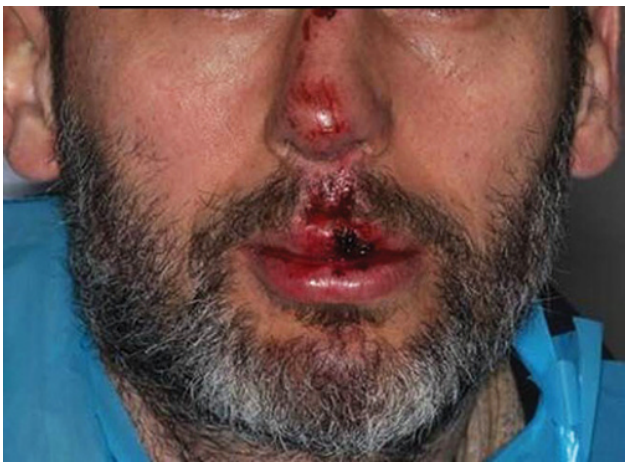
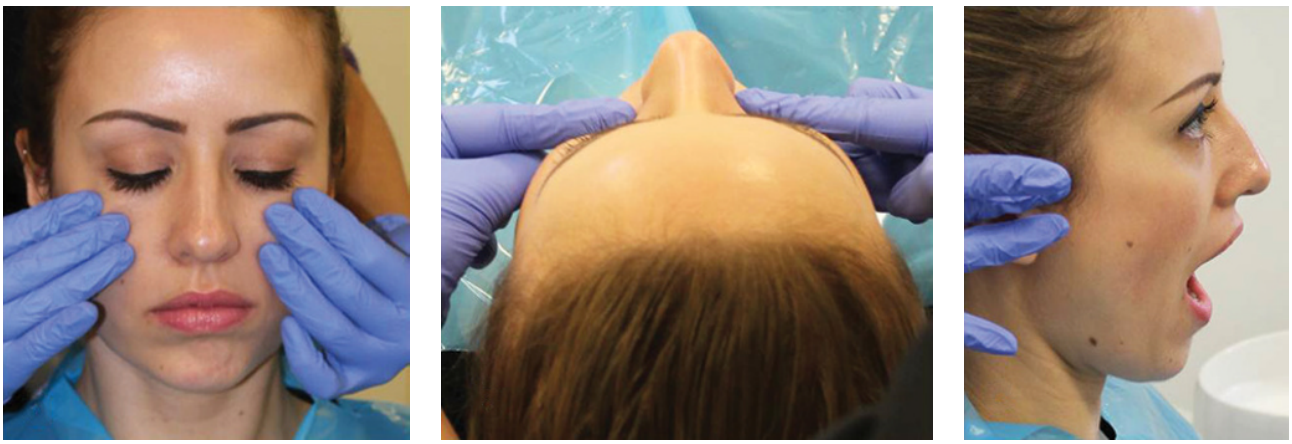


Figure 21.1 Photograph of adult patient capturing soft tissue injuries.



(a) (b) (c)

Figure 21.2 (a) Palpating for step deformities. (b) Checking for flattening of cheek. (c) Checking jaw movement.

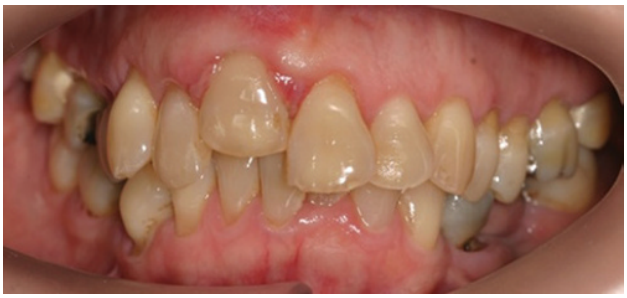


Figure 21.3 Displacement of UR1 showing change in gingival margin.

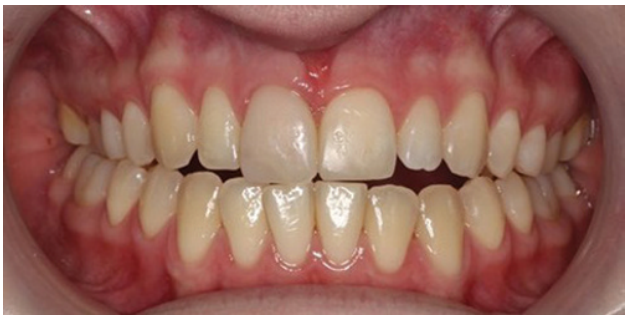


Figure 21.4 Displacement of UR1 with a notable change in the occlusion.

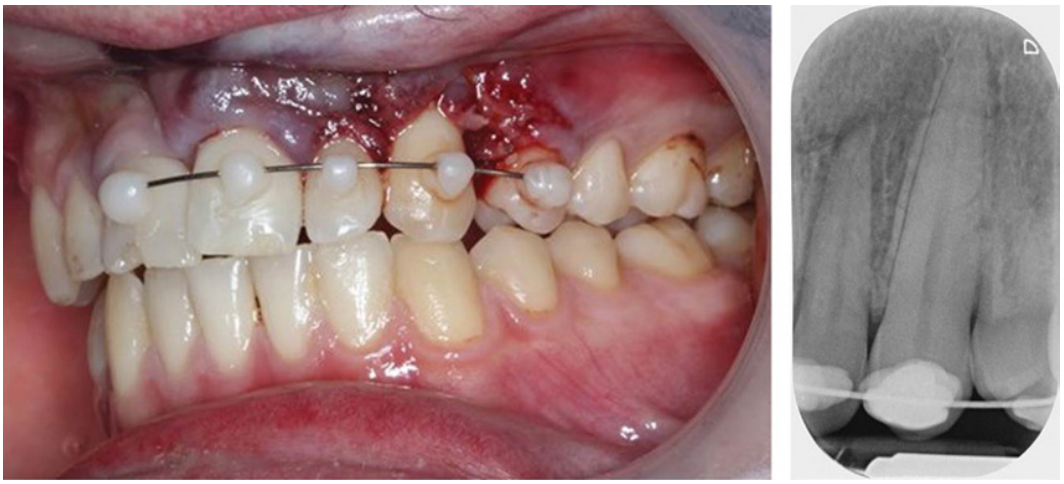


Figure 21.5 Clinical view and radiograph showing dentoalveolar fracture in the UL1,2,3,4 region.

When checking for mobility of teeth, if moving a single tooth results in several teeth moving together this is strongly indicative of a dentoalveolar fracture and would be seen as radiolucent lines on a radiograph (Figure 21.5). If there is an associated haematoma (bruising) then a dentoalveolar fracture is almost certain. In the case of a significant sublingual haematoma, you should eliminate the possibility of a mandibular fracture.

The assessment described previously is often carried out in a few minutes and the findings should be taken in the context of the overall condition of the mouth. The oral hygiene status of the patient should be noted, as well as the presence of periodontal disease, caries and atypical wear, which, together with the general motivation of the patient, can influence future management.

The types of injury can then be noted. It is important not to focus solely on the clinically obvious injured teeth at this stage as root fractures and other injuries may be missed.

Remember, if there are lacerations in the lips, as well as missing tooth fragments, pieces of tooth may be embedded in the lip. Gentle palpation of the lips between the forefinger and thumb can be helpful (but very painful!) in which case a soft tissue radiograph is indicated as discussed later.

Special Investigations

Sensibility Testing

Following a crushing injury, the traumatised pulp is unlikely to respond to sensibility tests. These tests have been shown to yield false negative results for up to 3 months following acute trauma and therefore their validity must be questioned as part of acute management (Gopikrishna, Pradeep and Venkateshbabu, 2009; Bastos, Goulart and de Souza Côrtes, 2014).

The pulp may become necrotic at a later stage and, therefore, sensibility tests are very useful at follow-up. Bearing in mind that patients will be anxious and traumatised emotionally, applying an electric current or thermal stimuli may not be welcomed by the patient. As a result, the authors feel that sensibility testing should be deferred to a subsequent appointment when the patient has hopefully recovered from the acute trauma. Baseline sensibility measurements can be initiated at this appointment.

When carrying out a sensibility test, it is important to test adjacent and opposing teeth and not to focus only on the obviously injured teeth, as they may be directly or indirectly injured. This also helps with trying to establish signs of vitality by comparing injured with uninjured teeth, as some results may be misleading as a consequence of the trauma. Sensibility testing in the primary dentition is of limited value, mainly given the unpredictable response from the child patient.

A 'trauma stamp' may be useful to help record and compare sensibility testing results over a period of time (Figure 21.6).

	12	11	21	22
Colour				
Mobility				
Sinus present				
Tenderness to percussion				
Tenderness to palpation				
Cold test				
Electric pulp test				

Figure 21.6 An example of a trauma stamp.

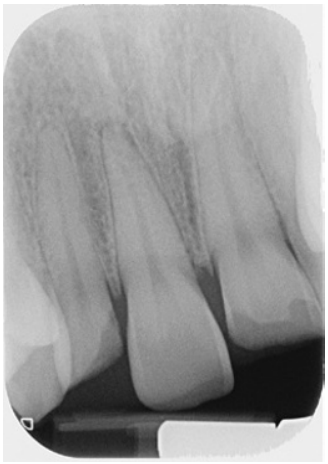


Figure 21.7 Periapical radiograph confirming intact periodontal ligament, no obvious root fractures and uncomplicated crown fractures UR2 and UL1.

Radiographic Examination

Periapical Radiographs Periapical radiographs are taken routinely in primary dental care settings, with the use of film holders. In the presence of displaced teeth this can be difficult, and may require adaptation of normal technique. The radiographic report should include reference to at least the periodontal ligament, root and location of any fractures (Figure 21.7).

Things to look for and document:

- Widening of the periodontal ligament space indicative of displacement rather than periapical pathology.
- Root form and development – in child patients, does the tooth have an open or closed apex? How much root growth has occurred? This information impacts on management and helps with regards to monitoring the outcome of treatment
- Size of the pulp.
- Location of the pulp in relation to the injury.
- Socket outlines.
- Loss of periodontal ligament space.
- Foreshortened roots.

- Root fractures.
- Pulp canal obliteration indicative of previous trauma that may be confirmed on further questioning of the patient.

Upper Standard Occlusal Radiograph This view can be very useful if a root fracture is suspected (Figure 21.8). Position the x-ray tube so that it bisects the upper anterior teeth as shown in Figure 21.9. Given the direction of the beam, the authors recommend the use of a thyroid collar. In young children, this radiographic view may be very useful, as it is a relatively simple and does not involve the use of holders which can be 'off-putting' and difficult to use in young children.

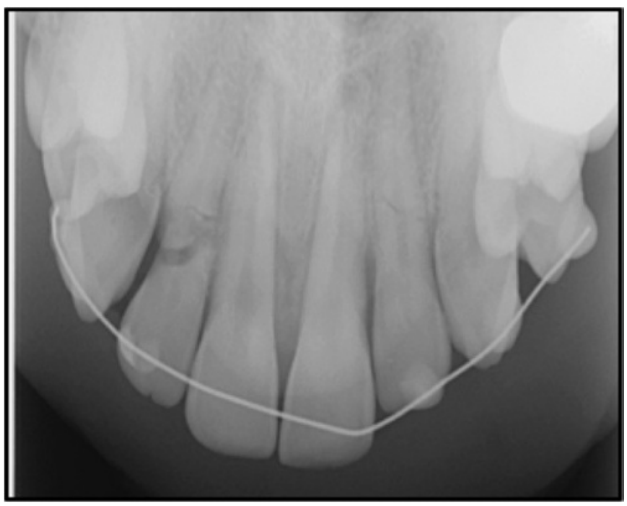


Figure 21.8 Upper standard occlusal showing root fracture of the UR2.

Figure 21.9 Positioning the x-ray tube for an upper standard occlusal radiograph.

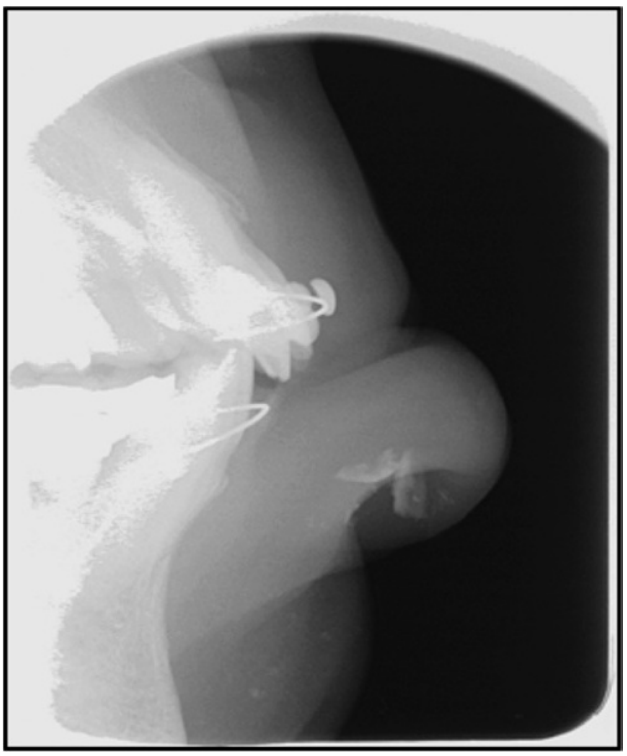


Figure 21.10 Soft tissue radiograph showing embedded tooth fragments in the lower lip.

Soft Tissue Radiograph In cases of a tooth fracture with the fragment(s) unaccounted for and a lip laceration, a soft tissue radiograph, with 30–50% exposure of the usual radiation dose, should be taken to rule out the possibility of tooth fragments being embedded in the lip (Figure 21.10).

Dental Panoramic Tomogram (DPT) A DPT is indicated when a mandibular fracture is suspected. If DPT facilities are not available and you suspect a fracture, referral of the patient to the nearest maxillofacial unit is indicated.

Photographs Photographs provide the best record of extraoral and intraoral injuries. Photographs provide a retrospective view of the injuries and may highlight gradual, subtle changes over time that may not be readily apparent on visual assessment.

Photographs are an essential baseline record and may be important for reporting purposes, if required in the future.

Recording photographs in the dental environment, with informed consent, is the ideal. Where attendance is delayed, the patient, or a person accompanying the patient, may usefully be asked to take a photograph of the trauma on their smart phone as soon as possible following the incident. Consent and any photographs taken

prior to the dental attendance will become part of the clinical record, aiding future treatment and providing information relevant to any future reporting.

Diagnosis

Using the information gained from the patient's history, clinical findings and special investigations, it should be possible to reach a diagnosis or diagnoses (Tables 21.2 and 21.3). It is rare for a patient to present with a single injury to a single tooth. Dental trauma often presents as polytrauma. The correct diagnoses will aid effective management (Tables 21.2 and 21.3).

Table 21.2 List of diagnoses and definitions for fracture injuries.

Diagnosis: fractures	Definition
Infraction	Incomplete fracture in enamel and dentine.
Enamel fracture (Figure 21.12)	Fracture confined to enamel.
Uncomplicated crown fracture (Figure 21.12)	Fracture confined to enamel and dentine with NO pulp exposure.
Complicated crown fracture (Figure 21.13)	Fracture confined to enamel and dentine with pulp exposure.
Uncomplicated crown-root fracture	Fracture confined to enamel, dentine and cementum with NO pulp exposure.
Complicated crown-root fracture (Figure 21.16)	Fracture confined to enamel, dentine and cementum with pulp exposure.
Root fracture – apical/mid/cervical (Figure 21.14)	Fracture confined to dentine, cementum and pulp.

Table 21.3 List of diagnoses and definitions for luxation injuries.

Diagnosis: luxations	Definition
Concussion	Injury to the periodontal tissues with tenderness to touch but no mobility or displacement.
Subluxation	Injury to the periodontal tissues with increased mobility, tenderness to touch but with no displacement.
Lateral luxation (Figure 21.18)	Displacement of tooth in a non-axial direction (most often palatally). Tooth is firm and there is often a bite disturbance.
Intrusion (Figure 21.19)	Displacement of tooth axially down the long axis of the tooth into the socket. Tooth is firm and appears shorter than corresponding tooth on other side.
Extrusion (Figure 21.17)	Partial displacement of the tooth out of the socket. Tooth is mobile and there is often a bite disturbance.
Avulsion (Figure 21.20)	Complete displacement of the tooth out of its socket.

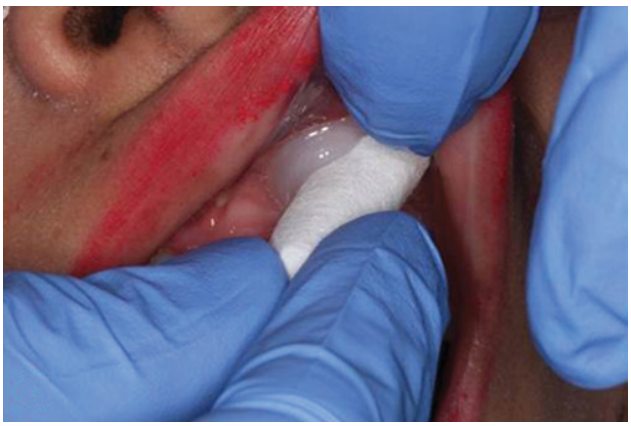
Management

Patients, adults and children are likely to be anxious at the prospect of having treatment aimed at the immediate management of their injuries. Also, patients may have been unable or concerned about eating or drinking following the trauma in fear of affecting the site, or may simply have been unable to drink or eat, given the pain involved, or the nature of the injury. As such, provision of, and assistance in consuming a glucose drink may be prudent before starting any treatment.

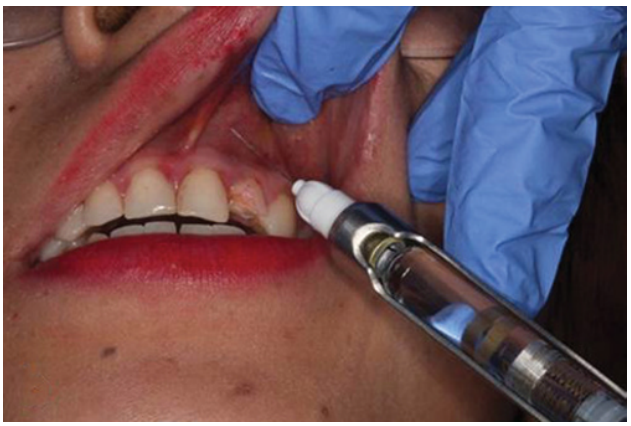
Paediatric trauma patients can be difficult to examine and treat given the distress caused by the traumatic injury and potential challenging behaviours, limited cooperation and anxiety associated with the dental environment. These circumstances can be distressing for the child and the parents, let alone the members of the dental team in attendance.

When managing trauma in the primary dentition, one of the most important considerations is the close relationship between the apex of the primary tooth root and the underlying permanent successor's tooth germ. One of the key principles in the management of trauma in the primary dentition is to prevent further damage, if any, to the developing permanent tooth. Damage to the permanent tooth, which does not always occur, can result from direct trauma from the primary tooth, mismanagement of the trauma or infection subsequent to the trauma. Disturbances can vary from hypoplasia and hypomineralisation of the tooth to dilaceration of the crown or root, or possibly failed or ectopic eruption. With this in mind, on occasion in the management of trauma in the primary dentition, it is best to adopt the 'if in doubt, take it out' philosophy. Good knowledge of dental development and accurate diagnosis of the injuries will allow the dentist to make informed decisions about potential disturbances to the developing tooth germ.

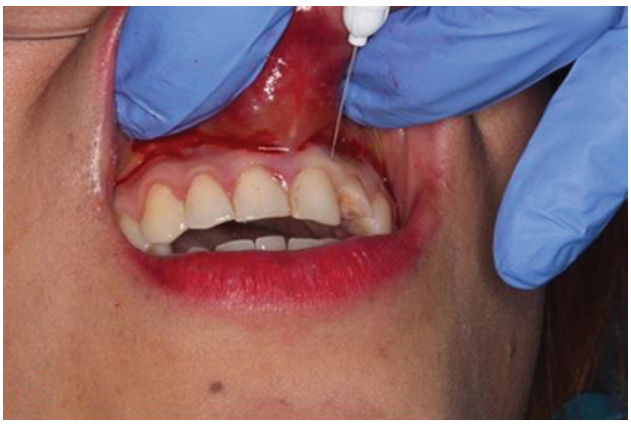
Effective management is dependent on achieving good local anaesthesia (LA), albeit that the administration of LA may heighten the already elevated anxiety of the patient. Buccal and palatal anaesthesia is important for repositioning teeth, as well as exploring crown-root fractures. A tried and tested approach to pain-free LA, as described next, is illustrated in Figure 21.11. In children, in particular, with polytrauma, one must be mindful of dosage and local anaesthetic toxicity.



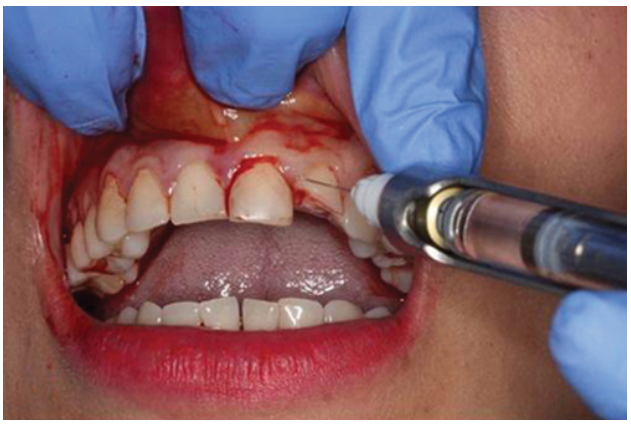
(a)



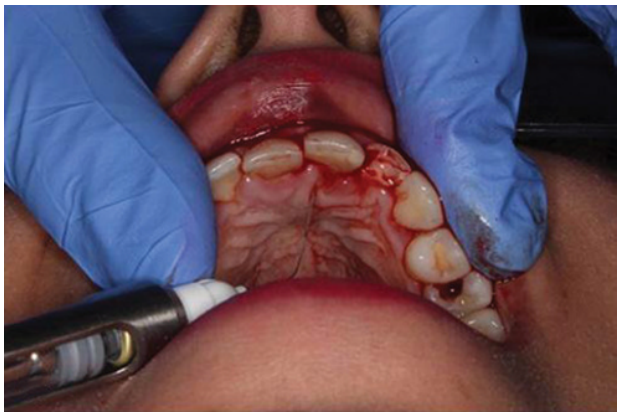
(b)



(c)



(d)



(e)

Figure 21.11 (a) Application of topical anaesthetic. (b) Injecting local anaesthetic into the bolus of previously given local anaesthetic. (c) Infiltration of buccal papilla. (d) Injecting further into buccal papilla aiming palatally. (e) Palatal infiltration.

Step A
Apply topical anaesthetic for several minutes.

Step B
Retract the soft tissues to make the sulcus taut and inject a small amount of local anaesthetic into the surface of the mucosa; wait a minute then go back into the same site, inserting the needle deeper and injecting more local anaesthetic. Then move the needle a few millimetres, through the bolus of local anaesthetic already administered, towards the next tooth to be anaesthetised.

Step C
Infiltrate the buccal papilla of the first tooth anaesthetised and follow through to include all the injured teeth.

Step D
Inject further into the buccal papilla aiming for the palatal side (the coincident palatal gingiva will blanch as a result).

Step E
Palatal infiltration into the blanched area.

Management of Uncomplicated Crown Fractures – Permanent Teeth

Fractures confined to enamel and/or dentine (Figure 21.12) are relatively straightforward to manage. If the patient attends with the tooth fragment in hand and it is large enough, it may be possible to reattach it using composite resin. Following cleaning, see if you can easily locate the fragment back into position. If this is possible, administer LA, etch both the fragment and the fractured surface of the tooth, wash and apply the bond to both, cure and then paint flowable composite to both surfaces, reposition the fragment and cure for a few seconds. This will partially set the resin and allow you to remove excess composite. Then fully cure on both buccal and palatal/lingual surfaces.

If the fragment cannot be relocated, a composite restoration should be placed. The authors feel that this is almost as quick as a temporary glass-ionomer 'bandage' and prefer this approach in almost all cases, unless patient cooperation does not allow for a composite restoration; then a glass-ionomer 'bandage' should be applied. One way or another exposed dentine should be covered to reduce sensitivity and the risk of loss of pulp vitality.

Management of Uncomplicated Crown Fractures – Primary Teeth

Fractures confined to enamel and/or dentine in primary teeth are relatively straightforward to manage. Usually, if the fracture is confined to enamel, smoothing the defect with a Soflex disc is sufficient. If the fracture involves dentine, then a glass-ionomer 'bandage' or composite restoration may be placed (depending on patient compliance). Exposed dentine should be covered.

Management of Complicated Crown Fractures – Permanent Teeth

The management of fractured teeth with exposed pulps (Figure 21.13) should aim to preserve the pulp regardless of the time elapsed since the injury. Under LA, and after achieving the best possible isolation (ideally under a rubber dam), open up the exposure using a small round diamond bur and remove 2–3 mm of the pulp. Apply pressure using a small pledget of cotton wool lightly soaked in sodium hypochlorite to cleanse the exposed potentially inflamed superficial pulp. If the pulp looks healthy and is not bleeding, apply non-setting calcium hydroxide, cover with glass ionomer, and reattach the fragment or build up with composite to full contour. For the immature permanent tooth the benefit of this pulpotomy technique allows for continued root development. In the long term, a vital tooth with a long root and thick dentine walls is desirable.

If the pulp bleeds, remove another 1–2 mm, using the small round diamond bur, and apply gentle pressure. If haemorrhage does not stop, it is likely that the pulp system is chronically inflamed and extirpation is required.

For both types of crown fractures, the teeth should be reviewed long term for any signs or symptoms of pulp necrosis and/or apical periodontitis. Generally, if there are two or more signs or symptoms (Table 21.4), root canal therapy is indicated.

Management of Complicated Crown Fractures – Primary Teeth

Given the complexity of the injury and difficulty in patient management, the treatment of choice for complicated

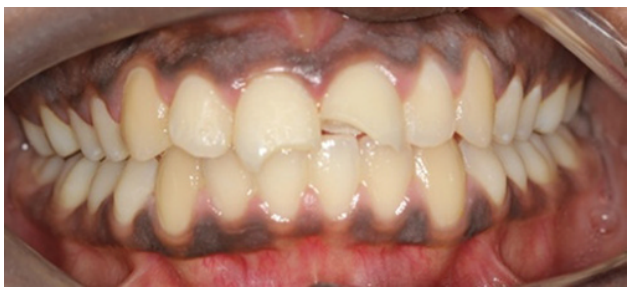


Figure 21.12 Enamel fracture UR1 and dentine fracture UL1.

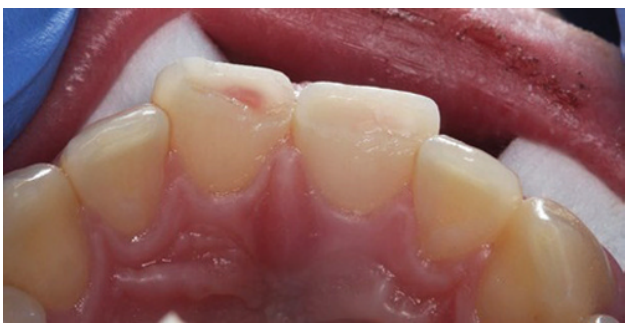


Figure 21.13 Complicated crown fracture UR1.

Table 21.4 Signs and Symptoms of pulp necrosis and/or apical periodontitis (adapted from American Association of Endodontists, 2013).

Signs	Symptoms
Discolouration	Spontaneous pain
Tenderness to percussion	Pain on biting
Buccal tenderness	
No response to sensibility testing	
Sharp pain upon thermal stimulus	
Radiographic signs, e.g. periapical radiolucency or widening of the periodontal ligament space	
Presence of a sinus	

fractures of primary teeth is typically extraction. If the extraction is complicated, it is not recommended to go 'digging' for an apical root portion, as this action can cause damage to the permanent successor. Normally, any retained fragment will resorb physiologically; however, this must be monitored until the permanent successor erupts.

Management of Root Fractures – Permanent Teeth

The management of root fractures and the prognosis of the affected teeth are determined by the position of the fracture line and whether there has been displacement of the coronal fragment (Figure 21.14). In the latter scenario, the coronal fragment will be loose and interfere with the occlusion.

If a root fracture is suspected but is not obvious on a periapical radiograph, an upper occlusal radiograph is an excellent view to help visualise the fracture (Figure 21.8).

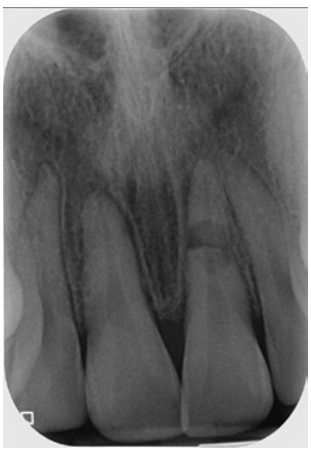


Figure 21.14 Periapical radiograph showing displaced apical third root fracture UL1.

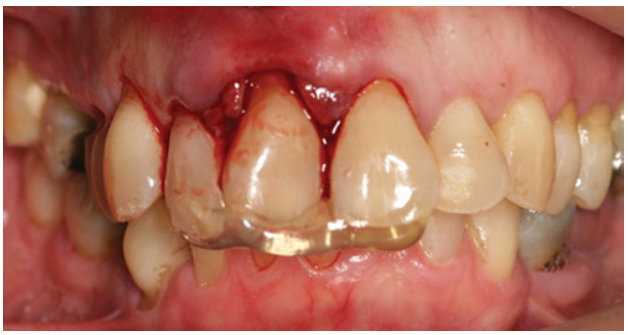


Figure 21.15 Temporary splinting of teeth to non-injured adjacent teeth.

Following the diagnosis of a root fracture, the coronal fragment should, if displaced, be digitally repositioned under LA. Thereafter, the following should procedure be undertaken:

- Examine the occlusion, making sure that it is free of any interference.
- Temporarily splint the tooth in position as illustrated in Figure 21.15.
- Take a check radiograph.
- Apply a non-rigid splint for 4 weeks (for apical and middle third root fractures).

Four months rigid splinting is considered appropriate for cervical third root fractures.

Permanent teeth that have been treated for root fracture should be reviewed long term for any signs or symptoms of pulp necrosis. Root canal therapy up to the fracture line only (the apical portion usually remains vital) should be commenced if there are two or more signs or symptoms of pulp necrosis (Table 21.4).

Management of Root Fractures – Primary Teeth

No treatment is required if the coronal fragment is not displaced. If, however, the coronal fragment is displaced, repositioning and splinting may be considered if patient compliance is good, otherwise the coronal fragment should be extracted.

In the event of loss of the coronal fragment 'digging' for the apical portion of the root of a primary tooth is, as discussed above, contraindicated, as this action can cause damage to the successor tooth. Any retained root fragment should therefore be allowed to resorb physiologically.

Management of Crown-Root Fractures – Permanent Teeth

The management of crown-root fractures (Figure 21.16) depends on the extent of the fracture and the presence or absence of pulpal involvement.

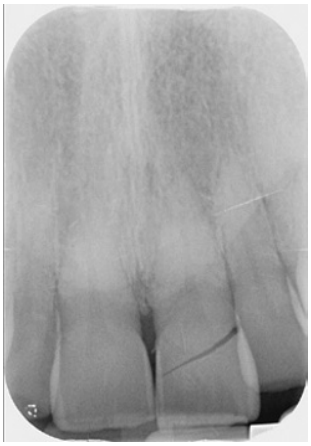


Figure 21.16 Periapical radiograph showing crown-root fracture UL1.

In uncomplicated crown-root fractures, the coronal fragment, if available, can be reattached (as described earlier) with care being taken to obtain moisture control using retraction cord or electrosurgery. Alternatively, the tooth can be restored with composite. Again, effective moisture control is important.

The true extent of a crown-root fracture is difficult to assess before the tooth has been anaesthetised. It is important that the patient gives consent for an examination under anaesthetic, so that they are fully aware that the tooth may be found to be unrestorable.

Various approaches can be adopted to attempt to preserve badly fractured teeth, even if it is only for a few years until the patient stops growing, when further treatment options become available. Future planning will benefit the patient and keep options available to them. Surgical crown lengthening to expose the fracture and facilitate the provision of an extracoronal restoration is an approach often adopted.

In some cases, elective root canal treatment may be required to enable the restoration of the tooth with an appropriately designed postcore restoration. Such an approach may be provided in conjunction with orthodontic treatment to extrude the root, possibly followed by crown lengthening surgery.

Teeth with complicated crown-root fractures, if considered restorable, require root canal treatment followed by one of the following six approaches:

1) Fragment removal and restoration.
2) Fragment removal, crown lengthening and restoration.
3) Orthodontic extrusion, with or without crown lengthening and restoration.
4) Surgical extrusion and restoration.
5) Decoronation for alveolar preservation, with or without tooth replacement.
6) Extraction, with or without tooth replacement.

Management of Crown-Root Fractures – Primary Teeth

In the primary dentition there are two main treatment options for managing crown-root fractures:

1) Fragment removal only. If the fracture involves a small portion of the root only and there is no pulpal involvement, the fractured portion can be removed and the tooth restored.
2) Extraction. This is recommended if there is pulpal involvement or significant tooth mobility. As in the management of other injuries to the primary dentition, extraction should not include 'digging' for a retained apical portion. A retained apex should be monitored through to the eruption of the permanent successor.

Management of Extrusion – Permanent Teeth

An extruded tooth will appear longer than the adjacent teeth (Figure 21.17) and is often loose given that it is being retained by soft tissues only. Extrusion may present a dental emergency, if there is a risk of inhalation.

In the absence of any airway risk, the management of extrusion may be delayed to a convenient window in the day when there is time and access to the armamentarium of instrumentation for optimal management and enhanced clinical outcome. The procedure is as follows:

- Digitally reposition the tooth under LA.
- Check the occlusion.
- Temporarily splint the tooth in position (Figure 21.15).
- Take a check radiograph.
- Apply a non-rigid splint for 2 weeks.

In all cases of extrusion, root canal therapy should be commenced if there are two or more signs or symptoms of pulp necrosis. If the tooth has an open apex, it is always better to give it a chance to revascularise.

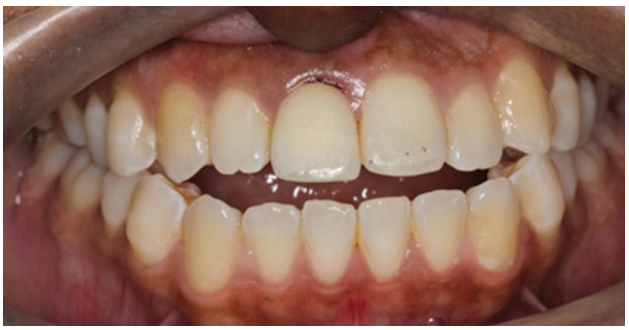


Figure 21.17 Extrusion UR1.

Management of Extrusion – Primary Teeth

The treatment of choice for extruded primary teeth is dependent on the extent of tooth displacement and patient cooperation:

- For minor extrusion (<3 mm) the tooth can be repositioned, or possibly left to see if spontaneous rearrangement occurs.
- Extraction is the treatment of choice for severe extrusion of primary teeth.

As with the other injuries to the primary dentition, follow-up is recommended to ensure normal exfoliation and eruption of the permanent successor.

Management of Lateral Luxation – Permanent Teeth

Lateral luxation injuries do not require immediate emergency management, even if the affected tooth has an open apex. Such injuries should, however, be treated as soon as possible. They are often associated with one or more dentoalveolar fractures (Figure 21.18). The luxated tooth is typically locked in position and firm. With palatal displacements, the patient is normally unable to occlude, given the interference caused by the displaced tooth.

Digital repositioning should be carried out under LA by disengaging the apical part of the root high in the buccal sulcus first and then moving the crown of the tooth labially. Thereafter:

- Check the occlusion.
- Temporarily splint the tooth in position (Figure 21.15).
- Take a check radiograph.
- Apply a non-rigid splint for 4 weeks.

Root canal therapy should be commenced if there are two or more signs or symptoms of pulp necrosis.

Management of Lateral Luxation – Primary Teeth

In the primary dentition, in the absence of any occlusal interference, spontaneous repositioning may occur. If there is marked displacement of the tooth, digital pressure repositioning under LA or extraction may be indicated. If the tooth is severely displaced labially, indicating extraction, the developing tooth germ of the permanent successor tooth may have been damaged and could be damaged further if great care is not taken during the extraction. Repositioned luxated primary teeth should be monitored for normal exfoliation, or until the permanent successor tooth erupts.

Management of Intrusion – Permanent Teeth

Intrusion injuries carry the most unfavourable prognosis of all the traumatic dental injuries (Filippi, Pohl and Von Arx, 2001). At presentation, the affected tooth appears short and can be mistaken for a crown fracture (Figure 21.19).

Treatment options include:

- Spontaneous eruption. This is the treatment of choice for immature permanent teeth with minor or moderate intrusion.
- Orthodontic repositioning. This method is usually recommended for delayed presentation.
- Surgical repositioning. This technique is recommended for severe intrusion (<7 mm).

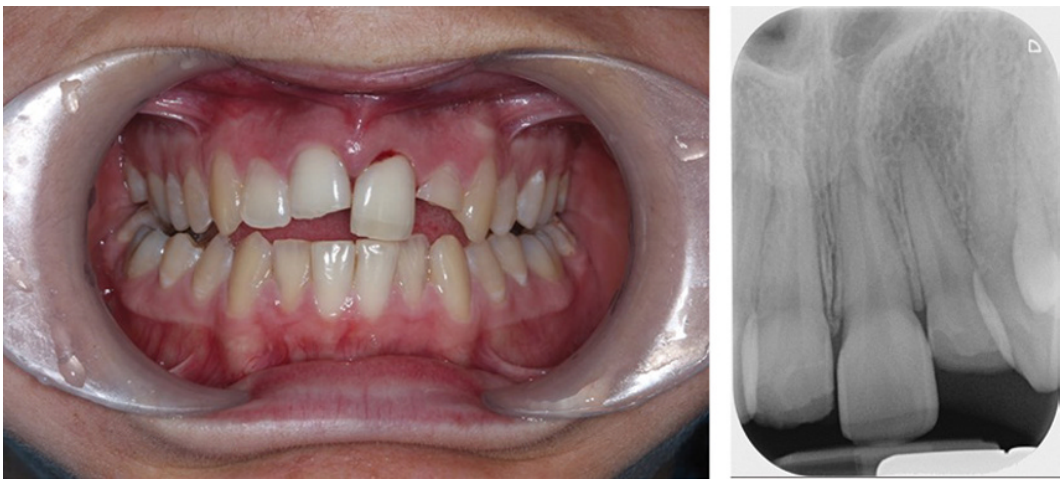


Figure 21.18 Lateral luxation UL1 with corresponding periapical radiograph.

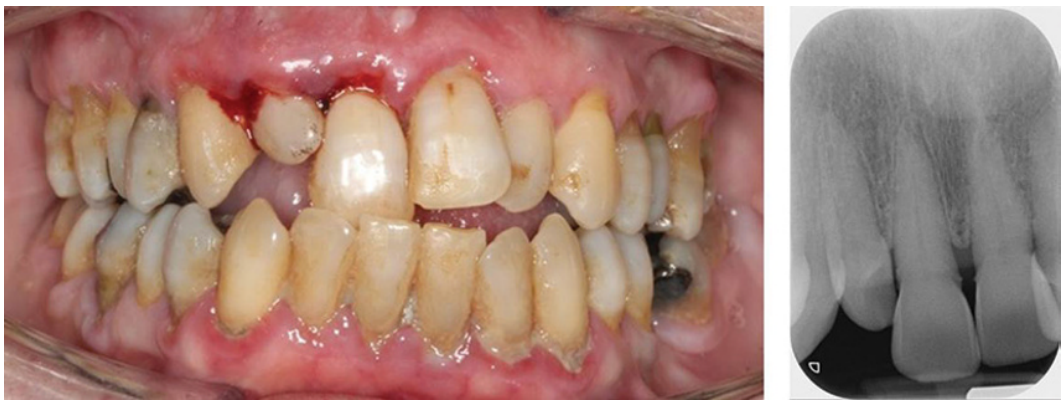


Figure 21.19 Intrusion UR2 with corresponding periapical radiograph.

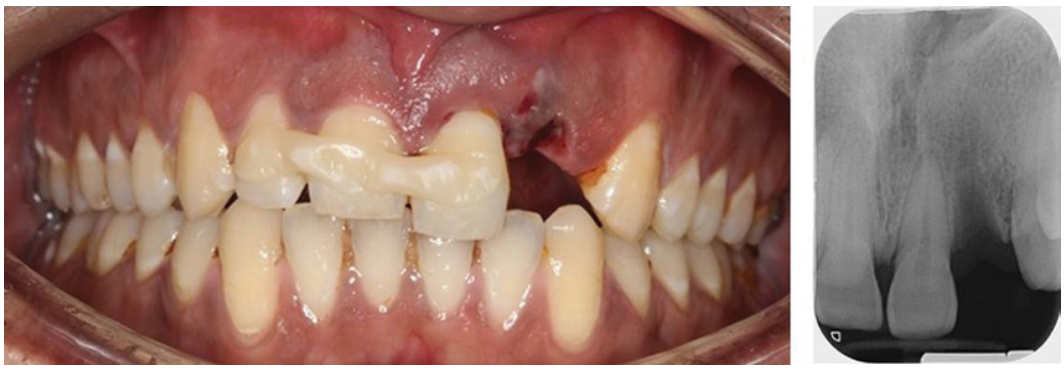


Figure 21.20 Avulsion UL2 with corresponding periapical radiograph.

Common to the above treatment options, the tooth should initially be disengaged from any impaction followed by:

- Digitally repositioning of the tooth.
- The occlusion being checked to ensure the absence of any interference.
- Temporarily splinting the tooth (Figure 21.15).
- A check radiograph being taken.
- The application of a non-rigid splint for 4 weeks.

Management of Intrusion – Primary Teeth

Intrusion in the primary dentition is significantly associated with damage to the permanent successor. The treatment options include:

- Spontaneous eruption. If the apex is displaced toward or through the labial bone, the tooth can be left to spontaneous re-erupt. Measuring the height of the tooth against the adjacent teeth can help monitor the eruption of the intruded tooth.
- Extraction is the treatment of choice if the apex is displaced into the permanent successor, or there is failure to re-erupt.

As with the other injuries to the primary dentition, an intruded tooth, assuming it is left to re-erupt, should be monitored for normal exfoliation, or until the permanent tooth erupts.

What Injuries Require Immediate Emergency Management?

The only traumatic dental injuries that require immediate emergency management are avulsion and extrusion, in particular if there is a risk of inhalation of the tooth.

Avulsion – Permanent Teeth with Closed Apex

An avulsed tooth (Figure 21.20) should ideally be replanted within minutes at the scene of the incident. When the patient subsequently attends the surgery, preferably as soon as possible following the replantation, a full assessment should be carried out, as described previously, checking that the tooth has been repositioned correctly. If this is not the case, apical pressure should be applied using index finger and thumb to correctly reposition the tooth under LA. Once correctly positioned and the occlusion confirmed,

Table 21.5 Summary of splinting times.

Type of injury	Splinting time
Lateral luxation	4 weeks
Extrusion	2 weeks
Intrusion	4 weeks
Avulsion (extraoral dry time <60 min)	2 weeks
Avulsion (extraoral dry time >60 min)	4 weeks
Apical third (×3) root fracture	4 weeks
Mid third (×3) root fracture	4 weeks
Cervical third (×3) root fracture	4 months[a]

[a] Rigid splinting is recommended by the authors.

the tooth should be temporarily splinted to the adjacent teeth and a check radiograph taken. A summary of splinting times is shown in Table 21.5.

Unfortunately, despite public health programmes to raise awareness of what to do if a tooth is knocked clean out of the mouth, trauma patients with an avulsed tooth often attend the dental surgery with their tooth wrapped 'safely' in tissue, resulting in the death of any delicate periodontal ligament cells that survived the trauma. Under such circumstances reimplantation may be contraindicated, especially if oral health is poor (see later).

If an avulsed tooth is not replanted immediately, the storage medium to transport the tooth becomes critical (Poi, Sonoda, Martins et al., 2013). Various media have been investigated in an effort to replicate the environment of the tooth socket and provide optimal conditions to maintain the viability of the periodontal ligament cells.

Balanced salt solution formulations are marketed as transport media for avulsed teeth, for example, Save-A-Tooth (Figure 21.21). If such a medium is not available, a readily available alternative is cold milk.

Dentists should be prepared to give advice to a member of the public over the phone concerning the immediate management of an avulsed tooth, as immediate reimplantation provides the best outcome. The advice, in layman terms, should be as follows, once you have ascertained who is on the other end of the phone:

- By looking in the injured person's mouth, make sure it is a permanent tooth, as a primary tooth should not be replanted.
- Keep the person calm.
- Locate the tooth and pick it up by the crown, making sure to avoid contact with the root – *Pick it.*
- If it is dirty run it briefly (10 s) under cold running water, pour bottle water over it, or have the patient lick it – *Lick it.* The surface of the root should not be rubbed to remove dirt.

Figure 21.21 Save-A-Tooth: commercially available avulsed tooth transport medium.

- Encourage and assist the person to replace the tooth back in the socket, with the person holding the tooth by the crown between index finger and thumb – *Stick it.*
- Once the tooth is back in place, ask the person to bite on a tissue or towel to hold the tooth in position.
- If replacement is not possible, then the tooth should be placed in an appropriate storage media, as described above.
- Advise or assist the person in obtaining immediate help from a dentist.

The prognosis for a reimplanted avulsed tooth is directly related to its extraoral dry time (EODT) (Andreasen and Andreasen, 1994) – the longer the tooth is out of its socket and dry, the poorer the prognosis (Andreasen and Kristersson, 1981). This is due to complications introduced by bacterial and foreign body contamination compromising the viability of the periodontal ligament cells. As a result, various forms of resorption may ensue. In adults, external replacement resorption (ankylosis) is most common (Darcey and Qualtrough, 2013).

The treatment strategy is determined by the EODT (Figure 21.22). Patients should be advised of the questionable long-term prognosis of teeth after prolonged drying-out of the periodontal ligament.

Avulsions (Closed Apex) with EODT <60 Minutes

- Saline irrigation to clean the root surface without touching it.
- Digitally replant the tooth under LA.
- Check the occlusion.
- Temporarily splint the tooth in position with clear light-cured acrylic (Figure 21.15).

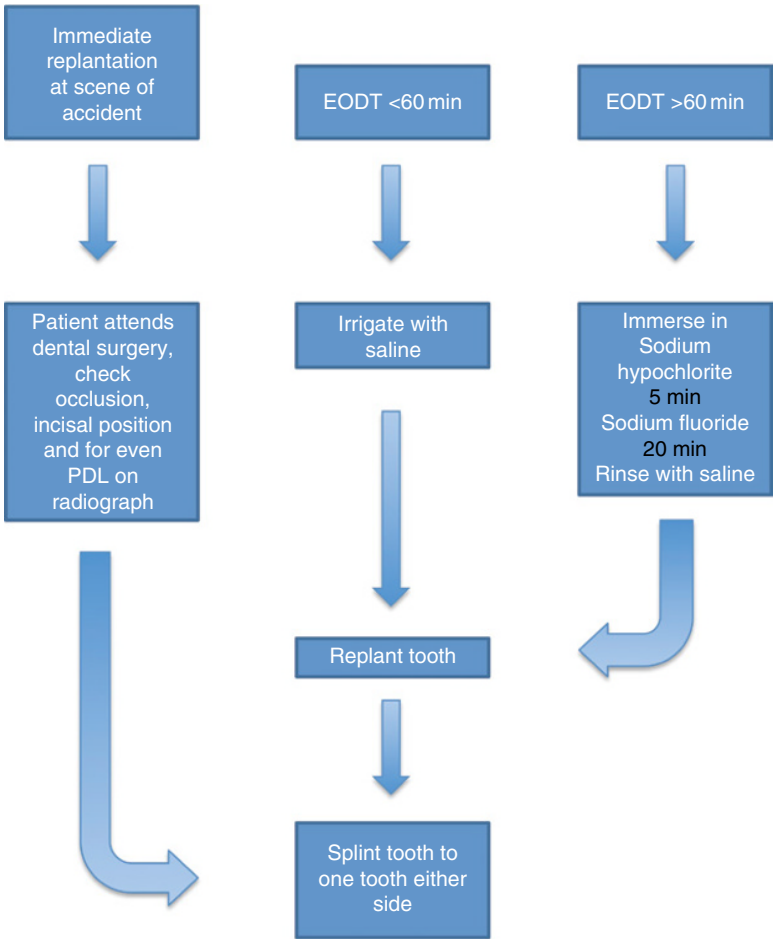


Figure 21.22 Treatment strategy for avulsed teeth. EODT, extraoral dry time. PDL, periodontal ligament.

- Take a check radiograph.
- Apply a non-rigid splint for 2 weeks.
- Start root canal treatment as soon as possible, ideally within 7 days.

Avulsions (Closed Apex) with EODT >60 Minutes

- Bathe the tooth in sodium hypochlorite for 5 min.
- Rinse with saline.
- Bathe the tooth in 0.5% sodium fluoride for 20 min.
- If there is time, root canal treat the tooth extraorally.
- Digitally replant the tooth under LA, not having touched the root surface in preparation.
- Check the occlusion.
- Temporarily splint the tooth in position with clear light-cured acrylic (Figure 21.15).
- Take a check radiograph.
- Apply a non-rigid splint for 4 weeks.
- Start root canal treatment as soon as possible, ideally within 7 days.

Avulsions, with the exception of severe intrusion injuries, are the only form of dental trauma in mature teeth that requires root canal treatment as soon as possible.

Avulsions (Open Apex) with EODT <60 Minutes

- Saline irrigation to clean the root surface without touching it.
- Irrigate the socket with saline under LA.
- Digitally replant the tooth.
- Check the occlusion.
- Temporarily splint the tooth in position with clear light-cured acrylic (Figure 21.15).
- Take a check radiograph.
- Apply a non-rigid splint for 2 weeks.

Avulsions (Open Apex) with EODT >60 Minutes

Under such circumstances the avulsed tooth has an extremely poor long-term prognosis. Given the long EODT, ankylosis (replacement resorption of the root) is highly likely, assuming the tooth is retained.

- Remove attached non-viable soft tissue with gauze.
- Root canal treatment can be carried out prior to replantation or later.
- Saline irrigation to clean the root surface without touching it.
- Irrigate the socket with saline under LA.

- Bathe the tooth in 0.5% sodium fluoride for 20 min.
- Digitally replant the tooth.
- Check the occlusion.
- Temporarily splint the tooth in position with clear light-cured acrylic (Figure 21.15).
- Take a check radiograph.
- Apply a non-rigid splint, capable of functioning for 4 weeks.
- Refer to a specialist centre for multidisciplinary follow-up care.

When managing avulsed teeth with an open apex, there is the possibility of revascularisation; however, the risk of inflammatory root resorption should be weighed up against the chances of revascularisation. If inflammatory root resorption occurs, it is very rapid in paediatric patients. These patients must therefore be monitored closely. As soon as there are any signs of inflammatory resorption, root canal treatment should be commenced.

Despite the relatively poor prognosis for avulsed teeth affected by prolonged EODT, the replantation of mature (closed apex) teeth is recommended as the treatment of choice in well maintained mouths. Alveolar bone will be maintained over whatever period of time the replanted tooth is retained, sometimes years. Subsequent replacement of the tooth with a dental implant will then remain a possibility, without the need for grafting, in particular in growing patients (Filippi, Pohl and Von Arx, 2001).

Prescription of antibiotics, as part of the immediate management of avulsed teeth, is controversial. Currently there is limited evidence to support the prescription of antibiotics in caring for avulsed teeth; however, many clinicians find a course of antibiotics enhance the clinical outcome (Trope, 2002). For patients over 12 years of age give doxycycline (100 mg twice a day for 7 days) and for those 12 years of age and younger, a penicillin-based antibiotic with a dose according to age. The risk of discoloration of permanent teeth must be considered if prescribing a tetracycline-based antibiotic in the management of young children.

Avulsion – Primary Teeth

Avulsed primary tooth are never replanted given the potential damage to the permanent successor.

Generic Postoperative Advice

It is important to give good postoperative advice, as this can help prevent further complications and aid healing:

- Avoid contact sports for at least 2 weeks.
- Eat soft foods for 2 weeks.
- Careful oral hygiene using a soft toothbrush in the region of the trauma.
- Rinsing with chlorhexidine gluconate 0.1% alcohol free mouth wash for 1 week twice daily.
- To return to the dentist immediately following the onset of any infection or increase in pain experienced.

Equipment and Materials to Manage Dental Trauma

Essential Armamentarium

The following materials and equipment are used to assess and manage dental trauma (Figure 21.23):

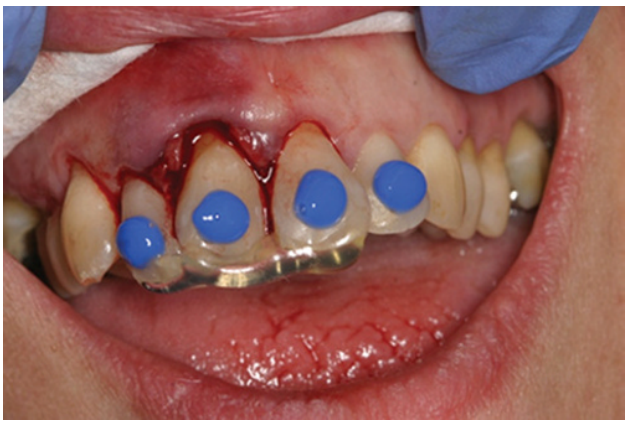
- Examination kit with flat plastic.
- Electric pulp tester and Endo-frost™.
- Topical anaesthetic.
- Local anaesthetic.
- Clear light-cured acrylic (Triad™) (for temporary splints).
- 018 stainless steel archwire and orthodontic wire cutters.
- Composite resin.
- 37% phosphoric acid gel.
- Combined primer and adhesive.
- Curing light.
- Diamond burs.
- Articulating paper.

Step by Step Clinical Guide to Simple Splinting

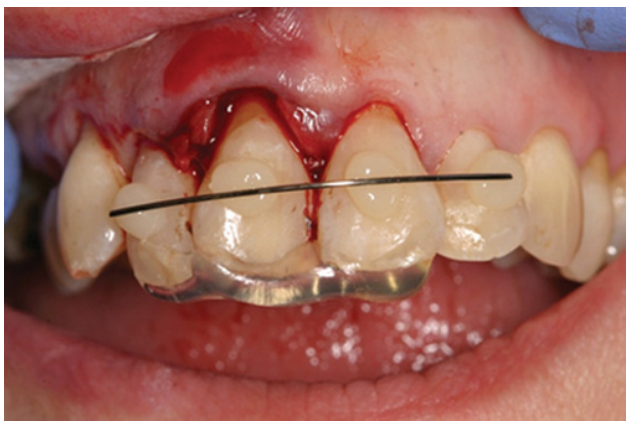
Splinting can be completed simply and effectively as follows (Figure 21.24):

- Prepare the composite (large and small balls).
- Cut the wire to length to include one tooth either side of the injured teeth.
- Spot etch the teeth to be splinted (Figure 21.24a).
- Wash and dry the teeth.
- Apply dentine bonding agent and light cure.
- Position the large composite balls to the bonded surfaces.
- Place the wire (018 stainless steel) on the composite balls and for a few seconds light cure secure the wire in place (Figure 21.24b).
- Place the small composite balls onto the large composite balls to encase the wire in composite and fully light cure the composite on each tooth (Figure 21.24c).
- Remove the temporary splint and check the occlusion.

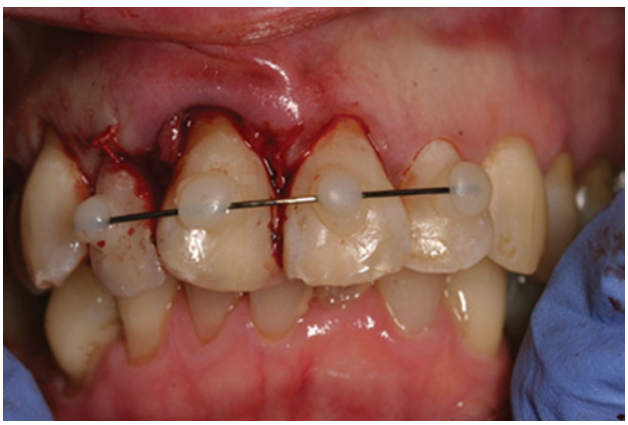
Figure 21.23 Recommended dental trauma kit.



(a)



(b)



(c)

Figure 21.24 Step-by-step splinting. (a) Spot etching teeth to be splinted. (b) Securing a 018 stainless steel wire in place. (c) Encasing the wire with the small composite balls.

When Should I See the Patient Again?

The aim of appropriate recall is to monitor healing and check for signs and symptoms of any infection and pulpal necrosis. There are other unwanted consequences of dental trauma such as resorption that may present later and early diagnosis may improve the outcome.

If teeth have been splinted, the next appointment will be for splint removal, as summarised in Tables 21.6 and 21.7. At this stage baseline sensibility recording can commence. Detailed recall periods for all dental traumas are set out in the International Association of Dental Traumatology website.

Splint Removal

The kit required is shown in Figure 21.25. The steps outlined below for splint removal are illustrated in Figure 21.26:

1) Remove the composite down to the wire using a tapered diamond bur in a fast handpiece (Figure 21.26a).
2) Remove the wire (Figure 21.26b).
3) Remove the bulk of remaining composite using a tungsten carbide composite removal bur in a slow handpiece (Figure 21.26c).
4) Polish off the remaining composite using an abrasive disc (Figure 21.26d).

Is There Anyone I Can Refer the Patient To?

If dental trauma is extensive or you are unable to manage the trauma within your dental practice consider referring the patient to one of the following:

- A colleague who has an interest or experience in managing dental trauma.
- An endodontic specialist.

Table 21.6 Recommended recall intervals from time of injury for fractures.

Type of injury	Appointment from time of injury	Clinical exam[a]	Sensibility testing	X-rays	Splint removal	Photos
• Uncomplicated and complicated crown fractures • Uncomplicated and complicated crown-root fractures	3 months	✓	✓	✓		✓
	6 months	✓	✓	✓		✓
	Annual review	✓	✓	✓		✓
• Root fractures[b]	4 weeks	✓	✓	✓	✓	✓
	3 months	✓	✓	✓		✓
	6 months	✓	✓	✓		✓
	Annual review	✓	✓	✓		✓

[a] Should include assessment of discolouration, mobility, tenderness to palpation and the percussion and the possibility of a draining sinus.
[b] Splint removal at 4 months for cervical third root fractures.

Table 21.7 Recommended recall intervals from time of injury for luxation injuries.

Type of injury	Appointment from time of injury	Clinical exam[a]	Sensibility testing	X-rays	Splint removal	Photos
• Avulsion EODT <60 min • Extrusion	2 weeks	✓	✓		✓	✓
	6 weeks	✓	✓			✓
	3 months	✓	✓	✓		✓
	6 months	✓	✓	✓		✓
	Annual review	✓	✓	✓		✓
• Avulsion EODT >60 min • Lateral luxation • Intrusion	4 weeks	✓	✓		✓	✓
	3 months	✓	✓	✓		✓
	6 months	✓	✓	✓		✓
	Annual review	✓	✓	✓		✓

[a] Should include assessment of tenderness to percussion, buccal tenderness, discolouration, mobility and the possibility of a draining sinus.

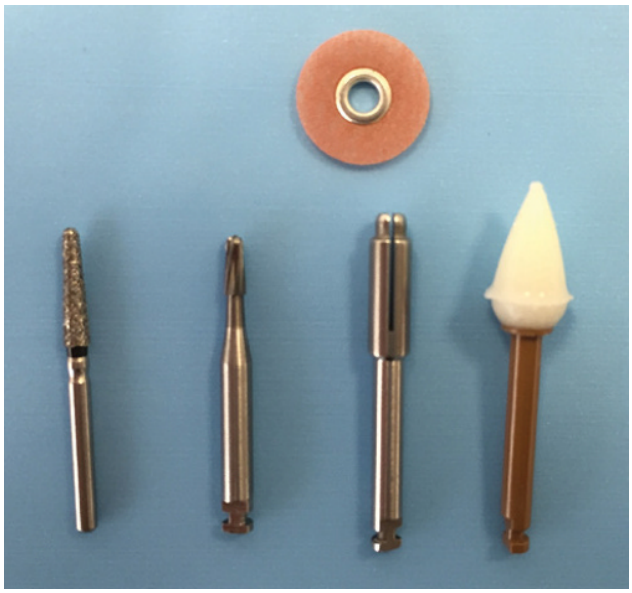


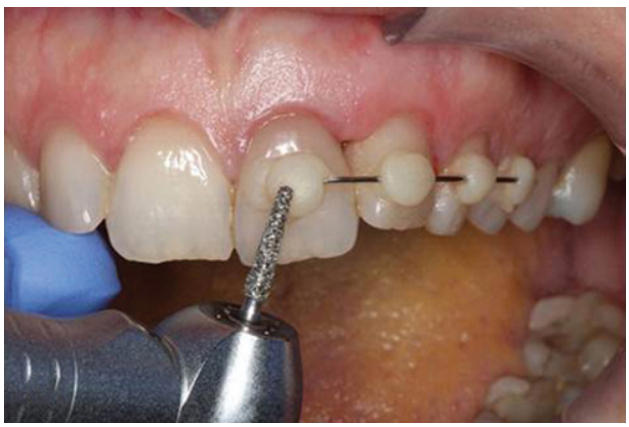
Figure 21.25 Splint removal kit.

- A dental teaching hospital, if there is one within easy reach.
- A general hospital maxillofacial department.

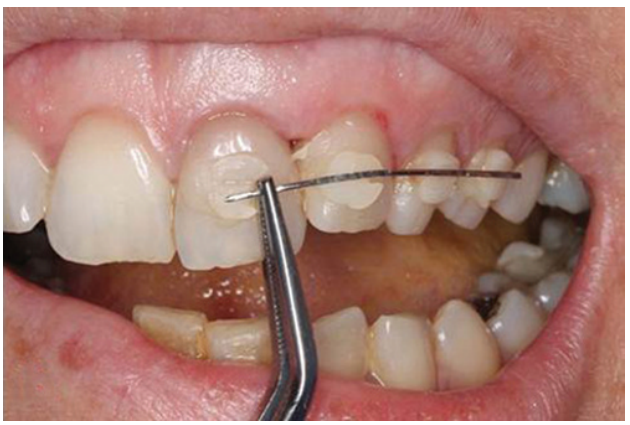
Where Can I Get More Information?

Further information can be accessed from the following websites:

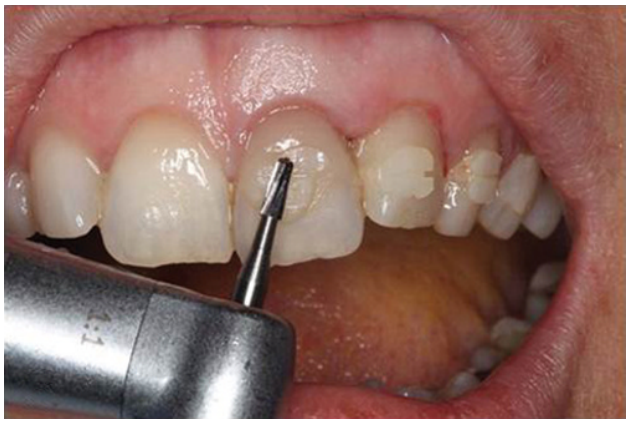
- www.dentaltraumaguide.org
- www.nhs.uk/conditions/broken-tooth/pages/introduction.aspx
- www.dentaltrauma.co.uk



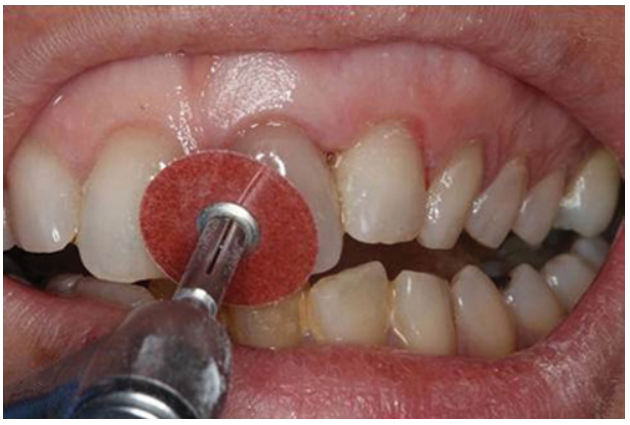
(a)



(b)



(c)



(d)

Figure 21.26 (a) Removal of surface composite. (b) Removal of stainless steel wire. (c) Removal of further composite with a tungsten carbide bur. (d) Polishing remaining composite with an abrasive disc.

References

American Association of Endodontists (2013) Endodontic Diagnosis. American Association of Endodontists Colleagues for Excellence Newsletter, 2013. https://www.aae.org/uploadedfiles/publications_and_research/newsletters/endodontics_colleagues_for_excellence_newsletter/endodonticdiagnosisfall2013.pdf (accessed 12th July 2017).

Andreasen, J.O., Andreasen, F.M. (1994) *Textbook and Color Atlas of Traumatic Injuries to the Teeth*, 3rd edn. Copenhagen/St Louis: Munksgaard/CV Mosby.

Andreasen, J.O., Kristersson, L. (1981) The effect of limited drying or removal of the periodontal ligament: periodontal healing after replantation of mature permanent incisors in monkeys. Acta Odontologica Scandinavia 39:1.

Bastos, J.V., Goulart, E.M., de Souza Côrtes, M.I. (2014) Pulpal response to sensibility tests after traumatic dental injuries in permanent teeth. Dental Traumatology 30:188–192.

Darcey, J., Qualtrough, A. (2013) Resorption: part 1. Pathology, classification and aetiology. British Dental Journal 214:439–451.

Filippi, A., Pohl, Y., Von Arx, T. (2001) Decoronation of an ankylosed tooth for preservation of alveolar bone before implant placement. Dental Traumatology 117: 93–95.

Gopikrishna, V., Pradeep, G., Venkateshbabu, N. (2009) Assessment of pulp vitality: a review. International Journal of Paediatric Dentistry 19:3–15.

International Association of Dental Traumatology Dental Trauma Guidlines (2012) https://www.iadt-dentaltrauma.org/1-9%20%20iadt%20guidelines%20combined%20-%20lr%20-%2011-5-2013.pdf (accessed 12th July 2017).

Poi, W.R., Sonoda, C.K., Martins, C.M., et al. (2013) Storage media for avulsed teeth: a literature review. Brazilian Dental Journal 24:437–445.

Royal College of Surgeons Faculty of Dental Surgery Clinical Guidelines. https://www.rcseng.ac.uk/dental-faculties/fds/publications-guidelines/clinical-guidelines/

Trope, M. (2002) Root resorption due to dental trauma. Endodontic Topics 1:79–100.

22

Procedures in Aesthetic Dentistry

Subir Banerji and Shamir Mehta

Introduction

There can be considerable variation between individuals in the ideal appearance of the *anterior aesthetic zone*, which comprises the hard and soft tissues visible when the patient makes a broad smile. There are, however, *universal concepts* in dental aesthetics that are generally 'acceptable' to dental professionals, patients and the public alike. These include:

- The elimination of oral disease.
- The need for appropriate dental symmetry, proportion and harmony.
- An appreciation of tooth position, form and morphology.
- An understanding of the variations that exist in tooth colour and shade.

When a patient attends a dental practitioner seeking alteration to their anterior aesthetic zone, often with the aim of enhancing their dental and, in turn, facial attractiveness, it is essential that the practitioner:

- Carefully listens to the patient's concerns.
- Adopts a systematic and meticulous approach towards all relevant clinical assessments and evaluations.
- Has a clear understanding of the universal concepts of dental aesthetics and beauty.
- Appreciates the varying protocols and materials that are available to affect any planned changes (often tooth colour/shade, size/shape/proportion and position), inclusive of the limitations inherent in the possible treatment option.
- Underpinned treatment by the principles of 'beneficence', i.e. doing good and acting in the patient's best interest and 'non-maleficence', i.e. doing no harm.

Valid informed consent must be obtained when planning elective dental treatment. Considerations of the possible treatment options should be systematic, professional and conducted in a suitable environment, adopting a clear, accurate, balanced, logical, comprehensive and, where possible, evidence-based approach to give the patient an as complete and comprehensive understanding as possible of all the risks and benefits of the proposed options, especially the option the patient selects.

This chapter outlines the key stages and principles for the evaluation of the anterior aesthetic zone and provides an overview of the techniques commonly applied to plan the effective and predictable implementation of proposed changes to dental appearance, avoiding the ambiguity often associated with subjective concepts in dental aesthetics and beauty.

This chapter also includes a summary of some of the techniques and treatments frequently applied in aesthetic dentistry. Such treatments should aim to meet the anticipated, realistic expectations agreed with the patient, and provide long-term aesthetic and functional stability. Wherever possible, minimal intervention approaches and techniques should be applied.

Many conventional views on smile evaluation and the planning of aesthetic rehabilitation tend to be erroneously based on traditional concepts applied in the provision of complete dentures, rather than a thorough knowledge and understanding of the features of the natural dentition.

Smile Assessment

Equipment

- Dental mirror.
- Dental probe.
- Periodontal probe(s).
- Willis gauge.
- Fox's bite plane.
- Wooden spatulas.
- Camera/video camera.

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

Procedure	Rationale
Patient history Clear, complete, contemporaneous and accurate records should be made and kept for all patient history findings.	The use of a confidential medical history template (completed prior to the initial appointment) may prove beneficial when screening for common conditions.
Medical history	The patient's medical history may: • Prevent them from attending for frequent and lengthy treatment sessions. • Require an alteration of the treatment protocol to take account of the condition itself and or the drugs used to treat it. • Contraindicate a certain form of treatment due to an allergy to a dental material or product that may be required to execute the treatment in an effective manner. • Contribute to the aesthetic concern itself, such as drug-induced gingival hyperplasia. In relation to those patients seeking elective treatments aimed at enhancement of the aesthetic zone, it is also relevant to screen for a possible diagnosis of body dysmorphic disorder. This is a psychiatric illness that is characterised by the preoccupation with an imagined defect in appearance.
Presenting complaint	Concerns with the appearance of the aesthetic zone, often include concerns about tooth: • Colour. • Position. • Shape. The use of a preconsultation aesthetic evaluation form may help to elicit salient information, especially relating to perceptions of self-appearance. As far as possible, this should be noted using the patient's own words.
Dental and sociobehavioural history	To note: • The patient's last dental visit and overall frequency of attendance. • Home care/oral hygiene practice. • Attitudes towards dentistry, past experiences and their expectations/treatment goals. • Occupation. • Relevant habits. • Dietary preferences.
Extraoral examination Clear, complete, contemporaneous and accurate records, inclusive of any negative findings, should be made and kept on all aspects of the extraoral examination	To include assessments of the: • Temporomandibular joints, the associated musculature, the cervical lymph nodes and salivary glands. • Facial features: vertical facial proportions, facial symmetry, facial profile, facial shape and width. • Lip morphology and mobility. • The facial skin.
Temporomandibular joints (TMJs) and masticatory muscles	TMJs to be examined bilaterally for the presence of: • Any tenderness or pain upon palpation of the area anterior to the auricular tragi or intra-auricularly. • Signs of asynchronous movement and mandibular deviation on opening or closure. • Clicking sounds, and the stage – early, middle or late on opening and or closure. • Grating sounds, crepitation and/or joint locking. The use of a stethoscope may prove helpful. Muscles (generally the temporalis and the superficial and deep elements of the masseter muscles) should be examined, including palpation, for signs of tenderness, discomfort and hypertrophy. Normal jaw opening should provide a minimum interincisal distance of 35 mm, and 12 mm of movement during lateral jaw movements.
Facial features: facial proportions – frontal view	In general, when viewed from in front, with the patient adopting a natural pose, the face can be divided into three zones: • Upper third – hairline or forehead to the orphic (brow) line. • Middle third – orphic line to the interalar line (base of the nose). • Lower third – between the base of the nose and the tip of the chin (Figure 22.1). In a 'well-proportioned face' the three zones should be of similar vertical dimension. The lower third is thought to have the greatest influence on facial appearance and may be 'altered' by dental intervention.

(*Continued*)

Procedure	Rationale

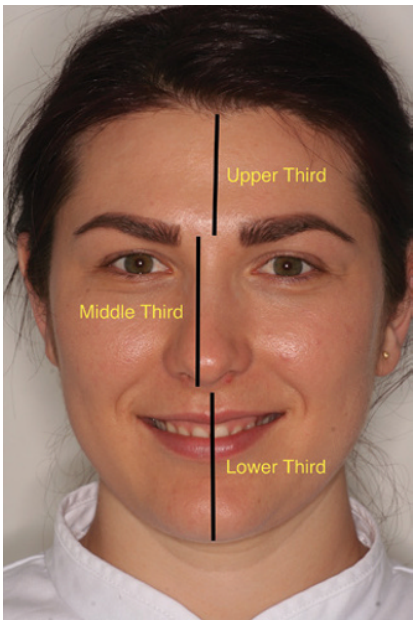


Figure 22.1 The upper, middle and lower third when viewing the face from a frontal prospective.

Facial features: facial symmetry – frontal view

The facial midline (vertical plane) and interpupillary line (horizontal plane) are often used as reference lines/planes to determine the level and extent of asymmetry present (Figure 22.2). Aesthetic harmony is said to exist when the vertical and horizontal reference planes are perpendicular to each other and the facial plane is coincident (within 2.0 mm) of the dental midline. A set of wooden spatulas or a Fox's bite plane can serve as useful tools for assessing such features.

The interpupillary line may also help to determine and describe the position/orientation of the incisal, gingival and occlusal planes against an established horizontal axis.

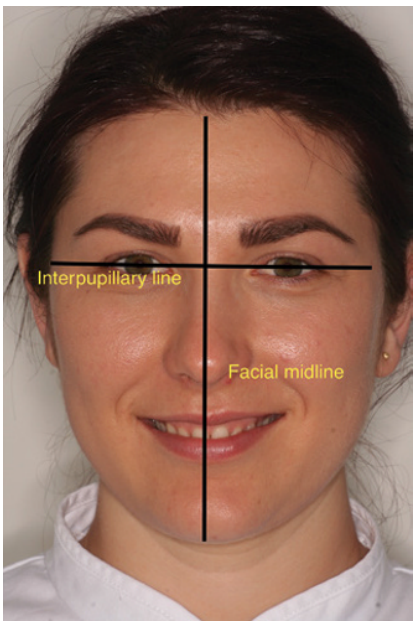


Figure 22.2 The interpupillary and facial midlines.

(*Continued*)

Procedure	Rationale
Facial features: profile – lateral views	Assessed laterally, with a natural head pose, using the Frankfort plane to verify head orientation, three types of profile are typically apparent: • Normal. • Convex. • Concave. The 'E-line' (an imaginary line that connects the tip of the nose to the tip of the chin) may be used to determine the profile. A 'normal profile' is thought to exist when the upper and lower lips are 4 mm and 2 mm posterior to the E-line (Figure 22.3). The concept of the 'normal profile' may, however, display marked variations between patients of different ethnicity.
Facial features: facial shape and width	Four facial shapes have been described: • Ovoid. • Square. • Tapering. • Square-tapering. Four typological categories have also been defined by Ahmad (2005) in an attempt to correlate personality with facial shape: • Lymphatic – rounded full features associated with a timid personality. • Sanguine – prominent thick, well-defined features linked with intransigence and spontaneity. • Nervous – large forehead, thin delicate features. • Bilious – rectangular and muscular features associated with a dominant personality. It has been postulated that the morphology of the teeth and any restorations should conform to these facial types. The facial width may be assessed as the width of 'five eyes'.

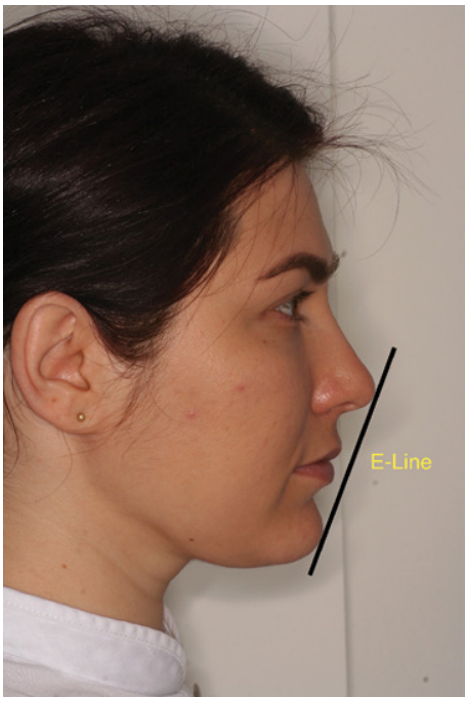
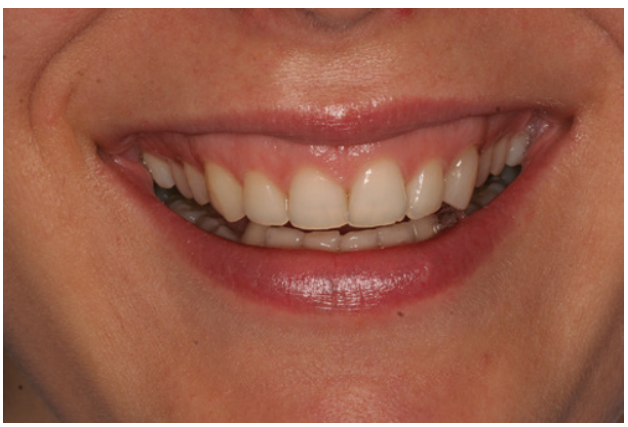


Figure 22.3 The E-Line.

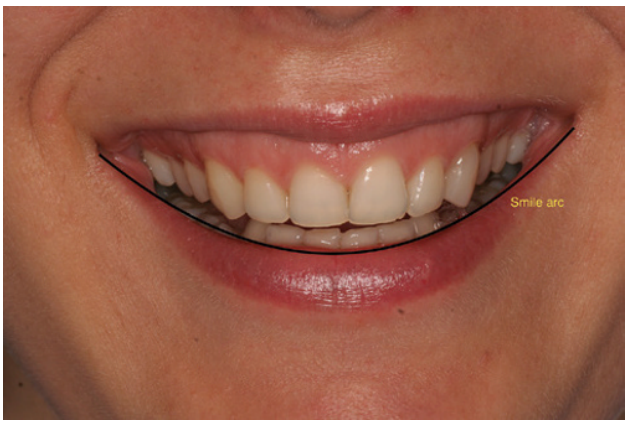
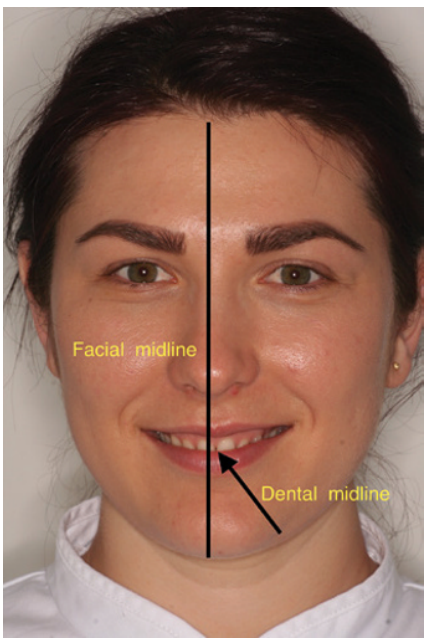
(*Continued*)

Procedure	Rationale
Lips/labial features – morphology and mobility	Morphological descriptions can include reference to the level of fullness (thick, medium or thin), width and symmetry. As a rule: • Wide lips are associated with a wide smile; a smile that is at least half the width of the face is said to be aesthetically pleasing. • Full lips are associated with the dominance of the maxillary central incisors in the smile zone. Lip mobility – refers to the amount of lip movement on smiling. The rest position of the upper lip can be used to determine the level of incisal display at rest. This may typically range from: • 3.0–3.5 mm for a 30-year-old. • 1.0–1.5 mm for a 50-year-old. • 0.0–0.5 mm for a 70-year-old. Phonetic tests, with the enunciation of *'F' and 'V' sounds* can help establish and determine the desired spatial relationship between the maxillary incisal edges and the lower lip; ideally the maxillary incisal plane should follow the curvature of the lower lip as an accepted universal concept. A video image taken perpendicular to the facial midline with the patient talking and smiling can be a valuable record of the relationship of the lip in motion and the amount of the teeth and gums visible during function.
Facial skin	Facial skin may be classed according to: • The level of pigmentation. • Tendency to burn. • The likelihood of a reaction to treatment. The Fitzpatrick skin phototype classification may prove helpful when planning facial aesthetic treatments.
Intraoral examination	To include a systematic assessment of the: • Soft tissues. • Periodontal tissues. • Dental hard tissues. • Occlusion and arch form. • The aesthetic zone. • Any edentulous spaces.
Soft tissue examination	The soft tissues of the mouth and oropharynx should be meticulously assessed for any abnormality. The presence of a tongue thrust or high frenal attachment should also be identified and recorded accordingly.
Periodontal tissues	As part of essential practice, the patient's overall standard of oral hygiene should be ascertained, noting the presence of any plaque and calculus deposits, anomalies in the colour and form of the gingivae, sensitivity, bleeding on probing and suppuration, tooth mobility and the presence of any furcation defects. Periodontal probing should also be undertaken and recorded. The Basic Periodontal Examination provides an excellent starting point. Where complex restorative care is planned or instability is suspected, it may be prudent to determine the levels of clinical attachment loss at six points per tooth, as well as undertaking and recording periodic plaque and bleeding scores to assess any developments following the provision of preventative advice and periodontal treatment.
Dental hard tissues	A dental hard tissue chart should be completed, noting: • Teeth present/ absent. • Presence, location and extent of any carious lesions. • Any sound and defective restorations (noting signs of failure – such as leakage, marginal adaptation, lack of appropriate interproximal contact, restoration form, function and appearance). • Tooth fractures and or cracks. • Signs and location of pathological tooth wear. • Tooth malformations.

(*Continued*)

Procedure	Rationale
Occlusion and arch form	Static occlusal features to assess and record include any signs of: • Tilting, rotation, drifting, supraeruption crowding, spacing, presence of diastema. • The overjet, overbite. • The arch form. • Interarch relationships: incisor, canine and molar segment relationships. • The occlusal vertical dimension/resting vertical dimension. Dynamic occlusal assessment to note: • The intercuspal position (ICP). • Signs of occlusal instability. • The ease at which centric relation (CR) can be located, the first point of tooth contact in CR (CRCP – centric relation contact point) and the presence and extent of any slides between ICP and CRCP. • Tooth relationships during the undertaking of protrusive mandibular movement – the anterior guidance. • Tooth relationships during lateral excursive mandibular movements – canine guidance/group function. • The presence of any working side/non-working side occlusal interferences.
The aesthetic zone/smile zone	The examination should include (Mehta, Aulakh and Banerji (2015): • Smile-zone shape. • Dentolabial relationships. • Dental midlines. • Tooth colour, texture and form. • Tooth size, shape, proportion, symmetry and axial inclination. • Contact areas and embrasures. • Gingival aesthetics.
Smile zone shape	Six shapes have been described: • Straight. • Curved. • Elliptical. • Bow-shaped. • Rectangular. • Inverted.
Dentolabial relationships	'Lipline' is a term that describes the relationship between the inferior border of the upper lip and the maxillary teeth/gums on smiling/enunciating the sound 'E' (E-test). Three categories are recognised: • Low smile line – maxillary anterior teeth exposed by no more than 75%; no gingival display. • Medium smile line – 75–100% of clinical crown display as well as the interdental papillae, • High smile line – line extends beyond the gingival margin – the 'gummy smile' (Figure 22.4).  **Figure 22.4** A high smile line showing the teeth and the gums.

(*Continued*)

Procedure	Rationale
	'Smile width' – the display of 10 maxillary teeth is the most common pattern seen (extending to the first molar teeth); the presence of any spaces between the buccal surfaces of the posterior teeth and the labial commissure – the buccal corridor, can give rise to a less than ideal appearance. 'Smile arc' (Figure 22.5) – refers to the relationship between the curvature of the lower lip and curvature of the incisal edges of the maxillary incisor teeth; ideally these planes should be symmetrical, with the superior lip border positioned slightly below the upper incisal plane, yielding a 'convex incisal curve'. In the case of a worn dentition, this may take the form of a 'flat' or 'reverse smile', thought to be less aesthetically pleasing as often associated with an 'aged-appearance'.  **Figure 22.5** The smile arc.
The dental midlines	Ideally, the dental midline should be coincident with the facial midline; a 2 mm discrepancy is less noticeable (Figure 22.6**).** However, when more than 4 mm, orthodontic intervention may be indicated. The upper and lower dental midlines show coincidence in 25% of the population only; a small discrepancy is likely to have limited impact.  **Figure 22.6** Here the dental midline is not coincident with the facial midline but the discrepancy is within 2 mm.

(*Continued*)

Procedure	Rationale
Tooth colour, texture and form	A colour assessment should consider: • Hue – base colour. • Chroma – saturation of base colour. • Value – brightness. Colour variations between individual teeth and amongst differing regions of the same tooth (polychromacity) should be noted and suitably recorded with the aid of a shade guide to determine the base shade guide. The presence of oral disease, caries, non-vital teeth, stained and leaking restorations can impart a poor aesthetic appearance. There appears to be an association between 'whiter teeth' with higher levels of physical attractiveness and a more youthful look. The patient's skin complexion may also influence colour perception. Variations in texture should be noted especially when planning isolated restorations; variations in lustre and texture can be copied if desired. The maxillary central incisor teeth have a dominant role in determining the dentofacial aesthetics. The shape of maxillary central incisor is commonly described as: • Ovoid – egg shaped. • Square – quadrangular. • Triangular – tapering. Associations have been made with shape and personality/gender and an individual's strength index. Form may also change with age and tooth wear.
Tooth size, proportion, shape, symmetry and axial inclination *Tooth size and proportion*	Maxillary central incisor teeth may be found to have an: • Average length of 10–11 mm – one sixteenth of the facial height. • Average width of 8–9 mm. • Average height-to-width ratio of 1.2:1; width being 75% of the length. Values provide helpful guidelines when planning restorative rehabilitation (especially of a worn dentition). However, racial and left/right variations do occur. The Golden Proportion is a mathematical concept applied in architectural design and engineering to study and design proportionality in the beauty of art and nature. It suggests an ideal mathematical proportion of 1:1.618. In terms of the anterior maxillary dentition it would imply that the maxillary central incisor should be 1.618 times wider than the maxillary lateral incisor, which in turn would be 1.618 times wider than the maxillary canine when viewed from a frontal direction. Hence, the width of the maxillary canine according to this concept should be 62% of the width of the lateral incisor. However, Golden Proportion relationships have not been found to be common in natural dentitions. They may, however, be used as a guide where multiple anterior teeth are absent to help plan the aesthetic rehabilitation of the smile zone.
Tooth shape	Maxillary central incisors should be viewed in profile to assess the planes of curvature: 2–3 planes may exist. The shape of the incisal edges should be noted; variations may be copied when restoring adjacent teeth. Maxillary lateral incisors often display considerable variations in morphology, including peg-shaped lateral incisors (unilaterally or bilaterally). Maxillary canine (shape and position) can have a bearing on the progression of the smile in passing from the anterior to posterior regions. The mandibular anterior dentition should also be assessed, with particular attention being given to the profile of the incisal edges of the teeth.
Tooth symmetry and axial inclination	In the natural dentition, there is rarely perfect left/right symmetry. This may be further influenced by morphological discrepancies such as unilateral peg-shaped teeth/missing teeth). The axial inclinations of the anterior maxillary teeth have a tendency towards a mesial tilt – an inclination towards the vertical midline.
Contact areas, connectors and embrasures	An embrasure is the triangular incisal space that exists inferior to the contact point. Embrasure spaces should ideally increase in size in progressing distally away from the midline. Similarly, contact areas should be positioned in a more apical location when moving distally from the midline in a symmetrical manner. The connector may be defined as the 'area between two adjacent teeth that seem to touch in a frontal view'. Connectors should be symmetrical across the dental midline.

(*Continued*)

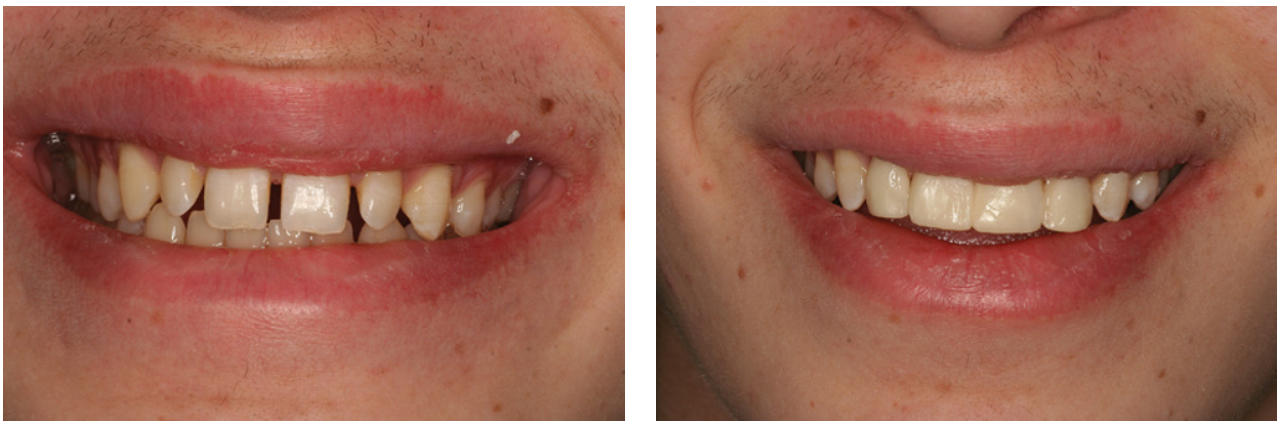
Procedure	Rationale
Gingival aesthetics	For optimum aesthetics to exist, the gingival levels of the anterior maxillary segment should be symmetrical about the midline, with the horizontal gingival levels of the central incisor and canine teeth being placed slightly more apical (by approximately 1 mm) than that of the lateral incisors. The presence of 'black triangles' between the teeth is usually considered to be highly unattractive. The gingival biotype – thick, normal or thin should also be determined.
Pulpal assessments	Baseline pulpal and periapical health assessment should be determined by the means of: • Clinical examination – detection of any features often associated with endodontic pathology. • Radiographic examination, as indicated clinically. • Special tests. The presence of any dentine hypersensitivity elicited with a 3 in 1 air:water syringe is helpful when planning bleaching treatments.
Edentulous spaces	Denture bearing areas (ridges) should be appraised for size, shape (round, flat, inverted, knife edged) as well as the consistency and thickness of the overlying mucosa (thick, thin, soft, firm, mobile). Any existing removable appliances should be carefully examined.
Special tests/special investigations	Some special tests used when planning treatment for the aesthetic zone include: • Radiographic examination. • Vitality and sensitivity testing. • Colour photographs. • Study casts, preferably mounted on an appropriate form of dental articulator. • Diagnostic wax-ups and resin mock-ups. • Kesling set-ups.
Summary	A summary of the findings should be presented and assimilated to arrive at a diagnosis/differential diagnosis. The latter in turn will help to establish a logical treatment plan.

Patient Expectations

To meet patient's expectations in the provision of aesthetic dentistry, techniques which offer predictability should be used. One such technique is the 'intraoral mock-up' or 'dry-and-try techniques'. The protocol(s) are summarised in the following sections.

Direct Mock-Up (Figure 22.7)

- Select an appropriate shade of resin composite. Isolate and dry the anterior maxillary teeth.
- Where an increase in the length of the central incisor teeth is desired, measure the width of the tooth using a Michigan O probe (with William's markings). Apply resin composite to one of the maxillary central incisor teeth; the amount of material added should generally aim to attain a rough length to width ratio of 1.2:1. An average width maxillary central incisor of 8–9 mm and a length of 10–11 mm would be deemed suitable. The length of a central incisor should be approximately one-sixteenth of this length. The rest position of the upper lip may be a useful guide to determining a suitable length. Where a decrease in the length of the selected tooth is desired, a surgical marker-pen can be used to mark the desired length to attain the above proportions.
- Ask the patient to say the letters 'F' or 'V', and observe the relationship between the incisal edge and upper border of their lower lip. Ideally, the incisal edge should be contoured to follow the profile of the upper border of their lower lip.
- With the aid of a set of wooden spatulas, determine the relationship between the incisal edges of the maxillary anterior teeth and the interpupillary line.
- View the profile of the maxillary incisor teeth in a lateral direction and the nasolabial support.
- Consider contouring the mock-ups at this stage to reflect crudely the patient's age, sex, personality and strength index culminating in an ovoid, square, tapering or square-tapering profile.
- For cases where there may have been considerable loss of incisal edge tissue, thought should be given to the position of the contact area. This should be ideally positioned in the incisal third of the maxillary central incisor tooth, 6 mm coronal to the crestal bone to develop ultimate papillary infill.



(a) (b)

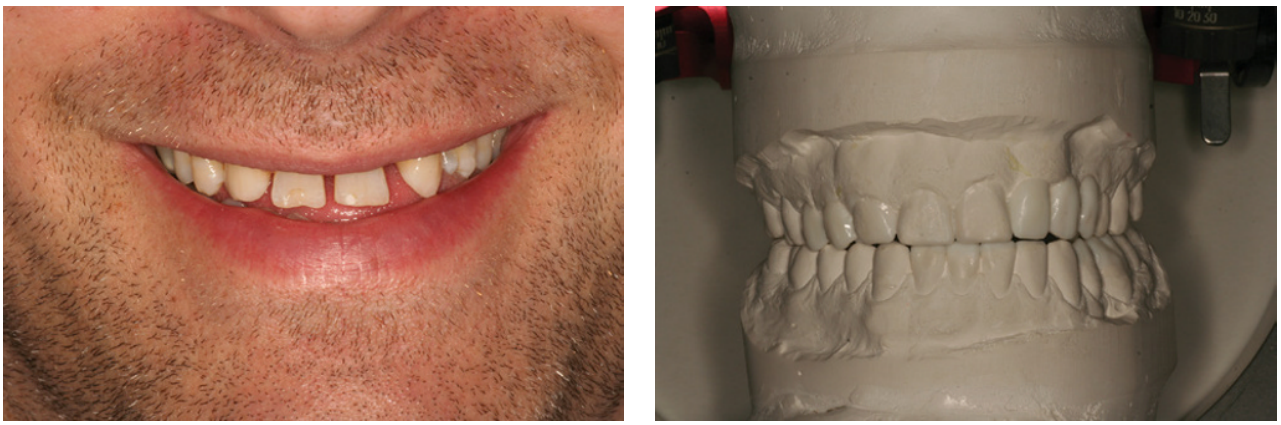
Figure 22.7 (a, b) A trial mock-up using composite without bonding has been tried on this patient to show the appearance after the diastemas have been eliminated.

- For cases where there is a need to alter the width of the maxillary central incisor teeth (such as in the case of diastema closure), resin composite may be added to the interproximal surface(s).
- Now observe the relationship between the maxillary dental midline and the facial midline; the discrepancy should be no greater than 2.0 mm.
- Repeat for the contralateral tooth.
- In relation to the maxillary lateral incisor teeth, the incisal edge should be placed a couple of millimetres apical to that of the central incisor; develop the profile of the incisal edge in accordance with the patient smile arc.
- Going from the midline, the axial inclination of maxillary anterior teeth should assume a 'mesial tilt'.
- For cases where an alteration in the width of the lateral incisor is desired, the concept of the Golden Proportion may be applied. The use of a Golden Proportion gauge (Golden Mean Gauge), may be helpful.
- Now add resin to the maxillary canine teeth, applying the concepts discussed previously, with the aim of maintaining symmetry across the midline. The average length of a maxillary canine should be 11–13 mm.The connector areas (area between two adjacent teeth that appear to touch when viewed frontally) should take the form of the 50-40-30 rule, such that the connector area between the central incisors is 50% of the length of their clinical crowns, between the central and lateral incisors is 40%, and 30% of the length between the lateral incisor and canine respectively.
- Now observe the width of the patient's smile. The presence of black spaces between the cheeks and teeth (negative buccal corridor) may look particularly unaesthetic.
- Observe the mandibular teeth in relation to the maxillary. You may consider adding resin to the mesial surfaces of the lower central incisors.
- For simple cases, make corrections to accommodate for the patient's occlusal scheme.
- Show the changes to the patient. It is advisable to take high quality photographs of the mock-up, and perhaps consider making a video recording to assess the effects of dynamic aspects such as speech.
- If the patient is satisfied and you are planning the use of direct composite, take a silicone overimpression. This can be carefully sectioned and the palatal 'key'/index used to help apply resin in a layered manner with increased predictability for the occlusal and morphological end-point.

Direct–Indirect Mock-Up

For more complex cases, often involving multiple teeth with planned occlusal changes, the use of a diagnostic 'wax-up' may prove helpful. To guide the technician and provide a bespoke approach, the direct mock-up technique must be carried out on one or two teeth to help establish the aesthetic prescription (as opposed to relying on biometric guides). Take an overimpression of the mock-up using alginate or silicone putty and some appropriate photographs.

- For cases involving planned occlusal changes where the alteration in the shape of the anterior teeth may alter the existing anterior guidance, the wax-up should be undertaken on casts mounted on an appropriate form of dental articulator. It is imperative for the clinician to prescribe/dictate the occlusal end point. The records supplied can help the technician fabricate



(a) (b)

Figure 22.8 (a, b) A mock-up has been fabricated in the laboratory on study casts mounted on an articulator for this patient. The teeth have been removed and repositioned using wax to give a more aesthetic outcome.

a 'functional diagnostic wax' incorporating the required aesthetic and occlusal changes.

- Upon return of the wax-up, an impression of the wax-up is carefully taken to form a 'matrix'. Teeth are lightly lubricated with petroleum jelly, and a chosen shade and quantity of temporary crown and bridge material is placed into the matrix, which is then seated onto the teeth, yielding a 'trial smile'. Flash excess is trimmed away. Critically appraise the 'trial smile' prior to demonstrating it to the patient.
- You may also choose to have the technician provide the patient with a 'clip-on smile' which mimics the prescription, so that they may have further opportunity to appraise and discuss these changes with family and friends.
- The wax-up, once verified, may then be indexed using a silicone base material. The silicone key will provide the necessary information to form the 'palatal shelf to enable resin layering', or be used to help with the process of precision tooth preparation for veneer or crown restorations.

Indirect Mock-Up using Digital Smile Design

With the use of appropriate photographic/video-graphic views and software, a new 'smile' can be designed on a computer applying biometric guides (ratios and proportions):

- The technology can also allow changes in alignment (axial inclination, overlap, rotation and some further orthodontic correction) to be displayed, as well as permitting the use of a 'library of tooth shapes' to meet the patient's demands/permit further discussion. Colour alterations can also be shown.
- From this information, a 3D virtual wax-up can be simulated (or 2D on articulated casts).
- With the use of CAD software, a virtual wax-up/provisional restorations can be milled and used to gain informed consent as described previously.

Kesling set-up (Figure 22.8)

This is a traditional diagnostic laboratory procedure whereby the teeth are sectioned off from a duplicate cast and realigned/re-set into the desired positions to assess the occlusal outcome of a proposed treatment plan and help facilitate patient communication.

Minimally Invasive Techniques

Vital Bleaching

Tooth whitening/tooth bleaching refers to an oxidative process/reaction that takes place following the application of a product to the tooth that alters the light-absorbing or light-reflecting nature of the tooth structure, thereby enhancing the perception of its 'whiteness' (Li and Greenwall, 2013). The process invariably involves the use of peroxide-based products (hydrogen peroxide/carbamide peroxide) applied either chair side or using a home-based system requiring the fabrication of customised trays. When carrying out these treatments, make sure to adhere to local regulatory standards and legislation to ensure safe and effective care.

Advantages/Benefits

When used properly, vital bleaching can offer the merits of (Li and Greenwall, 2013):

- A generally predictable, minimally invasive method to enhance the shade of discoloured/ stained teeth and improve overall smile aesthetics.

- Patient safety, with no significant long-term oral or systemic health risks (especially with the supervised use of 10% carbamide peroxide-based products).
- No adverse effects reported on enamel micro-hardness or the surface morphology of involved teeth (with the supervised use of 10% carbamide peroxide-based products).
- Long-term history of successful use (over 20 years).
- Relatively low financial cost.

Disadvantages/Risks

The most frequently documented side effects include (Li and Greenwall, 2013):

- Transient (often mild to moderate) primary tooth sensitivity.
- Gingival/mucosal irritation.

There is also the *potential* for:

- Oral soft tissue mucosal burns and ulceration, often referred to as 'tissue blanching' especially form poor technique or ill-fitting trays.
- Adverse effects on enamel (mineral loss) and restorative materials – however, as such these remain largely undocumented.
- Systemic toxicity of H_2O_2 -based products, especially their capacity to produce free radicals, with the consequences of pathological cellular damage – especially if any ingestion of dental material(s) may have taken place. Treatments should be avoided in pregnant/nursing mothers, patients suffering from/undergoing cancer therapy or with known allergies as well as other medical conditions.

Patients must be advised also about:

- The occasional lack of predictability with the outcome of vital bleaching treatments.
- The need for longer term care (including 'top-up' treatments).
- The risk of short-term relapse and the formation of transient/initial 'white patches'.
- The potential need for any restoration replacement in the aesthetic zone (which may no longer be in colour synchrony with the residual dentition, or may have suffered an alteration in their structural integrity) including the consequences of replacing functionally sound restorations amongst symptom-free and otherwise healthy teeth.

Direct Composite Veneers (Figure 22.9)

Indications include:

- The management of fractured, discoloured and rotated teeth.

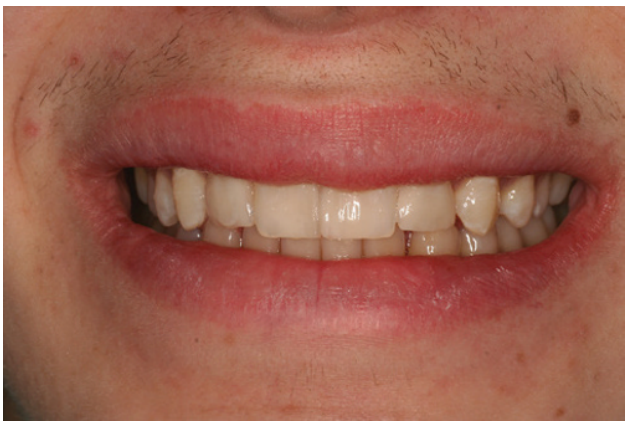


Figure 22.9 The patient shown in Figure 22.7 has had the anterior central and lateral incisors restored with direct composite veneers.

- Treatment of tooth malformations (e.g. peg-shaped lateral incisors).
- The closure/narrowing of diastemata.
- The management of congenital or acquired defects.
- The management of palatally positioned teeth.
- The treatment of the worn anterior dentition.
- The camouflaging of teeth, such as the modification of a canine to mimic a lateral incisor.
- Where an increase in tooth length or width may be indicated.
- As a prelude to the use of indirect techniques to gain consent and verify acceptance/tolerance.

Advantages/Benefits

- Can offer the potential to apply changes to the colour and shape of a tooth in a minimally invasive manner (with biological conservation) when compared with the use of indirect restorations.
- Offers the ability to readily undertake intraoral adjustments, repairs and polishing.
- May be placed in a single visit, with the possible absence of associated laboratory costs; cost-effective alternative to indirect restorations; immediate result.
- No need for working impressions or provisional restorations.
- Lack of need for a cement interface.
- Can allow for the direct masking and chromatic customisation of the restoration without reliance on the dental technician, who without the benefit of the patient's presence will otherwise have to depend on photographic records and or written instructions from the dental operator.

Disadvantages/Risks

- Placement requires good operator skill.
- May take considerable chairside time.

- Relatively lower resistance to wear compared with ceramics.
- Reduced lustre when compared with glazed porcelain.
- Tendency towards discolouration, staining, chipping and fracture.
- Higher maintenance requirements and higher reliance on the patient to maintain good oral hygiene.

Orthodontics

For an overview of this treatment modality, please refer to Chapter 16. If orthodontics is required in the provision of aesthetic dentistry, then referral to a specialist practitioner should be considered.

Indirect Aesthetic Restorations (Figure 22.10)

Ceramic Veneers

Valid informed consent must be obtained. The use of diagnostic means of appraisal involving mock-ups is strongly advised.

There are several ceramic materials available for the construction of veneers. These may be broadly divided into:

- Feldspathic porcelains.
- Lithium disilicate and leucite-reinforced ceramics.

It is important to understand the differences and prescribe accordingly.

Indications

- Management of discoloured teeth, where other techniques with greater biological preservation have failed, may be inappropriate or be against the patient's wishes.
- Morphological changes – inclusive of the management of malformed/conical teeth, diastema closure, alteration in tooth height/profile – especially where alternative options which are less invasive such as orthodontics and or resin bonding may be declined/not be appropriate to an individual's needs.
- Restoration of an extensive hard tissue defect – significant coronal fracture, severe loss of enamel by erosion/wear, congenital and acquired defects – where alternative options may not be suitable/consent not attained.

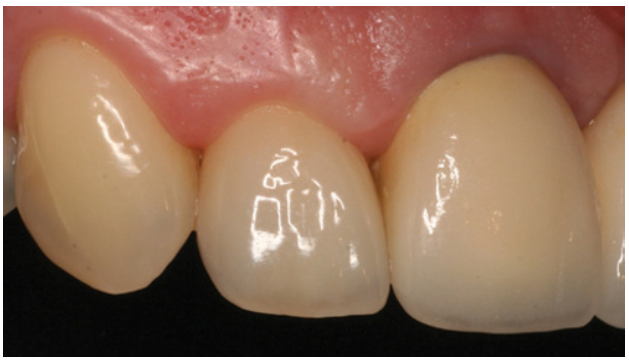


Figure 22.10 A feldspathic ceramic veneer on the upper right lateral incisor and a full ceramic bonded to precious metal alloy on the upper right central incisor at a 10-year recall.

Contraindications:

- Inadequate enamel tissue/local factors that may result in unpredictable adhesion.
- Where the positional change required may be significant and beyond the scope of a veneer restoration and impact adversely on oral health.
- Grossly discoloured tooth/teeth.
- Brittle, heavily restored tooth/teeth.
- Patient has a tendency towards parafunctional habits that may compromise the prognostic outcome.

Advantages/Benefits

- Can provide a solution to an aesthetic dilemma with better conservation than crown restorations due to adhesive propensity.
- Ceramics can offer high compressive strength, with the potential to enhance the flexural toughness of the residual tooth tissue.
- Ceramic veneers offer a superior aesthetic outcome versus resin-based materials by retaining gloss, reduced wear resistance and colour stability.
- Can offer superior marginal adaptation than resin based restorations with reduced risks of overhanging margins and better soft tissue tolerance.

Disadvantages/Risks

- Cannot be readily repaired and polished intraorally.
- Low flexural strength, vulnerable to chipping and fracture.
- Can be abrasive towards antagonistic surfaces.
- Different coefficient of thermal expansion with resin-based lutes, increasing the risk of leakage.
- High onus on operator skill.

Conventional Crown Restorations

Traditional, full coverage mechanically retained crowns are now used less frequently to provide enhancement of the anterior aesthetic zone, unless in cases where treatment by minimal intervention is likely to be/has already been unsuccessful. Such circumstances may include:

- The replacement of existing crown(s).
- The lack of adhesive potential.
- Recurrently failing adhesively retained restorations.

- Where teeth may be heavily restored and marked changes to the anterior occlusal scheme may be indicated.
- Heavily discoloured/brittle/root-filled teeth.
- Where the patient may express psychological concerns with adhesively retained restorations.

Advantages/Benefits

In general, the benefits of placing or replacing a crown would include:

- The restoration of form and function, including the elimination of any possible plaque and food traps and possible leakage between the tooth and restoration, which may lead to pathology.
- Enhancement of the fracture toughness of a tooth (especially in the case of a brittle tooth).
- Independent of the adhesive potential/colour of the residual tooth.
- Offers greater control over the occlusal morphology.
- May permit the use of metal occluding surfaces that are less abrasive than ceramic.
- Good aesthetic outcome, with the merits offered by ceramic-based restoration.
- Evidence available to support long-term success.

Disadvantages/Risks

Potential risks associated with conventional crowns include (Maglad et al., 2010):

- Possible soft tissue, gingival and periodontal trauma, caused by iatrogenic damage sustained during the preparation phase or by an ill-fitting or poorly contoured temporary and/or definitive restoration.
- The further (and sometimes copious) loss of healthy dental hard tissues which may occur during the removal of the existing crown and from further tooth preparation; the loss of tooth tissue by volume has been estimated to be in the region of 60–70% when preparing a tooth to receive a porcelain fused to metal crown and an all ceramic crown respectively (Edelhoff and Sorensen, 2002).
- Iatrogenic damage to the adjacent teeth or opposing teeth/tooth.
- The risks of developing reversible and irreversible pulp tissue damage because of further 'stresses re-laid to the pulp tissues' by the processes of tooth preparation and crown cementation. The risk of irreversible pulp tissue damage following the preparation of a tooth to receive a full coverage crown has been estimated to be 19% in one frequently cited study in the dental literature (Saunders and Saunders, 1998). However, it has been suggested that a more realistic estimation of the loss of vitality following the preparation and provision of a crown restoration is 4–8% in the 10 years following active treatment (Whitworth, Walls and Wassell, 2002).
- The risk of an occlusal anomaly.
- A risk of fracturing or exacerbating wear of the opposing tooth/teeth, symptoms of temporomandibular joint dysfunction syndrome or the development of a phantom bite.
- Failure due to caries (commonest cause of failure).
- Loss of retention, resulting in decementation or partial decementation.
- Material complications such as chipping or fracture, often termed 'prosthesis fracture' or 'porcelain veneer fracture'.
- Tooth fracture.
- Dissatisfaction with the aesthetic outcome, with no scope to reverse changes made (unless undertaking replacement crowns).

However, the above should be weighed against reported predictable long-term survival data of such restorations, with an estimated mean survival time of a crown estimated to be 10–15 years (Scurria et al., 1998).

Review and Maintenance

It is imperative to discuss the maintenance and monitoring requirements associated with any form of treatment provided at the outset, as these are likely for each of the options discussed. The importance of good home care and adherence to preventative advice cannot be overemphasised.

References

Ahmad, I. (2005) Anterior dental aesthetics: facial perspective. British Dental Journal 199:15–21.

Edelhoff, D., Sorensen, J. (2002) Tooth structure removal associated with various preparation designs for anterior teeth. Journal of Prosthetic Dentistry 87(5):503–509.

Li, Y., Greenwall, L. (2013) Safety Issues with tooth whitening using peroxide-based materials. British Dental Journal 215:29–34.

Maglad, A, Wassell, R, Barclay, S, Walls, A. (2010) Risk management in clinical practice. Part 3. Crown and bridges. British Dental Journal 209:115–122.

Mehta, S.B., Aulakh, R., Banerji, S. (2015) Patient assessment: preparing for a predictable aesthetic outcome. Dental Update 42:78–86.

Saunders, W., Saunders, E. (1998) Prevalence of periradicular periodontitis associated with crowned

teeth in the adult Scottish subpopulation. British Dental Journal 185:137–140.

Scurria, M., Bader, J., Shugars, D. et al. (1998) META analysis of fixed partial denture survival: prostheses and abutments. Journal of Prosthetic Dentistry 79:459–464.

Whitworth, J., Walls, G., Wassell, R. (2002) Crowns and extra-coronal restorations: endodontic complications: the pulp, the root-treated tooth and the crown. British Dental Journal 192:315–327.

Further Reading

Banerji, S., Mehta, S.B., Ho, C.K.C., eds (2017) *Practical Procedures in Aesthetic Dentistry*. Oxford: Wiley-Blackwell.

Wilson, N.H.F., ed. (2015) *Essentials of Esthetic Dentistry. Principles and Practice of Esthetic Dentistry*, Volume 1 (Series Editor B.J. Millar). Edinburgh: Elsevier.

23

Medical Emergencies

Kathleen Fan, Syedda Abbas, Shariff Anwar, Nikolas Fanaras, Leandros Vassiliou, Rahul Jayaram, Andrew Ross and Suranjana Lahiri

Introduction

Medical emergencies can occur anywhere and at any time. As such the General Dental Council 'Scope of Practice' 2013 states: 'A patient could collapse on any premises at any time, whether they have received treatment or not. It is therefore essential that all registrants are trained in dealing with medical emergencies, including resuscitation, and possess up to date evidence of capability'. Every dental practice or clinic has a duty of care to ensure an effective and safe service is provided for its patients (Jevon, 2012).

Chain of Survival

The occurrence of medical emergencies in dental practices is low, but importantly the survival from cardiac arrest is associated with the speed of resuscitation. The Chain of Survival (Figure 23.1) depicts the actions linking sudden cardiac arrest with survival (Nolan et al., 2010).

The first link shows the importance of recognition of those at risk of cardiac arrest and calling for help in the hope that early treatment will prevent progression to cardiac arrest. The central links illustrate the integration of cardiopulmonary resuscitation (CPR) and defibrillation as the fundamental components of resuscitation. Immediate CPR can double or triple survival from out of hospital cardiac arrest due to ventricular fibrillation. Studies suggest that each minute delay in defibrillation reduces the probability of survival to discharge by 10–12% (Nolan et al., 2010). The final link of the chain shows the importance of post-resuscitation care in the restoration of quality of life by preserving the function of, in particular, the brain and heart.

Medical Risk Assessment

Although medical emergencies can occur to anyone at any time, they are more likely to occur in certain patients. Ischaemic heart disease is the leading cause of death in the world and sudden cardiac arrest is responsible for more than 60% of adult death from coronary heart disease (Finegold, Asaria and Francis, 2001). Identification of these cases and other patients who are at higher risk of medical emergencies are essential as it may enable the prevention of emergencies occurring by modifying their treatment, e.g. a diabetic hypoglycaemic event, by carefully planning the time of their dental treatment to avoid impact on eating, anxiety and pain management in those with ischaemic heart disease.

Medical history taking is important each time the patient is seen to identify any changes that may have occurred. Patients with known epilepsy who report frequent convulsions or had a recent change in medical history would raise alarm bells of possible increased risk of an epileptic fit. It is important for the clinician to check with the patient even when paper or electronic medical histories have been given.

After completion of medical history taking it is possible to assign the patient to a physical risk category. The most commonly used scoring system is the American Society of Anesthesiologists Classification (ASA) and is a system originally set up to assess a patient's fitness for surgery. The Resuscitation Council (UK) (2012) has suggested its use to help identify those at greater risk of a medical emergency during treatment and also provides guidance for selecting patients who would benefit from being referred for treatment within a hospital setting.

ASA 1: Normal healthy patient – no clinically important comorbidity and without clinically significant past/present medical history.
ASA 2: A patient with mild systemic disease.

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

Figure 23.1 The chain of survival. CPR, cardiopulmonary resuscitation. *Source:* King's College Hospital, London. Reproduced with the kind permission of the Resuscitation Council (UK).

ASA 3: A patient with severe systemic disease.
ASA 4: A patient with severe systemic disease that is a constant threat to life.
ASA 5: Moribund patients who are not expected to survive without the operation.
ASA 6: A declared brain dead patient who organs are being removed for donor purposes.

Patients with ischaemic heart disease, asthma, epilepsy, diabetes and allergies are potentially more at risk of developing medical emergencies in the dental clinic (ASA 2, 3 or 4 depending on the severity of the condition).

Teamwork

Teamwork is especially important during management of a medical emergency. It is important that each member of the team is aware of the situation. There should be a team leader (usually the senior dentist) who is making the decisions and delegating tasks to appropriate members of the team, e.g. getting the emergency kit, or calling for an ambulance. Effective communication is essential with clear requests for each task by the team leader and effective listening of individual team member response. Regular simulations of medical emergency situations within the practice will allow members for the team to practice their roles.

Calling an Ambulance

There will be a number of situations in dental practice when it will be necessary to call for an ambulance. It is useful to have a card near the telephone with the practice address for such times. On speaking to the emergency number operator tell them that you require the ambulance.

Once connected to the ambulance service:

- Give details of the emergency, preliminary diagnosis (e.g. possible myocardial infarction).
- Information about the patient (e.g. 65-year-old man, conscious, chest pain, blood pressure, pulse rate).
- What is being done for the patient (e.g. oxygen is being given by face mask).
- Provide exact address or location and telephone number from which the call is being made.
- If appropriate stay on line and listen to important advice provided by the ambulance control officer.
- Arrange for someone to meet the ambulance when it draws close.
- Note the time that the call for emergency services was made (Haas et al., 2010, Jevon, 2013).

Resuscitation Council (UK) Standards

The Resuscitation Council (UK) updated its standard for primary dental care in 2013.

The key recommendations are:

- All primary care dental facilities should have a process for medical risk assessment of their patients.
- Specific resuscitation equipment should be available immediately in all primary care dental premises. This equipment list should be standardised throughout the UK.
- All clinical areas should have immediate access to an automated external defibrillator (AED).
- Each primary dental care facility should have a plan for summoning assistance in the event of a cardiorespiratory arrest (999 in the UK).
- There should be regular practice and teaching using simulation-based cardiorespiratory arrest scenarios.
- Dental staff's knowledge and skills in resuscitation should be updated at least once a year.

Assessment of the Sick Patient and the ABCDE Approach

The most important aspect regardless of condition is appropriate initial assessment according to basic life support guidelines. It is vital a systematic approach is followed for the assessment and management of a sick patient. This allows the clinician to stay as calm as possible and avoids missing important signs and the delivery of key treatment. Each step of the assessment should be made and immediate action taken where indicated. However, monitoring should be undertaken only after completion of steps A, B, C, D and E. Help should be called for at the earliest opportunity, whether this is the senior dentist or the emergency services.

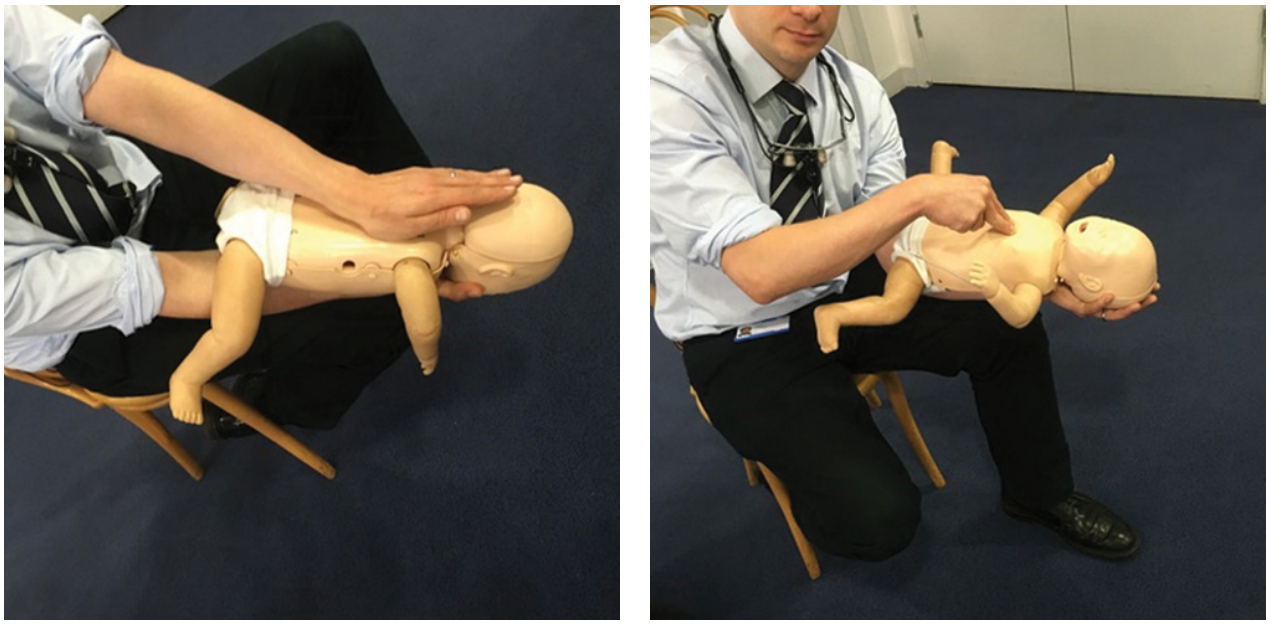
The principle of the ABCDE approach is to provide a system which avoids missing life-threatening pitfalls in patient management. Each step in the ABCDE approach is essential. The order of the categories was determined by the speed at which each one can precipitate devastating decline in the patient, i.e. if there is a problem with A (airway), it must be resolved as much as possible before addressing B (breathing) as failure to establish an airway precludes the possibility of successfully restoring respiration.

The ABCDE approach is used in all areas of emergency medicine, whether in medical, surgical or trauma scenarios. It provides structure to what can often seem to be a chaotic situation. It is simple and memorable and as can be seen in the following information, easily summarised and recalled. However, there is no substitute for attending dedicated courses in emergency care provided by qualified and experienced tutors.

A – Airway	
Upper airway obstructions often carry characteristic presentations but can be silent.	Shortness of breath caused by upper airway obstruction should be treated as an emergency.
Look and **Listen** for signs of airway obstruction	• Soft tissue swelling is possible with allergic reactions or infections (see also Anaphylaxis section). • Paradoxical chest and abdominal movement. • Cyanosis (late sign). • Gurgling – due to secretions. • Choking – foreign body. • Snoring – partial obstruction in patient with altered consciousness (sedation). • Stridor – an *inspiratory* 'wheeze' type noise pathognomonic of upper airway compromise. • Wheezing – expiratory wheeze is usually caused by lower airway collapse commonly seen in patients with asthma or COPD. • Silent – total airway obstruction.
Act	• Stop dental and other non-urgent treatment.
Choking (Figures 23.2 and 23.3)	• The airway can be opened by head tilt/chin lift or jaw thrust manoeuvres. • A visual inspection of the mouth and pharynx can be made and offending objects removed. • Remove debris and fluids using suction or forceps as appropriate. • Back blow and abdominal thrust if there is foreign body obstruction. • Give oxygen 15 l/min (via a reservoir bag) – or the highest flow available. • Consider an airway adjunct if the airway is not easily maintained, the patient can tolerate it and you can insert it confidently (e.g. an oropharyngeal/Guedel airway).
Monitor	• Aim to maintain O_2 saturations between 94 and 98%. • Consider that very sick patients or those with coexisting respiratory disease may not be able to achieve this. • Continue to observe for signs of improvement/worsening.

(a) (b) (c)

Figure 23.2 Management of choking. (a, b) Back blows. (c) Abdominal thrust.



(a) (b)

Figure 23.3 Management of choking in paediatric patients. (a) Paediatric back slap. (b) Paediatric abdominal thrust.

B – Breathing	
Assessment includes counting respiratory rate and inspecting the patient for abnormal breathing. Place your cheek over the patient's mouth and looking down the body to the chest.	Respiratory rate (RR) (age dependent) – increased rates associated with initial distress but decreasing rates can indicate catastrophe! Normal rate 12–20 for adults and 20–30 for children (1–5 years) although this latter figure changes yearly in very young patients.

Look for:	• Tachypnoea (RR >20) is the usually the first sign of respiratory distress. • Slow RR is also a worrying sign – may be a sign of oversedation or tiring.
	• Abnormal breathing patterns. • Symmetry of chest movements. • Depth of breathing. • Abnormal chest and abdomen movements with breathing. 'Paradoxical' movements refer to thrusting in and out of abdomen in time with attempted in- and expiration respectively. • Use of accessory muscles – this can be seen as tensing of shoulder and neck musculature and bracing of the shoulders often using the arms of a chair for example. • Cyanosis – bluish discolouration of mucous membranes precipitated by low circulatory oxygen concentrations. • Abnormal breath sounds on auscultation including unequal air entry, decreased air entry and wheeze.
Act	• Continue monitoring (including pulse oximetry if available – normal 97–100% PaO_2) and treating as for **A** (Airway). • Treat underlying course if possible, e.g. asthma beta-2 agonist inhaler. • Failure of respiratory effort should be treated with CPR immediately (please see Cardiopulmonary Resuscitation section).
C – Circulation Tachycardia is one of the most important markers of severity in acute shortness of breath. Emergencies originating from the cardiovascular system will be addressed in appropriate sections of this chapter. Simple faints and vasovagal episodes account for a great number of collapsing incidents and can be rectified by simple measures.	
Look and **Feel**	• Colour of the hands and face for: – Cyanosis (as above). – Temperature. – Clamminess. • Cool and clammy hands may be indicative of reduced blood pressure precipitating collapse. • The capillary refill time: – Can be measured by firmly pressing a patient's finger (preferably whilst held at their heart level) for 5 s and upon release, monitoring the time for its colour to return to the surrounding colour. – This can also be done over the sternum if the peripheral circulation is suspected to be poor for other reasons. – A normal refill time is <2 s.
	• The pulse rate can be measured at the wrist (radial), neck (carotid) or groin (femoral) and should be assessed for: – Rate – as with breathing, a raised or lowered pulse rate provide parameters of measuring the patient's condition. – Rhythm – pulse should be regular and a good knowledge of past medical history will allow the practitioner to assess whether an abnormal rhythm is acute in onset. A pacemaker or internal cardiac defibrillator can be quickly checked for and is usually found under the skin of the upper left anterior chest wall. – Volume – pulse volume is a crude assessment of circulation especially where the normal character is not known but can provide information regarding pulse pressure.

Act	• Formally measure blood pressure. BP <90 mmHg suggests shock. • Lay the patient as flat as possible to minimise the required blood pressure needed to achieve cerebral perfusion. A slight head down positioning may be applied if possible (for low BP due to vasovagal or simple faint or anaphylactic shock). • Chest pain – sit patient up, consider glyceryl trinitrate, aspirin, O_2 and call ambulance. • Continue airway and breathing management. • Consider high flow oxygen (15 l). • As with breathing, circulatory arrest is an indication for cardiopulmonary resuscitation.
Monitor	• Blood pressure. • Pulse.
D – Disability	
Refers generally to the conscious state of the patient and what may be affecting it. **Look** and **Listen**	• Responsiveness most easily be measured using the AVPU scale which represents severity of conscious impairment based on: – **A**lert – i.e. no conscious deficit, and an alert responsive patient. – **V**erbally responsive – i.e. the patient responds to verbal prompting, e.g. if their name is called. – Response to **P**ain – the patient is only roused by painful stimuli, e.g. pressure over the sternum or nail bed. This represents a quite serious loss of consciousness. – **U**nresponsive and clearly an extremely worrying state of consciousness. • Pupillary size and responsiveness to light can be measured and may be indicative or previous medication uses (pin point pupil –opiate drugs including illicit).
Act	• Take measures to review medication history and possible causes of drug interactions and counteract if possible. • Measure blood glucose to exclude hypoglycaemia and give glucose supplement if required. • Review A B C to exclude hypoxia or hypotension as causes for altered level of consciousness. • Consider oxygen. • Consider call for ambulance.
E – Exposure	
Exposure of the patient is the only way to be sure that no physical sign is missed and should be undertaken with the dignity of the patient second only to their health and safety. Exposure should not be prolonged to avoid unnecessary heat loss.	Look for urticaria if anaphylaxis is considered.
Monitor	Once full A, B, C, D and E assessment has been performed and maximal treatment given, the cycle should be started again and repeated until patient recovery or help arrives.

Learning Points

- The ABCDE approach provides a structured and safe approach to *any* medical emergency.
- When in doubt it can always be turned to and provides simple and safe methods to assess and provide potentially lifesaving, simple treatments.
- It can also provide reassurance in not so urgent situations.
- It should be used in an ordered ABCDE fashion and repeated after each cycle ABCDE (clearly re-exposure is unlikely to be necessary).
- ABCDE provides a common language when communicating the condition of a patient to other healthcare professionals.

Respiratory Problems: Shortness of Breath

In the community, management of shortness of breath involves managing complications in patients with severe respiratory disease and other acute events. The

medical history will identify patients with chronic respiratory symptoms in which their disease process may alter their dental management, e.g. severe chronic obstructive pulmonary disease requiring long-term oxygen therapy, or heart failure (see later). These patients may suffer worsening shortness of breath during consultation or procedures. They will nevertheless require assessment in the same manner as a patient with acute symptoms.

General Assessment and Common Conditions

An outline of general respiratory conditions and their management is given here. If a history can be obtained, symptoms of wheeze, cough, chest tightness or shortness of breath can be specifically asked for and if present then further questioning can commence. This should include:

- Timing of symptoms (e.g. morning or evening).
- Other triggers (e.g. dust, pollen, cold weather, stress).
- Drug reactions (e.g. to NSAIDs, aspirin, beta-blockers).
- Duration of symptoms.
- Smoking history.
- Occupational history.
- Exercise tolerance.
- Family history.

When presented with acute shortness of breath the most important task, regardless of condition, is appropriate initial assessment according to basic life support guidelines. Each step of the assessment should be made and immediate action taken where indicated, with monitoring undertaken only *after* completion of ABC (see the ABCBE approach described previously). Help should be sought at the earliest opportunity and emergency services called with the utmost urgency should the practitioner feel unable to cope with the situation in their facility.

Asthma

Asthma is an obstructive airway disease characterised by:

- Acute, chronic and acute on chronic airway inflammation.
- Symptoms of breathlessness and wheeze.
- The wheeze of asthma is on expiration: this can help differentiate between it and upper airway obstruction/constriction.

There is no agreed definition of asthma. The International Consensus Report describes asthma as a chronic inflammatory disorder of the airways encountered in susceptible individuals with symptoms associated with widespread but variable airway obstruction and an increase in airway response to a variety of stimuli. Obstruction is often reversible, either spontaneously or with treatment. The following factors are recognised by the British Thoracic Society as being associated with a diagnosis of asthma:

- Chemical or environmental triggers.
- History of hypersensitivity/atopy, e.g. hay fever, eczema.
- Emotional states including laughter, stress (particularly in children).
- A family history of atopy or asthma (possibly the strongest predictor of disease).

In a patient with known asthma, a history of severity and frequency of symptoms as well as medication use is invaluable. Although not foolproof, a patient's dependence on medication to achieve the symptoms profile they describe can provide a good barometer of disease severity.

With this knowledge, we must still assess each patient as an individual. Assessment of a patient with symptomatic shortness of breath includes:

- Symptom evaluation by questioning the patient.
- A, B, C assessment as described in the section on the ABCDE approach.
- Prompt and effective examination of the respiratory system comprising:
  - Measurement of respiratory and heart rate (good indicators of breathlessness but must be taken in context).
  - Oxygen saturation monitoring.
  - Auscultation for breath sound abnormalities if equipment available and clinician confident to do so.
  - Peak flow measurement is a simple test to perform and most useful in a patient aware of their usual score (if available and the clinician is confident to interpret).

There are specific criteria to assess severity of an asthma attack (taken from British Thoracic Society, 2008 (revised 2012)):

1) Moderate exacerbation:
   - Increasing symptoms.
   - Peak expiratory flow (PEF) 50–75% best/predicted.
   - No severe attack symptoms.
2) Acute severe attack:
   - Inability to complete sentences.
   - Respiratory rate >25/min.
   - Tachycardia >110.
   - PEF 33–50% best/predicted.
3) Life-threatening attack:
   - Severe asthma symptoms +:–.
   - Cyanosis.
   - Bradycardia (heart rate <50 bpm).
   - Exhaustion and conscious level drop.
   - Oxygen saturations <92%.
   - Silent chest.
   - PEF <33% best/predicted.
   - Poor respiratory effort.

Treatment

Dental or other non-urgent activities should be stopped and the patient placed in a comfortable seated position immediately, with prompt assessment using the ABCDE approach. Remove any objects or substances used in treatments including dental impression materials, mouth props, and rubber dams. It must be borne in mind that these may have precipitated symptoms whether caused by asthma, allergic reaction/anaphylaxis, pain or emotional distress. Check for a clear airway. Treatment then consists of oxygen therapy and attempts to reverse bronchospasm.

Oxygen	• Fifteen litres of oxygen can be delivered through a reservoir bag and remains the mainstay of oxygen therapy particularly if monitoring in unavailable.
	• In a hospital setting, oxygen should be titrated to maintain saturations of 94–98% on pulse oximetry (carbon dioxide retention is discussed later). This does not mean that saturations above this necessitate removal of oxygen therapy.
Bronchodilators – a practical and readily available treatment plan is provided in the box opposite and the remainder of this subsection outlines the other potential management options as outlined by the British Thoracic Society and can be used as the experience and availability of resources to the practitioner allows.	• In the absence of a nebuliser, the patient should be given up to 10 activations (puffs) of their salbutamol inhaler. A large-volume spacer may be useful, especially with children. This can be repeated every 10 min.
	• Treatment may be initiated with two puffs and a further two puffs given every 2 min up to a maximum of 10 in 10 min. Ten puffs may now be given every 10 min in succession without the need to escalate by two puffs per 2 min.
Beta-agonists (e.g. salbutamol) are often the staple of obstructive airway disease. Their actions on receptors are believed to cause:	• Relaxation of bronchial smooth muscle.
	• Decrease in mast cell mediator release.
	• Inhibition of neutrophils, eosinophils and lymphocyte functional responses.
	• Increase mucociliary transport.
	• An effect on vascular tone and oedema formation.
	• Many patients will regularly use these medications.
The mode of bronchodilator delivery will be determined by the patient.	• Mild attacks may be amenable to inhaler treatment as described above.
	• If there are concerns regarding this or the patient feels unable to do this then a spacer device may be used. The latter is especially relevant to children.
	• In more severe attacks, nebulised salbutamol 2.5 mg should be used as first-line treatment (if available). This should be given even in the absence of supplemental oxygen. (A flow rate of 6 l/min is required to drive most nebulisers and it is important to be familiar with any equipment.) This would be given in the ambulance or in hospital as would any subsequent escalation in treatment.
Escalation of treatment would include:	• Steroid treatment and nebulised ipratropium bromide.
	• If anything other than a moderate attack is suspected, or there are any further concerns, referral to the local Emergency Department should be made.

Observation and Further Management

- Asthma describes a condition of *reversible* bronchoconstriction. Failure to achieve this with initial, simple measures should prompt escalation of treatment (Table 23.1). Refer to the local emergency department.
- Continue treatment whilst awaiting assistance or transfer.
- Oxygen and nebulised salbutamol if available.
- Steroids in the form of oral prednisolone (in hospital).
- Ipratropium bromide nebulisers, not to be given continuously (maximum frequency four per day) (in hospital).
- Salbutamol may be given 'back to back' assuming no ill effects.

Table 23.1 Treatment ladder for asthma.

Step	Adult	Child aged 5–12 years	Child aged 2–5 years
Step 1	Inhaled short-acting beta agonist, e.g. salbutamol as required	Inhaled short-acting beta agonist, e.g. salbutamol as required	Inhaled short-acting beta agonist, e.g. salbutamol as required
Step 2 (patients requiring regular preventer therapy)	Inhaled corticosteroid (200–800 µg), e.g. beclometasone	Inhaled corticosteroid (200–400 µg), e.g. beclometasone *or* other preventer inhaler	Inhaled corticosteroid, e.g. beclometasone *or* leukotriene antagonist, e.g. montelukast
Step 3	Long-acting beta agonist +/– increasing dose inhaled steroid (to 800 µg)	Long-acting beta agonist +/– increasing dose inhaled steroid (to 400 µg)	Combine options from Step 2
Step 4	Increase inhaled steroid dose (up to 2000 µg) +/– add further drug, e.g. leukotriene antagonist, beta agonist tablet or theophylline	Increase inhaled steroid to 800 µg	
Step 5	Daily steroid tablet	Daily steroid tablet	

Asthma in Children

Treatment principles are the same as those for adults (Table 23.2). Beware vital observation parameters are different in children:

1) 2–5 years of age:
   - Tachycardia = >140 bpm
   - Tachypnoea = >40 respirations/minute
   - Prednisolone dose = 20 mg (in hospital)
2) >5 years of age:
   - Tachycardia = >25 bpm
   - Tachypnoea = >30 respirations per minute
   - Prednisolone dose = 30–40 mg (in hospital)

Table 23.2 Treatment for a paediatric asthma attack (taken from British Thoracic Society, 2008 (revised 2012)).

Oxygen	Via tight fitting facemask
Bronchodilator	• Inhaler or spacer device. • Two puffs repeated after two minutes if no improvement. • Increase dose by two puffs on each subsequent dose, i.e. 2 puffs → 2 min → 4 puffs → 2 min → 6 puffs… (max 10 puffs). • Spacer devices can be fitted with face masks for infants. • Advice from the emergency services should be sought regarding nebuliser therapy if available.
Steroids	• With expert (in hospital) advice: 20 mg prednisolone for 2–5 year of age; 30–40 mg for children over 5 years of age. • Patients already receiving maintenance doses of steroid should be given an additional 2 mg/kg of steroid up to 60 mg.

Other Causes of Respiratory Distress

We have focused on asthma as it represents the most common condition likely to be encountered in the scenario of acute shortness of breath. The management also encompasses a reasonable approach to almost any case of shortness of breath including undiagnosed respiratory disease.

Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) affects 3 million people in the UK. It warrants special mention as people often have a reluctance to initiate oxygen therapy. The World Health Organization definition of COPD is 'a lung disease characterized by chronic obstruction of lung airflow that interferes with normal breathing and is not fully reversible'. This is based upon the physiological response to chronic hypercapnia seen in COPD. This leads to respiratory drive being influenced by oxygenation levels (as opposed to levels of CO_2). The fear is that high flow oxygen therapy which raises blood oxygen saturation will in turn lower the respiratory drive. This is a proven physiological response and trials have shown that 'overventilated' patients are more likely to become acidotic. Current research suggests that in the absence of blood gas analysis, COPD patients should be provided with oxygen to aim for saturations between 90 and 92% (Resuscitation Council (UK), 2012). The aim is to ensure adequate but safe oxygenation. In the primary care setting, these guidelines provide the safest course of action.

Other patients with a risk of CO_2 retention include those with chronic severe asthma, bronchiectasis, cystic fibrosis, chest wall disease and neuromuscular disease. Patients may carry alert cards with advice regarding oxygen therapy. In an emergency situation, the Resuscitation Council advise giving high flow oxygen 15 l in situations of acute shortness of breath.

Acute Shortness of Breath in a COPD Patient

- Dental or other non-urgent activities should be stopped and the patient placed in a comfortable seated position immediately (usually upright) with prompt assessment (ABCDE approach).
- Check airway is clear.
- Administer oxygen with pulse oximetry: if possible aim for oxygen saturation of 90–92%.
- Consider two puffs of short-acting bronchodilator beta-2 agonists.
- Monitor conscious level using AVPU.
- Consider referral to the local emergency department.
- Continue treatment whilst awaiting assistance or transfer.

Hyperventilation Syndrome

Hyperventilation syndrome (HVS) is a condition where shortness of breath is perceived in response to emotional or physical stress with worsening symptoms perpetuated by this initial symptom. Signs include:

- Fast breathing.
- Dizziness.
- Feeling faint.
- Blurred vision.
- Tingling.
- Muscle stiffness.

This leads to a vicious cycle which can be incredibly distressing for patient and practitioner. A history of such events as well as panic attacks may be present. This condition may present with concurrent symptoms of chest pain, paraesthesia or tingling characteristically described as perioral in nature, blurring of vision and several other non-specific symptoms. If there is no history of true respiratory disease and absence of clinical signs, e.g. wheeze, HVS may become an important differential diagnosis. During a suspected occurrence of HVS:

- Be calm and reassure the patient.
- Stop the cause of the anxiety.
- Ask the patient to concentrate on slowing their breaths.
- Take them to a quiet room to recover.
- The classical 'breathing into a paper bag' treatment can be effective for hyperventilation, but is no longer recommended.

Summary

- Shortness of breath is a common complaint.
- Use a structured basic/advanced life-support approach for assessment.
- Initiate treatment if necessary.
- Prudent use of oxygen therapy.
- Appropriate medication if available.
- Constant reassessment.
- Transfer to secondary care/emergency facility under monitored supervision.

Airway Management

Prompt recognition of airway obstruction along with appropriate management is essential for all dental personal. Use the Look-Listen-Feel approach.

Partial airway obstruction may be clinically diagnosed by the following:

- Inspiratory stridor.
- Gurgling.
- Crowing or stridor.

Complete airway obstruction in an awake patient can be identified by clinical distress and 'see-saw' breathing caused by paradoxical chest and abdominal movements when attempting to breathe.

Basic Manoeuvres to Open the Airway

Head tilt and chin lift (Figure 23.4)	
Place the palm of one hand on the patient's forehead and with the fingers of the other hand under the mentum (point of the chin) lift patient's chin gently.	This manoeuvre stretches the tissues of the neck and pulls the tongue forward to open the airway.
Check airway patency to confirm success of manoeuvre (Look-Listen-Feel) for no more than 10 s.	Look – for movement of chest and abdomen. Listen – for airway at the mouth and nostril. Feel – over the mouth and nostril for airflow.
Jaw thrust (Figure 23.5)	
Position patient supine.	This is an alternative airway manoeuvre and is recommended in patients with suspected cervical spine injury.
Stand behind patient.	
Place index and other fingers behind angle of mandible bilaterally and the thumbs on the body of the mandible bilaterally.	
Apply forward force to lift the mandible and with the thumbs open the mouth by rotating the mandible slightly downwards.	
Check airway patency to confirm success of the manoeuvre (Look-Listen-Feel).	

Figure 23.4 Management of airway – head tilt, chin lift.

Figure 23.5 Jaw thrust.

Adjuncts to Basic Airway Manoeuvres

Simple airway adjuncts may prove essential in maintaining a patent airway. Oropharyngeal (Guedel) and nasopharyngeal airways in combination with basic manoeuvres overcome upper airway obstruction at the level of soft palate and base of tongue.

Procedure for Inserting a Guedel/Oropharyngeal Airway

1) Guedel airways are suitable for the unconscious patient.	Use in a conscious patient may induce vomiting and laryngospasm.
2) Choose the appropriate size (most common for adults are sizes 2, 3 and 4). Roughly estimate size by placing the airway on one side of patient's face. The flange should coincide with the incisors and the curved flattened end with the angle of the mandible when viewing the patient from the side.	The correct size can be estimated by placing the airway against the face. It should extend from the incisors to the angle of the mandible (Figure 23.6).
3) Open the patient's mouth: ensure there is no foreign material.	Suction if necessary.
4) Always insert the Guedel airway upside down and gradually rotate it through 180° after passing beyond the hard–soft palate junction.	Initially the curve part of the airway pushes down on the tongue.
5) After insertion perform head tilt/chin lift and check airway patency.	If the airway is not patent despite correct placement and suctioning, the level of the obstruction may lie lower. In this case a cricothyroidotomy might need to be considered.
6) Ventilate patient with bag-valve-mask and assess air entry and chest movements.	

Procedure for Inserting a Nasopharyngeal Airway

Nasopharyngeal airways are relatively soft and malleable and comprise the adjuncts of choice in conscious patients especially if there is trismus. Some designs require a safety pin through the flange to act as stopper preventing the tube after its placement from inadvertent slippage into the airway beyond the nares. There is usually a flared distal end that sits outside the nares to prevent it being lost inside the nose.

1) Check the nostril for patency. Usually the right nostril is used.
2) Choose appropriate size (most common for adults are sizes 6 or 7). Size number corresponds to the internal diameter of the tube in millimetres.
3) It is very important to lubricate the tube using water-soluble jelly.
4) Insert the airway with the bevel directed vertically along the floor of the nose. Advance with concomitant gentle twisting action. If obstruction is felt remove and insert into the other nostril.
5) After insertion perform head tilt/chin lift and check airway patency.
6) Ventilate patient if needed with bag-valve-mask and assess air entry and chest movements.
7) If the airway is not patent despite correct placement the level of the obstruction may lie lower and in this case a cricothyroidotomy might need to be considered.

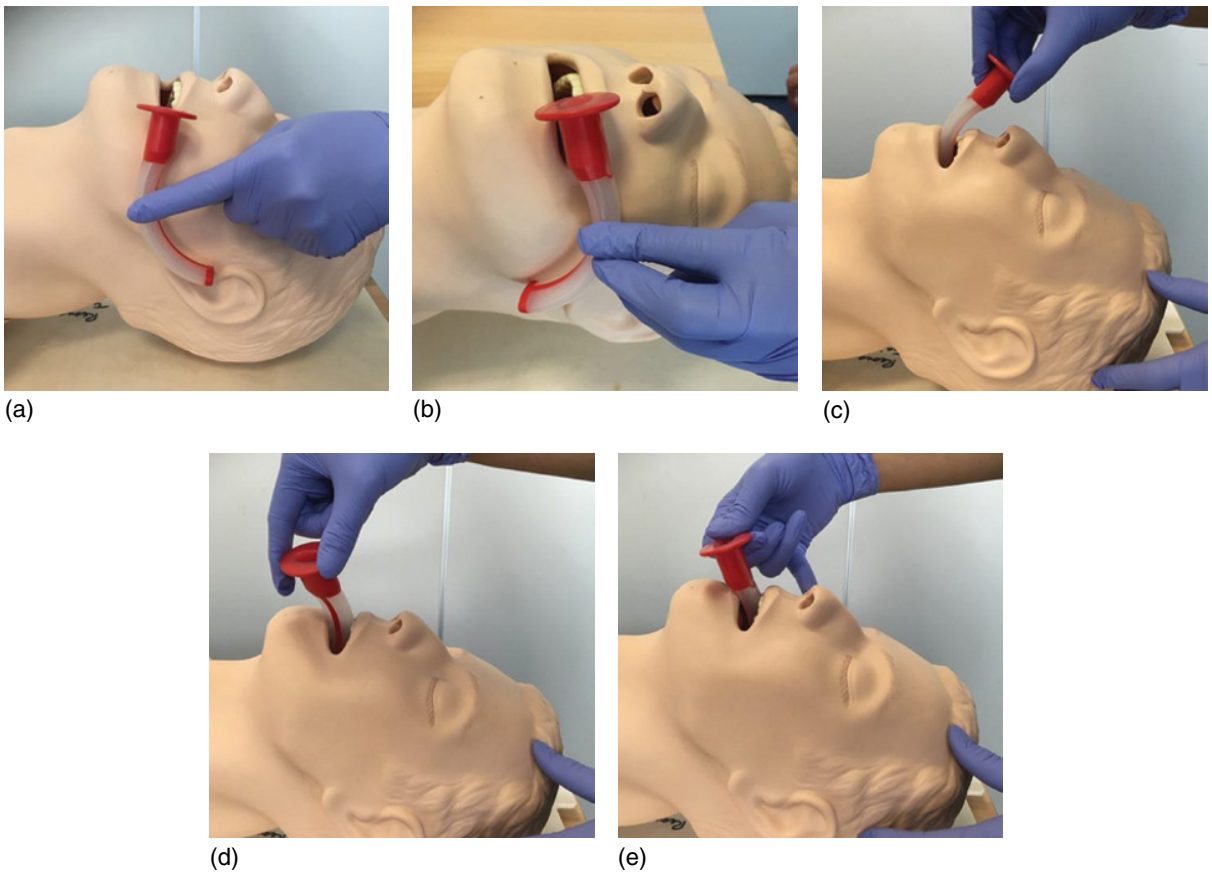


Figure 23.6 Procedure of sizing and inserting a Guedel airway. (a) 'Soft to soft' (commissure to tragus). (b) 'Hard to hard' (incisor to angle of mandible).

Choking: Foreign Body Airway Obstruction

Foreign body obstruction (choking) is most commonly witnessed during eating. However, it can also occur during the provision of dental care. When the foreign body enters the oropharynx, the patient may immediately cough. Spontaneous coughing can effectively remove the item, but if coughing is ineffective then active intervention (e.g. back blows, chest thrust, abdominal thrust) will be necessary.

Management of Choking

Signs of choking: sudden onset of respiratory distress with:

- Coughing.
- Gagging/gurgling.
- Stridor.

1) Stand to side/just behind the patient (Figure 23.2(a,b)). 2) Lean patient forward. 3) Deliver five back blows between the scapulae using the heel of the hand. 4) If back blows fail, proceed to abdominal thrusts.	After each blow check to see if the foreign body has been dislodged.
Abdominal thrust/Heimlich manoeuvre Preparation: If the patient is conscious, position them standing up or sat upright. Resuscitator is standing behind the patient (Figure 23.2(c)). Reassure patient. If the patient is unconscious position him/her supine on the floor.	This manoeuvre artificially creates cough by forcefully moving the patient's diaphragm up, increasing intrathoracic pressure and moving air rapidly out of the patient's lungs with a force adequate to blow out any foreign material lodged in the upper airway. Avoid performing abdominal thrust in the third semester of pregnancy and with suspicion of a full stomach.

Identify patient's xiphisternum and umbilicus. Procedure:	
1) Encourage patient to cough. If ineffective proceed with abdominal thrust.	
2) Place your arms around patient's waist.	
3) Make a fist with one hand positioning the thumb midway over patient's umbilicus–xiphisternum distance.	
4) Cover your fist with the other hand and thrust up and cephalad with sufficient subdiaphragmatic force to lift the patient off his/her feet.	
5) Deliver five upward thrusts forceful enough to dislodge the foreign body and relieve airway.	Do not thrust forcefully in children.
6) Repeat manoeuvre until foreign body is expelled.	
7) Keep firm grip of the patient as he/she may lose conscious.	
8) If patient loses consciousness lower them to the floor.	
9) Call for ambulance if not already done.	
10) Start CPR 30 chest compressions even if there is a pulse (European Resuscitation Council Guidelines for Resuscitation, 2015).	Studies show that higher airway pressures can be generated using chest thrusts compared with abdominal thrusts, hence chest compression should be started promptly if the victim becomes unresponsive or unconscious.

Algorithms of Airway Obstruction (Figures 23.7 and 23.8)

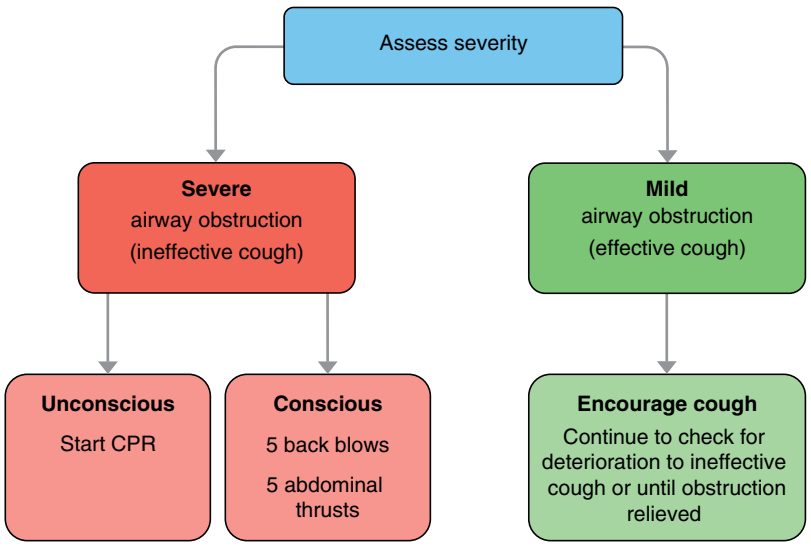


Figure 23.7 Adult Choking Treatment Algorithm. *Source:* King's College Hospital, London. Reproduced with the kind permission of the Resuscitation Council (UK).

Cardiac Emergencies in the Dental Practice

The cardiovascular system, put simply, is a central pump with a closed network of pipes. The aim of a functioning cardiovascular system is the effective uninterrupted pumping and circulation of oxygen-enriched arterial blood to and carrying oxygen depleted blood and waste products away from the end organs. The heart's function is dependent on its contractility and the rate and rhythm of its contractions.

Heart disease is the leading cause of death for both men and women. It is therefore vital that the dental professional can recognise and effectively manage a cardiac emergency that might arise in their practice setting; this is covered in this section.

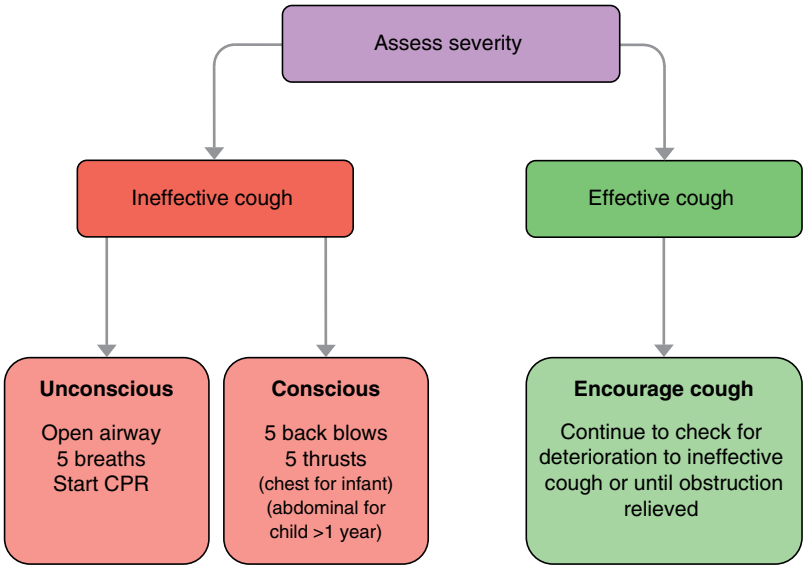


Figure 23.8 Paediatric Choking Treatment Algorithm. *Source:* King's College Hospital, London. Reproduced with the kind permission of the Resuscitation Council (UK).

Risk Assessment

Risk assessment is an integral part of risk management. Most cardiac patients will have clues in the medical history and physical examination to indicate that they are at risk.	Do not treat a stranger! It is vital to know your patient prior to starting any form of intervention.
Verbal history and physical examination should supplement the information gained from the questionnaire.	Physical examination should start as soon as the patient enters the room.
Look for obvious signs such as: the patient's posture, habitus, skin colour, exercise tolerance, respiratory pattern.	
Additional findings of heart rate, rhythm, blood pressure and pulse oximetry can be gained where appropriate.	Especially prior to prolonged, interventional procedures and with use of sedation.
A note should be made of the patient's medications.	Consider possible drug interactions and the side effect of the drug which may impact on dental treatment.
Common presenting features of cardiac emergencies include shortness of breath, chest pain, palpitations, cyanosis and sudden loss of consciousness.	Breathlessness is typically a sign of increased oxygen demands and left-sided heart failure.
These patients can also have altered blood pressure, poor peripheral circulation or poor central circulation.	This manifests as peripheral cyanosis, cold clammy extremities, and altered mental state and level of consciousness.
Central cyanosis is seen on the lips/ tongue.	Usually a sign of cardiac failure or respiratory disease, or of both together in the case of cor pulmonale.
Chest pain can be of cardiac or non-cardiac origin.	In a cardiac context, it is due to an inadequate myocardial blood supply (ischemia) or myocardial cell death (infarction).
Non-cardiac chest pain should be a diagnosis of exclusion once more sinister cardiac causes are excluded.	Common non-cardiac causes are respiratory, heartburn, musculo-skeletal, panic attack, anxiety and chest wall problems.
Palpitations and sudden loss of consciousness can be symptoms of cardiac arrhythmias (dysrhythmias).	Arrhythmias are abnormal heart rate or heart rhythm.

Ischemic Heart Disease

Ischemic heart disease is the result of progressive myocardial ischemia.	This is due to reduction of coronary blood supply usually by atherosclerosis.
Atherosclerosis is the deposition of lipids and cells on the blood vessel's inner walls.	This can then stay localised as a thrombus and occlude the blood vessel or break off and migrate as an embolus.
Occlusion of the coronary arteries can lead to myocardial oxygen deprivation (ischemia) or myocardial cell death (infarction).	Ischemia presents as angina pectoris and cardiac cell death as myocardial infarction (MI).

Angina Pectoris

This is a symptom of coronary heart disease and is defined as acute onset severe chest pain due cardiac muscle ischemia.	Results from an imbalance between the oxygen demands and supply to the heart's muscle. This is secondary to spasm or obstruction of the coronary arteries.
Angina is defined as two subtypes: stable and unstable.	Angina can be precipitated by exercise (climbing stairs), emotion and stress.
Stable or exertional angina presents as central crushing chest pain precipitated by exertion and relieved by rest.	These patients are classically asymptomatic at rest.
Unstable angina occurs unpredictably at rest or with minimal exertion, lasts longer, can present with episodes of worsening severity or increasing frequency (crescendo angina).	The unpredictable nature of unstable angina indicates a much worse prognosis and this condition is now classed along with myocardial infarction as acute coronary syndrome (ACS).
Angina can present as central crushing chest pain or discomfort. Usually lasts less than 15 min.	Usually described as a feeling of heaviness, tightness across the chest, a burning or choking sensation.
There may also be referred pain radiating to the arms, lower jaw, neck, back or the epigastrium.	
Associated symptoms of nausea, sweating and breathlessness may occur in some cases.	
Pain classically stops within 5 min of cessation of the exertion or initiating stimuli and responds well to administration of glyceryl trinitrate (GTN) (a coronary vasodilator).	Usually patients with a background history of angina will carry their supply of GTN either as a spray or tablets. This should also be an essential part of the emergency tray in the practice.
Prolonged pain and poor response to rest or GTN with or without haemodynamic instability point towards an acute coronary syndrome (MI or unstable angina).	

Immediate Management

Stop the dental procedure in a safe manner.	If this is the first presentation for the patient call for ambulance.
Assess the patient's airway, breathing, circulation level of consciousness.	ABCDE
Position the patient in the most comfortable position.	In these cases, this would most likely be a sitting up upright position.
Reassure the patient and give GTN sublingually.	
Check for any signs of haemodynamic instability.	Check the patient's heart rate and blood pressure.

Further Care

The patient should be monitored closely for resolution of the symptoms.	If not settled, give second dose of GTN, if pain still not eased then call for ambulance and administer 300 mg aspirin if not allergic.
It is useful to compare this presentation with any previous episodes with the patient.	It is prudent to consider this as sinister and refer for the exclusion of myocardial infarction if uncertain.

Acute Coronary Syndrome/Myocardial Infarction

Unexplained or new onset chest pain which is not relieved by cessation of the precipitating stress or administration of GTN.	Associated symptoms are usually present.
The pain is of a similar nature to angina but usually more severe and prolonged.	Nausea and vomiting, sweating, shortness of breath and a sense of impending doom.
There can also be signs of haemodynamic instability. Note occasional MI can be silent, e.g. in diabetics. Central chest pain. Radiation to arm, neck or jaw.	Definitive diagnosis in the dental surgery environment is not possible.
Should be considered as MI, until proven otherwise.	
Pain lasting more than 15 min or recurring episodes of pain less than 15 min.	This needs a 12-lead electrocardiogram tracing and the assessment of raised cardiac enzyme levels in the blood.
Cool clammy skin, thready and or irregular pulse and a fall in blood pressure.	
ACS includes ST-segment elevation, MI (STEMI), non-ST elevation MI (NSTEMI) and unstable angina (UA).	

Immediate Management

Stop the dental treatment in safe manner. Position the patient comfortably, most likely sitting. Call for an ambulance immediately.	Give 300 mg of aspirin – crushed or chewed. If the patient becomes unresponsive check for 'signs of life' (breathing and circulation) and start CPR in case of cardiac arrest or if the patient becomes unresponsive.
Offer GTN sublingually.	
Give oxygen therapy via a face mask 15l if the patient is cyanosed, or consciousness level deteriorates.	
Basic life support with an ABC approach should be instituted.	
When the ambulance arrives provide relevant information about the medical history and the medications administered.	

Cardiac Arrest/Cardiopulmonary Resuscitation

Cardiac arrest is the cessation of blood circulation, due to failure of the heart to efficiently contract.	It is important to rule out other causes of unconsciousness.
Cardiopulmonary resuscitation.	CPR refers to the process of supporting ventilation and cardiac output in a collapsed patient with cardiac arrest (guidelines are frequently updated. Current guidelines according to the Resuscitation Council UK).
Myocardial infarction (heart attack) is different from a cardiac arrest, but it is the most common cause of cardiac arrest.	
Diagnosis of a cardiac arrest depends on the patient being unresponsive to 'shake and shout' and having no central (carotid) pulse.	If a patient has a pulse they have not suffered a cardiac arrest.
Survival of out-of-hospital cardiac arrest depends on early recognition.	Prompt basic life support with cardiopulmonary resuscitation and early defibrillation has been shown to improve survival.
Early transfer to hospital and access to advanced life support with cardiac defibrillation and medication is appropriate.	

Immediate Management

Stop the dental treatment in a safe manner.	Check response. Shake and shout: 'Are you all right?' If the patient is responsive – then work out the cause. If the patient is unresponsive, follow the basic life support algorithm (Figures 23.9 and 23.10) and as soon as the automated external defibrillator (AED) arrives, switch it on and follow the instructions.
Unresponsive patient: call for help.	
Position the patient flat.	Improves venous return.
Open airway.	Assess airway: head tilt, chin lift. Check airway is clear, consider suction. Look, listen and feel for normal breathing.
Not breathing normally: call for ambulance and send for AED.	
Confirmed cardiac arrest. Call for help and call for ambulance.	Unresponsive patient without a central pulse.

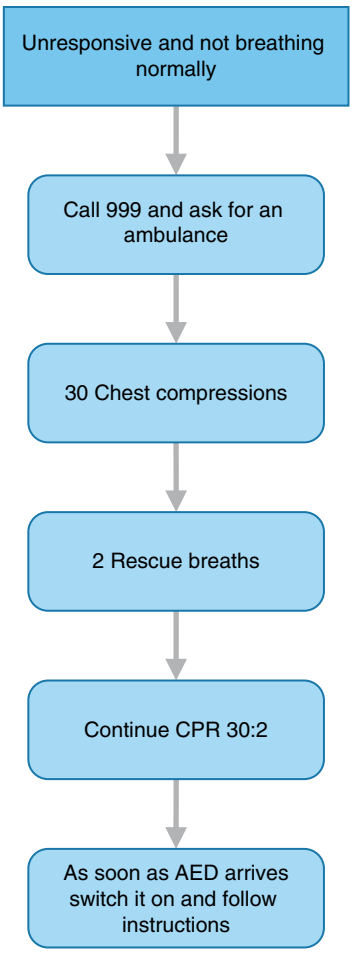


Figure 23.9 Adult Basic Life Support (Resuscitation Council (UK) 2015 Guidelines). *Source:* King's College Hospital, London. Reproduced with the kind permission of the Resuscitation Council (UK).

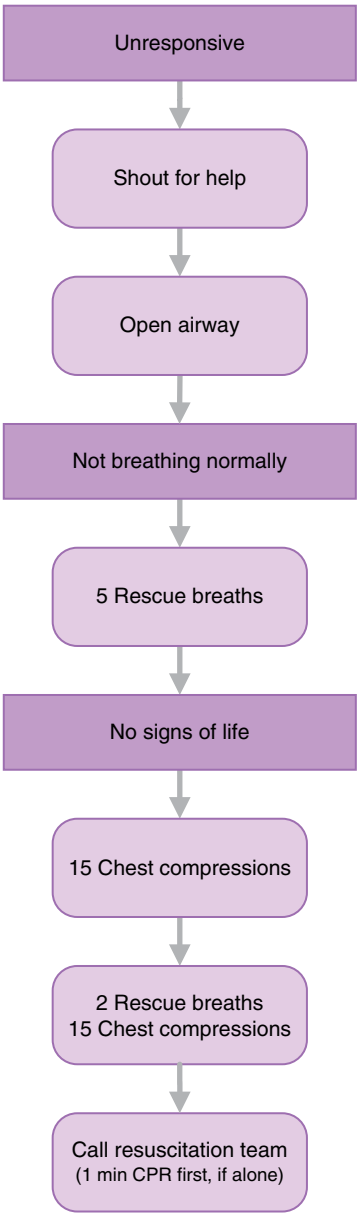


Figure 23.10 Paediatric Basic Life Support. (Resuscitation Council (UK) 2015 Guidelines). *Source:* King's College Hospital, London. Reproduced with the kind permission of the Resuscitation Council (UK).

Start CPR promptly and continue until the ambulance personnel arrive.	CPR cycles – 30 chest compressions and two rescue breaths (can be done in dental chair). During chest compression, prepare for ventilation if two persons available, e.g. oropharyngeal airway connecting to high flow oxygen. Attach AED and assess rhythm: follow AED algorithm.
Handover to the ambulance team on arrival.	Update them on the patient's medical history and assist the team in a safe transfer.

Chest Compressions

Previous guidelines on hand position during chest compressions:	Finding the xiphisternum: measuring two finger breadths up for position of the first hand.
	Compressions to a depth of one-third of the anteroposterior chest diameter.
These have been replaced by:	Hand placement in the centre of the sternum, i.e. the middle of the true sternal bone not including the manubrium (the centre of the chest), without any other measurement.
	Compression depth of 5–7 cm.
	Minimise compression interruption.
	Do not palpate pulses to assess adequacy of compressions.

Finally:

- Compression-only CPR is beneficial, i.e. without ventilation attempts at all. This is effective for a limited period of around 5 min.
- If a rescuer is unable, not trained, not confident, or unwilling to give artificial ventilations then uninterrupted compression-only CPR should be given.
- Interruptions in chest compressions are both common, as well as being associated with decreased chance of survival.

Automated External Defibrillator

An AED (Figure 23.11) is a portable device that can diagnose a life-threatening cardiac arrhythmia in a

(a)


(b)

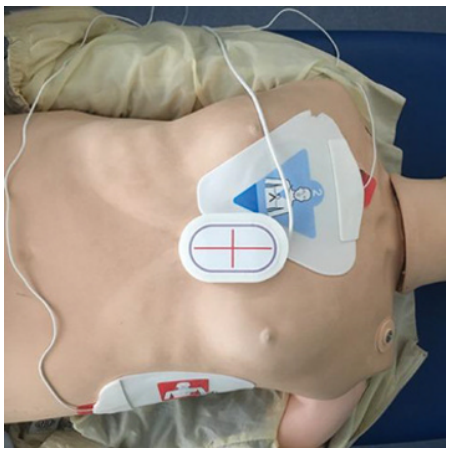

(c)

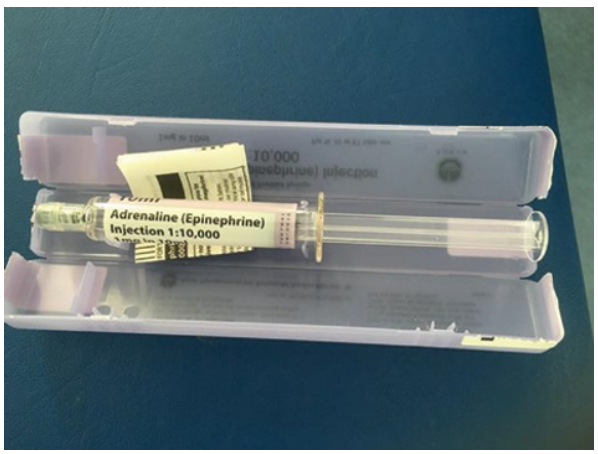
Figure 23.11 Automated External Defibrillator. Position pads according to manufacturer's instructions. *Source:* King's College Hospital, London. Reproduced with the kind permission of the Resuscitation Council (UK).

cardiac arrest patient and treat them with electrical therapy (shock) to stop the arrhythmia, allowing the heart to re-establish an effective rhythm and a cardiac output. AED devices are designed to provide diagnosis and simple clear instructions in the acute management of a cardiac arrest. They are designed to be used as an adjuvant to CPR and can be used by the layman or with minimal training. The device is composed of a central electrical unit with two leads and attached pads which can produce and interpret an ECG tracing and give out clear verbal instructions to the user. The AED is designed for the treatment of the two life-threatening arrhythmias – pulseless ventricular tachycardia (VT) and ventricular fibrillation (VF). In both these cases the heart's electrical activity does not produce a life-sustaining cardiac output. Ventricular tachycardia leads to ventricular fibrillation and eventually asystole, irreversible brain damage and death, if left untreated. After 3–5 min of a cardiac arrest irreversible brain and tissue damage starts to set in. The success of the resuscitation of a cardiac arrest patient depends on the early recognition of the condition followed by maintenance of circulation with basic life support and chest compressions until further intervention such as defibrillation and or cardiac stimulant medications are in place. AED use is becoming an integral part of CPR training and should become a part of the life-support training of the whole dental team.

Anaphylaxis

Anaphylaxis is a severe and potentially life-threatening allergic reaction. It is encountered in dental practice relatively infrequently but the rate of occurrence in general is increasing. There is a spectrum of severity encountered in symptoms ranging from itch and rash in a mild occurrence to, in severe cases, life-threatening circulatory or breathing problems (Figure 23.12).

Anaphylaxis is triggered by exposure to an allergen that causes a cascade of inflammatory mediators acting on tissues throughout the body.	An allergen can be: • A drug (e.g. penicillin, aspirin, local anaesthetic, chlorhexidine). • An ingredient in a medical preparation. • Latex. Outside of the clinical setting it may be food, or a bee or wasp sting. The allergen does not need to be ingested – contact alone may precipitate a reaction.



(a)

(b)

Figure 23.12 Anaphylaxis. (a) Adrenaline prefilled syringe. (b) Adrenaline Epipen.

A massive degranulation of mast cells occurs due to the actions of IgE, an antibody generated by the body on contact with the stimuli.	The involvement of antibodies explains why repeated exposure causes progressively more severe symptoms as the relevant antibody remains within the body ready to be reactivated.
The antibodies facilitate the release of inflammatory mediators into the bloodstream which act on capillaries and other tissues in the body causing the low blood pressure, airway swelling and constriction seen in anaphylactic shock.	Histamine is one of the major inflammatory components released at this stage.
In clinical practice the administration of medicines (penicillin), contact with latex gloves, rubber dams, chlorhexidine mouthwash or environmental exposure to the trigger represent the most likely cause (insect stings and food account for nearly twice as many cases as medicines outside of the clinical setting).	

Risk Assessment

A key step in the prevention of anaphylaxis lies in taking a detailed allergy history including asking specifically about local anaesthetics, antibiotics and latex.

Symptoms

Speed of identification is essential. In severe reactions, the time from exposure to the allergen to death can be as little as 5 min. Prompt treatment with adrenaline can be life saving and recovery is normally complete.

Airway and breathing	
These symptoms represent a severe reaction.	
• Airway swelling, particularly tongue or pharynx.	This can be very dramatic.
• Breathlessness.	Breathing rate will increase and can cause tiring.
• Wheeze.	Noisy breathing on expiration.
• Stridor.	Noisy inspiration – can be laboured.
• Voice change.	
Circulation	
• Hypotension.	Cold /clammy extremities, reduced level of consciousness.
• Increased heart rate.	Rapid, thready pulse.
• Distress, feeling of impending doom.	
Other	
Abdominal pain, diarrhoea and vomiting.	
Rash or erythema, angiooedema, swollen lips.	

Equipment and Drugs

NB, Drug doses listed are for adults (see flow chart for paediatric doses):

- Oxygen therapy (high flow, 15 l/min with mask with reservoir or bag and mask for immediate application).
- Airway adjuncts – Guedel (Figure 23.6) or naso-pharyngeal airway.
- Blood oxygenation monitoring – finger saturation probe.
- Blood pressure monitoring.
- Defibrillator +/– 12 lead ECG machine.
- Adrenaline (epinephrine): 500 µg (0.5 ml of 1:1000 adrenaline) for intramuscular (IM) delivery. The patient may have their prefilled device with them (Epipen, 300 µg).
- Salbutamol (5 mg nebulised if available) – requires suitable training.
- Cannulas for intravenous (IV) access – if available and requires suitable training.
- IV fluids: normal saline (500 ml of 0.9% NaCl), Hartmann's (500 ml bags), or Gelofusine (500 ml bags).
- Hydrocortisone 200 mg IM and chlorphenamine 10–20 mg IM. These are not first line drugs and may be delivered by paramedics on arrival

Management

NB, Drug doses listed are for Adults (see flow chart for paediatric doses).

• Stop administration of 'trigger' and seek urgent medical assistance immediately.	Remove drug or contact source immediately.
• Follow anaphylaxis algorithm (Figure 23.13).	
• Assess and manage Airway and Breathing using the ABCDE approach.	Look, listen and feel for breath sounds – in particular, wheeze or stridor. In cases in which the airway is compromised, intubation may be required and specialist medical help is essential.
• Apply high flow oxygen immediately (15 l). Arrange for monitoring/measurement of oxygen levels as soon as possible.	
• Ensure the patient is in a comfortable position. Patient may prefer to sit up if they have airway or breathing difficulty, but those with hypotension need to be placed flat with legs raised.	To improve blood pressure.
• If adrenaline is required, deliver 500 µg IM (0.5 ml 1:1000 adrenaline) – this can be repeated after 5 min if no significant improvement. Severe reaction, life-threatening airway, breathing or circulatory compromise. Adrenaline can be repeated after 5 min if no improvement.	IM injection is delivered to the anterolateral aspect of the middle third of the thigh.
• Assess and if required treat *Circulation:* If no pulse, commence CPR (see appropriate section). If equipment/experience allows gain venous access.	Check for pulse, assess rate if possible.
• Observe and record vital signs.	

Supplementary Actions

- Salbutamol (5 mg). Can be delivered via nebuliser if available and wheeze present.
- Chlorphenamine (10 mg IM).
- Hydrocortisone 200 mg IM).

After initial management, the patient should be assessed in Accident and Emergency as recurrence via the original stimulus is possible. All medications given must be documented clearly as should the triggering stimulus.

Syncope

Syncope is defined as transient loss of consciousness due to transient global cerebral hypoperfusion characterised by rapid onset, short duration, and spontaneous complete recovery. It is a prevalent disorder and is reported as the most commonly encountered 'medical emergency' in dental practice. It is the most common cause of loss of consciousness. In most cases the cause of syncope is benign but it is important to differentiate the rare but serious cases. Syncope has a bimodal distribution. In adolescents and young adults, the reflex mechanism is most common, e.g. vasovagal, situational. Above age 65 years, a cardiac cause or orthostatic hypotension should be suspected.

Aetiology

There are different causes of syncope in dental practice and however brief it is, it is important that recognition and appropriate management is instigated. The aetiology of syncope may be subdivided into the following:

- Neurogenic/reflex.
- Orthostatic.
- Cardiogenic.

Neurogenic: Reflex Syncope

This is a heterogeneous group of conditions in which cardiovascular reflexes become intermittently inappropriate, in response to a trigger. The result is vasodilatation and/or bradycardia leading to a fall in arterial blood pressure (BP) and global cerebral perfusion:

- Vasovagal syncope (common faint|): the most frequent form of syncope and is mediated by emotion or by orthostatic stress and is usually preceded by prodromal symptoms of autonomic activation (sweating, pallor, nausea). This is the only form of syncope where there is hypotension with bradycardia and not tachycardia.
- Situational syncope: reflex syncope associated with some specific circumstances, for example postexercise syncope, micturition syncope.
- Carotid sinus syncope: triggered by mechanical manipulation of the carotid sinuses, hence some clinicians advise to not palpate bilateral cervical lymph nodes at the same time.
- Atypical form: used to describe those situations in which reflex syncope occurs with uncertain or even apparently absent triggers.

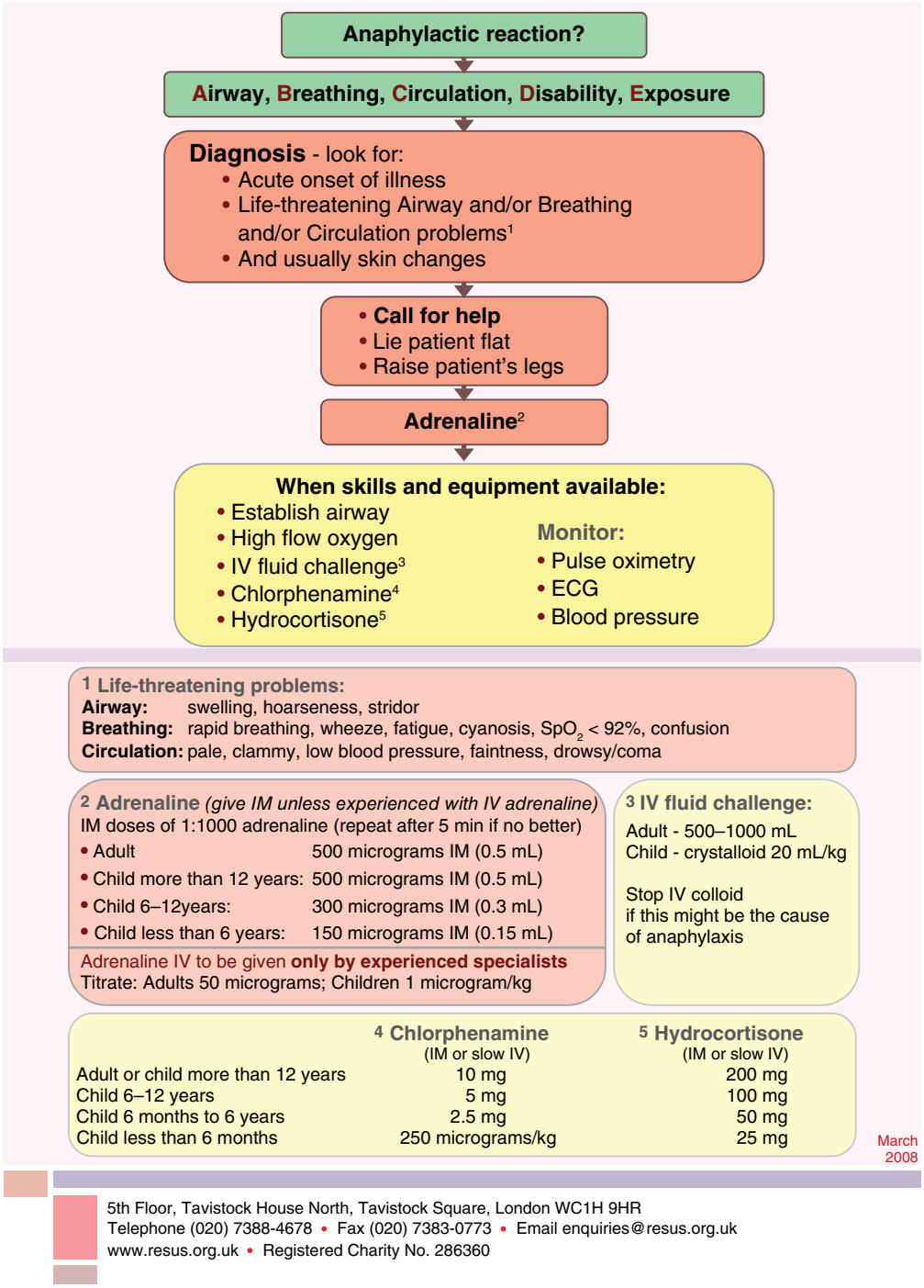


Figure 23.13 Anaphylaxis algorithm. *Source:* King's College Hospital, London. Reproduced with the kind permission of the Resuscitation Council (UK).

Orthostatic Syncope

This is a common cause of syncope in the elderly population and usually secondary to autonomic failure, the use of vasodilator drugs or to volume depletion. In autonomic failure, vasoconstriction is deficient, and so on standing BP falls and syncope or presyncope occurs. It is classically described as exhibiting a 'postural drop' where there is a decrease of 20 mmHg in systolic BP and 10 mmHg in diastolic BP within 3 min of standing.

Cardiogenic Syncope

In syncope due to cardiac causes, arrhythmias are the most common cause, but structural cardiovascular disease can also cause syncope. Arrhythmias may induce haemodynamic impairment, which can cause a critical decrease in cardiac output and cerebral blood flow.

Vasovagal Syncope: Risk Assessment

- Fear and anxiety of dental treatment: identification of cause or association may enable the clinician to avoid such events.
- Pain.
- Fatigue.
- Fasting.
- Low blood pressure.
- Previous episode.
- Medications – antihypertensive and cardiac medication. These agents reduce blood pressure or affect the cardiac output.

Management

Prodromal Symptoms

Nausea, clammy sweating, blurring, greying or possible loss of vision, light headedness, tinnitus – due to cerebral hypoperfusion.

Anoxic Phase

- Loss of consciousness, pallor, sweating.
- Pupil dilatation, tachypnoea, bradycardia. Loss of muscle tone and eyes roll up. Patient falls if not seated or lying These are usually brief episodes with complete recovery.
- There may be myoclonic jerks. Prolonged convulsions, 'blue face', or tongue biting and associated prolonged confusion following the episode can distinguish a true primary seizure from a seizure secondary to vasovagal syncope.

Recovery Phase

- In the horizontal position.
- Skin colour, pulse and consciousness usually returns within seconds.
- If the patient is not able to fall, or be positioned into a horizontal position, a secondary anoxic seizure may occur.

Action

1) Stop treatment.
2) Assess patient (ABC, determine level of consciousness).
3) Lie the patient back, head down and feet up (lateral decubitus position if pregnant).
4) Loosen tight clothes, especially around neck to increase cerebral perfusion.
5) Give oxygen 15 l/min.
6) Monitor vital signs: pulse and blood pressure. Bradycardia and hypotension will indicate reflex syncope.
7) Check glucose: to differentiate loss of consciousness from hypoglycaemia.
8) If prolonged or atypical, call for emergency services for transfer to hospital.
9) Continue to monitor until ambulance arrives.
10) If patient recovers rapidly, continue to monitor. Confirm diagnosis. Typical syncope is brief.

Assessment of Syncope

History and examination are the most sensitive way to assess syncope:

1) Was loss of consciousness complete?
2) Was loss of consciousness of rapid onset and short duration?
3) Was recovery spontaneous, complete and without sequelae?
4) Was postural tone lost?

If the answer to all four questions is 'yes', the episode is highly likely to be syncope. If the syncope occurred when seated or lying down, it is more likely to be cardiogenic.

If there is postevent confusion or if the patient sustained an injury it would suggest a seizure occurred.

If the person with syncope has sustained an injury or has not made a full recovery of consciousness, use clinical judgement to determine appropriate management. It may be necessary to refer the patient to hospital for further assessment.

It is important to record details of the episode:

- Circumstances of the event, person's posture immediately before loss of consciousness.
- Prodromal symptoms (such as sweating or feeling warm/hot).
- Appearance (for example, whether eyes were open or shut) and colour of the person during the event.

- Presence or absence of abnormal movement during the event (for example, limb-jerking and its duration).
- Any tongue-biting (record whether the side or the tip of the tongue was bitten).
- Injury occurring during the event (record site and severity).
- Duration of the event (onset to regaining consciousness).
- Presence or absence of confusion during the recovery period.
- Weakness down one side during the recovery period.

Ask questions which help to differentiate from potential non-syncope episodes (possible causes of loss of consciousness in dental practice), e.g.

- Exertional onset.
- Chest pain.
- Dyspnoea (possible angina).
- Low back pain.
- Palpitations (possible heart disease, acute MI).
- Severe headache, focal neurological deficits, diplopia (possible embolus).
- Ataxia (cerebrovascular accident (CVA); CVA /transient ischaemic attack(TIA)).

Differential diagnosis of possible loss of consciousness in dental practice:

- Epilepsy.
- Metabolic disorders (hypoglycaemia, hypoxia, hyperventilation).
- Intoxication.
- Drug-related emergencies.
- TIA/CVA.
- Acute MI.
- Adrenal insufficiency.
- Allergic reaction.

Prevention of Syncope

Detailed medical history, examination and discussion of any concerns or fears concerning treatment may indicate patients more likely to suffer syncope. Identification of the cause of syncope is key for the treatment or prevention of a syncopal episode. If fear and anxiety has been uncovered, then discussion of sedation techniques may help avoidance of such events.

In cases of orthostatic hypotension, educate the patient to rise slowly from chair, and ensure they are well hydrated prior treatment.

Epilepsy and Adult Seizure Management

Epilepsy is a neurological condition where spontaneous, abnormal electrical activity of the brain occurs, often leading to seizure. Prolonged seizure (>5 min) or immediate recurrence should prompt urgent medical attention.

Overview

Symptoms of epilepsy vary widely but abnormal movements or convulsions occur commonly. These are often termed 'seizures'. Major seizures cause loss of consciousness while minor seizures cause alterations of consciousness.	Seizures occur due to abnormal electrical activity in the brain resulting in convulsions (abnormalities of body movements) or causing altered behaviour, mood or awareness.
Once epilepsy is diagnosed, seizures are managed with regular medication. Factors that can increase the likelihood of a seizure include failure to take medication as instructed, sleep deprivation, alcohol/drug use and infection.	These include carbemazepine, sodium valproate and phenytoin.
Prevention of seizure is the best management of these patients. Ensuring patients have taken their normal dose of anticonvulsant drugs before attending for dental treatment is important, especially in the presence of infective processes.	
Before a seizure the patient may experience a 'prodrome', an early warning set of minor symptoms – hours or days before a seizure. An 'aura' may be experienced immediately preceding a seizure: this can be the perception of flashing lights, an unusual taste or smell, a sense of 'deja-vu' or experiencing emotions out of context such as fear or joy.	The patient may not always be aware of this taking place but friends or family members may notice a subtle change in mood or behaviour.
The 'tonic–clonic' seizure is the type most likely to require medical attention in the dental practice.	Historically referred to as 'grand-mal', this is a generalised seizure.
A sudden loss of consciousness occurs followed by rigidity of the limbs (tonic phase) and cessation of breathing. The limbs may then begin to jerk uncontrollably (clonic phase). Urinary incontinence or tongue biting may also occur. There is a period of drowsiness and memory-loss following recovery.	Blueness of the lips (central cyanosis) may be noted. The 'post-ictal' phase.

Minor Seizures

Partial seizures affect a specific part of the brain and consciousness is minimally affected. Symptoms are dependent on which area of the brain is involved and may be visual, motor or sensory.	These are 'focal' seizures and may be encountered during a consultation: • Visual – hallucinations of lights. • Motor – involuntary movements of specific body parts. • Sensory – unpleasant tingling or sensation.
Some patients may experience brief pauses or 'absences'. This may come in the middle of speech, reading or while listening to information. The patient will often be unaware any 'absence' has taken place and continue as if nothing has happened.	These are also known as 'petit-mal' and occur often in the absence epilepsy of childhood.
Complex partial seizures affect a larger part of the brain, often associated with the 'prodrome' described earlier. These last longer than simple partial seizures (up to a few minutes), demonstrating lip smacking, freezing or rhythmical movements.	This will be associated with a muddled feeling and drowsiness on recovery.

Signs and Symptoms of a Major Seizure

Patients may have a brief 'aura' prior to a seizure.	The patient may not be aware of this.
Tonic phase: loss of consciousness, rigid limbs with cyanosis, patient may cry out or bite tongue.	Both tonic and clonic phases do not have to be present.
Clonic phase: jerking movement of limbs.	
There may be urinary incontinence.	
Typically, fitting lasts for a few minutes. The patient may remain unconscious, even though convulsions have ended.	
Having gained consciousness, the patient will remain confused and drowsy and often is unaware that they had a seizure.	This disorientation, amnesia and a feeling of being unwell may last several hours after the seizure.

Management of Adult Tonic–Clonic Seizures

The primary objective is to provide first aid and limit potential for harm from nearby objects and complications of the seizure. Little can be done to arrest the seizure by non-specialists.

1) Move away anything from patient that could be hazardous or cause injury.	The main danger to the patient at this stage is sustaining damage by striking nearby objects.
2) Allow patient to fit without attempting to prevent convulsions and do not attempt to put anything in the patient's mouth. Loosen any clothing around the patient's neck. Place a cushion under their head.	The risks of airway obstruction mean that no objects should be placed in the mouth. Tongue biting cannot be prevented.
3) Deliver high flow oxygen.	15 l/min via non-rebreather face mask. Note time the episode started.
4) If seizure lasts >5 min or recur in quick succession summon urgent medical assistance (call for ambulance) and administer buccal midazolam: • Adult dose: 10 mg • Paediatric dose: <5 years = 5 mg; 5–10 years = 7.5 mg; >10 years = 10 mg	At this point medical assistance is now urgently required. The longer the seizure persists the harder it becomes to control and it is more likely that damage can occur to the tissues of the brain.
5) If fitting has ceased place the patient in recovery position and reassess if breathing normally. Continue to monitor ABC. If not breathing normally then start resuscitation.	
6) Check blood glucose level to exclude hypoglycaemia.	If blood glucose is <3.0 mmol/l or hypoglycaemia is clinically suspected, give oral glucose.
7) After the seizure has subsided the patient may be confused, requiring support and an explanation of what has happened.	The patient must not be left alone until fully recovered.
8) Transfer to hospital is indicated in the following circumstances: • Status epilepticus. • First seizure. • Difficulty monitoring patient's condition. • Injury sustained during seizure.	See NICE Guidelines (2016) for further information.

Status Epilepticus: A Medical Emergency

Status epilepticus is a medical emergency and is defined as more than 30 min of seizure activity or two or more sequential seizures without full recovery of consciousness between seizures. Prolonged seizure activity can cause hypoxia leading to irreversible brain damage, pulmonary oedema, kidney and liver failure and potentially death. This requires urgent specialist medical attention; management of this condition is dependent on intravenous access and infusions of specialist drugs and is beyond the scope of this text.

Diabetes Mellitus

Diabetes mellitus is a metabolic disorder characterised by chronic hyperglycaemia, due to insulin deficiency, peripheral insulin resistance or both. It is a common condition and will be seen in dental practice. Hypoglycaemia is the most likely problem seen in dental practice.

Diabetes can be primary or secondary. Primary diabetes can be divided into type I diabetes mellitus and type II diabetes mellitus. Type I diabetes mellitus usually presents in younger age (childhood or adolescence) where an autoimmune destruction of the B cells in the pancreas results in complete insulin deficiency. The patients need lifelong insulin replacement. Type II diabetes mellitus is found in older ages where partial insulin deficiency and peripheral insulin resistance are the causes of hyperglycaemia. Insulin replacement therapy is not always required.

Secondary diabetes mellitus can be due to endocrine disease such as Cushing's disease, pancreatic disease or drug induced (e.g. corticosteroids).

Clinical Signs and Symptoms

Polyuria	The overload of the renal tubular re-absorptive capacity by the increased blood sugar levels leads to osmotic diuresis and polyuria.
Thirst	The fluid depletion results in stimulation of thirst and loss of weight.
Weight loss	Insulin deficiency also results in breakdown of fat and muscle, and thus loss of weight.
• Fasting glucose ≥6.7 mmol/l or • Random glucose ≥10 mmol/l	Indicative of diabetes mellitus diagnosis.
Diabetes can also present with complications such as: • Increased risk of infection such as urinary tract infections, cellulitis, abscesses and mucocutaneous candidiasis. Infections lead to poor control of diabetes and possibly ketoacidosis, if left untreated. • Diabetic retinopathy and diabetic neuropathy are other potential complications.	Increased risk of infection is believed to relate to dysfunction of the polymorphonuclear leucocytes in diabetics.
Oral manifestations of diabetes mellitus include: • Severe periodontal disease and xerostomia due to dehydration. • Autonomic neuropathy, resulting in sialosis. • Changes to the filiform papillae and glossitis. • Oral candidosis, especially when the diabetic control is poor.	Oral manifestations may lead to the suspicion of diabetes in a previously undiagnosed patient.
Severe diabetes has been associated with mucormycosis of the nasal cavity and paranasal sinuses.	

Management

All diabetic patients are advised to commence a healthy and balanced diet.	Avoiding the consumption of simple sugars such as glucose and sucrose.
Type 1 diabetics are treated with insulin replacement therapy.	Two or three daily subcutaneous injections of insulin.
Insulins can be: • Short acting (4–6 h). • Intermediate (12–24 h). • Long acting (more than 24 h).	
Type 2 diabetic patients who fail to control blood sugar levels with diet alone are treated with oral hypoglycaemics:	

• Sulphonylureas, e.g. gliclazide.	Increases the insulin secretion and reduces the peripheral resistance to insulin.
• Biguanides, e.g. metformin.	Increases the insulin absorption from the gastrointestinal system and increases sensitivity to insulin.
• α-glucosidase inhibitors, e.g. acarbose.	Slows down the breakdown of complex sugars in the intestine.
• Thiazolidinedione (glitazones).	Increases insulin sensitivity.
• Meglitinides.	Stimulates insulin secretion.
• Other hypoglycaemics. • Patients who are poorly controlled with oral hypoglycaemics are treated with insulin also.	

Blood Glucose Monitoring

Blood glucose monitoring (Figure 23.14) provides an indication of how well the glucose metabolism is controlled. The blood sample can be taken from capillary, venous or arterial routes. In a dental practice setting, blood glucose monitoring relies mainly on finger pricking. Monitoring and good operation of the device is essential to avoid false results.

Equipment required:

- Blood sample monitor.
- Test strips.
- Control solution.
- Single-use safety lancets.
- Gloves.

Procedure

Action	Reason
Before using the device check that test strips are open and were not left exposed to air, monitor and strips are calibrated together, high and low internal quality control test is carried out.	To ensure accuracy of the result follow the manufacturer's advice.
Explain the procedure to the patient, ask them to wash their hands and keep them warm, and then sit or lie them down.	To allay some of their anxiety, ensure a non-contaminated sample, encourage good blood flow, and ensure patient's safety in case they feel faint.
Wash your hands and put on gloves.	To minimise cross-infection risk.
Take a blood sample from the side of the finger, using a single-use lancet. Assistance in the form of 'milking' the finger may be required to form a drop of blood large enough to cover the test pad.	Single-use lancets minimise the risk of cross-infection. The side of the finger is less painful and the blood sample can be obtained easier.
Apply the blood on the strip and connect to the monitor, as per the manufacturer's advice.	To ensure accuracy of the result.
Record measurement.	To ensure accuracy of the result.
Dispose of sharps and waste.	To minimise risk of cross-infection.
Observe for bleeding.	To ensure patient's safety.
Wash and dry hands.	To minimise risk of cross-infection.

Diabetic Emergencies

Hypoglycaemia

Risk Assessment:

- Known diabetic.
- Inadequate food intake.
- Weight loss.
- Excessive insulin.
- Strenuous exercise.
- Alcohol intake.

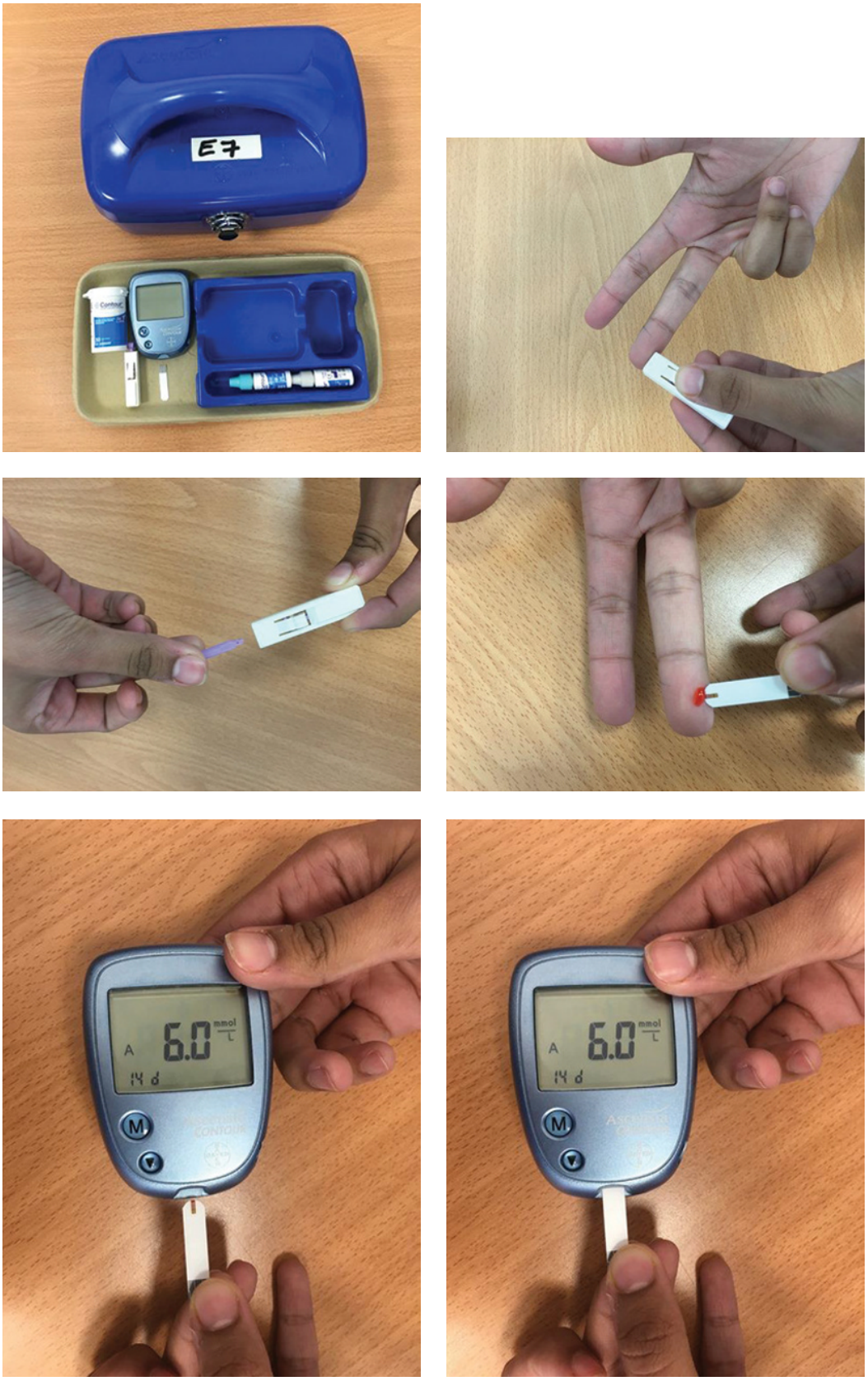


Figure 23.14 Blood glucose monitoring.

Diabetic patients should always eat prior to dental treatment and have their normal dose of insulin or oral hypoglycaemics.	Ideally treatment should not interfere with meals and medication. If food is omitted the blood sugar levels may fall below normal (hypoglycaemia).
In hypoglycaemia the concentration of plasma glucose is <3.0 mmol/l.	Some patients may show symptoms at higher levels.
Recognition of this state is very important.	Any acutely collapsed diabetic should be assumed hypoglycaemic until proven otherwise.

Symptoms and Signs

- Sweating.
- Pallor.
- Tachycardia.
- Drowsiness: NB, consumption of alcohol can mask the symptoms of hypoglycaemia.
- Slurring of speech.
- Clumsy, inappropriate behaviour.
- Confusion, aggression.
- Fitting, seizures.
- Unconsciousness.

If left untreated the patient lapses into coma and death may ensue. The following protocol should be followed.

Management of Hyperglycaemia

Action	Reason
1) Assess the patient following the ABCDE approach. Confirm the diagnosis by measuring blood glucose and if there is any difficulty or the patient becomes unresponsive, the ambulance service should be summoned immediately.	To establish diagnosis and ensure patient's safety.
2) In the early stages, where the patient is conscious and has an intact gag reflex, offer a drink that contains oral glucose in the form of sugar, lucozade, cola (not diet), milk with added sugar, or glucose tablets/gel. This can be repeated after 10–15 min if required. Buccal glucose gel/Glucogel can also be given.	To raise blood sugar levels and aid recovery. Dextrose gel is rapidly absorbed from the buccal mucosa.
3) In more severe cases where the patient has impaired consciousness, is uncooperative or cannot swallow safely glucagon should be given.	Glucagon stimulates glycogenolysis mainly in the liver. Ensure airway is clear and place in the lateral position. Consider the use of basic airway if necessary. Give high flow oxygen.
Adults/children >8 years old or >25 kg 1 mg IM/SC glucagon Children <8 years old or <25 kg 0.5 mg IM/SC glucagon	The lateral thigh is a safe place to give the injection.
4) Glucagon requires 5–10 min to act and sufficient glucose stores are essential.	It can be inefficient in anorexic or alcoholic patients.
5) Check blood glucose 10 min later to ensure that it has risen to at least 5 mmol/l in conjunction with an improvement in the patient's mental status.	To ensure recovery.
6) If the patient becomes unconscious check for 'signs of life' (breathing and circulation) and commence CPR in the absence of pulse or normal breathing. Call for help.	To maintain vital organ function until help arrives or the patient recovers.
7) Following the initial treatment, or once the patient is alert and can swallow safely, give glucose and if possible some food high in carbohydrates should be given e.g. biscuit, sandwich or meal.	To maintain the blood sugar levels and replace the glycogen depot in the liver for the patients who had glucagon.
8) Following full recovery, the patient can go home if accompanied.	To ensure patient safety.
9) The patient's medical practitioner should be informed.	To ensure further follow up and treatment if required.

Adrenal Crisis

Adrenal crisis is a life-threatening state that is caused by insufficient levels of cortisol, which is a hormone produced and released by the adrenal gland. This is a rare event in the dental surgery but is a well taught topic as appropriate precautions may avert a life-threatening situation.

A patient with adrenal insufficiency may become hypotensive when under physiological stress, such as in the dental setting. To prevent an adrenal crisis, at-risk patients are advised to either increase their corticosteroid

dose temporarily, or reintroduce corticosteroid treatment temporarily. There is no consensus regarding the exact steroid regimen to follow.

Aetiology

Adrenocortical insufficiency may be primary or secondary. The primary hormone of importance in adrenal crisis is cortisol. The adrenal cortex produces three steroid hormones:

- Glucocorticoids (cortisol).
- Mineralocorticoids (e.g. aldosterone).
- Androgens.

Primary adrenocortical insufficiency is where there is dysfunction of the adrenal gland itself. The causes include:

- Autoimmune disease (Addison's disease).
- Adrenal haemorrhage.
- Infections (e.g. TB and HIV infections).
- Certain metabolic disorders.

Secondary adrenocortical insufficiency occurs when exogenous steroid suppresses the hypothalamic–pituitary–adrenal axis. Too rapid a withdrawal of exogenous steroid may precipitate an adrenal crisis. A sudden stress, e.g. dental treatment or surgical extraction, may lead to the inability of the adrenal gland to respond. Such situations may precipitate an adrenal crisis.

Risk Assessment

A thorough medical history should be taken to identify potential risk.

Having identified a patient as being at risk of developing an acute adrenal crisis give 'steroid cover' according to guidelines (Figure 23.15).

Known adrenal disease, e.g. Addison's disease.	Patients may carry a 'steroid warning card'. Patients may have been advised by their physician of the need for steroid replacement in times of infection and traumatic stress. Their medical condition may alert to the use of corticosteroid, e.g. asthma, chronic obstructive pulmonary disease or rheumatoid arthritis.
May shown clinical features of Addison's disease.	Hyperpigmentation with associated non-specific symptoms, e.g. fatigue, nausea, vomiting, muscle weakness, cramps.
Long-term steroid use.	Determine the dose of glucocorticoid, duration, frequency and route of administration, e.g. oral, topical or inhalational.
Stress.	
Infection.	

Presentation of Adrenal Insufficiency

- Weakness, tiredness, fatigue.
- Anorexia.
- Gastrointestinal symptoms (nausea, vomiting, constipation, abdominal pain, diarrhoea).
- Salt craving.
- Postural dizziness.
- Muscle or joint pain.

Presentation of Acute Adrenal Crisis

May present with:

- Confusion, loss of consciousness or coma.
- Lethargy.
- Extreme fatigue and weakness.
- Speaking may be difficult in extreme cases.
- Muscle paralysis may occur.
- Skeletal muscle paralysis occurs due to hyperkalaemia (raised potassium).

Management

Stop dental treatment in any patient who is at risk of development of adrenal insufficiency and develops the above symptoms.	
If there are signs of hypotension, then position the patient supine with legs up.	Signs of hypotension: appears confused, sweaty and clammy.
Assess the patient following the ABCDE approach.	Patients are usually hypotensive with tachycardia.
Monitor vital signs (pulse, blood pressure, oxygen saturation).	Provide basic life support as necessary.
Summon medical assistance (ambulance to transfer patient to secondary care).	

STEROID-DEPENDENT PATIENT REQUIRES CONTINUOUS/PARENTERAL STEROID COVER

See Surgical Guidelines:
www.addisons.org.uk/surgery

TYPE OF PROCEDURE	PRE-OPERATIVE AND OPERATIVE NEEDS *(See Notes **1, 2**)*	POST-OPERATIVE NEEDS *(See Notes **6, 8, 9**)*
LENGTHY, MAJOR SURGERY WITH LONG RECOVERY TIME ***eg. open heart surgery, major bowel surgery, major bowel surgery,***	100 mg hydrocortisone IM or IV just before anaesthesia. *(See Notes **2, 3, 7**)* Immediately followed by: ■ 100 mg IM or IV 6 hourly **or** ■ continuous infusion 200 mg/24 hours	100mg IM or IV every 6 hours **or** continuous IV infusion 200mg/24 hours *(See Notes **3, 4**)* until able to eat & drink normally *(discharged from ITU)* Then double oral dose for 48+ hours. Then taper the return to normal dose
MAJOR SURGERY WITH RAPID RECOVERY ***eg. caesarean section, joint replacement***	100 mg hydrocortisone IM or IV just before anaesthesia. *(See Notes **2, 4, 7**)* Immediately followed by: ■ 100 mg IM or IV 6 hourly **or** ■ continuous infusion 200 mg/24 hours	100mg IM or IV **or** continuous infusion 200mg/24 hours for 24–48 hours *(See Notes **3, 4**)* for 24–48 hours *(or until eating & drinking normally)* Then double oral dose for 24–48 hours. Then return to normal dose
LABOUR AND VAGINAL BIRTH	100 mg hydrocortisone IM or IV at onset of active labour. *(See Note **4**)* Immediately followed by continous IV infusion 200 mg/24 hours or 100 mg IM or IV 6 hourly until delivery	Double oral dose for for 24–48 hours after delivery. If well, then return to normal dose
MINOR SURGERY ***eg. cataract surgery, hernia repairs, laparoscopy with local anaesthetic***	100 mg hydrocortisone IM just before anaesthesia *(See Note **6**)*	Double oral dose for 24 hours. Then return to normal dose
MINOR PROCEDURE ***eg. skin mole removal with local anaesthetic***	Bring the next dose of the day forward, to 60 minutes ahead of the procedure	An extra dose 60 minutes after the procedure. Then return to normal dose
INVASIVE BOWEL PROCEDURES REQUIRING LAXATIVES ***eg. colonoscopy, barium enema***	Hospital admission overnight with IV fluids and 100 mg hydrocortisone IM during preparation. 100 mg hydrocortisone IM at commencement *(See Note **6**)*	Double dose oral medication for 24 hours. Then return to normal dose
OTHER INVASIVE PROCEDURES ***eg. endoscopy, gastroscopy***	100 mg hydrocortisone IM just before commencing	Double dose oral medication for 24 hours. Then return to normal dose
MAJOR DENTAL SURGERY ***eg. dental extractio/s with local or general anaesthetic***	100 mg hydrocortisone IM just before anaesthesia *(See Notes **6, 7, 8**)*	Double dose oral medication for 24 hours. Then return to normal dose
DENTAL SURGERY ***eg. root canal work with local anaesthetic***	Double dose *(up to 20 mg hydrocortisone)* one hour prior to surgery	Double dose oral medication for 24 hours. Then return to normal dose
MINOR DENTAL PROCEDURE ***eg. replace filling, scale and polish***	Bring the next dose of the day forward, to 60 minutes ahead of the procedure	An extra dose where hypoadrenal symptoms occur afterwards. Then return to normal dose

NOTES

1. It is good practice to give the steroid-dependent patient first-on-the-list status (alongside insulin-dependent diabetes) to minimise the risks of dehydration.
2. For any nil-by-mouth regimen, please arrange an intravenous saline infusion (0.9% saline or equivalent) to prevent dehydration and maintain mineralcorticoid stability, eg. 1000 ml every 8 hours if >50 kg.
3. Continous IV hydrocortisone infusion is preferble to 6 hourly IM orIV injection as it gives more stable cover. Please arrange as 100 mg bolus followed by 8.33mg per hour or 200 mg per 24 hours.
4. Active labour is cervical dilation >4cm.
5. It is advisable to arrange continuous IV infusion cover for steroid-dependent patients taking CYP3A4 accelerants, eg. anticonvulsants, rifampicin and antifungal drugs, to minimise the risk of decompensation.
6. IM hydrocortisone is preferable to IV injection for its more sustained duration.
7. Please administer bolus hydrocortisone over a minimum of 10 minutes to prevent vascular damage.
8. Note that hydrocortisone acetate cannot be used due to its slow-release, microcrystalline formulation. Please use hydrocortisone sodium phosphate or hydrocortisone sodium succinate, 100 mg.
9. Monitor electrolytes and blood pressure post-operatively for all procedures requiring parenteral steroid cover. If the patient becomes hypotensive, drowsy or peripherally shut down, administer 100 mg hydrocortisone IV or IM bolus immediately.
10. If any post-operative complications arise, eg. fever, delay the return to normal dose.
11. Please ensure back-up supplies of oral and injectable hydrocortisone are available for resuscitation before commencing surgery. Even at full steroid cover, post-operative resuscitation may occasionally be required.
12. A pre-assessment meeting with the anaesthetist is advisable for all steroid-dependent patients, to ensure any comorbidities and potential drug interactions are taken into account.
13. Patients who have been taking 5 mg prednisolone or more long-term should be regarded as potentially suppressed and managed with perioperative supplemental steroid cover, on a precautionary basis.

Figure 23.15 'Steroid cover' guidelines. *Source:* Courtesy of ADSHG, www.addisons.org.uk/surgery.

Give oxygen.	
Administer 100 mg hydrocortisone IV (if adequately trained and available). If not able to give IV then administer IM instead.	Hydrocortisone is not considered an essential part of the emergency drug kit as the incidence of adrenal crisis is low. The patient may have their own supply of hydrocortisone. Hydrocortisone will need to be mixed.
Start intravenous fluids if available and adequately trained.	The patient is likely to be hypotensive.
Transfer to emergency department in secondary care.	

Emergency Drugs and Equipment in Dental Practice

The dental practice and all clinical areas should have access to drugs used in medical emergencies, along with equipment for airway management and an AED. Specific drugs and equipment are recommended to be available in dental practice, and these include the following:

- Adrenaline injection.
- Aspirin (dispersible).
- Glucagon injection.
- Glyceryl trinitrate (GTN) spray.
- Midazolam 10 mg (buccal).
- Oral glucose solution/tablets/gel/powder.
- Oxygen.
- Salbutamol aerosol inhaler.

All emergency drugs should be stored together and easily accessible. They should be kept in a specifically designated and appropriate container. Where possible drugs in prefilled syringes should be available.

Drugs

Adrenaline injection (1:1000, 1 mg/ml)	• Action: adrenaline is an endogenous catecholamine and its action includes induction of vasoconstriction. • Indication: anaphylaxis. • Adult dose: 500 µg adrenaline, i.e. 0.5 ml of 1:1000 adrenaline.
	• Autoinjector preparation (e.g. Epipen) of 300 µg (0.3 ml of 1:1000). Usually patient's own. An alternative 500 µg preparation is also available. • Paediatric dose: – Child >12 years: 500 µg (0.5 ml 1:1000). – Child 6–12 years: 300 µg (0.3 ml 1:1000). – Child <6 years: 150 µg (0.15 ml 1:1000). • Route: IM (anterolateral aspect of middle third of thigh).
Aspirin dispersible (300 mg)	• Action: anti-platelet, inhibits thrombus formation. • Indication: myocardial infarction (chest pain similar to angina but prolonged and non- or partially responsive to GTN. • Dose: 300 mg. • Route: give orally, crushed or chewed.
Glucagon injection (1 mg)	• Action: increases blood glucose level. • Indication: hypoglycaemia, blood glucose <3 mmol/l. NB, some patients have symptoms at higher blood levels. Give glucagon in more severe cases when patient is uncooperative and unable to swallow safely. • Adult dose: 1 mg. • Paediatric dose: – Child >25 kg: 1 mg. – Child <8 years or <25 kg: 500 µg. • Route: IM.
Glyceryl trinitrate (GTN) spray (400 µg/dose)	• Action: causes arterial and venous dilatation, improves myocardial perfusion. This is also available in tablet form. • Indication: chest pain of cardiac origin (angina). • Dose: 1–2 spray/1 tablet. • Route: sublingual.
Midazolam (10 mg) (buccal)	• Indication: prolonged or recurrent seizures. • Adult dose: 10 mg. • Paediatric dose: – Child >10 years: 10 mg. – Child 5–10 years: 7.5 mg. – Child 1–5 years: 5 mg. • Route: buccal route.

Oral glucose solution/tablets/gel/powder	• Indication: hypoglycaemia, blood glucose <3 mmol/l. NB, some patients have symptoms at higher blood levels. Give oral glucose (10–20 g) in the early stages when patient is cooperative with intact gag reflex. • Route: orally
Oxygen	• Indication: hypoxia and all medical emergencies except hyperventilation, e.g. anaphylaxis, shortness of breath (asthma/ chronic obstruction pulmonary disease), ischaemic heart disease (angina/ myocardial infarction, epilepsy. • Dose: high-flow oxygen (15 l). • Route: via mask.
Salbutamol aerosol inhaler (100 µg /actuation)	• Indication: acute exacerbation of asthma. Less severe cases of anaphylaxis/allergic reactions where wheezing or shortness of breath is treated as indicated for asthma. • Dose: up to 10 activations in large volume spacer. • Route: inhalation.

Additional Drugs when Conscious Sedation is Provided

Flumazenil	• Action: a benzodiazepine (BZD) antagonist. It interacts with central BZD receptors to antagonise or reverse the effect of BZD overdose. • Indication: oversedation by use of BZD or overdose of BZD. • Dose: 200 µg over 15 s, then 100 µg at 60 s intervals. Usual dose is 300–600 µg. Maximum adult dose 1 mg (British National Formulary). It is short acting so may need to repeated. • Route: IV.
Naloxone	• Action: a competitive opioid antagonist. It temporarily reverses the action of opioids by competitively binding to the opioid receptors in the body and brain. • Indication: opioid overdose including overdose with multiple-agent intravenous sedation. • Route: it is conventionally given IV. Intranasal kits are also available; these are for patient use in overdose of recreational drugs. • Dose: 0.4–2 mg IV, repeat at intervals of 2–3 min to maximum dose of 10 mg. Subcutaneous/intramuscular route may be used, but only if IV access is not available, as the action is slower.

Medical Emergency and Resuscitation Equipment in Dental Practice

The Resuscitation Council (UK) (2013, updated 2017) recommends the following to be the minimum equipment necessary in general practice in the UK:

- Portable oxygen cylinder (D size) with pressure reduction valve and flowmeter.
- Oxygen face mask with reservoir and tubing.
- Basic set of oropharyngeal airways (sizes 1, 2, 3 and 4).
- Pocket mask with oxygen port.
- Self-inflating bag and mask apparatus with oxygen reservoir and tubing.
- Variety of well-fitting adult and child face masks for attaching to self-inflating bag.
- Portable suction with appropriate suction catheters and tubing, e.g. the Yankauer sucker.
- Single-use sterile syringes and needles.
- 'Spacer' device for inhaled bronchodilators.
- Automated blood glucose measurement device.
- Automated external defibrillator.

Techniques and Procedures for Medical Emergencies

Intramuscular Injection

This simple technique delivers medicine quickly without the requirement for intravenous access. In some medical conditions, IM injection may represent life-saving treatments.

Equipment required:

- A standard blue needle (25 mm and 23 G).
- Syringe of appropriate size.
- Drug to be delivered: many drugs are now in prefilled syringes, including adrenaline.

Site for Delivery

The traditional locations for IM injection are the upper thigh, buttock or deltoid (Figure 23.16):

- Upper thigh: target is vastus lateralis sited on the outer aspect of the upper thigh.
- Buttock: target is gluteus maximus, situated on the outer aspect of the upper part of the buttock. It can be helpful to palpate the iliac crest to determine the upper limit of the muscle. This will reduce the likelihood of damaging large vessels or the sciatic nerve.
- Upper arm: target is the deltoid muscle – the upper, outer aspect of the upper arm.

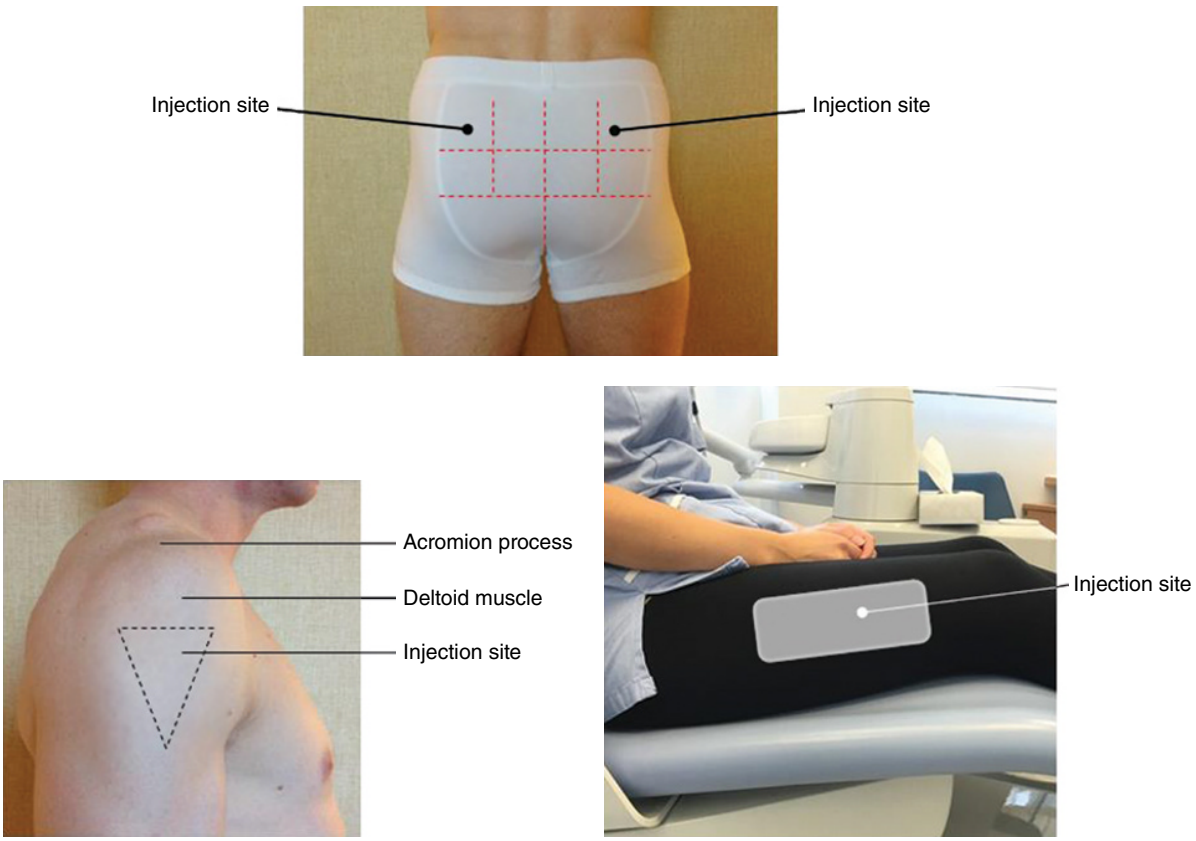


Figure 23.16 Sites for intramuscular injection.

Method: Non-Prefilled Syringes

Step	Explanation
Check equipment is in date and in working order.	
Draw up the drug without touching any non-sterile areas and change needle ready to administer drug.	Will reduce site infections.
Expel any air bubbles from the syringe.	
Insert needle approximately two-thirds of its length and pull back on plunger to ensure that it is not positioned in a vessel.	Some drugs are not appropriate for intravenous administration.
Deliver drug by pushing plunger and withdraw needle.	Follow drug instructions.
Dispose of sharp safely.	To avoid needle stick injury.

Prefilled syringes come ready for injection and save time. Most dental practices have these.

Adrenaline Auto-Injector Device

EpiPen is available in two preparations:

- 300 µg single dose for adults and children over 30 kg.
- 150 µg single dose for children 15–30 kg.

There is also an auto-injector device with a 500 µg single dose.

These devices are designed to allow self-administration of adrenaline by the patient and as such are designed to be self-administered into the upper outer thigh, stabbing in to the thigh at a 90° angle.

Intravenous Cannulation

There are numerous variations of peripheral cannula devices; however, all comprise the same basic components of a flexible, plastic tube loaded over a needle trocar for introduction into the vein. One should consult the device manual and local guidelines on peripheral venous cannulation.

Procedure

Step 1. Select an appropriate desired location and apply a tourniquet to a limb, usually an arm.
Step 2. Choose an appropriate vein: usually start looking distally if possible and it is always best if the vein can be seen or palpated to be continuing for at least the length of the cannula.
Step 3. Wearing gloves, clean the skin according to local guidelines, e.g. alcohol wipe.
Step 4. Select an appropriate cannula gauge.
Step 5. Hold/position the patient's arm in a comfortable way and try to ensure skin is taut over the vein.
Step 6. Warn the patient of a 'sharp scratch' and insert the cannula, bevel up, at a 30–45° angle, aiming distal to proximal along the vein.
Step 7. Once the needle has entered the vein, there will be 'first flashback' of blood passing into the connector region of the cannula.
Step 8. At this point, decrease the angulation of the cannula to the skin so any needle advancement goes along the lumen of the vessel and advance slightly.
Step 9. Withdraw the needle trocar from the cannula to achieve 'second flashback', where blood is seen in the tube of the cannula surrounding the needle itself.
Step 10. The cannula can now be advanced whilst holding the needle static until the full length of the device is inserted.
Step 11. Release the tourniquet.
Step 12. The needle can now be removed, but there may be backflow of blood. To avoid this, raise the arm slightly and/or place pressure over the cannulated vein proximal to it. Place sterile gauze between the cannula port site and skin.
Step 13. Attach stopper or other port connector device.
Step 14. Secure cannula to skin with appropriate available dressing or tapes.
Step 15. 'Flush' the cannula with normal saline (having checked batch and expiry dates), ensuring this is painless and there is no extravasation of fluid around the cannula site.
Step 16. Place a date on the cannula and document its insertion.

Inhaler Techniques

There are a number of inhalers and spacers available.

Inhalers

Salbutamol inhalers tend to come as metered-dose inhalers. The dose is either automatically administered on inspiration or the 'plunger' may require pressing to administer the dose.

Step 1. Shake and remove cap from inhaler.
Step 2. Ask patient to breathe as normally as normal.
Step 3. Bring inhaler to mouth at end of expiration.
Step 4. Depress plunger at the start of inspiration and continue to inhale slowly and deeply.
Step 5. Hold breath for 10 s or as long as is tolerated.
Step 6. Wait 30 s before repeating if necessary.

Spacers

Both large and small volume spacers are available – the most commonly used are small. The technique is similar to Inhalers (Figure 23.17).

Step 1. Shake and remove cap from inhaler.
Step 2. Place mouth piece into spacer.
Step 3. At the end of expiration, deliver dose of inhaler into the spacer.
Step 4. Breathe in slowly and deeply to full capacity and hold breath as previously described.
Step 5. Spacers have an in-built whistle which if sounded indicates the patient is breathing in too quickly.

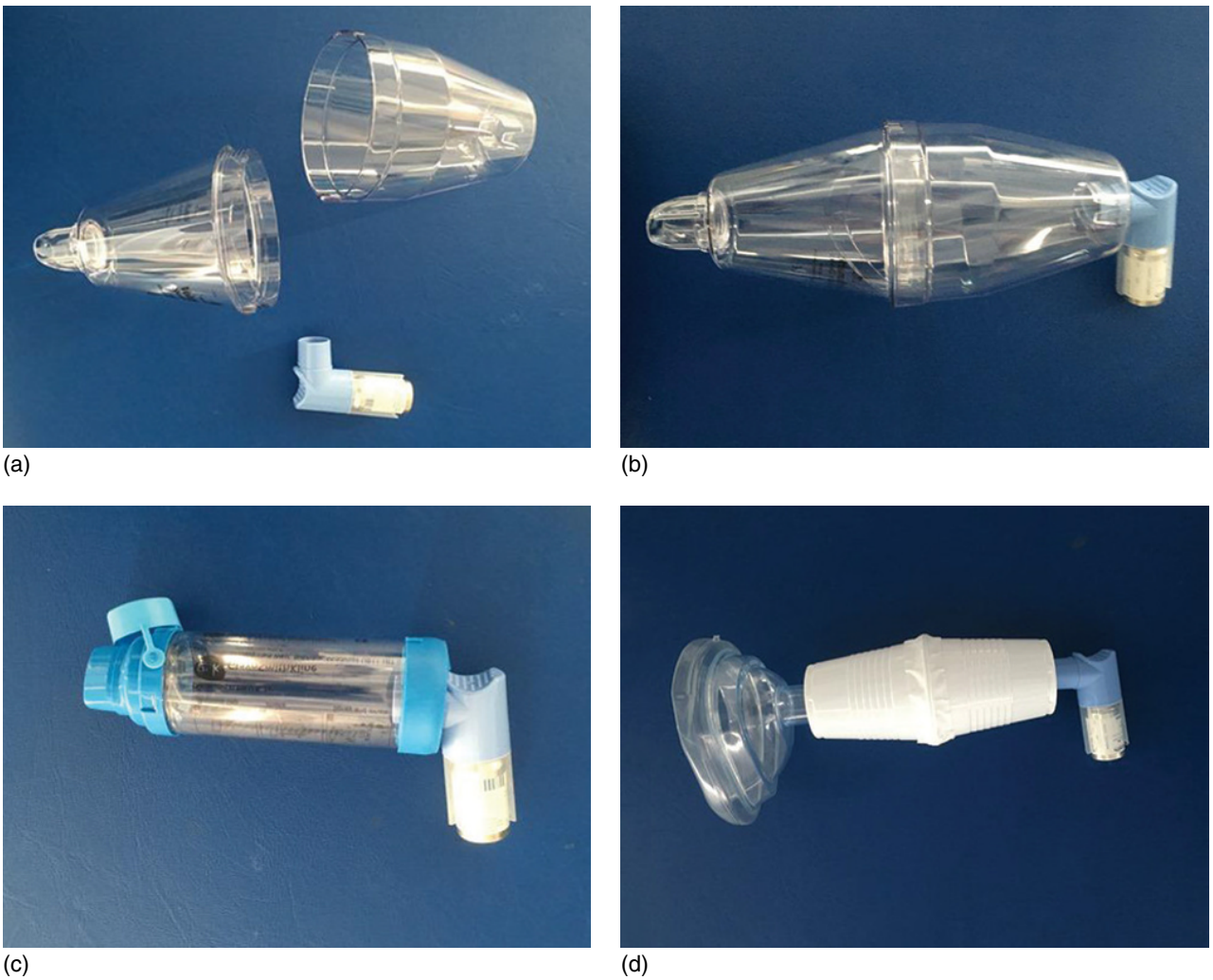
Spacers are also available for young children and infants with face masks. In this case, the procedure is slightly different.

Step 1. Prepare the spacer with the face mask and position the patient comfortably sitting up.
Step 2. Place the face mask over the child's mouth and nose and encourage them to breathe slowly in and out.
Step 3. Once a good, slow and steady rhythm is achieved, apply a dose of inhaler.
Step 4. Allow the child to take a further five breaths before removing device.
Step 5. Repeat as indicated.

Peak Flow

Peak flow is the maximum flow generated during expiration performed with maximal force and started after a full inspiration. This simple procedure provides a reasonable estimate of asthma attack severity.

Step 1. Place the patient in a standing position or sitting as upright as possible.
Step 2. Place the meter pointer to zero.
Step 3. Hold the meter horizontally.
Step 4. Take a full breath in and bring mouthpiece to lips, making a tight seal.
Step 5. Exhale as forcefully and maximally as possible.
Step 6. Repeat two further times and take the highest reading.



(a) (b) (c) (d)

Figure 23.17 Use of spacer. (a) Rotate both sections of spacer together and attach salbutamol inhaler. (b) Spacer ready for use. (c) Alternative spacer. (d) Emergency home-made spacer with two plastic cups.

Summary

This chapter provides a guide to the medical emergencies that may be encountered in dental practice and their management. Guidelines vary in different countries and are also regularly updated. It is essential that all members of the dental team are up-to-date with current guidelines in the management of medical emergencies (https://www.resus.org.uk/resuscitation-guidelines/) and regularly practice medical emergency scenarios as a team.

Acknowledgements

Thanks to Julie Davis and Christine Bell for secretarial support, and Roy Ellington, Senior Resuscitation Officer, David Chapireau, StR OMFS, Elizabeth Yeung, Specialty Registrar and Rabiya Aseem, Surgical CT1 for their help with the images.

References

European Resuscitation Council (2015), Guidelines for resuscitation: https://cprguidelines.eu/ (accessed 23rd July 2017).

Evidence Evaluation Process (2010) International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations. Circulation 122:S283–S290.

Finegold, J.A., Asaria, P., Francis, D.P. (2013) Mortality from ischaemic heart disease by cuntry, region and age: statistics from World Health Organization and United Nations. International Journal of Cardiology 169:934–945.

Haas, D.A. (2010) Preparing dental office staff members for emergencies: developing a basic action plan. Journal of the American Dental Association 141(Suppl 1):8S–13S.

Jevon, P. (2012) Updated guidance on medical emergencies and resuscitation in the dental practice. British Dental Journal 212:41–43.

Jevon, P. (2013) Basic Guide to Medical Emergencies in Dental Practice. Oxford: Wiley-Blackwell.

NICE (2016) Epilepsies: diagnosis and management. https://www.nice.org.uk/Guidance/CG137 (accessed 23rd July 2017).

Nolan, J.P., Soar, J., Zideman, D.A. et al. (2010) European Resuscitation Council Guidelines for Resuscitation 2010, Section 1 Executive Summary. Resuscitation 81:1219–1276.

Resuscitation Council (UK) (2013) Quality standards for cardiopulmonary resuscitation practice and training. https://www.resus.org.uk/quality-standards/primary-dental-care-quality-standards-for-cpr/ (updated May 2017) (accessed 23rd July 2017).

Resuscitation Council (UK) (2012) Medical emergencies and resuscitation – standards for clinical practice and training for dental practitioners and dental care professionals in general dental practice. A statement from the Resuscitation Council (UK). July 2012 (revised December 2012).

Further Reading

British Thoracic Society (2008) Scottish Intercollegiate Guidelines Network. British Guideline on the Management of Asthma. Thorax 63(Suppl 4):iv1–iv121. Revised January 2012.

Koster, R.W., Baubin, M.A., Caballero, A. et al. (2010) European Resuscitation Council Guidelines for Resuscitation 2010. Section 2. Adult basic life support and use of automated external defibrillators. Resuscitation 81:1277–92.

National Heart, Lung and Blood Institute (1992) International Consensus Report on the Diagnosis and Treatment of Asthma. National Heart, Lung, and Blood Institute, National Institutes of Health. Bethesda, Maryland 20892. Publication no. 92–3091, March 1992. European Respiratory Journal 5:601–641.

24

Audit in Dental Practice

Jackie Brown, Heather Pitt-Ford, Ellie Heidari and Dominic Flanagan

What Is Clinical Audit?

Audit is essentially a tool whereby we measure the standard of our patient care against prescribed standards. This enables us to assess the quality of care and implement changes if required in order to improve. Unless no improvement is required, an audit project is not complete until the standard has been re-measured to demonstrate the improvement. Audit should be undertaken regularly in dental practice in order to evaluate standards of care and make any necessary adjustments.

Definition of Clinical Audit

Clinical audit is a central part of Quality Improvement and is defined as 'a quality improvement process that seeks to improve patient care and outcomes through systematic review of care against explicit criteria and the implementation of change' (National Clinical Audit Advisory Group (NCAAG), 2009).

However NCAAG believes the contribution of clinical audit within the new quality assurance framework within the NHS should be:

- To define what constitutes good quality care (usually described in guidelines, based on scientific evidence and clinical experience).
- To assess the quality of care provided (*clinical audit*, patient experience surveys, critical incident enquiries, qualitative methods).
- To improve the quality of care provided (education, performance review, incentives, regulation, redesign, legislation).

NCAAG also believes that clinical audit has a very important role to play in the emerging quality assurance framework, as this depends upon the high-quality data which clinical audit creates.

While recognising what clinical audit is, it is equally important to recognise what it is not. In this regard it is important to distinguish clinical audit from two other activities with which it is frequently confused: *research* and *service reviews*.

- Clinical audit aims to assess the extent to which care is consistent with best practice and/or achieves expected outcomes. In contrast, *research* aims to establish and define what constitutes best practice. Research plays a valuable role in enhancing quality by producing knowledge to inform guidelines of best practice.
- Clinical audit differs from *service reviews,* which aim to provide a snapshot description of the state of a service, usually in one locality (although it may take a nationwide perspective) and are usually concerned with inputs rather than processes or outcomes. Such reviews are generally one-off with no attempt to re-review (NCAAG, 2009).

The Audit Spiral

The audit spiral has been described as an ongoing development and evolution of a clinical audit project as new developments take place (Bucknall et al., 1992). Thus the audit cycle is never complete as healthcare is constantly evolving (Figure 24.1).

The audit spiral:

- Measures performance against prescribed standards. Is change required?
- If so, perform a root cause analysis to ascertain any underlying cause of the problem.

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

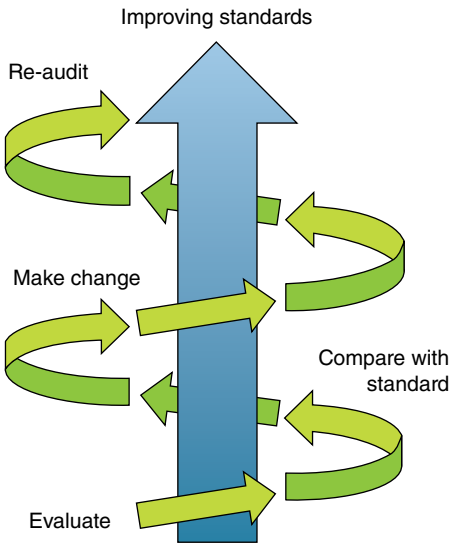


Figure 24.1 Audit spiral illustrating an upward trend in standards of clinical care.

- Draw up an action plan and decide who will implement it.
- Make changes.
- Re-measure.
- Repeat with any necessary adjustments for new developments.

Audit thus seeks to improve clinical practice.

Planning a Clinical Audit

Choosing an Audit

Audit should only be undertaken if the necessary improvements are achievable. For this reason it is important to involve all stake holders, including staff, who will need to implement the changes, and also budget holders, at an early stage. There must be a commitment to act on the findings.

Audit should address:

- Anything which is not working as well as it should.
- Outcomes of treatment performed regularly.
- Risk.
- Complaints.
- Adverse incidents.
- Legal issues.
- Compliance with standards such as National Institute for Health and Care Excellence (NICE) guidelines, guidelines produced by Royal Colleges and specialist societies, local guidelines.

Designing an Audit

Design of a clinical audit is very important. The following features should be considered:

- The title should state the objectives and what you are measuring.
- Decide on a standard against which to measure. This may be a national or local guideline or recommendation. National guidelines are tailored for local use, so that local guidelines may be developed from them.
- Identify sources of data for collection – where the data will be collected from.
- Identify persons involved:
  - Lead person for this clinical audit project.
  - Other people involved.
  - Outside assistance required.
- Identify materials needed, such as access to a computer.
- Decide on any exclusions from the data to be collected.
- Only record data that are going to contribute to achieving the objectives.
- Decide on number of cases and time scale.
- Choose a sample in such a way as to avoid bias.

When the Data Have Been Collected

Analyse the data and decide whether there is a problem. The cause of the problem may not be immediately obvious. It is therefore advisable to carry out a root cause analysis to find any underlying cause.

Root Cause Analysis (RCA)

This is a very important stage. It involves discovering the reason for the problem. RCA provides a retrospective review of an incident or event in order to identify:

- What happened.
- How it happened.
- Why it happened.
- How solutions can be developed and fed back to staff (National Patient Safety Organisation, 2011).

RCA uses a defined critical analysis approach. It can be used with groups of staff as a helpful investigative tool to identify why something keeps happening, or why there is a series of near-miss incidents. You can also use other methods such as 'brain storming' or 'brain showers', 'five whys' and the 'fishbone diagram' to explore and drill down further into the causes of an incident (National Patient Safety Organisation, 2011).

The analysis is used to identify areas for change, recommendations and solutions that aim to minimise the recurrence of the incident in the future.

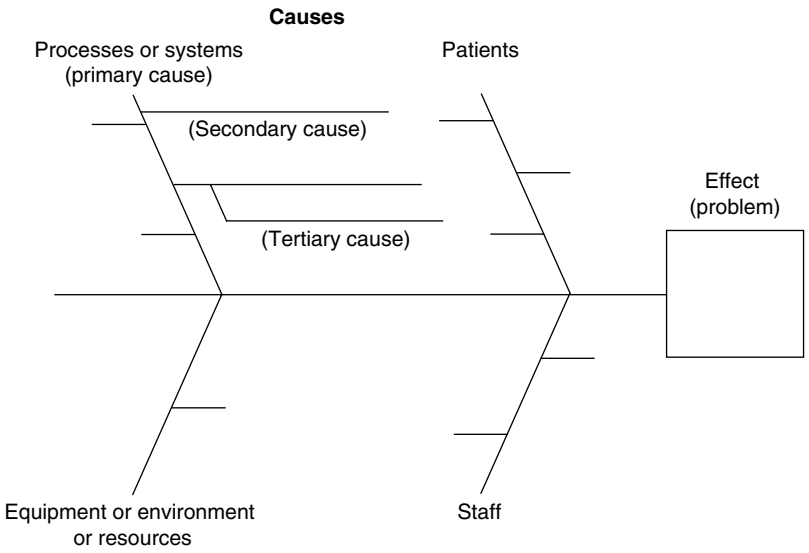


Figure 24.2 The fishbone diagram. Reproduced with permission of Healthcare Quality Quest. (2007) Leading a Clinical Audit Programme. Romsey, Hampshire: Healthcare Quality Quest.

The Fishbone Diagram

This may be helpful when there is an underlying problem which may not immediately be obvious. It involves drawing a skeleton of a fishbone on which each spine is labelled with a cause of the problem, as follows.

How to Do a Fishbone Diagram (Figure 24.2)

1) Draw a fishbone structure. Record in the head of the fish the problem, situation or effect you are analysing. Decide what the primary causes of this problem might be and label the spines on the diagram accordingly. Potential ways to identify primary causes are patients, processes or systems, equipment, environment, resources, staff or communication.
2) For each of the primary cause spines, think of ideas of causes that could be attributed to the primary cause. Attach your ideas (which are referred to as secondary causes) to the relevant primary spine as secondary spines. Attach any further explanations of a cause (which are referred to as tertiary causes) to the relevant secondary spine.
3) When you have finished thinking up ideas, decide if you want to set priorities among the potential causes or if you feel that you need to investigate any of the causes thought of.
4) Use your conclusions to develop an action plan to address causes of the problem or to investigate further.
5) You could use 'asking 'Why?' five times' or 'process mapping' (see the next sections) to investigate further.

Asking 'Why?' Five Times

Ask 'Why?' five times. Why has the problem occurred? Why has this occurred? etc., until the real underlying cause is discovered.

Process Mapping

Make a diagram of the stages of a process and analyse each stage. Remember, it may be the system which is at fault and not how it is implemented (Healthcare Quality Quest, 2007).

Implement Change and Re-audit

An action plan is drawn up, with specific named persons responsible for ensuring that it is implemented.

When changes have been implemented for an appropriate length of time, repeat the measurements in order to show the improvement.

The first audit cycle is then complete.

Repeat this process at regular intervals, adjusting to take account of new developments. This is the audit spiral.

The Audit Template

The template provided here has been drawn up so that you can create your own audit projects by following the different stages which are identified and explained in the template.

In the following sections of this chapter the template has been used to provide ideas for audit projects with 'recipes' for how these may be performed. These might be used as laid down, or adapted to make them more relevant to your clinical practice.

Title of audit	Give a clear indication of what you are measuring in the title, and the objective.
Background	Why is this audit worth doing? Is it an issue of local concern, has it been identified as a problem or is it being done in an effort to improve quality? Consider the objectives of this audit – what would you like to achieve?
The cycle	
The standard	Decide on what agreed or recognised 'standard' this audit is comparing current practice against. This standard ideally would be a national or published recommendation or guideline but may be a locally agreed criterion or policy.
Performing the audit	
Identify and collect the data	• First decide who is to collect the data, and who else will be involved in this audit project in any capacity. • Next identify a set of patients, case notes, service users, events or situations for this audit – decide how you will identify this group. • Decide if the data are to be collected prospectively or retrospectively. • Try, wherever possible, to make any patient-related information anonymous – you might give each patient a number or code rather than use their name, and keep the list of codes or numbers in an information file in a secure place or in a password-protected file.
Number of cases	Decide on how many cases or items you would like to audit, or alternatively decide on a period of time over which to run your audit.
Compare with the standard	You have now collected your data. You are now able to calculate the degree to which the agreed 'standard' is being met. This should be expressed as a percentage, e.g. 64% of 'cases' met the standard.
Implement change	At this stage you will know whether there is a problem – is the standard being met? If not: First try to analyse the reasons why the standard is not being met. Undertake a root cause analysis; for example, use the fish-bone analysis principle described above. Then decide on what change needs to be made and put this into action for a reasonable period of time.
Re-audit	This is the important part, and is where you complete the 'audit cycle'. *It is not 'audit' until you have completed this phase of the project.* Repeat the same audit after change has been implemented. Repeat the same analysis of your results. Hopefully you will find an improvement! Share the results – others may benefit from your findings.

Audit Ideas and Recipes

The following audits have been provided to give 'recipes' and ideas for future audits. They are divided into:

- **Patient-related audits:**
  1) Audit of patient record keeping.
  2) Audit of patient consent to treatment.
  3) Audit of quality of periapical films.
  4) Audit of radiological evaluation recorded in patient notes.
  5) Audit of unerupted maxillary canine teeth.
  6) Audit of emergency management of enamel/dentine tooth fractures in permanent teeth.
  7) An audit of the management of caries in the primary dentition.
  8) Audit of patient satisfaction by survey.
  9) Audit of delivery of oral health promotion advice.
- **Practice-related audits:**
  10) Audit of emergency drugs in dental practice.
  11) Audit on storage and dispensing of drugs held in general dental practice.
  12) Audit of equipment checks necessary for providing basic conscious sedation techniques in dentistry.
  13) Audit of washing and decontamination of instruments.
  14) Audit of sterilisers.
  15) Audit of storage and use of sterilised instruments.
  16) Audit of laboratory return times.
  17) Audit of patient waiting times.
- **Staff-related audits:**
  18) Audit of basic life support training.
  19) Audit of hand hygiene.
  20) Audit of use of personal protective equipment.
  21) Audit of training in child protection.

Patient-Related Audits

1. Audit of Patient Record Keeping

The following areas of a patient's clinical notes can be audited for accuracy and completeness according to Faculty of General Dental Practice (UK) recommendations (Faculty of General Dental Practice, 2009):

1) Minimum data set of patient details and demographics recorded for all dental examinations.
2) Classification of patients according to risk status for:
   - Caries.
   - Periodontal breakdown.
   - Oral mucosal health.
   - Likelihood of endodontic failure.
3) Currency of medical histories.
4) Currency and completeness of dental histories.
5) Quality of written reports on radiographs.
6) Quality and comprehensiveness of diagnosis and treatment plans.
7) Recording of the causes of endodontic problems.
8) Proportion of patients according to whether they are new patients, recall patients or patients attending for an unplanned visit.
9) Recall intervals for patients with different oral health profiles.

In this audit we suggest that you choose one or several areas from the list above to examine more carefully using audit. An example of an audit template is included here to help in data collection.

Title of audit	**Audit of patient record keeping**
Background • Why is this audit worth doing?	To improve quality of care of patients by having high standards in record keeping in terms of accuracy, legibility and timeliness. It is also necessary for medicolegal and clinical governance reasons.
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	100% of dental records should contain clear and complete details relating to the section you have chosen to audit, e.g. patient details or patient's medical history These should be written clearly, ideally in black ink (for ease of photocopying if necessary), dated and signed (and name printed) by the clinician (Department of Health, 1999; National Institute for Clinical Excellence, 2004; General Dental Council, 2005; Faculty of General Dental Practice (UK), 2009) .
Performing the audit	
Identify and collect the data	Examine patients' records with regard to the sections mentioned above.
Number of cases	Look at the relevant details and last entry in all dental records of patients attending the clinic in a 2 week period.
Compare with the standard • Calculate the degree to which the standard is met.	Calculate how many records were examined. Calculate % of records in a chosen section that are complete.
Implement change • Decide on what change needs to be made • Put this into action.	Analyse areas of discrepancy between records and ideal compliance – where were the notes deficient? Inform staff. Consult with staff about areas of non-compliance. Train staff to enable them to correct errors.
Re-audit • Repeat the same audit after change has been implemented.	Repeat audit every 3 months until a score of >90% has been achieved.

An Example of a Record Keeping Data Template

Audit number	**Dental record number:**	**Data collection date:**
Section 1		
Personal data	1) Patient's full name 2) Date of birth/age 3) Contact details/address 4) General medical practitioner's details	Yes No Yes No Yes No Yes No
	Score:	/4

(*Continued*)

Audit number	Dental record number:	Data collection date:
Section 2		
The dental record	5) Updated medical history	Yes No
	6) Diagnosis	Yes No
	7) Treatment plan	Yes No
	8) Proposed procedure/treatment outlined for next visit	Yes No
	9) Consent	Yes No
	Score:	/5
Section 3		
Staff	10) Name	Yes No
	11) Signature	Yes No
	12) GDC number	Yes No
	Score:	/3
Overall		
	13) All entries are legible	Yes No
	14) Dated	Yes No
	15) Written in black ink	Yes No
	16) Timed	Yes No
	Score:	/4
	Total score:	/16

2. Audit of Patient Records of Consent to Treatment

Title of audit	Audit of patient records of consent to treatment
Background Why is this audit worth doing?	Informed consent is required for treatment, to show that a patient understands and agrees to treatment they are to receive. A record of the consent, and any changes to their agreement, should be recorded in the patient's notes.
The cycle	
The standard What agreed 'standard' is this audit being compared against?	All patient notes should contain a record of their consent to the treatment proposed, given either by themselves or by a responsible competent adult, and the information they received. This should be either a direct entry in the notes or as a completed consent form within the notes. The practice should have a local policy on procedures deemed to require consent and in what form that informed consent is normally given and recorded, either implied or written (Care Quality Commission, 2010a).
Performing the audit	
Identify and collect the data	Retrospectively review patient notes to identify a record of the presence of information given and type of consent obtained (implied or written) made at the beginning of the most recent course of treatment.
Number of cases	50 patient notes from those patients receiving a course of treatment, which may be randomly selected from patients seen within the last year.
Compare with the standard • Calculate the degree to which the standard is met.	• Calculate the number of notes with a record of information and consent. • Compare to the standard (100%) and calculate % compliance.
Implement change • Decide on what change needs to be made. • Put this into action.	Analyse failures to comply with the requirement for all notes to show a record of information given and consent obtained to treatment, and identify reasons for failure. Meet with all staff involved to discuss reasons for failure. Develop a strategy to ensure consent is obtained and recorded reliably, and implement this.
Re-audit • Repeat the same audit after change has been implemented.	Re-audit in 6 months.

3. Audit of Periapical Radiographic Film Quality

Title of audit	**Audit of the quality of periapical films**
Background • Why is this audit worth doing?	To improve quality of periapical films, and to prevent unnecessary repeat radiographs which increase costs and radiation exposure, and waste clinical time.
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	Nationally-recommended standard for film quality (Royal College of Radiologists and the National Radiation Protection Board, 1994): Grade 1 = perfect radiograph without errors of technique, positioning, exposure or processing. Grade 2 = some faults but still diagnostic. Grade 3 = reject radiographs which are non-diagnostic. Standard: >70% Grade 1, <20% Grade 2, <10% Grade 3.
Performing the audit	
Identify and collect the data	Create a log of all films taken over a 3 month period. This should include: • Total number of films taken. • Type of view taken. • Number of films of Grade 1, 2, 3. • Date and operator of films taken. • Number of films retaken. Perform film reject analysis – reason for film faults for both Grade 2 and 3 films.
Number of cases	All films taken in a 3-month period.
Compare with the standard • Calculate the degree to which the standard is met.	• Calculate % of films achieving Grade 1, 2, 3. • Compare % of graded films with standard.
Implement change • Decide on what change needs to be made. • Put this into action.	Identify the most common cause for Grade 2 and 3 films. Train staff to enable them to recognise and correct errors.
Re-audit • Repeat the same audit after change has been implemented.	Repeat audit every 6 months.

4. Audit of Radiological Evaluation Recorded in Patient Notes

Title of audit	**An audit of the recording of a radiological evaluation of radiographs within patient notes**
Background • Why is this audit worth doing?	The IRMER 2000 legislation requires that all radiographs are evaluated and a report recorded in the patient's notes. Dental radiographs are frequently taken in dental practice and an appropriate report of radiographic findings should be entered in the patient's notes.
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	100% of all radiographs taken should have a short, relevant radiological report recorded in the patient's notes for that radiographic examination, entered within a reasonable time after the radiograph has been taken, e.g. before, or by, the patient's next appointment (Department of Health, 2000).
Performing the audit	
Identify and collect the data	Retrospectively review patient notes for: • Radiographs taken (note type and date). • The correlating radiographic evaluation (note date).
Number of cases	50 patient case notes/dental records.

Compare with the standard • Calculate the degree to which the standard is met.	Calculate the number of notes with radiographs and a radiological report recorded before or by the next patient appointment. Calculate % compliance with the standard.
Implement change • Decide on what change needs to be made. • Put this into action.	Investigate and analyse reasons for failure to record a radiological report in patient notes, e.g. Were case notes unavailable when radiographs were reviewed? How might that be overcome? Devise solutions. Address issues and introduce new strategies as appropriate at a staff meeting.
Re-audit Repeat the same audit after change has been implemented.	Re-audit in 12 months.

5. Audit of Unerupted Maxillary Canine Teeth

Title of audit	**Audit of impacted maxillary canine teeth**
Background • Why is this audit worth doing?	The aim of this audit is to improve the management of ectopic maxillary canines through timely diagnosis in children. Permanent maxillary canines should normally be palpable buccally by 8–10 years of age and should erupt at approximately age 11–13 years. If the canine is palpable buccally at age 8–10 years then no further action is required. If this is not the case or if the position of the canines appears to be asymmetrical on clinical examination, radiographs should be taken at approximately 10–11 years to identify the presence and position of the unerupted canine tooth. This is particularly important as a malpositioned unerupted tooth may cause damage to other teeth. If an abnormality is detected, the appropriate referral should be made (British Orthodontic Society, 2008).
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	If the canine cannot be detected clinically, then all affected children (100%) should undergo a radiographic examination such as a panoramic, periapical or maxillary occlusal radiograph at approximately 10–11 years, and an appropriate referral made if necessary. An exception would be made in the presence of dental anomalies and syndromes associated with delayed eruption (Husain, Burden and McSherry, 2016).
Performing the audit	
Identify and collect the data	Create a log of all paediatric dental patients aged 10 or over, with maxillary canines unerupted, seen during a 3-month period, but exclude patients with syndromes which may delay eruption. The log should include: • Age of patient. • Canines clinically detectable? • If not, has a radiograph been taken? • Has a diagnosis been recorded and referral made if appropriate?
Number of cases	All young patients (aged 10–11 years) with unerupted canines seen in a 3-month period.
Compare with the standard • Calculate the degree to which the standard is met.	Calculate the number of children aged 8–11 years seen in this period. Calculate the number of these children examined who show undetectable canines on clinical examination. Calculate the number of these patients who have been investigated, diagnosed, the diagnosis recorded correctly and the appropriate referral made.
Implement change • Decide on what change needs to be made. • Put this into action.	Analyse the results for deficiencies in the examination and investigation of unerupted canines. Discuss with staff and develop strategies to ensure that all patients are appropriately examined for presence and position of unerupted canines, and that examination of patients with unerupted canines is correctly recorded. Ensure that all patients with displaced canines are referred to an orthodontist at the appropriate time.
Re-audit • Repeat the same audit after change has been implemented.	Repeat audit every 2 years to create an audit spiral.

6. Audit of Emergency Treatment of Enamel/Dentine Tooth Fractures in Permanent Teeth

Title of audit	Audit of emergency treatment of enamel/dentine fractures in permanent teeth
Background • Why is this audit worth doing?	The urgent care option (for teeth with an enamel/dentine fracture) is to cover the exposed dentine. If the tooth fragment is available, it can be bonded to the tooth (Flores et al., 2007). Inflammatory changes are transient as long as the pulpal vascular supply remains intact and bacterial invasion is prevented. This may be achieved by an efficient sealing of the dentine; only in the case of improper sealing will further irreversible pulpal lesions occur. Prognosis of the pulp is very good. Long-term clinical studies show very little response to enamel/dentin fractures and subsequent restorative procedures, as long as there is no concomitant periodontal injury and the restoration is efficiently sealed (Maguire, Murray and al-Majed, 2000; Olsburgh, Jacoby and Krejci, 2002).
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	A local standard may be developed here, dependent on available services and facilities, which reflects a reasonable attempt to protect these teeth within as short a time as possible. A target of treatment within 3 days is suggested. The standard may therefore be that 100% of patients sustaining an enamel and dentine fracture should have this covered by a composite restoration within 3 days of sustaining the injury (Maguire, Murray and al-Majed, 2000). The exception would be if the patient does not attend within this time period.
Performing the audit	
Identify and collect the data	Evaluate the records of all patients who attend the practice who have at any time sustained an enamel/dentine fracture of a permanent incisor and still retained the tooth. Examine the date of injury, the date of attendance and calculate the time interval to first application of a protective restoration. Exclude those failing to attend within 3 days of injury.
Number of cases	All patients attending during a 6-month period.
Compare with the standard • Calculate the degree to which the standard is met.	Calculate how many received a protective restoration within 3 days of incurring a tooth fracture, and express this as a percentage.
Implement change • Decide on what change needs to be made. • Put this into action.	Consider factors that may prevent a rapid application of a protective restoration to the traumatised tooth. Such factors may include practice time allowed for emergencies and lack of information – advertising in the waiting area may help inform patients that these injuries should be treated promptly. Schools could also be informed.
Re-audit • Repeat the same audit after change has been implemented.	Re-audit after 6 months and continue as audit spiral.

7. An Audit of the Management of Caries in the Primary Dentition

Title of audit	An audit of the management of caries in the primary dentition
Background • Why is this audit worth doing?	In both 5- and 8-year-olds, filled primary teeth represented a significantly smaller proportion of the total obvious decay experience than in previous surveys. A rigorous preventive programme should be in place and caries risk assessed for individual patients (refer to audit no. 9). Active dental caries in restorable primary teeth should normally be treated with a restoration, either a filling or preformed metal crown as appropriate (Fayle, Welbury and Roberts, 2001; Scottish Intercollegiate Guidelines Network, 2003).

The cycle	
The standard • What agreed 'standard' is this audit being compared against?	The target for this audit would be that: • No primary teeth with active caries should remain at the end of a course of treatment. Exceptions to treatment would be: • Teeth near to exfoliation. • Unrestorable teeth. • Early caries in patients with low caries risk where preventive measures alone may be used. • Children who are unable to cooperate and children with medical complications, both of whom may need to be referred for specialist care.
Performing the audit	
Identify and collect the data	Examine all child patients at the end of their course of treatment within a specified period. Data to be collected by the responsible dentist. Collect the data prospectively. Record the total number of primary teeth the child has and the number of primary teeth with untreated decay at the end of a course of treatment.
Number of cases	All child patients attending in a 3-month period.
Compare with the standard • Calculate the degree to which the standard is met.	Calculate the % of children who have any untreated decay in their primary teeth, allowing for exceptions above. Ideally there should be no untreated decay at the end of each course of treatment.
Implement change • Decide on what change needs to be made. • Put this into action.	Untreated caries should normally be treated, either restoratively or preventively. See exceptions above. A preventive programme should be in place. It may be necessary to refer some patients to a specialist paediatric dentist. It may be appropriate to institute a recall system or reminders.
Re-audit • Repeat the same audit after change has been implemented.	Re-audit after 6 months and repeat as an audit spiral.

8. Audit of Patient Satisfaction by Survey

Title of audit	**Patient satisfaction survey**
Background • Why is this audit worth doing?	Communication with our patients and provision of information are essential parts of good quality care. This audit helps to gain information about patients' opinions about services that are offered to them in the practice and to ensure that targets for standards in patient care and service are met. This may help to reduce or prevent future complaints by patients.
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	The majority of patients (80%) that are attending the practice express a high level of satisfaction with the service provided by scoring 4 or greater on the patient satisfaction survey (question 3 onwards) (Newsome and Wright, 1999).
Performing the audit	
Identify and collect the data	All patients that are attending the practice will be offered a questionnaire. The questionnaires will be given by the receptionist on patient arrival. The reception staff will note the reasons for lack of completion or refusal to participate. Where possible, find out reasons for refusal or failure to complete questionnaires. A box should be replaced at the reception for patients to return completed questionnaires. The questionnaires will be anonymised.

Number of cases	All patients attending the practice in a 1-month period.
Compare with the standard • Calculate the degree to which the standard is met.	Calculate the number of questionnaires offered and calculate the % accepted and % returned. Calculate the % giving a satisfaction score of 4 or above. Compare to the standard (80%) and calculate % compliance.
Implement change • Decide on what change needs to be made. • Put this into action.	Analyse the results for areas of poor patient satisfaction and try to identify reasons for poor feedback. Consider comments made in the 'free text' responses. Meet with all staff involved to discuss reasons for areas of weakness. Develop a strategy to ensure improvements in areas where patients appear most dissatisfied. Train or re-train staff in order to improve staff communication skills.
Re-audit • Repeat the same audit after change has been implemented.	Re-audit in 6 months.

A Sample of a Patient Satisfaction Questionnaire

We would be grateful if you would please spend a few minutes of your time filling out this questionnaire. We will use the information you provide to help us to improve the care we give to our patients. All information provided will be anonymous.

Patient details
(please tick the appropriate box for each question)

1. Are you _____?
   Male ☐ Female ☐
2. Please indicate your age group
   0–16 ☐ 16–25 ☐ 26–45 ☐ 46–65 ☐ 65+ ☐

Booking your appointment
(please tick the appropriate box)

3. How satisfied were you with the process of booking your appointment at a time that was convenient to you?

Very dissatisfied 1	Fairly dissatisfied 2	Neither satisfied nor dissatisfied 3	Fairly satisfied 4	Very satisfied 5
☐	☐	☐	☐	☐

Reception and the waiting area
(please tick the appropriate box for each question)

4. On arrival were you treated politely by the reception staff?

Very impolitely 1	Fairly impolitely 2	Neither politely nor impolitely 3	Fairly politely 4	Very politely 5
☐	☐	☐	☐	☐

Would you like to add any comments about how you were treated by the receptionist (s)?

_____

_____

5. Were there sufficient seats?

Very inadequate 1	Fairly inadequate 2	Barely adequate 3	Fairly adequate 4	Perfectly adequate 5
☐	☐	☐	☐	☐

6. What was your opinion of the waiting area condition and decor?

Very unacceptable (scruffy or dirty) 1	Fairly unacceptable 2	Neutral (neither acceptable nor unacceptable) 3	Fairly acceptable 4	Very acceptable 5
☐	☐	☐	☐	☐

What would help to improve the waiting area most?

☐ Better décor
☐ Pictures on the wall
☐ Better furniture
☐ Up to date magazines
☐ Does not need improving
☐ Other (please specify) _____
☐ Music in the background
☐ Television
☐ More space (e.g. for wheelchairs)
☐ Children's toys/books

Your appointment (s)

(please tick the appropriate box for each question)

7. Was the start of your appointment delayed?

Yes ☐ No ☐

If you answered 'Yes', approximately how long did you have to wait in the waiting area before you were seen?

Less than 5 minutes 5	5–15 minutes 4	15–30 minutes 3	30–60 minutes 2	Over 60 minutes 1
☐	☐	☐	☐	☐

If you waited for longer than 15 minutes, was an explanation given for the delay?

Yes ☐ No ☐

8. Thinking about your relationship with the dental team, how do you rate the following:

	Very poor 1	Poor 2	Fair 3	Good 4	Very good 5	Does not apply
a) How well did the dental team listen to what you had to say?	☐	☐	☐	☐	☐	☐
b) How well did the dental team explain the cause of your dental symptoms?	☐	☐	☐	☐	☐	☐
c) How well did the dental team involve you in decisions about your dental treatment?	☐	☐	☐	☐	☐	☐
d) How well did the dental team put you at ease during your treatment?	☐	☐	☐	☐	☐	☐
e) How would you express your confidence and trust in the dental team?	☐	☐	☐	☐	☐	☐

Any other comments

_____
_____
_____
_____
_____

9. Thinking about the treatment you received, how would you rate the following:

	Strongly disagree 1	Disagree 2	Uncertain 3	Agree 4	Strongly agree 5	Does not apply
a) The dental team were thorough in doing the procedure.	☐	☐	☐	☐	☐	☐
b) The dental team were gentle when they worked on me.	☐	☐	☐	☐	☐	☐
c) I was satisfied with what the dental team did.	☐	☐	☐	☐	☐	☐
d) The dental team seemed to know what they were doing during the procedure.	☐	☐	☐	☐	☐	☐

Any other comments

_____

_____

_____

_____

_____

Overall
(please tick the appropriate box)

10. All things considered, how satisfied are you with your visit to our dental practice?

Very dissatisfied 1	Fairly dissatisfied 2	Neutral 3	Fairly satisfied 4	Very satisfied 5
☐	☐	☐	☐	☐

We would appreciate any other comments on any aspect of the .....

_____

_____

_____

_____

_____

Thank you for taking the time to fill in this questionnaire.

9. Audit of Delivery of Oral Health Promotion Advice

Title of audit	Audit of delivery of oral health promotion advice
Background • Why is this audit worth doing?	Preventive advice given to patients is an important way to promote oral health and prevent oral disease. The delivery of this part of a patient's dental care, by the dental team, may be audited.
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	At least 80% of patients should have received appropriate dental healthcare and prevention advice as part of their programme of dental care (National Institute for Clinical Excellence, 2004; Watt et al., 2004; Department of Health and the British Association for the Study of Community Dentistry, 2009).
Performing the audit	
Identify and collect the data	Examine patients' records for evidence that dental healthcare and preventive advice has been given. A checklist may be produced to record the type of advice given and date advice was given. Further detail could be provided about the type of advice given; this may be done as a prospective audit. The checklist in Table 24.1 suggests a regimen for checking advice given.

Table 24.1 Checklist for dental healthcare and prevention advice.

Audit number	Dental record number:	Date:
Recorded in dental records		Data collection
Section 1		
Effectiveness of self care	1) Patient's current oral hygiene and diet regimen	Yes No
	2) Principles of tooth brushing for oral health	Yes No
	3) Fluoride	
	a) Toothpaste	Yes No
	b) Mouthwash	Yes No
Healthy eating advice	4) Healthy diet advice	Yes No
	5) Diet diary (±)	Yes No N/A
Improving periodontal health	6) Mechanical plaque control	Yes No
	7) BPE/CPITN	Yes No
	8) Stop smoking guide (±)	Yes No N/A
	9) Risk factors examined that may influence the patient's oral health (Appendix G in NICE guidelines: Assessment of disease and disease risk.)	Yes No
Total score:		/7 (±)9

Number of cases	Examine all dental records of patients attending the clinic in the past 1 month.
Compare with the standard • Calculate the degree to which the standard is met.	Calculate how many records were examined. Calculate % of records showing an entry recording dental healthcare advice given.
Implement change • Decide on what change needs to be made. • Put this into action.	Analyse areas of discrepancy between records and ideal compliance. Inform the staff. Consult with staff about areas of non-compliance. Train staff to enable them to correct errors.
Re-audit • Repeat the same audit after change has been implemented.	Re-audit in 6 months.

Practice-Related Audits

10. An Audit of Emergency Drugs Kits in Dental Practice

Title of audit	Audit of emergency drugs and equipment kit
Background • Why is this audit worth doing?	A kit containing emergency drugs and equipment is necessary to cope with any serious medical emergency encountered in the dental surgery. The contents of this may depend on the type of patients you treat and treatments you provide, and may be decided following a risk assessment. It may include: • Glyceryl trinitrate (GTN) spray (400 mcg/dose). • Salbutamol aerosol inhaler (100 mcg/actuation). • Adrenaline injection (1:1000, 1 mg/ml). • Aspirin dispersible (300 mg). • Glucagon injection 1 mg. • Oral glucose solution/tablets/gel/powder. • Midazolam 10 mg/ml (buccal or intranasal). • Oxygen.

	Equipment may include: • Oxygen face mask with tubing. • Basic set of oropharyngeal airways (sizes 1, 2, 3 and 4). • Pocket mask with oxygen port. • Self-inflating bag and mask apparatus with oxygen reservoir and tubing (1 litre size bag) where staff have been appropriately trained. • Variety of well-fitting adult and child face masks for attaching to self-inflating bag. • Portable suction with appropriate suction catheters and tubing, e.g. the Yankauer sucker. • Single-use sterile syringes and needles. • 'Spacer' device for inhaled bronchodilators. • Automated blood glucose measurement device. • Automated external defibrillator. Equipment and drugs should only be used by adequately trained staff (British Dental Association, 2004; National Dental Advisory Committee 2015).
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	A kit of emergency drugs and equipment should be readily accessible and contain a specified set of drugs and accessories that are all complete, in working order, within their expiry date, and an oxygen cylinder checked and adequately full. The standard would be: • 100% compliance for all drugs being complete and within the expiry date. • 100% of staff know the location and can access the emergency drug kit, and (where appropriate) are trained in its use.
Performing the audit	
Identify and collect the data	Review the expiry date on all drugs in the emergency kit. Review the level within the oxygen cylinder. Review the presence and working order of all accessories, e.g. Ambu® bag, defibrillator. Assess staff knowledge of location, access and (where appropriate) use of emergency drugs.
Number of cases	Every emergency kit in the dental practice. Every relevant member of staff.
Compare with the standard • Calculate the degree to which the standard is met.	Calculate the % of drugs which are beyond their expiry date. Calculate the % of pieces of equipment not in full working order. Calculate the % of staff who are not appropriately trained or do not know the location of the emergency drug and equipment kit. Compare these figures to the standard (100% compliance) and calculate % compliance.
Implement change • Decide on what change needs to be made. • Put this into action.	Re-stock the drugs that have expired, and note the expiry date of the remaining drugs in preparation for re-stocking of these. Arrange re-charge of oxygen cylinder if necessary. Replace or repair any faulty equipment. Undertake staff training.
Re-audit • Repeat the same audit after change has been implemented.	Re-audit in 6 months.

11. Audit on Storage and Dispensing of Drugs Held in General Dental Practice

The Care Quality Commission (CQC) requires that each dental practice has a policy for storage and dispensing of practice-held drugs. You may design your own policy or adopt one such as that recommended on the BDA website (https://bda.org/advicesheets – advice sheet B9).

This policy should record the following information:

- Are drugs stored in the dental practice in a locked cabinet and is there a named key-holder?
- Are drugs dispensed to a written prescription in the patient's notes?
- Is a drug information leaflet provided with every prescription?
- Are all medicines labelled with patient's name, dentist's name, date, name of medicine, directions and precautions?
- Is a log kept of all prescribed medicines and to whom these are given?
- Is there a clear statement made of how the patient will be charged for drugs?

An audit of the practice's compliance with this policy can be performed on any aspect of the policy (an example is provided here) or a wider audit performed of compliance with the whole policy.

Title of audit	Audit of written prescriptions within patient's notes for drugs dispensed directly by the dental practice
Background • Why is this audit worth doing?	This audit will help show good practice and compliance with CQC recommendations on the safe storage and dispensing of drugs and medicines supplied directly by the practice This is a retrospective audit to calculate the % of patient notes containing a written prescription made when drugs are dispensed directly by the dentist. This will be compared against the practice's log book of drugs and medicines dispensed.
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	100% of patients' notes should record a prescription of drugs when these are dispensed directly by the dentist in the dental practice (Royal Pharmaceutical Society of Great Britain, 2005; Health and Social Care Act, 2008; Care Quality Commission, 2010b).
Performing the audit	
Identify and collect the data	Consult the practice's log book of drugs and medicines dispensed over a 3-month period. Identify patients who have received drugs dispensed directly to them, from stock held within the practice. Correlate this number against stock lists. Assess case notes for these patients to identify if a prescription has been entered.
Number of cases	All patients entered in the log book as receiving drugs dispensed within a 3-month period.
Compare with the standard • Calculate the degree to which the standard is met.	Record the number of correctly completed case notes. Compare against the number of patients receiving dispensed drugs, as recorded in the drugs log book. Calculate the % complying with the standard.
Implement change • Decide on what change needs to be made. • Put this into action.	Investigate for factors that may prevent correct completion of patient notes at time of prescription, e.g.: • Were the notes available to the dentist at the time that the prescription was made and drugs dispensed? Identify any causes of failure to complete the notes and instigate change to prevent recurrence, e.g.: • Practice meeting to remind staff of importance of note availability and correct completion for all patients, including emergency patients. • Review patient note retrieval system.
Re-audit • Repeat the same audit after change has been implemented.	Repeat audit in 6 months.

12. Audit of Equipment Checks Necessary for Providing Basic Conscious Sedation Techniques in Dentistry

Title of audit	Audit of equipment checks necessary for providing basic conscious sedation techniques in dentistry
Background • Why is this audit worth doing?	To assure quality and safety of care given to patients undergoing conscious sedation, the Faculties of Dental Surgery of the Royal Colleges of Surgeons and the Royal College of Anaesthetists published Standards for Conscious Sedation in the Provision of Dental Care in 2015 (https://www.rcseng.ac.uk/dental-faculties/fds/publications-guidelines/standards-for-conscious-sedation-in-the-provision-of-dental-care-and-accreditation/). This details both essential and recommended features of training, environment, equipment and maintenance, indications, responsibilities, patient assessment, contraindications, patient preparation, consent, aftercare and record keeping for inhalational and intravenous sedation. An audit of one or several aspects of this guidance would be an excellent way of monitoring standards and showing compliance with good practice.

The cycle	
The standard • What agreed 'standard' is this audit being compared against?	Select an area of the guidance referenced above. Having decided on the items or areas of guidance to be audited, select an appropriate standard, e.g. 100% compliance with the protocol for patient assessment and selection, or 100% compliance with required equipment and its maintenance. More information and further advice is also available in the reference The Dental Faculties of the Royal Colleges of Surgeons and the Royal College of Anaesthetists. (2015).
Performing the audit	
Identify and collect the data	Consult all appropriate records, e.g. patient records and/or 'maintenance' records held by the dental practice.
Number of cases/items	Review practice-held records over a 1-year period.
Compare with the standard • Calculate the degree to which the standard is met.	Calculate compliance with your chosen target/standard.
Implement change • Decide on what change needs to be made. • Put this into action.	Identify the most common causes for failure to service and maintain the equipment. All efforts should be made to correct the situation as soon as possible before undertaking any dental treatment with conscious sedation.
Re-audit • Repeat the same audit after change has been implemented.	Repeat audit every 12 months.

13. Audit of Washing and Decontamination of Reusable Instruments

Reusable and sterilisable dental instruments should be free of visible contamination before they are sterilised. They may be cleaned and decontaminated prior to sterilisation by use of:

- A washer/disinfector.
- An ultrasonic cleaner.
- Manual cleaning.

This process may be assessed by performing an audit.

Title of audit	**An audit of the effectiveness of decontamination for reusable dental instruments prior to sterilisation**
Background • Why is this audit worth doing?	Sterilisation is not effective if there is residual particulate contamination on the surface of a reusable instrument. An instrument should be free of debris and contamination before it enters the sterilisation process. This is the function of the decontamination process for instruments. This is a prospective audit performed to calculate the percentage of instruments which are free of visible soiling following cleaning/decontamination.
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	All reusable instruments should be free of visible soiling following cleaning/decontamination, and before sterilisation (Department of Health, 2013).
Performing the audit	
Identify and collect the data	Examine all instruments under bright illumination and magnification following cleaning. Create a log of the results of the visual inspection of all reusable instruments following cleaning and decontamination by whichever methods are in use in the practice. This should include: • Date. • Instrument. • Presence/absence of visible contamination. This inspection should be performed by a separate individual, who has not cleaned the instruments on that occasion.

Number of cases	All instruments cleaned over a 2-week period.
Compare with the standard • Calculate the degree to which the standard is met.	Compare % of instruments with residual contamination with the standard (100% free of contamination).
Implement change • Decide on what change needs to be made. • Put this into action.	Analyse the results: • Identify the type of decontamination method which is at fault (if more than one method is used in the practice). • Identify the type of contaminant, if possible. • Identify if all instruments are fully opened or disassembled, if appropriate. If a non-manual cleaning method is faulty, check the operating parameters and functioning of the apparatus. If the fault continues, seek manufacturer's advice. If manual cleaning, or if a particular contaminant is identified, re-assess the method and practice policy on cleaning. Instigate appropriate equipment maintenance, training, and/or changes to cleaning and decontamination policy.
Re-audit • Repeat the same audit after change has been implemented.	Repeat audit in 6 months.

14. Audit of Sterilisers

Title of audit	**Audit of the use and maintenance of steam sterilisers**
Background • Why is this audit worth doing?	The monitoring and testing of small steam sterilisation equipment is required by HTM01-05. In dental practice these will normally be Type N (non-vacuum) or Type B (vacuum). This will take the form of: • Validation and testing of all new sterilisers by the manufacturer. • Periodic tests by the user (or operator) which may be daily or weekly. • Periodic tests by the competent person (person responsible for servicing, testing and maintaining equipment) or service engineer which may be quarterly or annually. Daily and weekly tests of a steam steriliser, by the user, may be the subject of audit. The recommended tests are; • Steam penetration test (daily). • Automatic control test (daily). • Air leakage test (weekly). • Residual air test (weekly).
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	100% compliance with the timetable of testing of small sterilisers (Department of Health, 2013).
Performing the audit	
Identify and collect the data	Consult practice records of the tests undertaken on the steriliser to identify: • If tests have been completed. • The outcome of the tests.
Number of cases	Records of all tests on sterilisers, and their outcomes, within the practice over a 1-week period.
Compare with the standard • Calculate the degree to which the standard is met.	• Compare the number of tests undertaken with the ideal number of tests (daily and weekly) timetabled by HTM01-05. • Identify instances where tests show sub-standard performance of the equipment. • Calculate the compliance in undertaking tests.
Implement change • Decide on what change needs to be made. • Put this into action.	• Analyse the shortfalls in records or in testing and investigate possible causes. • Address reasons for any inadequate frequency of testing. • Instigate maintenance checks where tests reveal shortfalls in steriliser performance.
Re-audit • Repeat the same audit after change has been implemented.	Re-audit in 3 months.

15. Audit of Storage and Use of Sterilised Instruments

Title of audit	Audit of storage and use of sterilised instruments
Background • Why is this audit worth doing?	Sterilised instruments may be used directly on the day of sterilisation or stored for use at a later date. The maximum storage time should not exceed • 60 days – for pre-bagged and vacuum (Type B and Type S) autoclaved instruments. • 21 days – for instruments sterilised in non-vacuum (Type N) autoclaves then wrapped for storage. This audit assesses whether instruments are used within their maximum storage time.
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	100% of sterile instrument packs should be marked with the sterilisation date and/or 'use-by' date. 100% of reusable sterilised and wrapped instruments should be used before their sterile period expires (Department of Health, 2013).
Performing the audit	
Identify and collect the data	Examine all wrapped and stored instruments within the dental surgery at a chosen time: • Count the total number of wrapped instruments. • Correlate with type of sterilisation used. • Calculate the time elapsed from the date of sterilisation marked on the package. • And/or count number which have passed their marked maximum storage time ('use-by' date).
Number of cases	All wrapped sterilised reusable instruments.
Compare with the standard • Calculate the degree to which the standard is met.	Calculate the % of sterilised instruments which are still wrapped and unused but which have passed their maximum storage time. Compare % of expired wrapped instruments with the standard (100% should be used before expiry).
Implement change • Decide on what change needs to be made. • Put this into action.	Identify the number of expired wrapped instruments. Identify reasons why these instruments were not used within the safe storage period, e.g.: • Were they excess to needs? • Was stock rotation employed to use the oldest packs first? • Were all packs accurately dated? Develop a strategy for ensuring dating and time-ordered usage of sterile packs, if necessary. Ensure re-sterilisation of expired packs, if appropriate.
Re-audit • Repeat the same audit after change has been implemented.	Repeat this audit after an agreed interval (e.g. 3 months or 6 months).

16. Audit of Laboratory Return Times

Title of audit	Laboratory work return times
Background • Why is this audit worth doing?	Quite apart from the fit of any laboratory work, a concern is that the laboratory work will not arrive back at the practice soon enough to give the dentist time to check the work is acceptable before the patient's next appointment.
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	A locally agreed standard may be as follows: • All laboratory work should arrive at the practice one working day before the patient's next appointment.

Performing the audit	
Identify and collect the data	The dental nurse working with the dentists should record: • Date work carried out. • Date work: – Sent (postage by first, second, recorded, courier or collection service). – Collected. • Date work arrived at laboratory (request that laboratory record this on the laboratory form). • Date work arrived back at practice. • Date of patient's next appointment. • Turn round interval requested by laboratory.
Number of cases	Audit over a 6-week period for all laboratory work in the practice.
Compare with the standard • Calculate the degree to which the standard is met.	Work out the percentage of laboratory work that arrives back at the practice at least one working day before the patient's next appointment. Analyse other information gathered in this audit as this may be useful in improving practice arrangements, e.g. how long does the work take to reach the laboratory?
Implement change • Decide on what change needs to be made. • Put this into action.	Identify if there is a need to modify practice working arrangements regarding laboratory work. If so, using the data collected above, ascertain where changes are required and implement.
Re-audit	Once changes have been implemented, re-audit for a further 6 weeks.

17. Audit of Patient Waiting Times

Title of audit	**Patient waiting times in general dental practice**
Background • Why is this audit worth doing?	When given a specific time for an appointment, patients, not unreasonably, expect to be seen at, or about, that time. Dentistry is not, however, a precise art and many factors can mean that strict adherence to allocated appointment times may not be possible due to unforeseen circumstances. An audit of patient waiting times may help to plan the day's diary more accurately and to give patients a more realistic idea of waiting times.
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	The 'gold standard' should be that all patients are called into the surgery either at their allocated appointment time, before, or within 5 minutes of that time.
Performing the audit	
Identify and collect the data	Against their name on a printout of the day list, the dentist, therapist, hygienist or dental nurse should make a note of the time the patient is called in for their appointment.
Number of cases	Two working weeks, or 100 patients, for all dentists, therapists and hygienists.
Compare with the standard • Calculate the degree to which the standard is met.	Calculate the number of patients in the audit. Calculate the time interval between appointment time and time entering the surgery for each patient in the audit. Work out the percentage of patients called in at, before or within 5 minutes of their allocated appointment time. Analyse, where possible, patterns, lengths and reasons for extended waits.
Implement change • Decide on what change needs to be made. • Put this into action.	Discuss the findings with all practice staff. Decide on, and implement, changes in procedure within the practice which should result in an improvement in the number of patients seen on time.
Re-audit	Repeat the audit in 3 months.

Staff-Related Audits

18. Audit of Staff Training in Basic Life Support (BLS)

Title of audit	Audit of staff training in BLS
Background • Why is this audit worth doing?	Basic life support (BLS) is an important part of the management of medical emergencies in a dental practice. Sudden cardiac arrest is a leading cause of death affecting approximately 700 000 people in Europe per year (Gill et al., 2007). Training for the dental team in BLS is important to improve the quality of patients' care, it is part of the duty of care, is essential for good clinical practice and is part of a dentist's core skills. Each practice should ensure that: • Staff receive training and regular updates in BLS to maintain a level of competence appropriate to each individual's employed role. • All members of staff know their role in a medical emergency scenario. • There is evidence of in-house scenario-based team training in the management of medical emergencies. • All new members of staff have resuscitation training as part of their induction programme. • All staff training is recorded and updated annually.
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	All members of the primary healthcare team who have contact with patients should be trained and equipped, to a level appropriate for their expected role, to resuscitate patients who suffer cardiopulmonary arrest in the community. The minimum standard should be proficiency in BLS. All staff should ideally update their BLS training once a year. References: Cardiopulmonary Resuscitation: Standards for Clinical Practice and Training; a joint statement from the Royal College of Anaesthetists, the Royal College of Physicians of London, the Intensive Care Society and the Resuscitation Council (UK), 2008. This statement requires that healthcare professionals receive appropriate BLS training and regular annual updating (Resuscitation Council, 2008; Care Quality Commission, 2010c; Nolan, 2010).
Performing the audit	
Identify and collect the data	Review the training records for all staff working in the clinical environment who may be called on to assist in the management of a collapsed patient. Review the date of their initial BLS training and recent updates.
Number of cases	Training records of all clinical staff, and support staff in contact with patients, within the practice should be reviewed.
Compare with the standard • Calculate the degree to which the standard is met.	Calculate the % complying with the standard that all staff should update in BLS yearly.
Implement change • Decide on what change needs to be made. • Put this into action.	Identify the most common cause for failure to comply with the standard (why an update in BLS has not been achieved). Consult members of staff to identify the cause. Ensure that adequate provision of training and support in resuscitation is in place, both externally and in-house training for the team to enable staff to correct errors. Having identified members of staff who have not updated regularly, and who have not received BLS training or updating in the past year, arrange appropriate training to fulfil this requirement.
Re-audit • Repeat the same audit after change has been implemented.	Re-audit in 12 months.

19. Hand Hygiene Audit

Title of audit	Audit of hand hygiene
Background • Why is this audit worth doing?	Hand hygiene, by hand washing and alcohol gel application, is recognised as one of the most effective methods of cross-infection control. It is advised that this is performed to eliminate transmission of infection via the hands of healthcare workers from one patient to another, and to staff themselves.
The cycle	
The standard • What agreed 'standard' is this audit being compared against?	All staff should have access to, be aware of, and follow the hand washing technique recommended by the Health Protection Agency (see diagrammatic guidance – http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1194947384669) using soap ± alcohol gel: • Before and after every new patient contact. • Before placing and after removing gloves.
Performing the audit	
Identify and collect the data	• Assess presence of posters advising on hand washing technique at suitable locations near each hand washing sink. • Choose one team member to monitor hand hygiene (hand washing/gel application technique and frequency) of a selected member or members of staff by direct observation over an elected period, e.g. one clinical session. • Identify any variance from the recommended hand washing technique. • Count the number of times that hand washing/gel application should have been performed. • Count the number of times that hand washing/gel application was actually performed.
Number of cases	A selected member (or members) of staff over an elected period, e.g. one clinical session or one day.
Compare with the standard • Calculate the degree to which the standard is met.	• Calculate % compliance with hand washing poster availability. • Calculate % compliance with hand washing opportunities. • Assess the accuracy of adherence to the recommended hand washing technique.
Implement change • Decide on what change needs to be made. • Put this into action.	Ensure diagrammatic posters illustrating hand washing are easily visible to staff when washing hands. Undertake training updates on hand hygiene. Discuss at practice meeting to highlight findings of the audit. Enrol specialist help to identify deficiencies in hand washing technique (such as culture of gel agar culture plates inoculated by hand contact before and after hand washing, or use of UV-sensitive dyes applied in hand gel to identify inadequately cleaned areas when viewed under UV light). Ensure hand hygiene training of all new staff.
Re-audit • Repeat the same audit after change has been implemented.	Repeat audit in 6 months.

20. Audit of Use of Personal Protective Equipment (PPE)

Personal protective equipment is required for staff protection during any exposure-prone procedure in the dental surgery. The exact nature of the protection will depend in part on the nature of the procedure, although protective glasses would normally be worn during all procedures. The principles of use of PPE should be introduced to staff during induction and training, and staff training updated regularly to re-enforce its use.

Title of audit	An audit of the use of personal protective equipment (PPE)
Background • Why is this audit worth doing?	PPE is required to provide a safe working environment for all members of the dental team who are involved in exposure-prone procedures. It includes gloves, plastic aprons, face and eye protection and protective clothing. An audit will help identify if all staff are using, and therefore benefitting from, appropriate protection.

The cycle	
The standard • What agreed 'standard' is this audit being compared against?	Appropriate PPE should be used by all staff during all relevant procedures (British Dental Association, 2003; Care Quality Commission, 2010d; Department of Health, 2013).
Performing the audit	
Identify and collect the data	Survey all staff involved in exposure-prone procedures and identify: • Number of staff using PPE. • What items of PPE they are wearing/using. • What deficiencies in PPE are apparent.
Number of cases/items	All exposure-prone procedures over a 1-day (may be extended to 1 week) period.
Compare with the standard • Calculate the degree to which the standard is met.	Calculate % of PPE worn correctly. Compare against the total number of PPE items which should have been worn for the scrutinised procedures. Calculate % compliance with the standard (100%).
Implement change • Decide on what change needs to be made. • Put this into action.	Discuss the audit results with designated staff. Review and deliver any necessary training and updating. Ensure availability of necessary PPE.
Re-audit • Repeat the same audit after change has been implemented.	Repeat audit every 12 months.

21. Audit of Child Protection Training in the Dental Team

Title of audit	**Child protection training in the dental team**
Background	All members of the dental team should be aware of matters regarding child protection and possible presentations of child abuse in the practice setting. Abuse can be physical, emotional, sexual or occur through neglect. There is a professional obligation for the dental team to 'find out about local procedures for child protection. Make sure you follow these procedures if you suspect that a child may be at risk because of neglect or abuse' (General Dental Council, 2005). The rights of children and young people under the age of 18 are laid down in the United Nations Convention on the Rights of the Child (UNCRC) 1989. One to two children per week die in England and Wales as a result of abuse or neglect.
The cycle	
The standard	All members of the dental team are aware of local procedures for child protection.
Performing the audit	
Identify and collect the data	A designated dentist(s) in the practice should assess themselves and those staff with whom they work for evidence of awareness of local procedures if child abuse is suspected. Those staff not directly affected fall under the responsibility of the practice principal.
Number of cases	All staff.
Compare with the standard	Calculate what percentage of staff fulfil the criteria laid down in the GDC Standard (are aware of local procedures if suspecting child abuse). Compare with the standard (100%).
Implement change	Why, if present, is there a shortfall in those meeting the criteria? Ensure all staff have access to the required literature for local guidelines (General Dental Council, 2005). In addition, a copy of *Child Protection and the Dental Team – an introduction to safeguarding children in dental practice* (Harris et al., 2006; ISBN: 0955225701, http://cpdt.org.uk.fooshy.com/content.aspx?Group=home&Page=home_about) should be available for scrutiny in the practice. Consider attending further local training or arranging practice-based training.
Re-audit	Follow up after 3 months.

References

British Dental Association (BDA). (2003) BDA advice sheet A12. Infection control in dentistry. London: BDA.

British Dental Association (BDA). (2004) BDA advice sheet A3. Health and safety law for dental practice. London: BDA.

British Orthodontic Society. (2008) Guidelines for referrals for orthodontic treatment. Available from: http://www.chapelroad.co.uk/PDF's/Appendix%203%20-%20Guidelines-for-referrals.pdf (accessed 21st July, 2017).

Bucknall, C.E., Robertson, C., Moran, F., Stevenson, R.D. (1992) Improving management of asthma: closing the loop or progressing along the audit spiral? Quality in Health Care 1:15–20.

Care Quality Commission. (2010a) Essential standards of quality and safety. Outcome 2: Consent to care and treatment. London: CQC.

Care Quality Commission. (2010b) Essential standards of quality and safety. Outcome 9: Management of medicines. London: CQC.

Care Quality Commission. (2010c) Essential standards of quality and safety. Outcome 4: Care and welfare of people who use services. London: CQC.

Care Quality Commission. (2010d). Essential standards of quality and safety. Outcome 8: Cleanliness and infection control. London: CQC.

Department of Health. (1999) For the Record. Managing Records in NHS Trusts and Health Authorities. HSC 1999/053. London: DH.

Department of Health. (2000) Ionising Radiation (Medical Exposure) Regulations 2000. SI 2000 No1059. London: HMSO.

Department of Health. (2013) Health Technical Memorandum 01-05 – Decontamination in primary dental practices. London: DH.

Department of Health and the British Association for the Study of Community Dentistry (2009) Delivering Better Oral Health An evidence-based toolkit for prevention. 2nd edition. London: DH.

Faculty of General Dental Practice (UK). (2009) Clinical Examination and Record Keeping: Good Practice Guidelines. 2nd edition. London: FGDP.

Fayle SA, Welbury RR, Roberts JF (2001) Management of caries in the primary dentition. International Journal of Paediatric Dentistry 11:153–157.

Flores, M.T., Andersson, L., Andreasen, J.O., et al.; International Association of Dental Traumatology. (2007) Guidelines for the management of traumatic dental injuries. I. Fractures and luxations of permanent teeth. Dental Traumatology 23:66–71.

General Dental Council. (2005) Standards for Dental Professionals. London: GDC.

Gill, D.S., Gill, S.K., Tredwin, C.J., Naini, F.B. (2007) Adult and paediatric basic life support: an update for the dental team. British Dental Journal 202:209–212.

Harris, J., Sidebotham, P., Welbury, P., et al. (2006) Child Protection and the Dental Team – an introduction to safeguarding children in dental practice. Available from: http://cpdt.org.uk.fooshy.com/content.aspx?Group=home&Page=home_about (accessed 21st July, 2017).

Health and Social Care Act 2008 (Regulated Activities) Regulations 2010: Regulation 20.

Health Protection Agency. HPA Guidance on Handwashing. Available from: http://www.hpa.org.uk/web/HPAwebFile/HPAweb_C/1194947384669 (accessed 18th July, 2017).

Healthcare Quality Quest. (2007) Leading a Clinical Audit Programme. Romsey, Hampshire: Healthcare Quality Quest.

Husain, J., Burden, D., McSherry, P. (2016) Management of the Palatally Ectopic Maxillary Canine. (Update of 1997 Guideline written by Burden, D., Harper, C., Mitchell, L., et al.) London: Royal College of Surgeons of England.

Maguire, A., Murray, J.J., al-Majed, I. (2000) A retrospective study of treatment provided in the primary and secondary care services for children attending a dental hospital following complicated crown fracture in the permanent dentition. International Journal of Paediatric Dentistry 10(3):182–190.

National Dental Advisory Board. (2015). The Scottish Government 2015 'Emergency Drugs and Equipment in Primary Dental Care'.

National Institute for Clinical Excellence. (2004). Dental recall. Recall intervals between routine dental examinations. Clinical guideline 19. London: NICE.

National Patient Safety Organisation. (2011) Managing Clinical Effectiveness. NHS Scotland. Available from: http://www.nrls.npsa.nhs.uk/resources/collections/root-cause-analysis/ (accessed 21st July, 2017).

Newsome, P.R.H., Wright, G.H. (1999) A review of patient satisfaction: 1. Concepts of satisfaction. British Dental Journal 186:161–165.

Nolan, J.P. (2010) International Consensus on Cardiopulmonary Resuscitation and Emergency Cardiovascular Care Science with Treatment Recommendations (CoSTR). Resuscitation 81:e1–332.

Olsburgh, S., Jacoby, T., Krejci, I. (2002) Crown fractures in the permanent dentition: pulpal and restorative considerations. Dental Traumatology 18:103–115.

Resuscitation Council. (2008) Quality standards for cardiopulmonary resuscitation and training. London: Resuscitation Council.

Royal College of Radiologists and the National Radiation Protection Board. (1994) Guidelines on Radiology Standards in Primary Dental Care. Report of the Royal College of Radiologists and the National Radiation Protection Board. Documents of the NRPB 5 (3).
Royal Pharmaceutical Society of Great Britain. (2005) The safe and secure handling of medicines: a team approach. London: RPSGB.
Scottish Intercollegiate Guidelines Network. (2003) UK National Dental Health Survey 2003. Preventing Dental Caries in Children at High Caries Risk. SIGN.
The Dental Faculties of the Royal Colleges of Surgeons and the Royal College of Anaesthetists. (2015) Standards for conscious sedation in the provision of dental care and accreditation. Avaialble from: https://www.rcseng.ac.uk/dental-faculties/fds/publications-guidelines/standards-for-conscious-sedation-in-the-provision-of-dental-care-and-accreditation/ (accessed 21st July, 2017).
Watt, R.G., Harnett, R., Daly, B., et al. (2004) Oral Health Promotion Evaluation Tool kit. London: Stephen Hancocks Ltd.

Further Reading

Planning a Clinical Audit

Healthcare Quality Quest. (2007) Leading a Clinical Audit Programme. Romsey, Hampshire: Healthcare Quality Quest.
Royal College of Surgeons of England. (2000) Methodologies for Clinical Audit in Dentistry. London: Faculty of Dental Surgery

Audit of Patient Record Keeping

Akram, S., D'Cruz, L. (2010) Implementing NICE guidelines on recall intervals into general practice. Dental Update 37:454–462.
General Dental Council. (2005) Standards for Dental Professionals. London: GDC.

Audit of Patient Satisfaction by Survey

Hakeberg, M., Heidari, E., Norinder, M., Berggren, U. (2000) A Swedish version of the Dental Visit Satisfaction Scale. Acta Odontologica Scandinavica 58(1):19–24.
Ley, P. (1988) Communicating with Patients. Improving Communication, Satisfaction and Compliance. New York: Chapman and Hall.

Audit of Staff Training in Basic Life Support (BLS)

General Dental Council (GDC). (2009) Principles of Dental Team Working. Standards for Dental Professionals. London: GDC; pp. 10 and 11.
Gill D.S., Gill S.K., Trewin C.J., Naini, F.B. (2007) Adult and paediatric basic life support: an update for the dental team. British Dental Journal 202:209–212.

25

Procedures for the Management of Patient Concerns and Complaints

Catherine Bryant

Introduction

The successful practice of dentistry depends on a good dentist–patient relationship, and a successful dental practice is dependent on the delivery of high-quality dental care to patients, with whom there is a longstanding and trusting relationship. No dental team will be able offer perfect service to all patients all of the time. Mistakes and unforeseen situations will arise, but dissatisfaction and complaints are not an inevitable consequence of this, if such problems are identified early and promptly responded to in full.

A complaint may be considered to be an expression of dissatisfaction, which requires a response. Occasions when service has obviously failed to meet expected standards – late-running or double-booked appointments, missing laboratory work or adverse outcome – should be managed proactively and the affected patient provided with an early apology, explanation and solution. Dissatisfaction may, however, be much less apparent to the dental team, and may not be identified without actively encouraging patients to report it. When a patient is sufficiently dissatisfied with the service or the treatment that they have received and is driven to do something about it, they may complain to the dentist responsible for their care or to an external agency such as a commissioning organisation or the regulatory body – the General Dental Council. The route usually chosen is that which a patient perceives is the one most likely to produce a swift, meaningful and satisfactory outcome. The number of complaints made by dental patients is increasing around the world. This upward trend is particularly marked in the UK. An understanding of the factors likely to cause dissatisfaction, an appreciation of how to respond to a patient complaint, and an awareness of how complaints can be used to improve patient service are therefore essential for dental practitioners and their teams.

Complaints in Risk Management

Clinical governance is the term used to describe the framework which ensures that the clinical services delivered to patients continually improve and are as safe and effective as possible. Amongst the principles underpinning this approach to optimising the quality of patient care are risk assessment and risk management. These processes are utilised to minimise the occurrence of preventable, adverse outcomes. Complaints made by service users are amongst the measures used to identify clinical risk and thus reduce dissatisfaction and complaints amongst patients who subsequently present for treatment. Guidance on managing patient dissatisfaction and complaints emphasises the need for all members of a clinical team to reflect on and learn from such negative feedback. It is therefore only fair and motivating for staff to also record and disseminate information about positive feedback and praise of specific staff or aspects of service. Any correspondence of this nature should be forwarded, or at least copied, to the staff involved for use in professional portfolios. A telephone call or brief note to a patient to thank them for expressing their gratitude is usually well received.

Throughout the world, there is increasing scrutiny and assessment of the standards of clinical training in dentistry, improving access to high-quality postgraduate study, and greater emphasis placed on lifelong learning and continuing professional development which, in a growing number of countries, is now mandatory. In addition, there is free and unrestricted access to the publications of organisations such as the National Institute for Health and Care Excellence in the UK and the National Institutes of Health in the USA, which review areas of clinical practice and provide guidance on best practice for clinicians including dentists. Evidence based practice has been universally accepted as a tool to direct developments in clinical practice,

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.

with systematic reviews such as those published by the Cochrane Collaboration being central to this. It is interesting, therefore, that despite enhanced access to information and improvements in the knowledge and understanding of members of the dental team, the number of professional challenges, including complaints that are received, is greater than ever before. This cannot be related to changes in clinical standards and should not be interpreted as an indicator that dental services are worse than before. A more sophisticated sociological explanation has been suggested.

Why Do Patients Complain?

Patients who complain about clinical services frequently feel that this is the only way to get their concerns heard, or to receive the apology to which they believe they are entitled. Other means of expressing dissatisfaction or giving feedback about their experience are often unavailable to patients. It is worth noting that complaints in dentistry are often not associated with the quality of clinical care but about the environment in which patients were treated, interpersonal difficulties, the attitude of staff, communication problems and unmet expectations of customer service. It should not be assumed that poor patient experience will automatically result in dissatisfaction, or that the worse an experience, the more dissatisfied a patient will be. The role of blame is very important and even after a very poor experience, if a patient does not regard the dentist as responsible or 'to blame' for this, they may still be satisfied with their management. Unfortunately, once a patient has become dissatisfied with the service provided by a dental care professional, they tend to become increasingly sensitive to inadequacies in the quality of subsequent service, with diminished tolerance of further unfavourable episodes. Ultimately such patients may become overly sensitive about aspects of their care to justify their dissatisfaction. Patients who have made complaints about their clinical treatment have been found to have done so:

- To gain an understanding of what happened to them, and what may have gone wrong during their treatment if complications arose.
- To report that they want their concerns addressed, and action taken to remedy the problems identified. They may seek an explanation, apology, further treatment or financial redress.
- To be reassured that the same thing will not happen again.
- Out of a sense of duty to protect others.

In any service industry, including dentistry, it is acknowledged that most dissatisfied clients (patients) do not complain. They choose instead to find an alternative service provider and tell others why! Dental patients who do complain have therefore given this serious thought and made time to do so; they will therefore expect a swift and professional response.

Complaints about dental services are made as a result of a patient having a reason and the motivation to complain. The patient may perceive that they have good reason to complain, as a result of a problematic event or experience (e.g. clinical inadequacy, problems in accessing services, communication failures, or interpersonal difficulties such as staff rudeness or indifference). The motivation to make a complaint results from the emotional response to the problematic event or experience, and an expectation of what the complaint will achieve – apology, explanation, prevention of recurrence, or to see justice done. The key to resolving a complaint is to understand the motive for it being made. Satisfactory resolution is unlikely if a complainant's motivation and expectations are not fully explored and understood. If these are not explicit in the complaint received, then they should be clarified with the patient.

Complaints about Dental Care

Within most healthcare systems, a patient has a right to complain about their experience, whether this is justified or not. Professional standards for dentists and dental care professionals demand that patients' interests are put first and protected. Respecting the right of a patient to complain, and responding to this in a helpful and timely manner, is therefore an ethical and professional responsibility. Good communication skills, especially non-verbal skills, minimise the risk of complaints being made and are the cornerstone of successful complaints management. The development of good non-verbal communication skills is advantageous in all professional exchanges, but is especially valuable when managing complaints.

Particular attention should be paid to:

- Making eye contact with the patient which conveys a sense of interest, trust and desire to connect with them.
- Appearing interested and engaged in the conversation which demonstrates that the dental care professional is actively listening to the patient and values what they have to say.
- Looking at ease and relaxed which makes the patient feel comfortable and welcome.
- Speaking to a patient as an equal, in a manner that they can understand, in order to put them at ease which is known to improve compliance and satisfaction.

In the primary care setting, dental practitioners working both within a health service system and in private practice

will be expected to have a written complaints procedure, which should be available to patients. There is variation in the regulations pertaining to complaint handling in different countries, and indeed across the UK's national health service. These differences relate mainly to the responsibility for local complaints management, the timescale within which complaints must be managed, and the organisation to which they may be escalated, if not resolved locally to a patient's satisfaction.

Complaints about dental services may be made by any adult patient, or a family member, carer or advocate of an adult who is unable to complain independently. Caution should be taken in responding to a complaint made by a friend or relative of a patient who has the capacity to do this for themselves. It would be usual in these circumstances for the written permission of the patient concerned to be sought prior to a response being made. Parents or those with legal responsibility for children may complain on behalf of a child, but increasingly complaints are received from children and young people who are dissatisfied with their care.

A time limit for the receipt of complaints pertaining to clinical treatment is usually set by local and national policy. For example, in the UK, complaints should normally be made within 6 months of the event that is being complained about, or within 6 months of a patient finding out that they have a reason to complain. It would therefore usually be expected that complaints would be received within 12 months of the event, but in exceptional circumstances this time limit may not apply. The complaints process of a healthcare provider would not normally be expected to resolve issues of negligence or liability, or to award compensation.

Throughout the complaints process a patient has the right to:

- Be treated with courtesy.
- Be provided with support where necessary.
- Have mistakes acknowledged.
- Receive an explanation and apology.
- Expect that remedial action is taken quickly and effectively.
- Escalate their complaint to a professional body, regulator or ombudsman if they are dissatisfied with the way that it has been handled locally.

Complaints may be received from a patient or their representative by any member of the dental team, either verbally in person or on the telephone, in writing or electronically. It is therefore essential that all members of the team are aware of the complaints handling procedure in the environment in which they work. If a verbal complaint is made, this should be recorded in writing and copied to the complainant as soon as possible. Complaints may also be registered through health service provider websites, patient advice and liaison teams, the complaints office of primary or secondary care organisations, care quality commissions or the regulatory body with whom the dental care professional is registered. Once received, the aim of those managing complaints should be early, local resolution without the involvement of higher, external agencies.

The effective management of complaints arising in dental practice is essential, because modern healthcare services place patients at the centre of the design and delivery of clinical services. Addressing dissatisfaction and complaints effectively ensures that the standards of clinical services delivered to patients continually improve as areas of poor performance are acknowledged, learnt from and improved. Whatever the problematic experience and motivation for a patient to make a complaint, it is not uncommon for further complaints to be made as a result of poor or inadequate handling of the original one. Professional regulating bodies and public and private healthcare systems expect their registrants and members to practise in an increasingly reflective manner and encourage clinicians to use complaints to identify areas of their practice that may benefit from improvement. The other consequences of failing to effectively manage complaints locally include:

- Further worsening of the condition of patients whose dental treatment is associated with an adverse clinical outcome; for example, the onset of chronic pain following a dental extraction, implant placement or endodontic therapy, together with compromised functional recovery and return to normal lifestyle, resulting from high levels of stress related to poor complaint management.
- More stress for both practitioner and complainant.
- More work as further investigation is undertaken.
- More reputational damage over what can become a prolonged period.
- Escalation to health service regulator, ombudsman or registration body with greater attendant scrutiny of conduct, practice and handling of complaint.
- Risk of further alienation of the patient, thereby increasing the risk of litigation.

The Principles of Good Complaints Handling

The UK's Parliamentary and Health Service Ombudsman provides guidance, 'Principles of Good Complaint Handling' (http://www.ombudsman.org.uk/improving-public-service/ombudsmansprinciples/principles-of-good-complaint-handling-full), describing what is expected of public bodies when dealing with complaints.

These general principles are, however, equally useful and applicable to the management of complaints received by all those involved in the provision of dental services:

1) Get it right:
   - Act in accordance with the law and with regard for the rights of those concerned.
   - Act according to the local complaints policies and guidance.
   - Provide effective services, using appropriately trained and competent staff.
   - Take reasonable decisions, based on all relevant considerations, when investigating complaints.
2) Be customer focused:
   - Ensure that all patients can access services easily.
   - Inform complainants of what they can expect and what is expected of them.
   - Deal with people helpfully, promptly and sensitively, bearing in mind their individual circumstances.
3) Be open and accountable:
   - Be open and clear about policies and procedures, ensuring that information and any advice provided to patients is clear, accurate and complete.
   - Inform complainants of the reasons why decisions were made.
   - Handle information appropriately, respecting a patient's confidentiality.
   - Keep accurate and appropriate records.
4) Act fairly and proportionately:
   - Treat people impartially, with respect and courtesy.
   - Treat people without discrimination or prejudice.
   - Deal with patients who have complained and issues of concern objectively and consistently.
   - Ensure that decisions and actions are appropriate and fair.
5) Put things right:
   - Acknowledge mistakes and apologise where appropriate.
   - Put mistakes right quickly and effectively.
   - Operate an effective complaints procedure, which should include the offer of a fair and appropriate remedy when a complaint is upheld.
6) Seek continuous improvement:
   - Review complaints policies and procedures regularly to ensure they are effective.
   - Ask for feedback and use it to improve services and performance.
   - Ensure that the dental team learn lessons from complaints and use them to improve services and performance.

These principles are not a checklist to be rigidly applied to the management of a patient complaint, but reference to them and adoption of the underlying themes should help a dental care professional to produce a reasonable, fair and proportionate response to a complaint.

Stages of Managing a Complaint

Following the receipt of a complaint, it and the patient's right to complain should be acknowledged in writing. Following an investigation of the issues raised, the complainant should then be provided with a written response. Swift, early, local resolution is at this stage the primary objective. Staff involved must be apprised of the complaint made and any support or training needs should be identified and addressed. Clinical teams should learn from any mistakes made and the complaints process must be recorded comprehensively.

1) Receiving a complaint:
   - When a complaint is received from a patient or their representative it should be accepted with grace and staff members involved made aware of the situation.
   - The individual with responsibility for complaints handling within the dental practice or department should be notified of the complaint.
   - Written complaints, including those received electronically, should be stored securely, ideally in a 'complaints file' but not within the patient's notes.
   - A verbal complaint received by any member of staff in person or by phone must be recorded in writing and the patient provided with a copy.
   - The means by which future contact with the complainant will be made should be established.
   - The complainant should be informed of the local complaints policy and wherever possible provided with a copy of this.
2) Acknowledgement of a complaint:
   - A patient should receive an acknowledgement that their complaint has been received on the same day if possible and certainly within 2 or 3 days. In the public sector this will be specified by the parent organisation.
   - The patient should be given the name of the staff member who they can contact about their complaint, details of their availability and how they may be contacted.
   - The acknowledgement should include a description of how their complaint will be handled and the stages of this process.
   - The patient should be made aware of likely response time, which should be as short as possible but realistic to avoid further antagonising the patient with a late response.

- An offer to meet the patient to discuss their complaint and clarify any areas of confusion can be very valuable.
- It should be considered at this stage whether the complainant is vulnerable (affected by communication difficulties or mental health problems, for example) and would benefit from external support through the complaints process. When necessary this service can be arranged through agencies such as patient advice and liaison services, community health councils, independent advocates and Citizens Advice bureaux.

3) Investigation of a complaint:
   - The investigation of a complaint should be completed as soon as is practical, but it is vital that the full facts surrounding it are comprehensively explored. This process should not be unnecessarily prolonged but neither should it be rushed and incomplete.
   - Throughout the investigation it must be ensured that the patient's confidentiality is respected and the personal details of the complainant should not be discussed beyond those immediately involved in handling the complaint. Any written communications with the patient should be identified as 'private and confidential'.
   - The response must be thorough and the outcome should not be pre-judged.
   - The input of all those involved in the complaint must be sought.
   - Staff members whose actions are the focus of complaints must contribute to the complaint investigation and response, even if this is distressing and colleagues are keen or willing to do this on their behalf.
   - Where complaints are made about clinical treatment or outcome, careful reference must be made to clinical records.
   - Clinical records must not be amended or added to as a result of the complaint investigation.
   - It is essential to keep notes documenting the meetings and discussions held during the investigation of a complaint. Those involved should be aware of this and provided with a copy if desired.
   - If there are unavoidable and unforeseen delays during the investigation which mean that the complaint response cannot be provided to the patient within the previously agreed timescale, the patient should be informed, the delay explained and the timeframe revised. This is, however, unlikely to be well received by the patient, and should be avoided wherever possible.
4) Responding to a complaint:
   - The patient should receive a response to their complaint in writing, even if it was received verbally.
   - Copies of the complaint response should be provided to the subjects of the complaint.
   - The response should be clearly written, accurate and fair. The reason why clinical decisions were made or outcome was poor should be explained in layperson's terms, avoiding the use of clinical terminology wherever possible.
   - It must be ensured that any specific issues raised by the patient are addressed.
   - There should be careful use of language with attention given to the tone and sentiment used; do not be defensive.
   - Consideration should be given as to whether the response should be entirely personal or whether the use of a letter template, of the type made available to members of many dental associations, is preferable. When a template is used, great attention should be paid to personalising the document and addressing the specific issues raised by the patient. Dental defence organisations caution against this approach in complaints management, recommending the personal written approach.
   - A patient must be advised in writing of their right to escalate their complaint to the appropriate health care commissioner, regulator or ombudsman, if not satisfied with the local response received.
   - It is essential in all exchanges with a complainant, including the written response that the dental professional does not appear dismissive, defensive, aggressive or antagonistic towards the patient. The use of sarcasm is also to be avoided. Should a subsequent review of complaint handling by a higher authority identify this, the consequences may be significant, with concerns about professionalism being raised.
   - The individual responding to the complaint should not speculate about the motivation of a complainant, or about the content of unknown discussions or outcomes.
   - The content of the response to a complaint will be determined by the issues raised by the patient, but the general structure advised by the leading dental defence organisation may be summarised by the acronym REACH – recognition, empathy, action, compensation, honesty ('Handling Complaints', published by Dental Protection and available online at: http://www.dentalprotection.org/Default.aspx?DN=5ef8b2ee-0ae7-463c-9a10-a12c9ecfebb2).
   - Recognition must be given to the patient being sufficiently unhappy with an experience relating to their dental care and sufficiently motivated to complain. It is always worthwhile to express sadness that the patient felt that this was necessary, but that it is appreciated that they did, so that their concerns

may be addressed and service improvements made where necessary.

- Empathy has been identified as the key factor in resolving complaints. It is crucial to addressing the dissatisfaction expressed by a complainant, even if this is subsequently judged to be unjustified. Apologising for the fact that the patient felt angry, upset or frustrated is not an acceptance that there were failings in the service received by the patient, but does demonstrate understanding of their feelings, reflective practice and professionalism. It is clear to the patient from such responses that their concerns have been heard and taken seriously.
- Actions taken since receipt of the complaint, a description of what has been done, conclusions reached, changes made, training given, lessons learned, recommendations made for remedial action together with a description of steps taken to avoid recurrence of similar problems are all valuable in a complaint response. The inclusion of service improvements that will be made as a direct consequence of the complaint demonstrates active listening and a commitment to the delivery of patient-focused services.
- Compensation which may be sought by, or offered to a patient is not simply about financial redress. Often a patient will seek an apology for the way that they were treated, or for a problem that arose. Dental care professionals should not be reluctant to provide this; an apology is not an admission of guilt.
- Honesty and transparency throughout the complaints process are essential to ensure that the patient's concerns are addressed, let alone improve service delivery for other patients. If complaints are not managed in an open and professional manner, the patient is unlikely to be happy with the local response. As a consequence, escalation of the complaint to a higher authority is more likely and, even if the primary complaint is ultimately considered to be unfounded, the failures in the local complaints handling can come to assume greater importance, and the professionalism of those involved may be questioned.

5) Follow-up:

- It is vital that staff at the centre of a complaint, together with those involved in handling it, are supported through what can be a challenging time, both personally and professionally. A culture in which a transparent investigation can be carried out without the investigator being placed under duress or experiencing resentment from colleagues is essential. Managers and senior staff must ensure that this is the case.
- Complaints may highlight staff that require counselling and further development to address training needs. This applies to both clinical and non-clinical members of the dental team. Customer service, communication and interpersonal skills are often areas of weakness which can be strengthened.
- Staff who are found to demonstrate attitudes and behaviour that fall outwith that which is considered appropriate and acceptable to their role should be made aware of the expectations of their employment and involvement in the dental team. If necessary disciplinary action may be indicated.
- Service changes and improvements which are identified during complaint investigation should be implemented without delay. Information about agreed changes in patient management and clinical practice should be disseminated to all staff.
- Changes that are considered necessary following the investigation of a complaint may necessitate expenditure, increased staffing levels or the use of more costly clinical materials. This may be unwelcome, in particular in a climate of financial constraint. Complaints and subsequent financial redress may also be costly in the longer term.
- After a complaint has been resolved, it is valuable to debrief the whole team about its content and outcome, whilst ensuring that patient confidentiality is protected.
- Once the documentation (including notes taken during meetings, correspondence and staff statements) of a complaint is completed, it should be stored securely and separate from the patient's dental records for the period required by national regulators. In the UK this is currently 10 years.

Dental practitioners, working under the terms and conditions of provider contracts, may be required to formally report the number of complaints received to the appropriate responsible parent organisation. A contemporaneous record of complaints should therefore be maintained. It is good practice to periodically audit the complaints received within a dental practice to ensure that any common themes are identified and addressed, and to confirm that complaints have been managed according to agreed standards. Large organisations such as hospitals, which tend to receive significant volumes of complaints, may use coding systems to assist in this process and to identify areas of underperformance.

Vexatious Complaints

A vexatious complainant is one who makes repetitive, prolific, habitual and persistent complaints. These can be incredibly resource intensive, stressful and challenging to manage. Staff members who are the subjects of such complaints will require considerable support. Labelling complaints as vexatious is a last resort, when all reasonable means to resolve them have been exhausted. A prolific complainant, who raises the same issues repeatedly, despite having been given an exhaustive response, is likely to display certain types of behaviour including:

- Complaining about every part of the health system, regardless of the specific issue of concern in the dental setting.
- Seeking attention by contacting several agencies and individuals, often concurrently, to register their complaint.
- Always repeating the full complaint, together with the history of events involved in its management.
- Always responding, typically in a lengthy and repetitious way, to any letter from those involved in managing the complaint.
- Insisting that they have not received an adequate response.
- Focusing on trivial matters.
- Use of abusive or aggressive language.

When managing complaints that are apparently vexatious, consideration must be given as to why a patient may be so persistent. It should be confirmed that all aspects of the original complaint have been thoroughly investigated and problems identified, and that the patient is not correct in their belief that further enquiries and action are necessary. Any new complaints, possibly unrelated to those previously received from the patient, should be objectively investigated. It is usually helpful to control communication with a vexatious complainant, limiting this to one named member of the team, by one appropriate means (letter, email or phone). A limit may be set on the number of occasions in a given time – weekly or possibly daily – that staff will engage with the complainant. A telephone call at a set time may, for example, be preferable to staff receiving multiple calls on a daily basis. When this is agreed, the patient must receive contact at the time and in the manner that has been negotiated. It should be carefully explained to the complainant why their behaviour is unhelpful and the possible consequences of their continued complaints. This should be reinforced in writing. If this fails to stop continued complaints, then the practice owner or head of the organisation should be involved in making the decision to issue a final letter detailing that there is nothing further to add to the complaint response, and that it is the belief of the team that they have no further obligation to respond to subsequent visits, letters or calls. The patient should be made aware that members of the dental team will be supported in terminating any such attempts to communicate.

What Can Be Done to Reduce the Number of Patient Complaints Received?

When considering what interventions may help in reducing dissatisfaction and complaints from patients, dental teams should pay attention to some general principles of customer care. This is much easier to do if the working environment is one in which both positive and negative feedback can be shared, allowing the whole team to benefit.

It may be valuable for the dental team as a whole to consider questions such as those below during a training session to ascertain where training should be targeted and policy clarified:

- Is your organisation good at letting people know that it encourages and welcomes comments and feedback in respect of its service?
- Does your organisation regularly ask clients about their experience?
- Is it clear to everyone working in and using your service what changes have been made in light of comments and feedback received?
- If anyone in your organisation asked about your complaints process, would they be able to explain the system and advise where to go for further information and support?

When feedback is encouraged and welcomed, service users can assist in identifying areas of weakness in an organisation which may subsequently become the focus of a complaint. This facilitates the introduction of service improvements which are patient-led and should, as a consequence, enhance the delivery of dental care. It is vital to engage and provide frontline staff, in particular receptionists and nurses, with the skills and knowledge to identify signs of patient dissatisfaction, so that these may be addressed and resolved early and locally before a complaint is made. This customer care culture should be instilled into all members of the dental team as soon as they join the practice or organisation. The recruitment process is a good opportunity to examine an individual's understanding of patients'

needs and assess their communication skills and their ability to behave professionally and with empathy. The expectations of staff, their behaviour and the local policy for managing patient dissatisfaction and complaints should be discussed with all new members of the team at the time of induction. Regular updates and further development should be shared with team members during staff meetings and team training events.

It may be beneficial for all those in the dental team to be assessed, either by senior members of the team, or by an external training company. The *Handling Complaints* publication by Dental Protection available online at http://www.dentalprotection.org/Default.aspx?DN=5ef8b2ee-0ae7-463c-9a10-a12c9ecfebb2 emphasises that practitioners who are not the subject of complaints and legal action are those with excellent communication skills. These clinicians spend longer with patients at each visit, and have a polite and respectful manner. They demonstrate empathy and active listening when managing patients, have warm, humourous personalities, and reflect on their attitudes and manner to enhance patient care. Although these traits are second nature and held in abundance by some individuals, others can, with training, learn to improve their performance in these areas, benefitting the team and service as a whole.

Dental care professionals are motivated primarily by the desire to deliver high-quality clinical services to patients. Dentistry, however, is not an exact health science and on occasion, despite great efforts, the clinical outcome of treatment may fail to reach acceptable standards. This results in disappointment and frustration for both the dental team and the patient. Such an adverse outcome can be difficult for the dental team to manage. It may, from time to time, result in anger being directed at a dissatisfied patient, the apportioning of blame and hostility over payments for unsuccessful treatment. A complaint invariably follows, and the dentist–patient relationship may deteriorate further. It is vital therefore that dentists, as leaders of the dental team, develop a strategy and skills for dealing with adverse clinical outcomes. Given the benefits of this skill set and the significant number of complaints that can either be avoided, or resolved early as a result, dental defence organisations offer their members training in this area.

In summary, therefore, it may be possible to minimise complaints by:

- Equipping staff to recognise and respond early to signs and reports of concern and dissatisfaction.
- Treating patients with respect and dignity.
- Providing patients with clear information about the treatment that they require and involving them in decision-making.
- Giving patients choices in respect of their treatment.
- Keeping patients up to date with the progress of their treatment, the anticipated outcome and the effect that this will have on their oral health.
- Managing adverse outcomes with honesty, empathy and professionalism.

How Can Patients' Dissatisfaction and Complaints Be Used to Improve Service?

To continually improve the clinical services offered to patients, dentists and their teams must strive to obtain meaningful feedback on an ongoing basis. It is likely that different methods of receiving feedback will be preferred by different cohorts of patients. In-house comment cards and feedback forms, completed immediately after treatment, telephone and postal surveys, and communications by text or email can be combined to capture the views of a wide range of patients. The analysis of responses will allow 'blindspots' in services to be revealed, allowing the early identification of patterns of concern and the targeting of intervention where necessary. In all probability the remuneration of dental services will increasingly be linked to patient satisfaction and service accessibility. Greater engagement with patients about service design and delivery, followed by a positive shift of focus to address patients' needs, demands and preferences, will allow dental practices to thrive.

The widespread use of social media across the globe has the potential to give everyone a public voice. Its role in improving patient experience of clinical services is now being explored. Commercial organisations across the retail, service and industrial sectors have already embraced this technology and the benefit it can bring to service provision. It is now appreciated that the use of digital technology and modern social media may allow dissatisfied clients to share their complaints with an audience of unprecedented scale. The use of blogs, You Tube and digital image sharing platforms to publicise poor service, failing companies or undesirable business practises has already had a massive impact on organisations who then find themselves with very little opportunity for redress.

Exploring the role of media such as Twitter and Facebook to receive patient feedback may therefore be prudent for dental practices. This is a relatively inexpensive means of surveying patients' opinion and may engage groups of patients who do not normally respond to the opportunity to share their views by other means. The role of novel, interactive methods of capturing patient feedback may help to minimise the

need for dissatisfied patients to find their own innovative, but potentially damaging ways of doing so; however, moderating such means of communication can be challenging.

It may take some time for dentists and their teams to make the quantum leap towards accepting complaints as a valuable opportunity to improve service rather than as a threat. This will require professional support, education and training. Handled well, a complaint can improve the relationship with the patient, resulting in high levels of satisfaction, patient retention and loyalty. Badly handled complaints result in the loss of patients from a practice, reputational damage and increased risk of more complaints in the future.

Index

Note: page numbers in *italics* refer to figures; those in **bold** to tables.

Manual of Clinical Procedures in Dentistry, First Edition. Edited by Nairn Wilson and Stephen Dunne.