Abe Fingerhut · Ari Leppäniemi
Raul Coimbra · Andrew B. Peitzman
Thomas M. Scalea · Eric J. Voiglio *Editors*

Emergency Surgery Course (ESC®) Manual

The Official ESTES/AAST Guide

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Preface

Emergency surgery, or acute care surgery, has been part of every surgeon's daily work in facilities that receive acutely ill patients with non-trauma disease requiring quick decisions because of life- or organ-threatening disease. However, it has been only within the last few decades that the "specialty" of emergency surgery or acute-care surgery was created and formalized. The need for specific training in this discipline was obvious, but in many countries, especially in Europe, training (both the knowledge and the surgical competence) was incomplete or obscured by inclusion in general or gastrointestinal surgery programs.

Several years ago, it occurred to some members of the European Society of Trauma and Emergency Surgery (ESTES) that there was a need to set up and formalize Emergency Surgery Courses (ESC). The initial discussions involved Abe Fingerhut and Selman Uranues from Graz, Austria, who immediately materialized the first pilot course. Further discussions took place during the ESTES Meeting in Antalya between Abe Fingerhut, the incoming president at that time, Ari Leppänemi, Isidro Martínez Casas, and Dieter Morales García, who then initiated discussions within the executive board of ESTES.

Within a few months, a steering committee was set up under the leadership of Abe Fingerhut, then president of ESTES, and included Ari Leppaniemi (Helsinki, Finland), Korhan Taviloglu (Istanbul, Turkey), Fernando Turegano (Madrid, Spain), Selman Uranues (Graz, Austria) and Eric Voiglio (Lyon, France). Pilot courses were run in Graz, Istanbul, and Lyon, and the success was immediate.

However, there was also a need for a manual, a didactic accompaniment to guide the beginner and maintain a certain degree of standardization among the more experienced – an up-to-date summary of how to make the right decisions, decide the best timing for investigations and operative procedures, which procedures to perform and obtain the best results for these emergency settings.

As the idea spread, it became apparent that the need for such training and the manual was universal, and after discussion with key members of the American Association for the Surgery of Trauma (AAST) (Raul Coimbra, Andy Peitzman and Tom Scalea), we decided to collaborate to finalize this manual as a joint venture.

The final product is the fruit of many collaborators as authors, many of whom are world known in the field (see list). The editorial work was the

product of the publication committee (Abe Fingerhut, Ari Leppäniemi, Eric Voiglio, Raul Coimbra, Andy Peitzman and Tom Scalea) and ad hoc corrections from Fernando Turegano and Korhan Taviloglu.

We trust that this guidebook will be of use for all surgeons who are called upon to take care of the acutely ill, where urgent decisions and procedures are needed.

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Ari Leppäniemi — Helsinki, Finland
Raul Coimbra — San Diego, CA, USA
Andrew B. Peitzman — Pittsburgh, PA, USA
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Introduction

This is to introduce you to the Emergency Surgery Course (ESC©), an educative initiative of the European Society of Trauma and Emergency Surgery (ESTES) and the American Association for the Surgery of Trauma (AAST).

The goal of this course is to address the emergency and urgent surgical settings that can arise in almost any emergency department throughout the world. Based on the success of DSTC© in the trauma arena, the contents are designed for all surgeons, ranging from trainees with budding experience to accomplished (elective surgery) surgeons, visceral or orthopedic specialists, who take call and may be confronted with emergency surgical situations that they do not see every day. Moreover, training surgeons to meet emergency and urgent surgical conditions is difficult, especially as we ride through the beginning of the twenty-first century. The European Working restrictions have limited the number of hours surgeons can remain in the hospital, reducing exposure to patients and the hospital duties such as call; cost-containment of hospitals and spiraling technology have changed the face of treatment. Ethical considerations are in the foreground, making it more difficult to guide the toddling steps of novice surgeons on live patients, in the emergency setting in the operation room. More than ever before, training must be accomplished outside the hospital setting, outside the emergency arena. Simulation has taken giant steps in the training curriculum of young surgeons – training surgeons to deal with urgent and emergency settings is no exception.

The distinction between emergency and urgent surgery are according to the National Confidential Enquiry into Perioperative Deaths (NCEPOD) 1990 classification of degree of urgency of operation:

1. Emergency surgery entails immediate life-saving operation, usually within one hour, simultaneous resuscitation.
2. Urgent means an operation as soon as possible after resuscitation, usually within 24 h.

Of the scheduled operations, there are two types: (1) an early operation, but not immediately life-saving is an operation usually within 3 weeks. (2) An elective operation is one performed at a time to suit both patient and surgeon.

We want this course to be a “must” for the surgeon on call, who, either because of the ever evolving diagnostic modalities and management platforms, or because of the relative rarity of the pathology or the remoteness

of working conditions, requires acquisition or sharpening of specific knowledge and skills to care for acute surgical problems in the best and most appropriate way.

Knowledge of the most efficient diagnostic modalities, combined with expedient pre-, intra- and postoperative decision making, topped by cutting edge or time proven technical issues, constitute the core elements of the course.

Several modules will be available, the curriculum corresponding to the duration of the course, ranging from 2 to 3 days. The course will be composed of a mix of didactic lectures, interactive decision-making case scenarios and hands-on (animal and/or cadaver) skill-acquisition sessions.

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Korhan Taviloglu
Fernando Turegano
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Part I

Generalities

Intraoperative Strategy: Open Surgical Approach

1

Brandon R. Bruns, Ari Leppäniemi, and C. William Schwab

Contents

Objectives

- Outline the key intraoperative decisions in non-trauma emergency surgery.
- Identify factors that favor choosing a definitive management strategy.
- Describe conditions that favor damage control strategy.
- Briefly outline the main damage control strategy components and techniques.
- Describe the management principles following damage control laparotomy.

1.1 Introduction

- The vast majority of emergent surgery, despite the urgent nature of the problems, deals with patients that possess normal hemodynamic parameters and normal physiology:
  - These patients can be approached in a methodical fashion employing a thorough physical examination, appropriate laboratory studies, radiographic studies, and additional adjuncts to establish a specific diagnosis prior to the operative procedure.
  - Once obtained, the diagnosis guides decisions in relation to need for resuscitation and antibiotics, patient positioning, laparoscopic versus open surgical approach, type

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of incision, need for assistance, and postoperative care planning.
  - Most patients in this category require a single operation for resolution of their pathologic state.
- Other patients may present with signs of an acute abdomen with diffuse peritonitis:
  - These patients must be approached in a more expedited fashion. Resuscitation must commence immediately, and the history and physical examination is sometimes abbreviated. Diagnostic studies may be limited secondary to the patients underlying hemodynamic instability, and the diagnosis may not be secured in the preoperative phase of patient management.
- Lastly, in a very small subset of patients, extreme alterations in physiology and hemodynamic parameters exist:
  - This patient population presents shocked and septic. Hypotension, acidosis, hypothermia, and coagulopathy necessitate a unique intraoperative approach. Normal physiology cannot be fully restored preoperatively or during the operation; therefore, abbreviated operations with control of contamination, and occasionally hemorrhage, are used to temporize and subsequently are followed by additional operations – "damage control surgery."
- Irrespective of patient condition, the following precautions are common to most procedures envisioned in this course:
  - *Patient positioning and adjunctive procedures:*

    Critical aspect of any operation, the goal being to avoid interruptions to reposition, re-prepare the patient with antiseptic, and redrape the patient multiple times.

    Great care must be taken in securing the patient should extreme table tilt or rotation be needed, and in applying proper padding to pressure points and areas where nerves run superficially.

    A surgical "time out" observed before the beginning of the procedure to guarantee that the correct patient is receiving the correct operation on the correct area of the body and to ensure that all equipment and necessary blood products are available. Anesthesiology and surgical teams should agree on timely prophylactic antibiotic administration, the need for urinary catheter, and nasogastric tube insertion before starting the procedure.

In the severely ill patient, the following additional precautions and procedures must be considered:

1. Optimization of physiology: volume expansion, blood component therapy, antibiotics and vasoactive agents as needed, and correction of hypoxemia, anemia, and cardiac failure.
2. Mandatory placement of a urinary catheter for close observation of urine output (goal: 0.5 ml/kg/h).
3. Placement of a nasogastric tube preoperatively.
4. Central venous lines, and arterial lines.
5. And, although debated, in some cases, a pulmonary artery catheter can be helpful, especially in the elderly cardiac patient.
6. Early goal-directed therapy, including early infusion of crystalloid and blood products (goal: central venous pressure of 8–12 mm Hg, mean arterial pressure above 65 mm Hg, and mixed venous oxygenation at least 70 %).
7. Early initiation of broad-spectrum antibiotics at the onset of hypotension.
8. In certain patients with abdominal compartment syndrome in the ICU, deemed unsuitable for transportation to the operating room, a bedside laparotomy in an expeditious fashion to decompress the ACS.

- Most intraperitoneal processes are easily accessed with the patient in the supine position on the operating room table.
- Need for access to the perineum (placement of transrectal stapling devices, access for

endoscopic procedures, and the ability to lavage the rectum and distal sigmoid colon) or to the thorax should be anticipated.
  - Patient positioning and draping should allow for proper retraction, easy and quick extensions of incisions and timely conversion from laparoscopy to laparotomy, and performance of stoma and insertion of drains, as needed.

- *Incision:*
  - Both open and laparoscopic approaches are possible in many, if not most stable patients.
  - Trocar positions and skin incision should take into account previous incisions and operations, the possibility of full exploration of the peritoneal cavity, the need for adequate and proper retraction, as well as ample exposure adapted to the disease and procedure to be accomplished.
    In many cases, it is helpful to begin exposure in an area away from previous incisions in the hopes of avoiding troublesome scar and underlying visceral adhesions.
  - The very obese patient poses a unique challenge secondary to excess subcutaneous adiposity and intraperitoneal mesenteric fat. Larger patients typically require larger incisions for adequate exposure of the involved organ or organs.
    Laparoscopy, although often more difficult and requiring conversion, is particularly well suited to the obese, providing that surgeon expertise is available.
- *Exposure:*
  - Proper positioning of operating room lights, the need for a headlamp (best secured comfortably on the head prior to beginning the operation), and ample and adapted retraction are pivotal to safe and adequate exposure.
  - Retraction:
    In laparoscopy depends essentially on gravity, aided by table tilt and side rotation.
    In laparotomy depends on judicious use of self-retaining or handheld devices, as needed.
    A few examples include the Balfour™-type retractor, the Bookwalter™ retractor, or the Omni™ retractor.
- *Presence of additional operating room personnel:*
  - The operating surgeon may desire the assistance of a colleague or choose to operate with another surgeon or surgical team.
    Useful in long, difficult operations.
- *Staging:*
  - The key intraoperative decision: can the patient tolerate definitive control and complete repair of the principal disease process causing the emergency, be it hemorrhage, contamination, obstruction, or ischemia?
    If physiological stage of the patient is stable (not in hypovolemic or septic shock, no acidosis, hypothermia, or coagulopathy), and the appropriate resources (personnel, skills, equipment, time) are available, removal of the underlying cause and definitive repair and restoration of function can be performed.
    Occasionally, the patient's physiology changes during the conduct of the operation, and the successful performance of an operation is no longer feasible:
    - The surgeon and anesthetist must perform an expedited search for the etiology of the altered physiology and in the instance that normal physiology can be quickly restored; the operation can, most likely, continue; and a definitive procedure can be performed.
    - If the patient remains unstable, the operative plan should be changed and a staged operation may become necessary:
      - The surgeon's mindset must not be fixed; surgeon's ego must be set aside: Detect a change and react appropriately is imperative for the safety of the patient.

– Staged procedures are prudent decisions in the case of gross contamination, visceral necrosis, and infection:
  The initial operation may serve to control the source of infection and evacuate whatever contaminated products may be present. In this situation, return trips to the operating room will allow the surgeon to ensure adequate contamination control and do any additional debridement, drainage of purulence, resection of nonviable organs, or evacuation of infected material.
  Tissue beds are inspected for viability and if found to be compromised may be debrided to healthy tissue.

In some instances, the initial operation may leave some uncertainty as to the exact extent of the insult:

- For examples, when operating for mesenteric ischemia, one strategy frequently employed is the "second look" at 24–48 h after the initial operation to assess the viability of the bowel.
- Besides mesenteric ischemia, the concept of the "second look" can be applied to any questionable organ viability within the abdomen, skin and soft tissue, or chest.

Transfer to another facility may be appropriate should expert consultation or specific postoperative care be needed, but is not immediately available.

- *The Stable Emergency Surgery Patient*
- The stable patient usually allows adequate workup and often the diagnosis is known or highly suspected. Planned trocar or skin incision placement, adapted to patient bodybuild, the disease and involved organ(s) are straightforward. Unforeseen adhesions and disease can usually be dealt with accordingly.

– *The acute abdomen (etiology unknown):*
Classically, patients with peritonitis are taken directly to the operating room after a short period of fluid resuscitation, antibiotics and analgesia for a full abdominal exploration in an attempt to localize the causative agent and manage the pathology:

- Considerable debate exists as to whether these patients should undergo laparoscopic exploration or laparotomy:
  – With adequate expertise, many patients can be treated through the laparoscopic approach.
  – Otherwise, these patients are best evaluated utilizing a long midline incision from the xiphoid to the symphysis pubis through the linea alba.
- Upon entry into the peritoneal cavity, any blood, succus entericus, feculent material, or purulence is evacuated from the cavity and sent for culture analysis:
  – A full and systematic exploration of all the abdominal viscera is essential to avoid missing pathologies:
    Once the pathology is recognized and contamination controlled.
    Inspection should be routine.
    Small bowel from the ligament of Treitz to the ileocecal valve:
    - Taking care to examine the entire circumference and its mesentery
      Colon from the cecum to the peritoneal reflection of the rectum:
      - If retroperitoneal colonic abnormality is noted, the lateral peritoneal reflections can be incised and the posterior portion of the colon examined with medial visceral rotation.

    Foregut from the diaphragmatic crura to the ligament of Treitz:
    - Stomach:
      – Anterior stomach perforations can be clearly seen with simple inspection.
      – However, to avoid missed gastric perfora-

tions, the gastrocolic ligament should be divided and the stomach reflected superiorly.
  - Superior retraction of the stomach allows visualization of the posterior gastric wall up to the esophageal entry point near the fundus.

Pancreas:
- Entry into the lesser sac also allows inspection of the anterior portion of the pancreas.

Duodenum:
- Can be mobilized from its retroperitoneal attachments by performing a Kocher maneuver and inspecting the posterior surface

Gallbladder: easily inspected in the liver bed

Genitourinary system:
- Incise lateral attachments of either the right or left colon to rotate the colon medially:
  - Reveals Gerota's fascia, which can be incised, thus facilitating an anterior view of the kidney.
  - The ureter is easily identified as it crosses the iliac bifurcation into the internal and external branches.
  - Can be examined as necessary by carefully incising the retroperitoneal tissue overlying or adjacent to it:
    Great care should be taken in the inflamed retroperitoneum to avoid injury to the ureters.

  Finally, the solid organs of the abdomen:
  - Most instances allow inspection of the organs in their native beds.
  - However, mobilization may be required:
    - Liver: the hepatic ligaments can be incised.
    - Spleen: the lateral attachments can be easily cut.

- *The Acute Abdomen and Septic Shock*
  Patients in septic shock complicated by acidosis, coagulopathy, and hypothermia mandate a different resuscitative and operative approach from that of the typical patient: abbreviated operations and transport to an intensive care unit for restoration of normal physiology prior to definitive operative repair or damage control surgery, applied as early as possible.
  - *Intraoperative evaluation:*
    - Preoperative history, physical examination, and diagnostic adjuncts may be minimal.
    - Intraoperative decisions are guided by vigilant monitoring of the patient's physiologic status.
    - Patient physiology guides the extent of the operation:
      Operating times should be minimized.
      Abbreviated procedures performed.

  If physiology allows, definitive operation can be performed:
  - However, this can be safely delayed to a second look laparotomy after physiology is restored. In the face of hemodynamic instability, a planned return to the operating room in 24–48 h for definitive operation and second look is the most prudent and safest for the patient:
    - Control of bleeding:
      Packing of raw, bleeding surfaces or solid organs.
      Ligation of visible bleeding vessels (unless end arteries).
      Balloon tamponade techniques for inaccessible bleeding sites.
      Flow in an occluded end artery can be restored with a temporary vascular shunt.

- Hollow organ obstruction:
  Proximal diversion using tubes or ostomies
- Control of infection:
  The source of contamination (infection or necrosis) must be efficiency removed, either with drainage, resection, diversion, or closure of perforations.
  - Holes can be stapled or sutured.
  - In destructive injuries requiring resection, the ends can simply be tied off without attempting anastomosis or diversion at the first operation.
  - When resection is inappropriate (common bile duct, duodenum), controlling contamination with diverting tubes inserted into the hollow organ and external drainage might be the only options available.
    Copious irrigation of the abdomen with warmed crystalloid solution then helps remove particulate matter and dilute bacteria and debris.
  - Fashion a temporary abdominal dressing:
    Temporary abdominal closure:
    - Slows excessive heat and fluid loss and aids in the restoration of normal physiology
    - Can be attained using disposable plastic sheeting and vacuum devices that are available either commercially or fashioned in the operating room

    Additionally, skin and soft tissue infections may require repeat trips to the operating room for debridement and inspection of areas of questionable viability.

1.2 Postoperative Management

- The stable patient can return to the ward if post-inventional surveillance is satisfactory.
- The unstable patient requires appropriate postoperative monitoring in an intensive care unit setting:
  - Invasive hemodynamic monitoring
  - Early detection of complications of care
  - Restoration of normal physiology:
    Restoration of body temperature (rewarming with warmed intravenous fluids, increased ambient temperature of the room and warming blanket)
    Correction of coagulopathy (aside from restoring body temperature back to normal): infusion of crystalloid, blood, plasma, and cryoprecipitate as directed by laboratory parameters and signs of overt bleeding
    Correction of acidosis: infusion of volume and correction of body temperature

Diagnosis	*Hemodynamically Normal*	*Hemodynamically Unstable*
Appendicitis	Laparoscopic/open appendectomy	Open appendectomy versus drainage and antibiotics
Cholecystitis	Laparoscopic/open cholecystectomy	Cholecystostomy tube versus antibiotics
Diverticular disease	Resection, +/− ostomy or primary anastomosis	+/− resection, drainage of phlegmon
Abdominal wall hernia	Reduction and repair	Reduction, +/− resection, +/− second look
Ischemic bowel	Resection and primary anastomosis	Resection, +/− second look
Perforated viscus	Repair, +/− resection	Resection, +/− second look
Obstruction, adhesive	Adhesiolysis	Adhesiolysis, +/− second look
Obstruction, hernia	Reduction, +/− resection	Reduction, +/− resection, +/− second look
Obstruction, malignant	Resection, +/− anastomosis, +/− ostomy	+/− resection, fecal diversion, +/− second look
Skin and soft tissue infection	Drainage or debridement	Drainage or debridement, +/− second look

Leading Symptoms and Signs

2

Fernando Turégano-Fuentes

Contents

Objectives

- Categorize different abdominal clinical conditions in relation to the characteristics of the pain and the presence or absence of tenderness
- Describe other symptoms and signs leading to acute surgical intervention
- Describe the specifics of clinical diagnosis in the postoperative abdomen

2.1 Generalities

- Acute abdominal pain accounts for up to 50 % of emergency surgery consultations.
- All abdominal crises present with one or more of five main symptoms or signs:
  - Pain (often alone and inaugural)
  - Vomiting
  - Abdominal distension
  - Muscular rigidity
  - Shock
- The severity and the order of occurrence of the symptoms are important for diagnosis, together with the presence or absence of fever, diarrhea, constipation, and others.

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- The presence of tenderness on palpation is a hallmark of potential acute abdominal problem of surgical importance, and it generally implies inflammation of the visceral peritoneum.
  - May be accompanied or not by muscular rigidity (*defense guarding* or *guarding*).
  - Several grades (maximum: boardlike rigidity typical of perforated ulcer).
  - Usually implies inflammation of the parietal peritoneum.
    - Sometimes, it takes a great deal of clinical acuity and experience to differentiate between voluntary and involuntary guarding. In the past (pre-CT-scan era), errors with this distinction have led to numerous unnecessary abdominal explorations.
- Clinical expertise should not be replaced by easy availability of ultrasound (US) and CT scan; the latter is complementary and may sometimes be lacking.

2.2 Acute Generalized Abdominal Pain with Tenderness

- Generalized peritonitis consists of:
  - Diffuse severe abdominal pain
  - Patient:
    Who looks sick and toxic
    Typically lies motionless
    Has a tender abdomen with "peritoneal signs" (rebound tenderness, defense guarding, or boardlike rigidity)
- The three most common causes of generalized peritonitis in adults are:
  - Perforated appendicitis
  - Colonic perforation
  - Perforated duodenal ulcer
- An occasional patient with acute pancreatitis may present with a clinical picture mimicking diffuse peritonitis.

2.2.1 Perforated Appendicitis

- Typical history: midabdominal visceral discomfort, shifting to the RLQ and becoming a somatic, localized pain, with rapid generalization and diffuse tenderness
  - Sometimes inaugural
  - Otherwise after a slow but rapid, progression

2.2.2 Colonic Perforation

- The most common causes:
  - Colonic malignancy
    The tumor (usually rectosigmoid)
  - Distension upstream from malignant obstruction (usually cecum)
    - Often after several days of unrelieved complete obstruction in a patient with a competent ileocecal valve. Presenting symptoms include tenderness of the abdomen on the right side (sign of impending perforation) and history of previous abdominal distention associated with recent onset of constipation and lack of flatus.
    - Peritoneal irritation and tenderness are usually diffuse.
  - Acute sigmoid diverticulitis. Peritonitis is diffuse in large, non contained perforations, with free intraperitoneal gas on abdominal X-ray or CT.

2.2.3 Perforated Gastroduodenal Ulcer

- Incidence has decreased drastically, with some exceptions in socioeconomically disadvantaged populations worldwide.
  - In the Western world, perforated duodenal ulcers (DUs) are much more common than perforated gastric ulcers (GUs), presenting at times without a previous history of peptic ulcer disease.
- Signs and symptoms vary according to the time which has elapsed since perforation
  - Classically:
    Abdominal pain
    - Intense.
    - Of sudden onset.
    - Located in upper abdomen.
    - Accompanied most often by signs of diffuse peritoneal irritation and tenderness.

- May mimic acute appendicitis if spillage of gastroduodenal contents along the right gutter.
- May be associated with pain on the top of the shoulder (*Kehr's sign*).
- The finding of "coffee ground" or fresh blood in the NG tube suggests the possibility of *kissing ulcers* – the anterior perforated, the posterior bleeding.

– Patients:
- Restless
- In great pain
- Have boardlike abdomen

– Investigations:
- Free gas under the diaphragm in about two-thirds of perforated patients, best seen on an upright chest X-ray
  – Differential diagnosis
  Acute pancreatitis
  - In the absence of free air, marginal elevation of amylase (perforated ulcer can cause hyperamylasemia).
  - Abdominal CT scan is excellent at picking up minute amounts of free intraperitoneal gas and free peritoneal fluid.

  Acute perforative appendicitis
  Ruptured ectopic gestation
  Acute intestinal obstruction
  – Diffuse peritonitis from other causes (perforated gallbladder with bile peritonitis among other more rare causes)

2.3 Localized Abdominal Pain with Tenderness (Epigastric, Umbilical, RUQ, LUQ, Hypogastric, RLQ, and LLQ)

- Pain and tenderness are not always over the site of disease.
  – Initial pain of appendicitis may be epigastric or umbilical.
  – Obstructive pain arising from the transverse colon may be hypogastric.
  – Golden rule: examine the patient again within 2 or 3 h.
  – In nearly every serious case, other symptoms (such as vomiting, fever, or local tenderness, pointing more definitely to the nature of the lesion) may then be found

2.3.1 Periumbilical and Epigastric Pain

- Uncommon in the absence of incarcerated umbilical hernia and omphalitis
- May be due to:
  – Simple intestinal or biliary colic
  – Initial stage of small bowel obstruction
  – Acute pancreatitis
  – Or even initial stages of acute cholecystitis

2.3.2 RUQ Pain

- If the chest is clear (no right basal pneumonia):
- Calculous acute cholecystitis (AC)
  – The most common cause.
  – RUQ pain and tenderness (*Murphy's sign*) are accompanied by systemic evidence of inflammation (fever, leukocytosis) and usually by a mild or moderate elevation of bilirubin or liver enzymes, sometimes also mild elevation of the serum amylase.
  – Diagnosis is usually confirmed with US.
  – Intramural gas, and gas within the gallbladder lumen (*acute emphysematous cholecystitis*), typical of AC in diabetic patients can also be seen on abdominal X-ray.
- Acute Cholangitis
  – Characterized by *Charcot's triad* (RUQ pain, fever, and jaundice).
  – Disproportionate pain may be due to coexisting AC.
  – Can progress to include confusion and septic shock (*Reynold's pentad*) in the elderly patient, or when medical intervention is delayed.
  – Typical biochemical panel shows mildly elevated transaminases, variably elevated total bilirubin with a direct preponderance, and a disproportionately elevated alkaline phosphatase and glutamyl transferase.
  – Diagnosis usually confirmed by US, which, besides gallstones in the gallbladder, usu-

ally demonstrates mild intra- and extrahepatic ductal dilatation.
  - If no gallstones are seen, malignant periampullary biliary obstruction must be suspected.
- *Pyogenic liver abscess, amoebic liver abscess* (in tropical climates), and *hydatid disease* (endemic regions) may give rise to similar signs and symptoms.
- *Acute Acalculous Cholecystitis*
  - Manifestation of the disturbed microcirculation in critically ill patients.
  - Fever, jaundice, leukocytosis, and disturbed liver function tests are commonly present but are entirely nonspecific.
  - Pain may be minimal or difficult to discern because of patient status.
  - Early diagnosis requires a high degree of suspicion in patient with otherwise unexplained septic state or SIRS.

2.3.3 LUQ Pain

- Rare
- LUQ contains tail of the pancreas, fundus of the stomach, spleen and its blood vessels, splenic flexure of the colon, and upper pole of the left kidney, each of which may on occasion cause acute abdominal symptoms.
- *Acute Pancreatitis*
  - One of the most common causes of pain in the LUQ.
  - Vomiting and retching are frequent.
- *Perforation* (uncommon) of fundic gastric ulcer localized by adhesions
  - Free air is rarely seen.
  - Often discovered intraoperatively.
- *Leakage or Rupture of an Aneurysm of the Splenic Artery* (Uncommon)
  - Tends to have a predilection for the pregnant patient
  - Pain
    Is usually isolate unless rupture with severe intraperitoneal hemorrhage occurs
    May be intense when the aneurysm ruptures into the lesser peritoneal sac
    May closely simulate pain of peptic ulcer perforation or acute pancreatitis
- *Carcinoma or Stricture of the Splenic Flexure*
  - May rarely cause severe localized pain.
  - Constipation is common.
- *Left Perinephric Abscess*
  - Rare, pain may be lumbar
- *Spontaneous splenic rupture* of a normal spleen is very rare.
  - Splenic infarcts, common in sickle-cell crises, may cause pain aggravated by breathing.
- R*upture of an Inflamed Jejunal Diverticulum*
  - Rarer cause among others

2.3.4 Pain in the Hypogastrium

- Associated with rigidity
  - In a young or middle-aged man is usually due to appendicitis
  - In an older man acute diverticulitis or, infrequently, a rectosigmoid cancer with localized perforation
  - In a young woman, appendicitis or gynecological condition
- *Acute Urinary Bladder Retention*
  - Should always be considered in an elderly patient with a history of advanced prostatism, and a tumor-mass effect will be felt on palpation.
  - In the pre-US and CT-scan era, this condition has been known to lead to an occasional misdiagnosis and abdominal exploration.

2.3.5 RLQ Pain

- *Acute appendicitis* (*AA*)
  - Is the most common cause
  - Initial pain is epigastric or periumbilical; the localization in the RLQ usually takes place some hours afterward.
  - Associated signs and symptoms:
    Anorexia is very frequent.
  - Diarrhea, especially in children, is occasionally misleading (can be caused by a pelvic appendix irritating the rectum by contiguity, or irritation by a pelvic abscess).
  - Fever and leukocytosis may be mildly above normal, almost never precede the onset of pain.

Moderate tachycardia is common.

– Abdominal examination
  Palpation: *McBurney's* point of tenderness corresponds roughly to the position of the base of the appendix, just below a line joining the anterior superior iliac spine and the umbilicus.
  Tenderness elicited by light percussion is a remarkably reliable indication of parietal peritoneal irritation.
  No local muscular rigidity in a case of appendicitis without any peritonitis is common.
  Rigidity of the psoas should be tested for by extending the right thigh with the patient on his or her left side.
  Pressure over the LLQ will sometimes cause pain in the appendicular region (*Rovsing's sign*).
  Occasionally, palpation of a mass over the RLQ, together with a clinical picture consistent with appendicitis of several-days duration, should prompt the diagnosis of an *appendiceal phlegmon.*
– Anatomic variations
– When an appendix situated in the true pelvis ruptures, the pain will more frequently be felt in both RLQ and LLQ; there is usually no rigidity of the lower abdominal muscles, even when a pelvic abscess has formed, and clinical diagnosis is frequently overlooked. Usually, a tender swelling can be felt on rectal exam. This location, with the pelvic appendix lying against the rectum, frequently causes diarrhea, leading to misdiagnosis of gastroenteritis.
  Small bowel ileus can obscure the diagnosis of perforated iliac appendix lying behind the end of the ileum.
  Ascending (retrocecal or paracecal) inflamed AA may mimic acute cholecystitis, and a variety of acute right kidney or ureteric conditions (renal colic, pyelitis, acute hydronephrosis, pyonephrosis, or perinephric abscess)
– Differential diagnosis
– Acute cholecystitis, renal colic, pyelitis, acute hydronephrosis, pyonephrosis, or perinephric abscess (see above)
  Crohn's disease (inflamed iliac AA) (distinguished by the almost invariable history of previous attacks, together with bouts of diarrhea)
  • Nevertheless, AA caused by Crohn's disease may be the initial manifestation of that chronic process.
  Yersinia ileitis should also come into consideration.
  Acute gastritis or gastroenteritis (where pain and diarrhea somewhat dominates the clinical picture).
  Acute salpingitis is one of the most difficult conditions to distinguish from AA.
  Salpingitic pain is frequently felt on both sides from the onset, and the presence of vaginal discharge should aid in the diagnosis.
  Twisted ovarian cyst or hydrosalpinx or ruptured follicular cyst (*Mittelschmerz* or pain at mid-cycle), ruptured *corpus luteum* cyst (pain with the menses), ruptured pyosalpinx, and ruptured ovarian endometrioma can be misdiagnosed as AA on clinical grounds; imaging is essential.
  Influenza, although backache, headache, and pain in the eyeballs are more likely to be felt in influenza, and vomiting may precede the abdominal pain.
  Acute porphyria, but pain does not usually localize in the RLQ.
  An acute crisis of *diabetic ketosis.*
  Meckel's diverticulitis is infrequent.
  Cecal ulcers are rare.

2.3.6 LLQ Pain

• *Acute diverticulitis* (AD) of the sigmoid colon is the most frequent cause.
  – Signs and symptoms:
    Sometimes rigidity of the overlying muscular abdominal wall.
    Fever is often moderate.
    Increased C-reactive protein and leukocytosis with left shift.
    Vomiting is rare.
    Previous attacks of diverticulitis are often reported but may occur many years apart.

Colonic obstruction may occur (usually after repeated acute attacks of diverticulitis with development of extreme narrowing and thickening of the inflamed sigmoid).

- *Inflammation* around cancer of the sigmoid colon: associated tenderness

2.4 Acute Abdominal Pain Without Tenderness

2.4.1 Acute Mesenteric Ischemia

2.4.1.1 Mesenteric Arterial Thrombosis or Embolism

- Clinical examination is remarkably nonspecific (in early mesenteric ischemia).
- Signs and symptoms:
  - Severe abdominal pain, with very little findings on physical examination.
  - Previous abdominal angina will be consistent with arterial thrombosis (mild central cramping abdominal pain is frequent).
  - Presence of an arrhythmia such as atrial fibrillation points to embolism. *Any patient with an arrhythmia such as auricular fibrillation who complains of severe abdominal pain of sudden onset should be highly suspected of having embolization to the superior mesenteric artery* (*SMA*) *until proved otherwise*.
- Most patients present late after the onset of symptoms (once intestinal gangrene has set in).
  - Associated signs and symptoms:
    Abdominal distension
    Generalized tenderness
  - Signs of intestinal hypoperfusion (frequent bowel movements are common and usually contain either grossly or microscopically detectable blood)
- Plain abdominal X-rays are obsolete.
  - Used to be normal in the early course of the illness
  - Later, used to show adynamic ileus, with visible loops of small bowel and fluid levels
- Laboratory studies:
  - Usually normal until the bowel loses viability, when leukocytosis, hyperamylasemia, and lactic acidosis develop

2.4.1.2 Nonocclusive Mesenteric Ischemia

- Due to a low-flow state, in the absence of documented arterial thrombosis or embolus
  - Often due to a combination of low cardiac output, reduced mesenteric flow, or mesenteric vasoconstriction, in the setting of a preexisting critical illness
  - May involve the entire small intestine and colon, often in a patchy distribution
- Clinical picture may be indistinguishable from that of organic occlusion of the mesenteric vessels. *Any patient who takes digitalis and diuretics and who complains of abdominal pain must be considered to have nonocclusive ischemia until proved otherwise.*
  - Chronic renal insufficiency patients on hemodialysis are prone to this condition.

2.4.1.3 Mesenteric Venous Thrombosis

- Much less common
  - Occurs in patients with underlying hypercoagulable state or sluggish portal flow due to hepatic cirrhosis.
  - Use of contraceptive pills has been implicated as a pathogenetic factor.
  - Has also been described after splenectomy.
- Clinical presentation is nonspecific: abdominal pain and varying gastrointestinal symptoms may last a few days until eventually the intestines are compromised, and peritoneal signs develop.

2.4.1.4 Differential Diagnosis

- Acute diaphragmatic myocardial infarction very often manifests as acute epigastric pain without tenderness.

2.4.2 Pain Radiating to the Back

2.4.2.1 Dissecting Aneurysm of the Aorta

- Pain is unbearable.
  - On questioning, the pain is found to start in the thorax, radiating through the back, extend-

ing down to the abdomen and, initially, without any tenderness or rigidity on palpation.
  - Significant arterial hypertension of prolonged duration is usually a forerunner, and there will almost certainly be serious differences between an upper- and a lower-limb pulse according to the position of the lesion.
  - Clinical misdiagnosis with a renal colic has not been uncommon in the pre-CT-scan era, with dire consequences for the patient.

2.4.2.2 Leakage or Rupture of an Abdominal Aneurysm

- Is by far the more common cause of abdominal pain radiating to the back
  - Any patient with a known aneurysm and recent abdominal pain should be regarded as being in imminent danger of rupture.
  - When present, the pain prior to rupture is of a throbbing (pulsatile) or aching nature, and it is located in the epigastrium or the back.
  - Pain becomes steady when rupture has occurred.
  - Collapse in a patient with a known aneurysm almost always indicates rupture.
- Abdominal and flank examination usually reveals a mass which may occupy almost any part of the abdomen.
  - Usually represents the extravasated hematoma, and the left flank is the most common site.

2.4.3 Other

- *Biliary colic*
  - Pain as well as epigastric and RUQ symptoms are self-limited, disappearing within a few hours.
  - No local tenderness.
  - No systemic evidence of inflammation.

2.5 Nonspecific Abdominal Pain (NSAP)

- Defined as:
  - Pain lasting a maximum of 7 days.
  - No immediate cause can be found during the acute admission.
  - Specifically does not require surgical intervention.
- Presenting symptom of a large number of minor and self-limiting conditions
  - Constitutes a diagnosis by exclusion.
  - Up to 10 % of patients with NSAP over the age of 50 years have subsequently been found to have an intra-abdominal malignancy.
  - Association between NSAP and irritable bowel syndrome or celiac disease has been described.
- Women account for about 75 % of admissions with NSAP.
- Compared with active clinical observation, early laparoscopy has not shown a clear benefit in women with NSAP.

2.6 Painful Abdominal Wall Swelling: Incarcerated and Strangulated Hernia and Other Conditions

- *Incarcerated hernia*
  - One of the commonest forms of intestinal obstruction
- *Strangulated hernia*
  - Symptoms: those of intestinal obstruction, with the addition of a painful, tender, and often tense swelling in one of the hernia regions.
  - In certain cases there may be little local tenderness.
  - When omentum alone is strangulated or if a Richter's hernia is present, there will be pain, constipation, nausea, and sometimes vomiting, but the obstruction of the gut is never complete.
  - Diagnosis is usually easy as the patient will have usually been aware of the existence of the hernia for some time.
  - Torsion or inflammation of an undescended inguinal testis will be ruled out by the absence of the testicle from the scrotum on the affected side.

    Strangulated femoral hernia gives rise to more mistakes in diagnosis than a strangulated inguinal hernia.

  - Sometimes only a small knuckle of gut comprising a small portion of the circumference of the bowel may be caught in the femoral canal (*Richter's hernia*), and scarcely any projection may be felt in the thigh.
  - Some of these patients, usually elderly ladies, will be worked-up with a presumed diagnosis of intestinal pseudoobstruction, and only a CT scan can provide an accurate preoperative diagnosis. Inflamed and enlarged inguinal glands produce a more diffuse and fixed swelling, and fever is not uncommon. Usually vomiting is absent. Ultrasound may be helpful but, ultimately, only surgical intervention will differentiate between both conditions in some patients.
  - The swelling of a strangulated inguinal hernia comes out of the abdomen medially to the pubic spine and above the inguinal ligament, while strangulated femoral hernia is below.
  - An inflamed appendix in a femoral hernia sac (*Littre's hernia*) cannot be distinguished definitely from a strangulated femoral hernia before operation.
- Differentiation between incarceration and strangulation:
  - Often difficult to make certain whether a hernia is merely incarcerated or whether it is strangulated (with advanced ischemia or necrosis of its content), for pain and constipation are usually present in both cases.
  - With simple incarceration of short duration, pain tends to be milder than with strangulation.
- *Umbilical or Paraumbilical Hernia*
  - More common in women and the obese
  - Usually contains omentum and sometimes large and small bowel
  - Can be overlooked if small and deeply embedded in fat, but a local tenderness on pressure can always be felt
  - Often difficult to say before opening the sac whether one is dealing with simple incarceration or strangulation
  - Particularly frequent in cirrhotic with ascites
- *Ventral or Incisional Hernia*
  - Small bowel is more commonly found in the sac, as compared to umbilical hernias.
  - Abdominal pain, vomiting, constipation, and local tenderness indicate the need for operation.
- *Obturator Hernia*
  - Uncommon.
  - Most frequently found in wasted, elderly women.
  - Symptoms of obstruction of unknown cause predominate.
  - The only local symptom may be some pain radiating down the inner side of the thigh along the distribution of the obturator nerve.
  - If the diagnosis is suspected on clinical grounds, something very unusual, rotation of the thigh (*Romberg's sign*) will elicit pain.
  - Rectal examination may reveal a tender, palpable mass in the region of the obturator canal.
- Of note, *uncomplicated inguinal or incisional hernia* may be locally painful when the patient has peritonitis of any other origin.
- *Rectus Sheath Hematoma*
  - Usually manifests itself as a painful abdominal swelling of moderate size and imprecise limits.
  - Can be confused with other acute abdominal conditions of surgical importance.
  - Diagnosis is more straightforward if skin discoloration is already present, together with the typical history of bouts of coughing in a patient on anticoagulation medication.

2.7 Leading Symptoms and Signs in the Postoperative Abdomen

- *Uncomplicated Postoperative Abdomen*
  - Pain
    Usually present no longer than first 12–24 h
  - Gradually diminishes during the next several days
  - Ileus
    Frequent watery stools are not uncommon at the completion of a long ileus, but may also mean antibiotic-induced colitis.
    Beware that the passage of stool and gas (and also resumption of an oral diet) is not

always a guarantee that all is well within the peritoneal cavity.
In patients who are operated on for peritonitis, a persistent abdominal distention is common, and so is severe heartburn resulting from the increased intra-abdominal pressure which overcomes the resistance of a normal lower esophageal sphincter.
– Fever
Axillary temperature higher than 37 °C is common on the first postoperative night and gradually decreases thereafter.
No work-up is indicated for fever in the first 2–3 days, in an otherwise uncomplicated postoperative course.
Persistence or increase in body temperature (taken at the same time each day) after the first 2–3 days often portends the presence of an abscess in the wound or within the abdomen, if other common causes have been ruled out (postoperative atelectasis or pneumonia, UTIs, or phlebitis).
Conversely, the absence of fever in a postoperative abdominal complication is not unusual, since fever can be masked by antibiotics.

- *Complicated Postoperative Abdomen*
  – Pain
  Is frequent, and any new pain should be regarded with suspicion
  – Ileus
  Delayed or adynamic ileus is probably episodes of incomplete small bowel obstruction.
  If accompanied by fever, deep organ-space surgical site infection should be ruled out.
  – Tenderness and rigidity
  Usually present
  May be so mild as to be misleading
  May be masked by other symptoms
  – Fever
  May be heralded by a rigor
  – May be the only sign of deep organ-space surgical site infection (without pain or tenderness)
  – Peritonitis
  Almost always caused by an anastomotic disruption.
  However, signs and symptoms can be subtle.
    - Any unexplained signs or symptoms (oliguria and tachycardia, in the absence of fever, or tachypnea, in the absence of atelectasis or pneumonia) should raise the suspicion of anastomotic disruption.
    - Superimposition of the recent abdominal incision, postoperative narcotics, and the common use of epidural analgesia all add to the difficulty of assessing the changes in symptoms and findings in the postoperative abdomen.
  – Radiological signs are often indirect.
  Pleural effusion
  Ileus
- Early diagnosis and treatment are essential.
  – The key to an early diagnosis of a serious abdominal complication that warrants an early reoperation is a frequent daily assessment.
  – And for certain authors, early laparoscopic exploration, even when the initial operation was via laparotomy.
  – Management
  – Interventional radiology (percutaneous drainage)
  Endoscopy (stents, clips, sponges)
  Exploratory laparotomy or laparoscopy

Pitfalls

- Disregarding the value of a detailed history in the diagnosis of most conditions
- Overusing or underusing modern imaging techniques in the emergency ward
- Not taking into consideration the diverse anatomic positions of an inflamed appendix
- Not having a high index of suspicion in intestinal ischemia
- Not taking into account the differences pertaining to elderly patients

2.8 Summary

Acute abdominal pain accounts for up to 50 % of emergency surgery consultations. The presence

of tenderness on palpation is a hallmark of potential acute surgical abdominal problem(s). Surgeons must maintain the ability to diagnose acute abdominal conditions on clinical grounds in the emergency ward. Modern abdominal imaging has revolutionized emergency abdominal surgery, especially when the diagnosis is not clearly evident.

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3 Management Options: Nonoperative Versus Operative Management

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Contents

Objectives

- To review the indications for nonoperative management of the more common "surgical" emergencies.
- To define the role of interventional radiology and endoscopic techniques as alternatives to surgical management.
- To describe some less frequently encountered conditions and the specifics involved in their management.

The decision to operate or observe a patient is at times one of the more challenging decisions the acute care surgeon must make. To help us make that decision in the best interest of our patient, we have to consider our personal experience and clinical judgment, the natural history of the underlying disease, and its different clinical presentations, patient comorbidity and his/her surgical risk, the availability of interventional radiology or endoscopic procedures, and the information provided by imaging.

In practice, comorbidities and a high-surgical/anesthetic risk are probably the most important factor to consider in nonoperative management (NOM) for a specific patient. The anesthetic risk should be evaluated in collaboration with the anesthetist involved, using the ASA

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classification system, the APACHE II (Acute Physiological and Chronic Health Evaluation II), or p-POSSUM, according to individual practice and preferences.

In this chapter, we will review the indications for NOM of the more frequent "surgical" emergencies encountered in clinical practice, acknowledging that some of the assertions and recommendations contained are also mentioned in other chapters of this manual. By NOM or conservative approach, we refer to a nonsurgical therapy, even though some interventional radiologic or endoscopic procedure might be used at times.

3.1 Acute Appendicitis

- Despite the fact that early appendectomy has been advocated as the gold standard of therapy to avoid perforation, recent evidence has shown that acute appendicitis (AA) can be successfully treated nonoperatively.
  - Several studies, including five randomized trials, have suggested that antibiotic treatment should be the first line of treatment for uncomplicated AA and at times can cure AA.
  - The results from two meta-analyses showed that NOM for uncomplicated or complicated AA was associated with reduced risk of complications and had a similar duration of hospital stay compared with appendectomy.
- The duration of antibiotic treatment has not been consensual;
  - The failure rate (reported to be between 10 and 38 %) can be reduced to 3 % with a longer antibiotic regimen (specifically 9–14 days).
  - The necessity of an interval appendectomy after successful NOM is controversial but is usually advocated for patients with an appendicolith or an abscess on initial CT scan.
- NOM should be the first-line treatment
  - When appendiceal phlegmon is suspected (clinical diagnosis)

    Rationale: avoids the risk of right hemicolectomy for a benign condition.

    CT scan is indicated to:
    - Rule out an abscess within the phlegmon, in which case percutaneous drainage is indicated
    - Detect complicated AA surrounded by an inflammatory phlegmon (no clinical mass palpated on the RLQ), for which surgery is indicated.
- NOM is not indicated in the pregnant woman because of increased morbidity and fetal loss.

3.2 Acute Cholecystitis

- NOM can be considered in high-risk patients, irrespective of the grade of the Tokyo Guidelines.
  - Clinical improvement can be expected in 87 % patients.
  - Predictors of failure include age >70 years, history of diabetes, and persistent leukocytosis >15,000/mm^3 at 48 h. These patients or those who fail to respond rapidly (within 48–72 h) to medical management should undergo percutaneous drainage or operation.
- AC that develops during the first or third trimester of pregnancy is best treated conservatively with antibiotics, with delayed cholecystectomy either during the second trimester or the postpartum period, respectively.

3.3 Gastrointestinal Perforations

- *Gastroduodenal*
  - NOM in the healthy patient with an early healed perforation and no signs of peritonitis.

    Should be successful in most cases.

    Contrast CT should document sealing of the perforation.
  - NOM in the extremely high-surgical risk patient presenting with peritoneal signs

    Treatment consists of NPO, NG tube, antibiotics, thromboembolic prophylaxis, and acid-reducing medication.

Development of abscesses can be drained percutaneously.
Low threshold for surgical intervention if clinical deterioration occurs, especially in patients age 70 or greater.

- *Leakage after percutaneous endoscopic gastrostomy* (*PEG*)
  - Diagnosis: contrast study through the PEG tube (to eliminate intraperitoneal spillage).
  - Treatment: attach tube to gravity drainage, antibiotics, and i.v. fluids.
- *Post-ERCP perforations*
  - Occur in 0.5–1.2 % of procedures with mortality as high as 15 %
  - NOM:
    Nasogastric tube.
    Broad-spectrum antibiotics.
    Repeat ERCP with insertion of a stent is an option for expert endoscopists.
  - Ideal conditions for NOM:
    Absence of free leakage on contrast examination
    Absence of systemic inflammation or clinical peritonitis
    Absence of large or increasing pneumoperitoneum
- *Colonoscopy perforations*
  - Common causes: barotrauma from excessive insufflation of air, excessive use of cautery, or overzealous dilatation of strictures
  - NOM
    Indicated for patients who have had previous bowel preparation, are minimally symptomatic, without fever or tachycardia, and with a benign abdominal exam, typically after small perforations following therapeutic colonoscopy (e.g., polypectomy or biopsy)
    Treatment: nothing by mouth and broad-spectrum antibiotics. Patients who respond to conservative management typically have no or minimal pneumoperitoneum and no or minimal leak of contrast on CT. Perforations that follow are usually small and more amenable to NOM.
  - Perforations following diagnostic colonoscopy often result in sizable rents in the colonic wall and thus require prompt surgical treatment.
- *Postoperative anastomotic leaks*
  - NOM is possible and the most reasonable course of action in many anastomotic leaks, provided that there are no signs of generalized peritonitis or sepsis.
    Biliary leaks:
    - Most are amenable to NOM, provided interventional radiology and endoscopic therapy are available.
    - Of note, the presence of free bile in the peritoneal cavity can occasionally be very poorly tolerated with rapid sepsis warranting rapid surgical intervention.
    - Cystic duct stump leaks and ducts of Luschka leaks:
      - Most common postcholecystectomy causes of bile leaks.
      - Low-grade leaks (identified after opacification of intrahepatic radicals): sphincterotomy alone.
      - High grade (detected before radical opacification): biliary stenting.
      - Refractory leaks may require surgery.
      - Main bile duct injuries may also sometimes be treated with stents, while others require hepatobiliary expertise surgery.
    - Multiple studies have now documented a 90–100 % resolution rate for bile leaks posthepatic resection treated with sphincterotomy and stenting.

    Pancreatic leaks:
    - Many pancreatic-enteric anastomoses, usually less ominous events than in the past, will resolve with NOM and percutaneous techniques.
    - Reoperation may be required either due to inaccessibility of an infected fluid collection to percutaneous drainage or due to clinical instability associated with uncontrolled sepsis. As early reoperation carries a significant risk of mor-

tality, it should be avoided if reasonable nonoperative alternatives exist.

Anastomotic leaks after esophagectomy:

- Of critical importance: differentiate between leaks and conduit necrosis, especially after colonic interposition, and endoscopic examination is the best method for making this assessment.
- Clinically stable patients (controlled leaks or contained anastomotic disruptions) may be treated nonoperatively: endoscopically placed removable expandable stents are first-line treatment options
- Leaks are controlled in 70–100 % of patients.
- Stent migration may occur in 20–40 % of cases.

3.4 Intestinal Obstruction

3.4.1 Small Bowel Obstruction

- The majority of patients with *partial* adhesive small bowel obstruction (SBO) will respond to NOM, while the opposite is generally true for a complete SBO.
  - If there is gas seen in the colon on plain abdominal X-ray, partial SBO is likely
  - How long to wait before resorting to surgery remains debatable (the traditional 48 h time point has been challenged by some groups who advocate prolonging the waiting period to up to 5 days)
- Oral and i.v. contrast-enhanced CT scan can at times be very helpful in helping decide on a NOM course or otherwise, when one suspects a early postoperative SBO, or paralytic ileus or other non-adhesive cause of SBO like Crohn's disease, peritoneal carcinomatosis or radiation enteritis, all potentially amenable to NOM.
  - The "transition point" on CT scan does not rule out a successful NOM, provided that signs of intestinal compromise or of a fixed SBO are absent (pneumatosis intestinalis, portal venous gas, intussusception, torsion of mesentery, mesenteric edema, free intraperitoneal fluid).
  - In the case of early postoperative SBO, longer periods of observation may be tolerated as the risk of strangulation is low (<1 %).
  - The exception to this watchful waiting approach is postoperative obstruction following laparoscopic surgery which warrants an early surgical approach more often than not. It is quite frequent that bowel is incarcerated within a peritoneal defect caused by trocar placement.
  - Occasionally, a patient may develop SBO early in the aftermath of an operation for adhesive SBO; this is a case for prolonged NOM until adhesions mature and the obstruction resolves.
  - Similarly, patients with multiple prior episodes of SBO and patients who have undergone numerous abdominal operations should be treated NOM if possible.
- Treatment: fluid replacement and hemodynamic monitoring and large bore NG tube (softening the tube by immersion for a couple of minutes in very hot water, and spraying the nostril with a local anesthetic can make the insertion less unpleasant)
  - Adjunctive treatments
    Steroids in SBO from Crohn's disease
    Gastrografin, a water-soluble hyperosmolar contrast medium that promotes intestinal movement, is being increasingly used by many for diagnostic-prognostic and potential therapeutic purposes.
    - Technique: Instill 100 cc via the NG tube, clamp the tube, and wait 4–6 h before ordering a plain abdominal X-ray.
    - Presence of contrast in the large bowel proves that the SBO is partial, and resolution can be expected
- SBO from peritoneal carcinomatosis in a known cancer patient or from advanced radiation enteritis, present sometimes a

medical and ethical dilemma which should be solved with the patient, if appropriate, and certainly his/her family and the clinical oncologist.

3.4.2 Large Bowel Obstruction

- Advanced metastatic colorectal or pelvic cancer
  - Self-expandable metallic stents have been proven useful as palliation.
  - However, there is a risk of perforation and migration.
- Uncomplicated sigmoid volvulus: colonoscopic decompression is well established.
  - The mucosa should be assessed for the presence, location, and degree of ischemia, and a long rectal tube may be placed proximal to the point of obstruction and left in place for 48–72 h.
- Acute colonic pseudo-obstruction (Ogilvie's syndrome):
  - Intravenous administration of the acetylcholinesterase inhibitor neostigmine is an effective treatment with initial response rates of 60–90 %.
  - Colonoscopic decompression is successful in approximately 80 % of patients, with surgery largely limited to those in whom complications occur.
  - CT-guided transperitoneal percutaneous cecostomy has been reported in a few high-risk patients unresponsive to maximal pharmacological and endoscopic therapy, with good results.

3.5 Gastrointestinal Bleeding

- Gastrointestinal (GI) bleeding has historically been defined as "upper" (UGIB) or "lower" (LGIB) relative to the ligament of Treitz. However, with advances in endoscopic therapies and the advent of capsule endoscopy, a reclassification of GI bleeding into upper, mid, and lower has been suggested.
- With this new classification, UGIB is defined as occurring above the ampulla of Vater, mid GIB as occurring between the ampulla and the terminal ileum, and LGIB as that occurring within the colon.
- Most patients with GIB can be successfully managed initially nonoperatively, by means of diagnostic and therapeutic endoscopy and/or interventional radiology. The specific methods of endoscopic hemostasis depend on local skills and facilities and are dealt elsewhere in this manual.
- Decision-making is complex and requires an understanding of the perceived risk of rebleeding, the underlying pathology, morbidity associated with surgery, and the morbidity associated with failure of wait and see. Success rates with this approach vary depending upon the etiology of the bleed and the modality chosen, but even if control of hemorrhage is achieved initially by nonsurgical means, operation may still be necessary.
- *Upper GI bleeding*
  - *Variceal causes:*
    Rarely require surgery.
    Endoscopy is 90 % effective in control of hemorrhage from esophageal varices, but is not as effective in bleeding from hypertensive gastropathy (much more rare cause of severe UGIB).
    For the 10 % of patients who continue to bleed or rebleed, transjugular intrahepatic portosystemic shunting (TIPS) is 95% effective in controlling bleeding.
    Urgent surgical shunts are rarely required but can be considered in those who have good hepatic reserve and are not transplant candidates.
  - *Non-variceal causes:*
    Peptic ulcer disease (*the most common cause*).
    - Most cases resolve spontaneously.

    Close monitoring of vital signs, observation of the number and character of melena

stools, and serial hematocrit measurements should detect further hemorrhage.

If an NG tube is used, it should be frequently flushed.

When bleeding persists, endoscopic therapy remains the mainstay.

- Has been shown to result in primary hemostasis in the majority of cases (76–100 %, depending on the type of endoscopic therapy used).
- Repeat endoscopy is effective in 75 % of patients without increased morbidity.
  - Administration of high-dose proton pump inhibitors (PPIs) reduces the incidence of rebleeding and the need for surgery following endoscopic hemostasis.

Angiographic embolization (AE) is another option:

- Less effective (reported clinical success rates of 65 %)
- Can be very useful in bleeding duodenal ulcers when surgical risk is prohibitive
- Risk factors for failure: use of anticoagulants or corticosteroids at the time of admission, the use of vasopressors before primary AE, and the use of coils as the only embolic agent

If rebleeding occurs:

- Mild or moderate in intensity and stemming from a superficial lesion, NOM may be continued, unless the patient is elderly and transfusion requirements have exceeded four units of blood.
- About 10 % of patients with upper GI bleeding (UGIB) will require an operation. Identification of these patients is challenging and the timing of surgery is unclear, although outcomes are clearly improved if surgery is performed in a non-emergent fashion.
- The two characteristics at endoscopy that predict a high rebleeding risk (50–80 %) are active pulsatile bleeding or a visible vessel.
  - Conversely, nonpulsatile bleeding or an adherent clot is associated with a low risk of rebleeding.
- Ulcers >2 cm, posterior duodenal ulcers, and gastric ulcers also have a high risk of rebleeding.

Mallory-Weiss tears

- Self-limited 90 % of the time, but if intervention is required, endoscopy is highly successful.

Stress gastritis is uncommon in the era of acid-suppression therapy and typically is successfully managed medically.

Dieulafoy's lesion is successfully treated endoscopically in 80–100 % of cases.

Hemobilia or hemosuccus pancreaticus (bleeding into the bile duct or pancreatic duct) is generally managed with therapeutic angiography with high success rates.

- *Mid and Lower GI bleeding*
  - Accounts for approximately one-fourth to one-third of all GI bleeding events and stops spontaneously in about 80 % of cases.
  - *Diverticular disease* is the most common source of LGIB. Massive lower GIB of diverticular origin originates in the right colon in two-thirds of cases.
  - Colonoscopy is generally effective at stopping the bleed acutely. If this fails or the patient rebleeds, angiography can be considered.

    Therapeutic angiography can halt LGIB in 40–85 % of cases, but the rebleeding risk is high, particularly if the small bowel or the cecum is the source.
  - In diverticular disease, the overall risk of rebleeding at 1 year is 10 % but rises to 50 % at 10 years.
  - If the diseased segment has been localized, colonic resection is recommended in an elective setting for all except those patients who present a prohibitive operative risk.
  - *Angiodysplasia* is another common cause of LGIB and can be diagnosed and treated

successfully in most patients with colonoscopy or angioembolization.
  - *Meckel's diverticule bleeding* requires surgery

3.6 Acute Diverticulitis

- Acute, mild phlegmonous diverticulitis, even if recurrent, can be managed with oral antibiotics (such as metronidazole and ciprofloxacin) on an outpatient basis.
- For Hinchey 1 and 2 disease, initial NOM consists of:
  - Bowel rest and antibiotics alone, even in patients with small (<5 cm) abscesses
  - Percutaneous drainage (CT guided) for larger pericolic abscesses
  - CT manifestations of a severe attack (extraluminal gas, leakage of contrast, or abscess) in a patient who has failed to resolve after a few days of antibiotics are not necessarily an immediate indication for operation. Minor free intra-abdominal gas is also not an immediate indication for surgery if the patient is stable.
- Acute diverticulitis rarely affects patients with jejunal diverticulosis. The key to diagnosis and subsequent NOM and treatment with antibiotics (usually successful) is a CT scan.

3.7 Severe Acute Pancreatitis

- Current recommendations are not to give antibiotics for all patients with acute pancreatitis. Some do based on APACHE II score >8. Most authors give antibiotics only for extrapancreatic infection, such as cholangitis, catheter-acquired infections, bacteremia, urinary tract infections, and pneumonia (strong recommendation, high quality of evidence).
  - Imipenem, a wide-spectrum agent that achieves high levels within the pancreatic parenchyma, appears to be the drug of choice, although the use of prophylactic antibiotics does not alter overall mortality.
- Endoscopic sphincterotomy is the only invasive procedure that should be considered early, in the course of severe biliary AP, especially if ascending cholangitis is present.
- NOM is indicated unless infected pancreatic necrosis is diagnosed/suspected or other acute indications (i.e., abdominal compartment syndrome, gangrenous cholecystitis) arise.
  - Determining the presence of infected pancreatic necrosis can be challenging, since sterile and pancreatic necrosis are clinically indistinguishable.
  - It should be suspected with fever, leukocytosis, clinical deterioration, or failure to improve, typically in the second or third week after symptom onset. Contrast-enhanced CT scan may show gas bubbles within the necrotic pancreas, and this should be considered pathognomonic of infection. If not, fine-needle aspiration should be pursued. The false-negative rate is around 10–12 %, so even in the absence of documented infection (so-called sterile necrosis), surgery may be required if clinical suspicion remains high.

3.8 Miscellaneous Conditions

- *Esophageal perforations*
- NOM is feasible in patients with small, contained perforations promptly recognized, especially in the cervical esophagus, but also in some cases in the thoracic esophagus.
  - Criteria for NOM include minimal or no signs of systemic response, absence of tachycardia, fever or pain, no associated distal obstruction, and a perforation that is not in the abdominal cavity.
  - As concerns endoscopic complications, it is particularly important to know when *not to operate* rather than *when to operate*.
  - Despite strict adherence to these criteria, up to 20 % of patients managed nonoperatively develop complications within 24 h that require surgical intervention.
  - Broad-spectrum antibiotic treatment should be associated with nasogastric

decompression, percutaneous drainage of chest collections if present, and parenteral nutrition.
  - Endoscopically placed covered stents have been used with good results, both in malignant and benign perforations.
- *Esophago-gastric caustic injuries*
  - Endoscopic evaluation of the depth and spread of caustic necrosis is challenging, and initial endoscopy may overestimate the severity of the lesions. Moreover, superficial necrosis may heal after conservative management and thus enable resection to be avoided.
  - Zargar's endoscopic classification can help decide on the most appropriate course of action: stage I (inflammation alone), stage IIa (superficial ulceration), stage IIb (deep or circumferential ulceration), and stage III [limited (IIIa) or extended (IIIb) necrosis involving the entire esophagus, and/or the stomach, massive hemorrhage with hematemesis.
- *Acute gastric volvulus*
  - The abdomen may appear relatively innocent, with little epigastric pain and no abdominal findings on examination.
  - At times, the ability to pass an NG tube provides some temporary relief of epigastric/substernal pain and can buy some time for surgery, but NOM has very little, if any, role in the management of this infrequently encountered condition, and a sense of urgency must prevail in the surgical management.
- *Acute mesenteric ischemia*
  - Although very limited, there is definitely a role for endovascular management in the very earliest stages of acute mesenteric embolism when necrosis is not a significant risk. This situation is very uncommon in clinical practice, and a late presentation of the patient and late diagnosis is the rule, when surgical treatment is either unavoidable or already futile.
  - The evidence in favour of successful intra-arterial fibrinolysis and avoidance of surgery comes mostly from isolated case reports or small series of acute embolism of the superior mesenteric artery (SMA). A very early diagnosis, coupled with an absence of peritoneal signs, and the presence of normal abdominal plain radiographs, together with radiologists skilled in the procedure and a close SICU monitoring, are absolute prerequisites for this approach.
- *Rectus sheath hematoma*
  - Conservative treatment is the mainstay of management in hemodynamically stable patients with non-expanding hematomas.
  - Coil embolization can be an alternative in high-risk patients refractory to conservative therapy.

    Very rarely a surgical approach may be needed in case of failure of the NOM or the development of an abdominal compartment syndrome.
- *Spontaneous retroperitoneal hematomas* (*SRH*)
  - Increasingly encountered in clinical practice as a result of anticoagulation therapy, their clinical presentation may show a wide range of symptoms from femoral neuropathy to abdominal pain or a catastrophic shock or even abdominal compartment syndrome.
  - Surgery or radiologic intervention (TAE) should be performed if the patient does not respond to supportive therapy.

Pitfalls

- An incomplete knowledge and understanding of the natural history and different clinical presentations of the more common "surgical" emergencies
- Not taking into account the comorbidities of the patient and the estimation of his/her surgical risk
- Failure to understand the value of CT scan in helping decide on the most appropriate course of action in some cases and the value of less invasive management alternatives provided by interventional radiology and endoscopic procedures

3.9 Summary

The increasingly advanced age of the surgical population, with its correspondent comorbidities, a better understanding of the pathophysiology of many conditions, the easy availability of CT scan for emergency imaging diagnosis, and the increasing experience gained with interventional radiology and endoscopic procedures, coupled with the recognition of the effective use of antibiotics and other drugs as the main treatment strategy in many conditions formerly considered as mainly or exclusively surgical, has prompted a revolution in the management of many "surgical" emergencies. Some patients are just too sick to withstand an emergency surgical procedure, and the wise surgeon must at times refrain from his natural impulse to the scalpel and exercise his clinical wisdom, with the help from the new knowledge and the new technologies.

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Pathophysiology

4

Ari Leppäniemi

Contents

Objectives

- Characterize the pathophysiological processes in abdominal emergencies.
- Categorize these processes into corresponding groups.
- Outline the systemic and local consequences of these processes.
- Link the consequences into the development of symptoms and signs.
- Describe the primary aim of therapy in different pathophysiological conditions.

4.1 Introduction

Acute disease processes in the abdomen, whatever the cause, manifest in the vast majority of cases in a limited number of ways. These manifestations can be grouped according to the principal pathophysiological process and used as a guiding principle toward both diagnosis and therapy. Regardless of the organ or organ system involved, the clinical presentation of a specific pathological process in the abdomen is constant. Knowing the usual presentation of a disease, i.e., appendicitis, ruptured ectopic pregnancy, pelvic inflammatory disease, etc., allows early diagnosis, expeditious formulation of the principal goal of treatment, as well as understanding the natural course of the process if not interrupted by intervention that in most cases is surgical.

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4.2 Hemorrhage

Acute extravasation of blood can:

- Occur freely into the abdominal cavity (e.g., ruptured ectopic pregnancy or liver adenoma)
- Be contained and confined to the retroperitoneal space (ruptured abdominal aortic aneurysm) or specific pathological cavity (bleeding pancreatic pseudocyst)
- Bleed into a hollow organ such as the gastrointestinal (bleeding peptic ulcer), biliary, or urinary tract (renal tumor).

Depending on the amount of blood extravasated and speed of extravasation, the symptoms are dominated either by local irritation or compression caused by the blood and blood clot or by systemic manifestations of *acute hypovolemia* that, if untreated, can result in *exsanguination* of the patient.

If the bleeding stops spontaneously, the extravasated blood or clot can cause delayed problems in form of:

- Compression on adjacent organs
- Obstruction of hollow organs (urinary bladder tamponade)
- Infected hematoma and subsequent abscess formation
- Recurrent bleeding (at high risk if the underlying pathological process is not treated)

The main aim of treatment is to stop the bleeding, utilizing one or more of the following interventions:

- Operation
- Endoscopic procedure
- Interventional radiology (angioembolization)

The urgency of treatment depends on the rate of bleeding. Hypovolemic shock is corrected with intravenous volume expansion avoiding complete normotension in uncontrolled hemorrhage, thus reducing the rate of bleeding and decreasing the risk of recurrent bleeding after spontaneous hemostasis. Extravasated blood is replaced with blood transfusion including clotting factors to maximize the chance of hemostasis that in most cases requires mechanical intervention to seal off the bleeding vessel.

4.3 Contamination

The sources of bacterial contamination in the abdominal cavity include:

- Perforation of a hollow organ containing normal bacteria flora, such as the gastrointestinal tract (most common source of contamination)
- Bacterial translocation through gangrenous intestine (gangrenous appendicitis, ischemic or gangrenous loop of bowel) or other hollow organ wall (gangrenous cholecystitis)
- Previously contained abscess perforating into the free intraperitoneal space

Whether caused by translocation or frank perforation, the bacterial contamination will induce both a *local and systemic inflammatory response*.

Depending on the size and location of the perforation and the ability of the adjacent organs and the greater omentum to seal off the perforation, the condition can progress to:

- Generalized secondary peritonitis
- Walled-off inflammatory process followed either by resolution or formation of a mature abscess

Occasionally, the bacterial contamination is preceded by chemical contamination (e.g., perforated peptic ulcer) causing the initial reaction and symptoms, and the effects of bacterial contamination will manifest within the next few hours.

The aims of treatment

- Control the source of contamination
- Correct the disturbed homeostasis caused by the systemic inflammatory reaction

Source control can be achieved by

- Removal of the inflamed organ before or after perforation (acute appendicitis, strangulated bowel loop, acute cholecystitis)

- Surgical closure of the perforation (perforated peptic ulcer)
- Diversion of the intestinal contents with entero- or colostomy, if complete source control in the gastrointestinal tract cannot be reliably achieved or it is not safe to perform primary closure or anastomosis (e.g., the Hartmann' procedure for perforated sigmoid diverticulitis)
- Drainage of the content outside the body with aptly placed drains to create a "controlled fistula," such as in delayed perforation of the duodenum with no chance of reliable primary closure

4.4 Obstruction

A *mechanical obstruction of a hollow organ* leads to a distinct clinical picture dominated by colicky pain when the body tries to overcome the obstruction by enhanced peristaltic contractions. The cause of the obstruction can be intraluminal or caused by external compression, volvulus, or kinking. The progression and complications caused by the obstruction depend on the organ system involved.

Gastrointestinal tract
- Obstruction caused by peritoneal adhesions or bands
- Obstructed hernia
- Twists (volvulus)
- Tumors (especially in the colon)

The obstruction will cause proximal dilatation, ischemic necrosis, and eventual perforation, if the obstruction is not relieved. The risk of perforation increases with the diameter of the dilated bowel thus causing the cecum to be the most likely perforation site in distal colonic obstruction, especially if the ileocecal valve is competent. Temporary relief can be achieved spontaneously (vomiting, incompetent ileocecal valve) or intentionally (nasogastric tube), and sometimes the obstruction may resolve spontaneously, such as in adhesive small bowel obstruction.

Colonic pseudo-obstruction (Ogilvie's syndrome) is a nonmechanical dilatation of the colon that often requires some form of mechanical (endoscopic) or pharmacological (neostigmine) intervention to prevent overdilatation of the colon.

Biliary tract
- Obstruction in the main hepatic or common bile duct (usually caused by stone or tumor) will result in obstructive jaundice.
- If not relieved, a secondary liver injury will follow.
- An obstructed cystic duct will cause dilatation of the gallbladder with ensuing acute cholecystitis, perforation, or empyema.

Urinary tract
- Stone
- Tumor (including prostatic hyperplasia)
- Blood clot

Urinary obstruction will cause proximal dilatation of the urinary tract, renal insufficiency (if bilateral), and eventually loss of a kidney, especially if the obstruction is prolonged or associated with an infection.

Aims of treatment of hollow organ obstruction:

- Relieve the obstruction by correcting or removing the cause.
- Assess the viability of the obstructed organs.
- In urgent or complex situations, temporary relief of the obstruction by proximal diversion followed later by definitive treatment.

Examples of proximal diversion:

- Proximal colostomy in obstructive distal colon or rectal cancer
- Percutaneous transhepatic cholecystostomy or biliary drainage
- Suprapubic cystostomy

Internal drainage utilizing endoscopic placement of stents can also be a definitive procedure, as in patients with advanced cancer or chronic pancreatitis. In most cases, however, *surgical removal of the cause* of obstruction is the definitive treatment with best long-term effect.

4.5 Ischemia

A complete or partial occlusion of a visceral artery leads to end-organ ischemia unless sufficient collateral circulation exists. An acute obstruction is usually caused by thrombosis or an embolus, but occasionally an acute low flow state without obvious localized vascular obstruction can have the same effect.

Depending on the organ involved, the symptoms and localizing signs manifest in different areas of the abdomen. Ischemic pain is usually abrupt, severe, and sometimes poorly localized in the initial stage, and the localizing peritoneal irritation might not be yet present.

Vascular inflow occlusion of the solid abdominal organs (*liver, spleen, kidneys*) will result in ischemic necrosis if revascularization is delayed for more than a few hours.

- Warm ischemia is tolerated poorly by the kidneys, whereas in the liver, either the hepatic artery or the portal vein (if one of them is intact) usually provide sufficient oxygen to prevent cellular necrosis.
- Occlusion of a branch of the main artery can lead to partial infarction of the end organ, such as the spleen or kidney.

Gastrointestinal tract

- Acute occlusion of the *superior mesenteric artery* leads to massive necrosis of most of the small bowel and the right hemicolon.
- Thrombosis is usually more proximal than an embolus where the first jejunal branches might ensure the viability of a part of the proximal jejunum.
- Occlusion of the *celiac axis or the inferior mesenteric artery* seldom has dramatic effects.
- Decreased flow to the left hemicolon can lead to *ischemic colitis.*
- Thrombosis of the *superior mesenteric vein* leads to venous congestion and bowel edema with less clearly demarcated areas than arterial thrombosis. In most cases, it can be managed nonoperatively (anticoagulation) since the risk of necrosis is low.
- *Bowel strangulation* is a special form of ischemia where vascular occlusion is preceded by mechanical closed loop obstruction of the bowel caused by adhesions or incarcerated external hernia. If not corrected in time, the strangulated bowel loop will become necrotic and perforates.

4.6 Toxic Injury

Ingested drugs, toxins, alcohol, or corrosive agents cause a wide range of acute emergency surgical problems including:

- Alcohol-induced acute pancreatitis
- Toxic hepatitis
- Corrosive injury to the esophagus, stomach, and less commonly, duodenum
- Inflammation of a solid organ can lead to necrosis (liver, pancreas) and subsequent infection (infected peripancreatic necrosis) or decrease or loss of function (endo- and exocrine pancreatic insufficiency)
- In hollow organs, full-thickness necrosis usually leads to perforation and generalized infection (mediastinitis, peritonitis)

The primary aim of surgical treatment is to *manage the complications* caused by the toxic injuries (pancreatic necrosectomy, resection of necrotic esophagus) and subsequent *restoration of function* that can include complex reconstructive procedures or organ transplantation.

4.7 Abdominal Compartment Syndrome (ACS)

Increased intra-abdominal pressure (IAP) can be the result of

- Space-occupying process in the abdomen (primary ACS)
- Extensive fluid resuscitation (sepsis, burns) leading to visceral edema (secondary ACS)

Abdominal compartment syndrome is defined as sustained intra-abdominal hypertension (>20 mmHg) combined with evidence of new end-organ dysfunction.

Increased IAP will cause dysfunction of most organ systems within and outside the abdomen (most commonly in the renal, gastrointestinal, and respiratory systems) and can, if untreated, lead to multiple organ dysfunction syndrome and death.

While clinical recognition can be difficult, the IAP is easily measured through a urinary bladder catheter.

The main aim of treatment is to lower the IAP.

- Initially with *conservative* methods by decreasing intra-abdominal contents (nasogastric and rectal tubes, percutaneous drainage of ascites) and increasing abdominal wall compliance (short-term muscle relaxants, optimization of hemodynamics, removing constrictive bandages).
- If intra-abdominal hypertension persists, prompt *surgical decompression is necessary, leaving the abdomen open.*

The management of the ensuing open abdomen aims for delayed fascial closure when the principal cause of the ACS has been treated. If fascial closure is not possible, a planned hernia approach (usually with split-thickness skin grafting) is instituted and followed by delayed abdominal wall reconstruction procedure performed 6–12 months later. If the abdominal fascia cannot be closed, coverage with native tissue is always preferred, i.e., skin only closure.

Pitfalls

- Failure to recognize early systemic signs of hemorrhage
- Inability to achieve reliable source control of contamination
- Incomplete or delayed relief of hollow organ obstruction
- Delayed recognition and treatment of intestinal ischemia
- Ignoring the possibility of abdominal compartment syndrome

4.8 Summary

Acute abdominal emergencies present in a few distinct forms that have specific local and systemic manifestations, but with consequences that have many similarities regardless of the site or organ of the lesion. Massive hemorrhage leads to hypovolemic shock and exsanguination if the bleeding is not stopped. Bacterial contamination of the peritoneal cavity can lead to generalized peritonitis and septic shock unless limited by the body or source control achieved by surgical means. Hollow organ obstruction leads to proximal dilatation that often requires temporary or definitive measures to prevent permanent organ damage or perforation. Acute ischemia can cause irreversible damage to the organ involved unless revascularization can be performed rapidly. Finally, the complications caused by ingestion of toxic or corrosive agents often require surgical intervention.

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Postoperative Complications

5

Ronald V. Maier and Abe Fingerhut

Contents

Objectives

- Discuss common serious complications of operations for complex disease.
- Understand underlying pathophysiology.
- Explore decision-making process in approach to care.
- Elucidate prevention and treatment options.

Note: see individual chapters for specific complications.

5.1 Peritonitis/Abscess

- Both are manifestations of intra-abdominal infections:
  - Peritonitis: diffuse infection of the peritoneal space
    Site
    - Somewhat localized to one quadrant
    - Or generalized to two or more quadrants with a significantly increased risk of mortality
  - Abscess: localized infection in the abdomen
    Forms anywhere
    - Within the peritoneal space
    - In the extraperitoneal space, primarily the retroperitoneum
    - Or within the organs themselves, primarily the liver and spleen

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- Both occur more often today, postoperatively, due to the increasing severity of disease and complexity of procedures (including damage control) performed currently and the associated increased survival of the patient.
- Causes:
  - By far the most common cause is anastomotic leakage.
    Management depends on patient status.
    - Stable: nonoperative management is possible.
    - Unstable: surgery is indicated.
      - Laparotomy or for some laparoscopy

    If early intervention, the anastomosis can be redone, with or without protective stoma, if not, and most often.
    The two extremities should be brought out (double-barrel ileostomy or colostomy).
    Hartmann's procedure.
    Complete peritoneal toilet.
    Drainage.
  - Other causes are rare.
    Collections (abscess) in a stable patient can be drained percutaneously.
- There are no good guidelines on prevention of postoperative infections.
  - The current assumption is that factors that decrease SSI will also have a beneficial effect on the incidence of deep organ space infections, both peritonitis and abscesses.
  - These factors include:
    Avoidance of unintended injury to the bowel or other organs during any operative procedure (critical)
    Avoidance of hypoxia, hypothermia, and hyperglycemia
    Appropriate antibiotic prophylaxis and treatment
    Adequate delay in definitive completion of the surgery or closure of the wounds
- Diagnosis:
  - Primarily: pain and abdominal tenderness.
  - Fever and elevated WBC are frequent but may be absent early in the disease process.
  - Specific to diffuse peritonitis:
    Diffuse physical findings of tenderness, rebound, and guarding, such as following intestinal leak.
    Diagnosis can be made on physical examination leading to prompt surgical intervention.
  - Conversely, postoperative abscess or tertiary peritonitis can be significantly more difficult to diagnose.
    The clinical picture is less straightforward, and additional studies are frequently necessary to make the diagnosis.
    - Current multi-slice abdominal CT scans are the most useful.
- Treatment requires both source control and appropriate antibiotics.
  - Diffuse peritonitis (almost always indicating an uncontrolled GI source of contamination) mandates operative exploration for source control.
  - In contrast, intra-abdominal abscess may be sufficiently treated by drainage alone.
    Drainage is the appropriate initial step in the stable patient or patient responsive to initial therapy.
    Frequently can be placed percutaneously using radiologic guidance including fluoroscopy, CT, ultrasound, or laparoscopy.
    - There are no randomized prospective trials comparing open drainage to percutaneous drainage, but solid cohort studies suggest that the net success and mortality appear to be equal between the approaches, but percutaneous or laparoscopy avoid the potential iatrogenic morbidity of open drainage.
    - Open drainage is usually reserved for the patient in whom percutaneous drainage has failed or is not technically feasible.
  - Importantly, approximately one fourth of cases will require an additional intervention to resolve the infection.
    Need for reintervention is indicated when the patient fails to improve or worsens following intervention or when infection recurs.
    Mandatory or scheduled relaparotomies have not been shown to reduce the morbidity or mortality in these complex cases.

5.2 Paralytic Ileus

- Common postoperative disorder:
  - Occurring to some extent in most patients undergoing abdominal surgery
  - Most often transient, usually lasting 2–3 days, but may last for more than 7–10 days
- Caused by neural, humoral, and metabolic factors:
  - Direct intestinal exposure, manipulation, and desiccation
  - Retroperitoneal bleeding
  - Severe infection, both intraperitoneal and extraperitoneal, such as pneumonia
  - Electrolyte imbalances, particularly hypokalemia
  - Drugs, primarily narcotics
    Morphine binds to μ-opioid receptors in the CNS and colon causing nonpropulsive electrical activity.
- Of clinical importance, should increase suspicion and help identify preemptively the onset of intestinal ischemia or an intra-abdominal infectious process, such as a localized abscess or diffuse peritonitis, while still reversible
- Treatment:
  - Watchful support is in most cases appropriate and safe:
    NG suction and fluid resuscitation.
    Rapid correction of electrolyte imbalances, especially hypokalemia.
    The use of thoracic epidurals enhances return of bowel function.
  - In contrast, the development of secondary ileus after initial return of bowel function mandates evaluation for mechanical obstruction or intra-abdominal sepsis from abscess or peritonitis:
    Modern multi-slice CT scanners is exceptionally effective.
    Laparotomy may be necessary to definitively exclude these factors and to rule out intestinal ischemia or threatened viability of the intestinal wall due to intense and/or prolonged distension.

5.3 Bleeding/Coagulopathy

- Can occur after any invasive procedure with increasing risk paralleling the increase in complexity of the procedure.
- Diagnosis:
  - Should be suspected in any postoperative patient whom develops tachycardia, pallor, volume-dependent hypotension, oliguria, restlessness/anxiety, and/or abdominal distention.
    An anxious, agitated postoperative patient should never be sedated without evaluation for ongoing bleeding.
  - Note that the hematocrit fall may be delayed in the acute setting until intravascular volume is restored.
  - Evidence of bleeding site should be sought with physical exam and evaluation of all tubes and wounds/dressings, along with any evidence of diffuse bleeding from puncture sites indicative of a coagulopathy.
  - Coagulation tests, including platelet count, bleeding time, and PT and PTT along with fibrinogen levels and thromboelastograph (TEG) or rotational thromboelastometry (ROTEM) may differentiate primary versus secondary hemostasis failure.
- Causes:
  - Absence or loss of surgical hemostasis
  - Technical error
  - Resolution of vasoconstriction
  - Coagulopathy
- Management:
  - Absence or loss of surgical hemostasis and/or refractory hypotension, ACS, or ongoing need for blood transfusion usually requires returning to the OR and reoperation.
    A discreet bleeding point is frequently not found.
    However, evacuation of the dead space and blood, breaking the endogenous thrombolytic cycle, is frequently successful.
  - Hemostatic failure due to platelet or coagulation cascade failure.
  - Correction of hypothermia, suppression of drug-inducing agents.

  - Search for acquired secondary coagulopathy (consumption and/or dilution from tissue injury, volume resuscitation, sepsis, or transfusion with product poor blood component therapy).
  - Low fibrinogen level should be treated with FFP.
  - Early aggressive transfusion plus FFP and possibly platelets to achieve a near 1:1 ratio of packed RBC to FFP is associated with an improvement in overall survival following massive blood loss and transfusion and reduction in overall volume of blood products required (based on recent military observations after severe trauma).
- The variable impact on perfusion can further damage and cause progression in injured or diseased tissue or compromise the already completed repairs, leading to anastomotic break down, wound dehiscence, or intra-abdominal hypertension (IAH) and progress to abdominal compartment syndrome (ACS).

5.4 Abdominal Compartment Syndrome (ACS)

- Definition: end-organ dysfunction (new or ongoing) related to intra-abdominal hypertension (IAH)
  - Physiopathology:
    The abdominal compartment is contained with layers of initially elastic but ultimately poorly compliant tissue layers.
    Similar to cardiac tamponade, pressures may increase slowly until compliance of tissues is exceeded, with rapid increases occurring to small volume changes.
    When the intra-abdominal volume/pressure exceeds these limits, there is a direct effect on numerous organ functions, including cardiac, respiratory, renal, neurologic, and muscular systems.
    If not recognized and treated, the end result is worsening organ failure and potential death.
    In critically ill patients, ACS can be either primary from a direct increase in the intra-abdominal volumes or secondary due to illness outside the abdominal cavity:
    - Primary ACS is seen following events such as rupture of an AAA, spontaneous retroperitoneal bleed, pelvic bleeding, or direct injury to intra-abdominal organs.
    - Secondary ACS occurs following ischemia/reperfusion, burns, or infection, where total body, including intra-abdominal, edema occurs due to the host inflammatory response or systemic inflammatory response syndrome (SIRS).
      - In addition, the recent past trend of vigorously (and overly) resuscitating the patient with large volumes of crystalloid to reach an arbitrary goal, such as supranormal oxygen delivery, added an iatrogenic component to the edema, increased volume of tissues, and IAH.
    - Recurrent ACS is the redevelopment of ACS after treatment for primary or secondary ACS.
  - IAH can be easily measured using the fluid column height above the pubis in a Foley catheter, after instilling 50 cc of sterile saline inserted into the bladder.
    During ACS, IAH is defined as a pressure greater than 20 mmHg, but pressures can vary greatly between patients without signs of ACS.
    The primary effects of ACS are through impairment of perfusion and oxygenation:
    - Increased IAH
      - Decreases perfusion of all intra-abdominal organs and the abdominal wall compromising wound healing
      - Increases venous collapse and resistance with impaired renal, hepatic, and bowel function
      - Leads to IVC collapse responsible for decreased cardiac preload
      - Through elevation of the diaphragm compresses the heart similar to tam-

ponade, with decreased cardiac output and further decreases in organ perfusion
The restriction of the thoracic cavity compresses the lungs, elevates ventilatory pressures and causes loss of FRC, and decreases oxygenation with additional organ insult from worsening hypoxemia.
– Rapid decompression through opening of the abdomen creating an "open abdomen" is critical.

5.5 Damage Control (Open and Laparoscopic)

See also Chap. 1 (schwab, Leppaniemi)

- Definition: operations (whether via laparotomy or laparoscopy) that are limited, "incomplete" procedures performed in patients where persisting to complete the procedure would significantly increase the morbidity and mortality of the patient.
- Principal indications:
  – Operations performed for control of hemorrhage, contamination, or potential ischemia.
  – Injury to major vascular structures or highly vascular solid organs from extensive resections for malignancy, infection, or other diseases.
  Particularly true when significant blood loss and massive transfusion leads to the "Bloody Triad" of hypothermia, acidosis, and coagulopathy, associated with an unacceptably high mortality.
  – Laparoscopic procedures can produce or identify potentially morbid or lethal events that are unsafe to definitely pursue due to patient disease or comorbidity.
  Examples (can be best treated with placement of drainage to control the source, while life-threatening comorbidites are corrected):
    - Laparoscopic identification of a poorly identified bile leak after an ERCP
    - Abscess from unidentified perforated colonic processes
- Almost always require a less than optimal closure of the incisions and need for further operative intervention.

5.6 Reoperation: Timing

- Damage control reoperations
  – Necessary to:
  Complete repair or resection
  Perform anastomoses to restore intestinal continuity
  Evaluate for occult or missed injuries
  Rule out progression of ischemia
  Remove temporary packing used to control bleeding
  Remove temporary vascular shunts followed by vascular repair
  Manipulate or replace drains or drainage tubes
  Attempt delayed primary closure of the abdominal cavity
- Timing of reoperation
  – Dictated by:
  Disease and injuries present.
  Physiologic response of the patient to the initial or previous procedure.
  Somewhat variable (based on the above considerations): most reoperations occur between 12 and 72 h, preferring the soonest possible.
- Specific considerations for potential ongoing or progressive ischemia:
  – Whether from chronic or acute mesenteric ischemia or subsequent to repair of the mesenteric artery or ligation of the proximal mesenteric or portal vein.
  – Planned reoperation to rule out ischemia is indicated.
  Lack of improvement or progression of base deficit, lactate levels, or ongoing requirements for fluid resuscitation all indicate the likelihood of ongoing ischemia.

5.7 Wound Dehiscence/ Management

- Causes:
  - Inadequate perfusion due to the increased tension required for closure of swollen and noncompliant tissues or hypovolemia and hypoxia from any other cause (e.g., effect of smoking)
  - Infection causing direct breakdown of tissues and impairment of healing
  - Increased intra-abdominal pressure
  - Systemic effects of:
    Diabetes, malignancy, steroid or other immunosuppressive therapy, and chronic lung disease
- Prevention:
  - Consideration of time since insult helps determine whether a wound should be closed or reopened
    6–8 h is quoted for trauma, but no rules have been established in nontrauma surgical emergencies.
    - e.g., *a* contaminated ischemic lower limb may never be safe to close.

    Opening a wound and delayed primary closure is a viable option when in doubt.
  - Currently, there is no evidence that running versus interrupted initial fascia closure has an effect on the risk of dehiscence.
  - When in doubt – delay closure or reopen.
- In the critically ill patient, do not neglect both underlying malnutrition and inadequate levels of structural protein and cofactors for healing, as well as the additional stresses of the diseases involved.
- Diagnosis:
  - All wounds should be inspected if the patient displays any evidence of infection or if skin changes or significant drainage occurs at the wound site.
  - The classic salmon pink fluid drainage of peritoneal fluid from disrupted fascia mandates removal of any dermal closure and both visual and manual inspection of the wound fascia.
  - Similarly, any systemic sign of infection, or any local changes involving erythema, purulence, skin blistering, or darkening at the wound site, mandates close evaluation, and opening of the superficial wound if concern exists.
- Management:
  - In virtually all cases of wound dehiscence, unless physiologically prohibitive, the patient should be explored in the operating room.
  - The fascia should be taken down and carefully inspected for ischemia or infection.
    All diseased fascia should be resected back to healthy tissue.
  - Careful inspection of the abdomen is necessary to rule out anastomotic leaks, intra-abdominal abscess, or peritonitis that requires additional intervention. In cases where the fascia requires little or no debridement and tension on closure is acceptable, repeat fascial closure may be possible. To not repeat what has failed, additional techniques are required, most commonly the wide-based, interrupted "mass closure" encompassing both layers of fascia and rectus muscle with or without including the dermis and subcutaneous tissue in each bite. In cases where closure leads to unacceptable tension, the abdomen should be left open.

Pitfalls: Lack of Recognition

- Lethal pathophysiology – "Bloody Triad"
- Ongoing progressive disease: bleeding, ischemia, no source control
- Presence of IAH/ACS: possible recurrence
- Need for reoperation
- Wound compromise

5.8 Summary

Procedures should be limited to prevent a potential lethal outcome, and use a staged response to optimize survival. Aggressive restoration of physiology and minimization of comorbidity during constant monitoring is crucial. Make the commitment to a serial/ongoing process of care and plan on returning to "fight another day." In effectively dealing with complications, the surgeon must know and recognize the risks of complication, using a "worst case scenario" mentality.

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When to Operate After Failed Nonoperative Management

6

Gregory A. Watson and Andrew B. Peitzman

Contents

6.1 Introduction

Initial nonoperative management of patients with acute pathology is commonplace for several disorders. Inherent in this decision is the belief that surgery is best performed in a delayed fashion (when conditions are more favorable, both for the patient and the surgeon) or that surgery can be avoided altogether. However, despite our best intentions, nonoperative management will fail in a certain subset of patients initially believed to benefit from such an approach. In this chapter, we will discuss when to consider operative management (and, consequently, how to recognize that nonoperative management has failed) for several common conditions seen by general and acute care surgeons. Since these topics have already been described elsewhere in the text, details regarding epidemiology, diagnostic evaluation, and specific operative approaches will only briefly be discussed.

6.2 Gastrointestinal Bleeding (GIB)

- Not a viable option for patients who present with massive gastrointestinal bleeding (GIB) and shock: operation resuscitation and localization/treatment occur simultaneously in the operating room:

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- Intraoperative endoscopic evaluation.
- Segmental clamping of the bowel to facilitate identification of the bleeding segment.
- Bowel resection without localization of the source is not recommended as the rebleeding rate is high (50 % for hemicolectomy when the source is not localized).

- Indications for surgery in GIB include:
  - Failure of nonsurgical hemorrhage control
  - Ongoing hemodynamic instability
  - Transfusion of >6 units of blood
  - Difficulty cross-matching blood (due to antibodies)
  - Suspected or known malignancy (particularly with gastric ulcer)
  - Pathology not correctable without surgery (aortoenteric fistula)
- After successful resuscitation outside the operating room, the *nonoperative approach* (diagnosis and potentially therapy) is by endoscopy or interventional radiology:
  - Success rates vary depending upon the etiology of the bleed and the modality chosen, but even if control of hemorrhage is achieved initially by nonsurgical means, operation may still be necessary.
  - Decision-making is complex and requires an understanding of the perceived risk of rebleeding, the underlying pathology, the morbidity associated with surgery, and the morbidity/mortality associated with failure of observation.
  - Well-documented risk factors associated with poor outcomes include age >60 years, presence of comorbid disease, shock on presentation, onset during hospitalization, persistent or recurrent hemorrhage, and need for emergent surgery.
- Overall, 80 % of acute GIB is from an upper gastrointestinal source and is best discussed in terms of variceal and nonvariceal causes:
  - *Nonvariceal upper GIB*:
    Peptic ulcer disease is the most common cause:
    - Hemorrhage is controlled in 80 % of patients following initial endoscopic intervention and 75 % of patients following repeat endoscopy.
    - Angioembolization is less effective (65 % success rate).
    - Rebleeding is associated with increased mortality and about 10 % of patients will require operation.
      - The Forrest classification is a well-described risk assessment for rebleeding based upon ulcer characteristics.
        The presence of active arterial hemorrhage (Forrest Ia) or large, nonbleeding visible vessel (Forrest IIa) is associated with a substantial rebleed risk.
        Ulcers >2 cm, posterior duodenal ulcers, and gastric ulcers also have a high risk of rebleeding.
    - If a patient has stopped bleeding, has numerous high-risk factors for rebleeding, and is not a prohibitive operative risk, surgery is recommended in a controlled, planned setting to avoid the morbidity of emergent surgery.

    Other causes are less likely to require operation:
    - Mallory-Weiss tears are self-limited 90 % of the time, but if intervention is required, endoscopy is highly successful.
    - Stress gastritis is uncommon in the era of acid-suppression therapy and typically is successfully managed medically.
    - Esophagitis is generally managed medically with a high rate of success and endoscopy is useful for refractory cases.
    - Dieulafoy's lesion is successfully treated endoscopically in 80–100 % of cases.
    - Bleeding into the bile duct or pancreatic duct (hemobilia or hemosuccus pancreaticus) is generally managed with angiography and intervention with high success rates.
  - *Variceal-related upper GIB*:
    Rarely requires operation.

Endoscopy is 90 % effective for esophageal varices (although repeat may be required) but is not as effective for gastric varices.

For the 10 % of patients who continue to bleed or rebleed, transjugular intrahepatic portosystemic shunting (TIPS) is 95 % effective in controlling bleeding.

Urgent surgical shunts are rarely required but can be considered in patients who have good hepatic reserve and are not transplant candidates.

– *Lower GIB* (*LGIB*):

Colonoscopy is effective in identification of the source in 95 % of cases and has a low (0.5 %) complication rate.

Diverticular disease is the most common source.

- Massive lower GIB originates in the right colon in two-thirds of cases.
- Therapeutic colonoscopy is generally effective at stopping the bleed acutely.
- If this fails or the patient rebleeds, angioembolization can be considered (success rate: 40–85 % of cases, but the rebleeding risk is high, particularly if the small bowel or the cecum is the source).
- The overall risk of rebleeding at 1 year is 10 % but rises to 50 % at 10 years.
- If the diseased segment has been localized, elective colonic resection is indicated for good surgical candidates.

Angiodysplasia can be diagnosed and treated successfully in most patients with colonoscopy or angioembolization:

- Segmental colectomy should be performed if the lesion has been localized but continues to bleed.
- Hemicolectomy without specific localization of the source should be avoided because of the high risk of failure to resect the pathology, with high incidence of rebleed.
- However, if the source is felt to be the colon, or if all other causes have been eliminated, subtotal colectomy is recommended although the mortality is high (30 %) when performed emergently.

Tumor:

- Usually surgery, ideally nonemergent, is required.

– All patients who undergo angioembolization should be followed closely for signs of mesenteric ischemia (particularly patients with significant vascular disease), but the overall risk appears to be low.

- Up to one-third of patients with LGIB actually have a small bowel source:
  – If the patient's clinical status permits, a thorough search for the source should be performed before operation is considered.

6.3 Intestinal Obstruction

- Common problem and a frequent source of admissions to surgical services.
- Diverse array of causes described elsewhere.
- Patients most likely to be managed successfully without operation include those:
  – With partial obstruction secondary to adhesions (resolution in as many as 90 % of patients but recurrence may be as high as 50 %).
  – Whose condition derives from an inflammatory disorder (diverticulitis, inflammatory bowel disease).
  – With early postoperative obstruction.
  – Operation in the setting of simple obstruction is associated with mortality of <5 % but rises to 30 % in the setting of necrotic bowel.
- Criteria for continued observation or operation:
  – 24–48 h should be the upper limit of nonoperative management as the risk of complications rises dramatically and the likelihood of successful observation diminishes.

  - Patients who are going to respond to nonoperative therapy will generally improve within 8–12 h following nasogastric decompression and resuscitation.
    Close monitoring, frequent reexamination, and perhaps repeat imaging are warranted.
- Poor candidates for nonoperative management include those:
  - With a prior midline incision, colorectal operation, retroperitoneal procedure, or a history of carcinomatosis
  - With vomiting on presentation and certain CT scan findings (intraperitoneal free fluid, mesenteric edema)
  - Worsening abdominal distention or tenderness, persistently high nasogastric output or development of feculent drainage, and decreasing intestinal gas distal to the point of obstruction on radiographs
- In the case of early postoperative small bowel obstruction, longer periods of observation may be tolerated as the risk of strangulation is low (<1 %), but nutritional support (total parenteral nutrition) is necessary:
  - Condition occurring in approximately 10 % of patients who have had abdominal surgery and must be distinguished from ileus.
  - Almost 90 % of patients will improve without operation, and 70 % will do so within the first 7 days.
  - Indications for reoperation in this setting include:
    Failure to respond within 2 weeks
    Worsening clinical condition
    Progression of obstructive symptoms
- Patients with an inflammatory etiology for intestinal obstruction (diverticulitis, radiation enteritis, inflammatory bowel disease) typically respond well to supportive therapy and treatment of the underlying condition, and surgery is rarely required.
- Generally speaking, clear-cut indications for urgent surgical intervention (conditions which are unlikely to improve without operation) include:
  - Complete and closed-loop obstructions
  - Presence of peritonitis, pneumatosis, or pneumoperitoneum
  - Suspected or confirmed strangulation
  - Incarcerated hernia
  - Gallstone ileus
  - Nonsigmoid colonic volvulus
- Criteria that constitute failure of observation include progression to any of the conditions listed above or failure to improve in a timely fashion (usually 24–48 h).
- Several scenarios warrant caution and definitive nonoperative management is ill-advised in:
  - Sigmoid volvulus that responds to initial endoscopic decompression should be treated surgically to prevent recurrence.
  - Patients with recurrent adhesive bowel obstruction who do not present a prohibitive operative risk likely benefit from semielective exploration and adhesiolysis.
  - Patients with partial colonic obstruction, most often due to cancer, diverticulitis, or stricture.
  - Bowel obstruction in the absence of prior abdominal surgery or hernia if improvement is not noted with 24 h (likelihood of significant anatomic pathology is high. are less likely to improve without operation)

6.4 Acute Cholecystitis

- Decision to pursue initial medical management or operate urgently is complex:
  - Depending on the severity of the disease, the duration of symptoms, and the overall condition of the patient
- The Tokyo Guidelines, published in 2007, represent a severity scoring system which can be used to guide clinical decision-making and describe three grades of acute cholecystitis:
  - Mild (grade 1): acute cholecystitis without evidence of organ dysfunction
  - Moderate (grade 2): acute cholecystitis with marked local inflammation, mild systemic effects, or prolonged duration (>72 h) of symptoms

  - Severe (grade 3) acute cholecystitis with organ dysfunction
- Indications:
  - Early laparoscopic cholecystectomy is recommended for most cases of grade 1 and 2 disease.
    Safe
    Associated with (vs. delayed surgery):
      - Similar conversion rates to open procedure
      - Similar morbidity
      - Shorter hospital stay
      - Less complications of recurrence or nonresolution (17.5 % of patients)

    Recommended for elderly patients (at particular risk for morbidity if surgery is not performed during the initial hospitalization)
  - If a nonoperative approach is initially chosen for patients with grade 1 or 2 acute cholecystitis:
    Close monitoring to detect signs of worsening clinical status or disease progression, both of which prompt urgent intervention.
    Surgery should be performed in patients who initially respond to medical management or in recurrence (unless a prohibitive operative risk).
  - For the less common case of grade 3 acute cholecystitis or in those patients with milder disease (grades 1 and 2) who present a prohibitive operative risk, cholecystostomy (percutaneous or operative) is a viable option:
    Clinical improvement is generally seen within 72 h of drainage and complications are infrequent (10–20 %) although mortality following the procedure has been reported to be high (5–40 %), likely related to the severity of the underlying disease process.
    Selection of patients for cholecystostomy depends on good clinical judgment:
      - Few would argue that patients with severe acute cholecystitis and end-organ dysfunction (grade 3) would benefit from drainage.
      - For patients with milder forms of disease (grades 1–2) who are considered a high operative risk, cholecystostomy may not be required.
      - Predictors of failure for conservative treatment alone include age >70 years, history of diabetes, and persistent leukocytosis >15,000/mm^3 at 48 h. Thus, in patients with these risk factors or who fail to respond rapidly (within 48–72 h) to medical management, percutaneous drainage or operation is warranted.

6.5 Diverticulitis

- The Hinchey classification describes four stages of disease severity which correlate with increasing morbidity and mortality and are helpful when considering management options. Hinchey stage 1 has small, confined mesenteric or pericolic abscesses; stage 2 has larger abscesses often confined to the pelvis; stage 3 is purulent peritonitis and implies rupture of an abscess; and stage 4 is free diverticular rupture with fecal peritonitis.
- Initial nonoperative management is indicated for uncomplicated diverticulitis and mild (Hinchey 1 and 2) cases of complicated diverticulitis:
  - Conservative treatment with bowel rest and antibiotics, even in patients with small (<4 cm) abscesses, is usually effective.
    Antibiotics:
      - Amoxicillin and clavulanic acid (1 g and 125 mg) IV, 3 per diem.
      - If penicillin allergy, ciprofloxacin 200 mg/12 h + metronidazole 500 mg every 8 h.
      - Intravenous antibiotics and fluids are continued for at least 36–48 h until oral feeding is tolerated.
      - Outpatient oral amoxicillin and clavulanic acid (875 and 125 mg every 8 h) for 10 days is also possible.
  - Larger (>4 cm) abscesses should be drained as this appears to speed recovery.

  - Patients whose abscess cavity contains feculent material are unlikely to respond to drainage alone and early operative intervention should be considered.
  - Elderly patients and those who are immunosuppressed or immunocompromised are more likely to present with perforation and a lower operative threshold is warranted.
- Fewer than 10 % of patients admitted with diverticulitis require operation during the same admission.
- Clear-cut indications for emergent operative treatment include generalized peritonitis, uncontrolled sepsis, the presence of a large, undrainable abscess, uncontained visceral perforation, and failure of medical management or lack of improvement within 3 days. These findings are most characteristic of Hinchey stage 3 and 4 disease:
  - The overall rate of recurrence is 10–30 % within a decade of the index presentation, and most patients (roughly 87 %) who suffer one recurrence will not suffer a second.
  - The presence of a diverticular abscess on admission (even if drained successfully) and those with multiple comorbid conditions (including obesity) are significantly more likely to suffer a recurrence and to require an intervention, so a more aggressive approach (i.e., elective resection) may be justified.
  - Patients with diverticular stricture or fistula may be stabilized initially and evaluated, but operation will ultimately be required.
  - Although age less than 50 years had been an indication for elective resection in the past, more recent data do not support this approach. Acute, uncomplicated diverticulitis, even if recurrent, does not warrant surgery.

6.6 Acute Pancreatitis

- Most patients present with a mild form of disease and are unlikely to require surgery.
- Nonoperative management includes:
  - Intravenous fluids
  - Antibiotics (debated)
- Indications for surgery (required in 10–20 % of patients)
  - Infected pancreatic necrosis:
    High suspicion in patients with fever, leukocytosis, clinical deterioration, or failure to improve, typically in the second or third week after symptom onset.
    Contrast-enhanced CT scan may show gas bubbles within the necrotic pancreas, confirming the presence of infection.
    Fine-needle aspiration is confirmatory.
    - False-negative rate is around 10–12 %, so even in the absence of documented infection (so-called sterile necrosis), surgery may be required if clinical suspicion remains high.
  - Abdominal compartment syndrome
  - Gangrenous cholecystitis
- Timing of surgery:
  - Surgery during the initial course of the illness (first 2 weeks) is associated with mortality rates up to 65 % and should generally be avoided in the absence of specific indications.
  - Delaying intervention at least 2 weeks is recommended to allow demarcation of necrotic tissue, which limits the extent of surgery and may reduce the risk of bleeding.
    Mortality rates appear to be substantially lower (around 25 %) with this approach.
  - In Western countries, gallstones are associated with acute pancreatitis 40–60 % of the time. However, cholecystectomy should be delayed until there is significant resolution of the inflammatory response and clinical recovery.

6.7 Clostridium Difficile Colitis

- Nonoperative management includes:
  - Discontinuation of the offending antibiotic
  - Metronidazole and/or oral vancomycin
- In case of lack of improvement within 3–5 days: operative treatment is indicated:
  - Total abdominal colectomy with end ileostomy

Indications:

- Perforation, toxic megacolon with impending perforation, severe sepsis or septic shock, peritonitis, end-organ dysfunction, need for vasopressor support, and failure of medical management

– Or diverting loop ileostomy with antegrade colonic lavage
  Indications:
  - Need for ICU admission, hypotension requiring vasopressor support, neurologic changes, respiratory failure necessitating mechanical ventilation, increasing WBC count $\geq$20,000/mm^3, lactate concentration $\geq$5 mmol/L, and other signs of end-organ dysfunction
– Both procedures can be performed laparoscopically.

Conclusions

The decision to operate or observe a patient and the ability to recognize when nonoperative management has failed or is likely to fail is one of the more challenging decisions the general and acute care surgeon must make. To optimize outcomes, knowledge of the underlying disease, proper patient selection for a nonoperative approach, and timely recognition and intervention in the event of failure of conservative therapy are paramount.

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Part II

Techniques

Laparoscopy for Non-trauma Emergencies

7

Selman Uranues and Abe Fingerhut

Contents

Objectives

- Know how to position and prepare the patient.
- Know how to get open access to the peritoneal cavity/first trocar.
- Know how to explore the abdominal cavity.
- Know how to expose solid organs and hollow viscus.
- Know how to control bleeding and contamination.
- Know the principles of laparoscopic bowel resection and anastomosis.
- Know the principles of laparoscopic lavage and abdominal drainage.

Since its initial description in 1985, laparoscopy has acquired an increasing place in the diagnostic and therapeutic emergency setting and now has well-defined indications in the armamentarium of surgery for acute diseases. Laparoscopy is not only a technical variant or an additional therapeutic option; it has become a genuine component of the array of surgical treatment.

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7.1 Ergonomics

- Are important issues and directly affect outcomes
- Entail patient position and preparation, the surgeon and table position, the operating room (OR) setup, the trocar setup, and the instruments and technology needed

7.1.1 Patient Position and Preparation

- The patient is positioned supine, legs spread apart allowing the (assisting) surgeon to stand between the legs enabling access to any point of the abdominal cavity including the diaphragm.
- Precautions must be taken so that the patient does not slide when the table is inclined or tilted.
- Pressure points should be protected.
- Arms in adduction especially in emergencies of the lower abdomen or pelvis.
- Routine bladder catheter inserted (not only when lower abdominal procedures are indicated but also because the duration of the procedure is often unknown).
- Patient should be prepped and draped in order to correctly deal with any unexpected findings and intraoperative accident or to convert without delay.

7.1.2 Surgeon and Table Position

- The patient, table, and monitor should be positioned so that full access can be obtained to all four quadrants of the abdomen as required (Fig. 7.1).
- The surgeon should be able to move to either side or between the legs as necessary or preferred.
- The table should allow inclination or tilting as necessary.

7.1.3 Monitor and Screen Position

- Optimal ergonomics call for:
  - A flat screen placed at 15° below eye level (or at the gaze-down level, i.e., at the level of the surgeon's elbows).
  - The monitor placed so that the surgeon's vision, hands, target, and screen are aligned.

Fig. 7.1 Setup of the operating table and the positioning of the patient

– Either several monitors or the video monitors should be mobile and moved according to the site of the pathology to maintain the [ideal] alignment necessary for optimal ergonomic conditions.

7.1.4 Trocar Setup, Creation of Pneumoperitoneum, and Instrumentation

- Trocar setup:
  - Initial trocar layout depends on clinical findings and diagnostic probabilities:
    Triangulation is recommended to allow resection and adequate suturing as necessary.
    Lateralization of trocar insertion is recommended in case of intestinal distension (intestinal obstruction or ileus secondary to peritonitis or abscess).
    Avoid insertion through previous scars (incisions or drainage sites) for the first trocar.
    Add additional trocars as needed.
  - Should allow full and unrestricted exploration of the entire abdominal cavity as necessary
  - First trocar insertion:
    Routine open approach is strongly recommended (without use of the Veress needle), especially when there is considerable intestinal distension.
    The periumbilical approach is recommended in case of diagnostic doubt, unless prior surgery indicates otherwise.
  - Further trocars can be inserted once a preliminary survey of the entire abdominal cavity has shown that there is no need to abort or to convert to a laparotomy.
    Two trocars are placed on the right and left and lateral to the rectus muscle sheath at the level of the umbilicus (Fig. 7.2).
- Pneumoperitoneum
  - Should be established progressively, under close monitoring:

Fig. 7.2 Trocar positions for diagnostic laparoscopy

    Insufflation should be stopped immediately in case of any drop in blood pressure, unexplained tachycardia, or rise in respiratory pressure.
    If the patient stabilizes, laparoscopy can be resumed but with extreme caution (reduced abdominal pressure and close monitoring).
- Instruments
  - 30° scopes are recommended:
    The 10 mm scope offers better lighting and view.
    The 5 and 3 mm laparoscopes offer less trauma but reduced lighting and view.
- Essential instrumentation includes:
  - 3, 5, 10, and 12 mm ports
  - Atraumatic grasping forceps and clamps
  - Right-angle forceps
  - Titanium and absorbable clips
  - At least two needle holders
  - Energy-driven devices for hemostasis and cutting according to availability and surgeon preference
  - Scissors
  - Adequate suction-irrigation device

- Suture material and endoloops
- Umbilical or vascular tapes
- Rubber drains, tourniquets, clamps and bulldog clamps, and bowel and vascular clamps
- Plastic bags for the extraction of the operative specimen as required

7.2 Exploration of the Abdominal Cavity

- Hemostasis
  - Active bleeding in unstable patients requires open surgery.
  - Otherwise, in stable patients:
    Small vessels can be closed with clips or with 3/0 monofilament sutures or with modern coagulation devices (ultrasonic devices or Ligasure™).
    Large wound surfaces and lacerations of solid organs can be sealed quickly and effectively with autologous fibrin adhesive (Tisseal®, Baxter) and tamponed in combination with a fleece (Hemopatch®, Baxter).
    More active bleeding can temporarily be stopped by applying pressure followed by FloSeal® for permanent hemostasis.

7.3 Indications

The wide range of disease that may be diagnosed and treated by emergency laparoscopy includes acute cholecystitis, perforated duodenal ulcer, appendicitis and other causes of acute right lower quadrant pain including adnexal disease, complicated diverticular disease, intestinal obstruction including intussusception, incarcerated or strangulated inguinal or incisional hernia, peritonitis of all origins, iatrogenic perforations, suspicion of mesenteric ischemia, as well as certain postoperative complications.

If the diagnosis is not recognized beforehand, the surgeon should note the area of maximal inflammation, concentration of pus, or blood, as in the case of ruptured ectopic pregnancy.

7.3.1 Acute Cholecystitis

- Acute cholecystitis requires cholecystectomy.
  - Cholecystectomy for acute cholecystitis can be challenging because of:
  - Inflammation (difficult dissection) of the gallbladder
    Increased bleeding
    Fragility (perforation is possible)
    Adhesion to adjacent organs
    Altered anatomy
- Timing of operation
  - Although still debated, most authors agree that early (within 7 days of onset of signs) cholecystectomy appears to be safe and shortens the total hospital stay. In fact, as long as the patient is in good general health and there is no major anesthesia problem, early cholecystectomy can be performed within 48 h from onset.
  - Delaying cholecystectomy results in significantly higher conversion rates, surgical postoperative complications reoperation rates, and significantly longer postoperative hospital stay, without any advantages.
- Of note, the main biliary ducts are at increased risk in acute cholecystitis, and this warrants particular attention.
  - As the critical view of safety (Fig. 7.3) is more difficult and the demarcation of Rouvière's sulcus is present in only 70 % of patients, anterograde dissection, intraoperative cholangiograms (Fig. 7.4), and/or the use of indocyanine green is strongly recommended to landmark and delineate the biliary tree. Indocyanine green cholangiography has the advantage of delineation before any dissection takes place.
- Ideal treatment is based on the acute cholecystitis Tokyo consensus guidelines:
  - Grade I (mild acute cholecystitis, with no organ dysfunction and limited disease
  - Grade II (moderate acute cholecystitis: extensive inflammation but no organ dysfunction)
  - Grade III (severe acute cholecystitis including gangrenous cholecystitis or empyema with organ dysfunction).

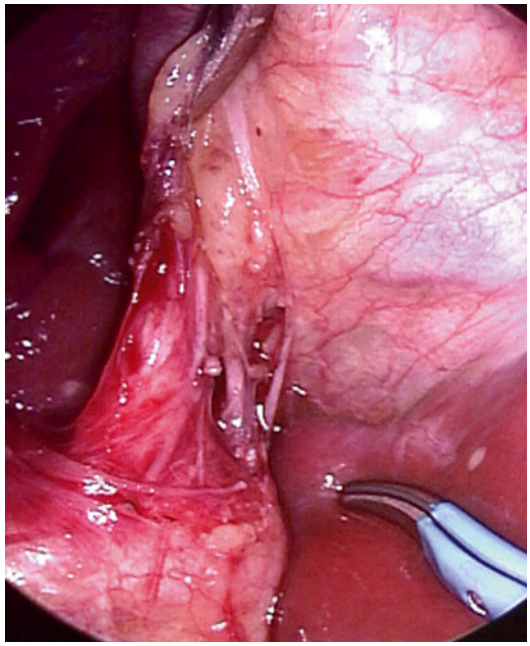

Fig. 7.3 Intraoperative view during laparoscopic cholecystectomy showing critical view of safety with cystic duct and artery at Calot's triangle

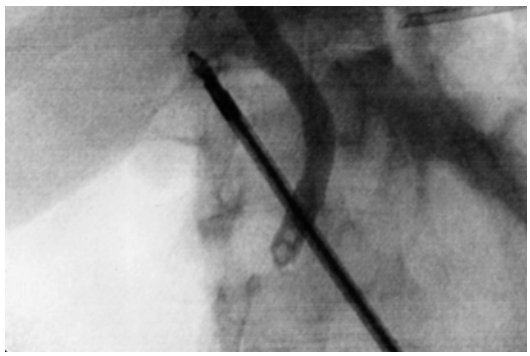

Fig. 7.4 Intraoperative cholangiogram showing the anatomy and (unexpected) common bile duct stones

- Both grades I and II (mild and moderate) cholecystitis can ideally be treated by laparoscopic cholecystectomy. In case of intraoperative difficulties subtotal cholecystectomy can be performed (although there are no proven advantages).
- Both grades II and III (moderate and severe) in high-risk patients can be treated by transhepatic drainage (cholecystostomy).

7.3.2 Perforated Gastroduodenal Ulcer

- Laparoscopic repair is feasible and should result in less postoperative pain and surgical site morbidity.
- The treatment of choice is simple closure of the perforation (Fig. 7.5) and adequate medical treatment of *Helicobacter pylori*.
  - Sutures, glue, and/or omentum, sometimes associated.
  - A hybrid procedure consists of drawing the omentum through the perforation by means of an endolumenal endoscope.
  - Open repair might be better when:
    Patients are hemodynamically unstable.
    Patients are at risk for pneumoperitoneum.
    Patients have already undergone previous upper GI surgery needing extensive adhesiolysis.
    More extensive time-consuming operations are necessary.
    Patients are at high risk (two or more Boey risk factors).
    Chronic ulcer with a diameter of more than 20 mm is present.

7.3.3 Acute Appendicitis and Acute Pelvic Problems in the Female

- Laparoscopic appendectomy (vs. open):
  - Can be advantageous in the obese and the elderly.
  - Can be performed in the pregnant women, but care is warranted to adjust trocar insertion to uterine height.

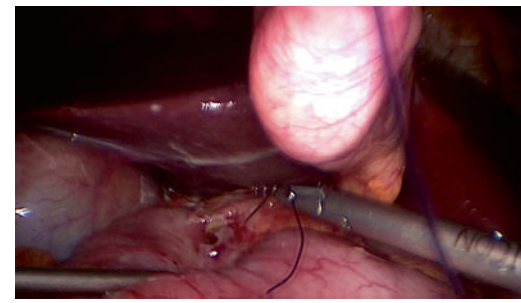

Fig. 7.5 Closure of a perforated acute post-pyloric peptic ulcer with two stitches

  - Stump closure is no longer a matter of debate: recent studies have reversed the purported advantages of staplers used routinely, and these should be reserved for patients when loop closure seems difficult or inappropriate (stump necrosis) or there is need for rapid closure. Higher costs for the staplers, however, must be considered, and loop-closure is often chosen instead
- Adnexal torsion and ruptured ectopic pregnancy:
  - Ideal settings for emergency laparoscopic surgery.
  - Patient must be hemodynamically stable.
  - Requires specific equipment (vacuum, special suction probe) for tubal preservation.

7.3.4 Complicated Diverticular Disease

- Hinchey stages I and IIa can be treated medically, sometimes combined with percutaneous drainage.
- Patients with persistent septic signs after drainage and in those with Hinchey IIb, Hinchey III and IV require surgical treatment.
  - Laparoscopic treatment has been shown to be safe and as effective as open treatment for Hinchey IIb and III.
  - Source control consisting of resection of the perforated colon segment, with or without immediate anastomosis, is still the standard treatment and can be performed laparoscopically.
  - However, some surgeons advocate simple laparoscopic lavage, associated or not with suture and/or drainage, the goal being to avoid a major bowel resection and potentially a stoma:
    Quantity: four liters of saline followed by drainage plus antibiotic therapy.
    Decreases mortality and morbidity (particularly surgical site complications).
    Suture or fibrin glue closure of the perforation (if obvious) can be attempted, sometimes reinforced with an omental patch.
    Usually no further surgery is required.

7.3.5 Intestinal Obstruction

- Laparoscopy can be indicated for obstruction related to adhesions or bands.
- It is of prime important to avoid all abdominal scars for the creation of pneumoperitoneum and/or initial trocar insertion.
- The first trocar insertion should be performed "open." at a location at a distance from the expected site of obstruction, if possible avoiding any scars.
- Intraoperatively, caution is warranted when running the distended intestinal loops.
  - The fragile serosa renders grasping and retraction dangerous. Tilting the table is of great help to move the distended and heavy bowel loops. The bowel should only be grasped at the mesenteric attachments (Fig. 7.6). It is recommendable first to find the collapsed loops and run them orally (Fig. 7.7).
  - Special atraumatic dissectors (Maryland) and retractors are a wise precaution.
  - Angled scopes may be useful for optimal viewing behind and lateral to adhesions, especially when mobilization of bowel is difficult.
  - Extreme caution is warranted in case of vascular compromise and/or necrotic bowel, as it is preferable to convert rather than to provoke a rupture with

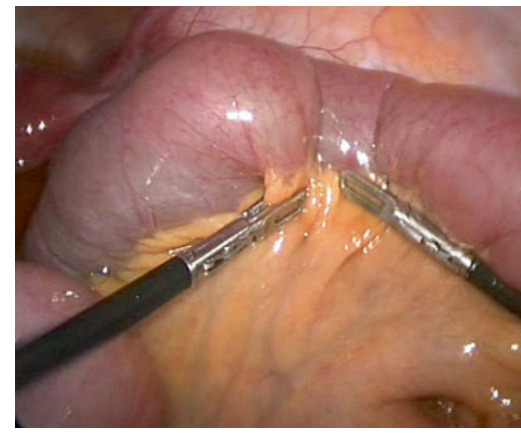

Fig. 7.6 Exploration of distended small bowel loops grasped at the mesenteric attachments

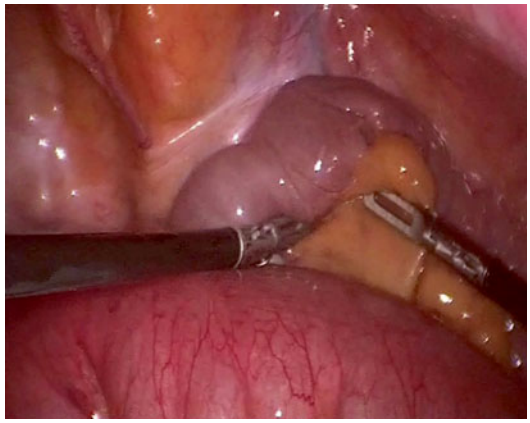

Fig. 7.7 Search for obstruction site by running the small bowel loops orally

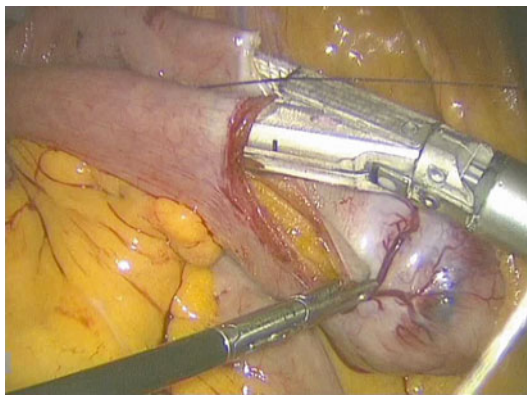

Fig. 7.8 Laparoscopic resection of a small bowel tumor causing obstruction. A stapled anastomosis is created with endostapler before resection

inundation of the peritoneal cavity with septic contents.

If necessary, intestinal resection with anastomosis may be performed via laparoscopy, but by using bulldog bowel clamps, spillage of septic intestinal contents has to be avoided at all costs (Fig. 7.8).

7.3.6 Incarcerated/Strangulated Hernias

- Only cohort and case series studies have been published on laparoscopic repair of incarcerated groin hernias.
- Either TEP or TAPP can be performed. but many surgeons would not recommend inserting prosthetic material in case of incarcerated hernia with intestinal necrosis or if resection is necessary.
- Laparoscopy has been used to repair complicated and/or nonreducible retro-xiphoid, Morgagni or diaphragmatic hernias, paraesophageal hernias, rare acute abdominal wall hernias, such as supra-vesical and Spigelian, or obturator hernias, internal hernias.

7.3.7 Mesenteric Ischemia

- As intestinal ischemia occurs most often in the elderly, frequently with comorbidity, diagnostic laparoscopy may be better tolerated (than laparotomy).
- Of note, however, creation of pneumoperitoneum may have a potentially adverse effect on mesenteric blood flow: low intra-abdominal pressure is recommended.
- After bowel resection with primary anastomosis trocars may be left in place to accomplish a second-look procedure, if indicated.

7.3.8 Peritonitis

- Performed more and more often in peritonitis by skilled laparoscopic surgeons, laparoscopy can be an excellent choice to perform source control (perforation closure, resection), reduction of bacterial contamination (lavage), and prevention of persistent or recurrent infection.
- Under low-pressure pneumoperitoneum not exceeding 12 mmHg, laparoscopic aspiration of gross purulent exudates, fecal debris, food particles, and intraperitoneal lavage is possible. Timing is important, as laparoscopy is best adapted to recent onset and localized peritonitis.
- All lavage fluid should be completely aspirated before the abdominal cavity is closed.
- The advantages of laparoscopic treatment of peritonitis include:
  - Complete exploration of the abdominal cavity with minimal parietal insult.

- Most causes of peritonitis (perforated duodenal ulcer, perforated appendicitis, perforation in diverticular disease, postoperative leakage after index laparoscopic operations) can, if done quickly after onset, be treated adequately via laparoscopy.
- Whenever needed, stoma may be fashioned laparoscopically.

7.3.9 Iatrogenic Perforations

- Laparoscopy is an ideal method to treat iatrogenic perforations, the most common being perforations during colonoscopy.
- Laparoscopic resection or suture repair of iatrogenic perforations is safe and is associated with reduced surgical and psychological stress for the patient because of its low morbidity and mortality.
- Laparoscopic suture, peritoneal rinsing, and drainage can be accomplished under optimal conditions, often without the need for protective stoma if performed early (<24 h after perforation (the colon is usually prepared for the colonoscopy, limiting the spillage of fecal matter)).
- Simple drainage performed laparoscopically also seems feasible for retroperitoneal ERCP perforations, but strict and close follow-up is necessary.

7.3.10 Immediate Laparoscopy for Postoperative Complications After Initial Laparotomy/Laparoscopy Operations

- Several postoperative complications including bleeding, intra-abdominal abscess, small bowel obstruction, bile leak, ischemic bowel disease, retrieval of retained foreign bodies, and anastomotic leakage, if revision is necessary, may be treated laparoscopically
- Indications for same-hospital stay include laparoscopic exploration and treatment of postoperative obstruction after laparoscopic bariatric surgery, reiterative adhesions, anastomotic leakage after colectomy, and gastrectomy. Of importance is the timing (as early as possible), the atraumatic handling of the gastrointestinal tract, and surgeon's level of experience in advanced laparoscopy.

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Laparotomy

8

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Objectives

- Be able to perform a midline laparotomy
- Be able to perform an oblique or transverse laparotomy
- Be able to perform a McBurney incision
- Know how to get access to the peritoneal cavity
- Know how to expose solid organs and hollow viscus
- Know how to control bleeding and contamination
- Know the main causes of mechanical obstruction
- Know the principles of surgical management of bowel ischemia
- Know the principles of peritoneal toilette and abdominal drainage
- Know how to close the abdomen
- Know how to manage special situations as abdominal compartment syndrome or enterocutaneous fistulas

8.1 Preparation of the Abdomen

8.1.1 Shave Prep

- Still debated today.
- Most surgeons prefer depilatory creams, but in the emergency setting, preoperative hair removal still has its proponents (as close to surgery as possible and not in the OR).

8.1.2 Skin Disinfection

- Abdominal wall is cleaned with topical antiseptic solutions.
  - From nipples to external genitalia.
  - Far behind in the flanks on each side to the table.
  - Be aware of adverse reactions and incompatibilities.
  - Leave adequate time for the antiseptic to dry completely (DO NOT blot or wipe off!).

8.1.3 Draping

- Apply sterile impervious drapes to expose the entire abdominal wall (from nipples to pubic symphysis and far behind in the flanks).
  - Rationale: possibility of extended incision, making another incision or insertion of drains and/or stoma formation
  - Meticulously, being sure that the skin at umbilicus is dry in order to prevent adhesive drape lift

8.2 Abdominal Incisions

- *Remember*: the coagulation mode of the electric bistoury is meant to coagulate and the cutting mode to cut. Coagulation is a third-degree burn, and inappropriate use of coagulation while opening the abdominal wall jeopardizes healing of the operative wound.

8.2.1 Midline Incisions

- Xipho-pubic midline incision: incision of choice for exploratory laparotomy
  - Gives access to all quadrants of the abdomen.
  - When the nature of the pathology is in doubt (and laparoscopy not available or contraindicated), begin the incision a few centimeters above and below the umbilicus, and, according to the findings, extend upward or downward.
  - If kept strictly midline, the incision will not encounter any named vessel or nerve, only one layer of fascia is cut, reducing the risk of hematoma, preventing the risk of paralytic hernia, and minimizing the risk of infection.
- In case of previous midline laparotomy, adhesions with underlying omentum or viscera are frequent.
  - It is advisable to enter the abdomen through an inviolated area.
  - In case of previous xipho-pubic incision, prefer the upper part of the abdomen to enter, as the liver and stomach are frequently easier to divide from parietal peritoneum than the colon or small bowel.

Procedure (Fig. 8.1):

1. Place a pad on each side of the planned incision.
2. Maintain equal traction on each side and use the scalpel to cut vertically, straight on the midline.
3. Incise to the left of the umbilicus, then straight up and down.
4. Cut the subcutaneous tissue, and expose the subcutaneous fat with pads on each side.
5. Apply traction on each side with hooked fingers on the pads to open the fat on the midline and expose the linea alba.
6. Use bipolar cautery or monopolar coagulation on forceps to selectively secure bleeding points.
7. Identify (crossing fibers) and cut the linea alba with the scalpel on the entire length of the incision without opening the peritoneum (this prevents contamination of the abdominal wall in case of peritonitis).
8. Lift both edges of fascia with one or two Kocher clamps on each side.
9. Make a small hole in the peritoneum.
   - Keep edges of fascia lifted and enlarge the hole; one finger cephalad and caudad to be sure there is no adhesion under the incision.
   - Scalpel can be used to cut up to the peritoneum, but most of the surgeons prefer to use cautery (if so, use the section and not the coagulation mode).
10. In case of peritonitis:
    - Withdraw liquid for analysis.
    - Protect the abdominal wall from contamination by placing wet pads in the peritoneal cavity on each side of the incision while enlarging the peritoneal opening.
11. Keeping the edges of fascia lifted, ligate and divide the ligamentum teres and incise the falciform ligament with cautery.
12. Place a plastic wound drape and remove the Kocher clamps.
13. Place self-retaining retractors.

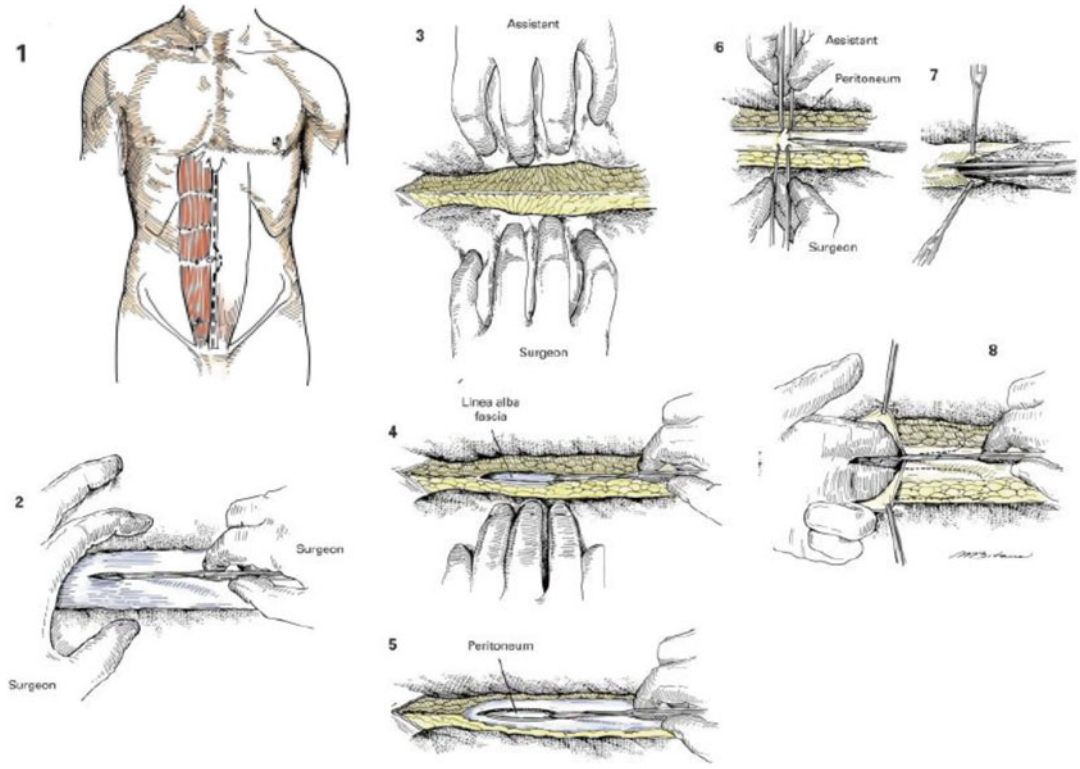

Fig. 8.1 Steps of midline xipho-pubic incision

8.2.2 Oblique and Transverse Incisions

- Nerves and arteries (consequences):
  - The intercostal nerves (T5 to T12) run medially and caudad within the abdominal wall. Division may result in weakness of the involved part of the abdominal wall, potentially leading to paralytic hernia (Fig. 8.2).
  - Intercostal arteries together with superior and inferior epigastric arteries provide the vascularization of the abdominal wall.
  - Whenever performing an incision other than midline, try to avoid nerves and arteries, i.e., incisions should be oblique medially and caudad remain laterally to the rectus abdominis.
  - Strictly transverse incisions are a good compromise, as only one or two nerves are sacrificed (Fig. 8.3).
  - Avoid incisions of the abdominal wall that interrupt nerves and/or vessels.
- In a patient with a previous transverse or oblique incision:
  - Use a midline or the same transverse or oblique incision: crossing a transverse or oblique incision by another, or even cutting parallel to a previous transverse or oblique incision, may lead to acute necrosis of the abdominal wall between the incision lines (Fig. 8.4).
  - Even if this severe complication is avoided, incisional hernia is most probable.
- Transverse incision should be performed only when the intra-abdominal affection is known, as extension of the incision is difficult if not impossible.
- As closure involves several muscular and fascial layers, oblique and transverse incisions are reputed to create less incisional hernia.

Procedure

1. Place a pad on each side of the planed incision; this should be at least 4 cm below the costal margin.
2. Maintain equal traction on each side and use the scalpel to cut vertically.
3. Cut the subcutaneous tissue, and expose the subcutaneous fat with pads on each side. Proceed down to the fascia.

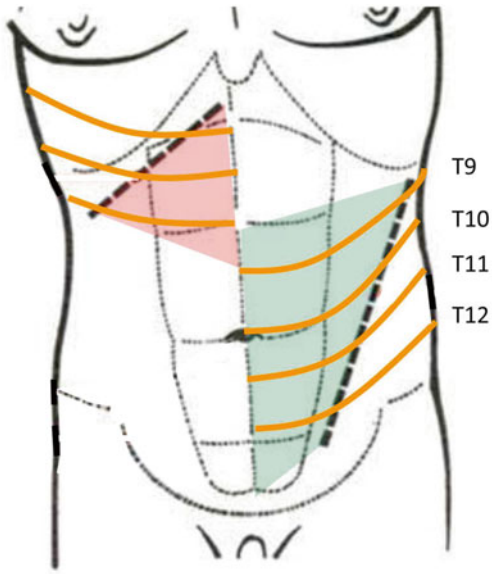

Fig. 8.2 Oblique incisions that interrupt nerves lead to paralytic hernia

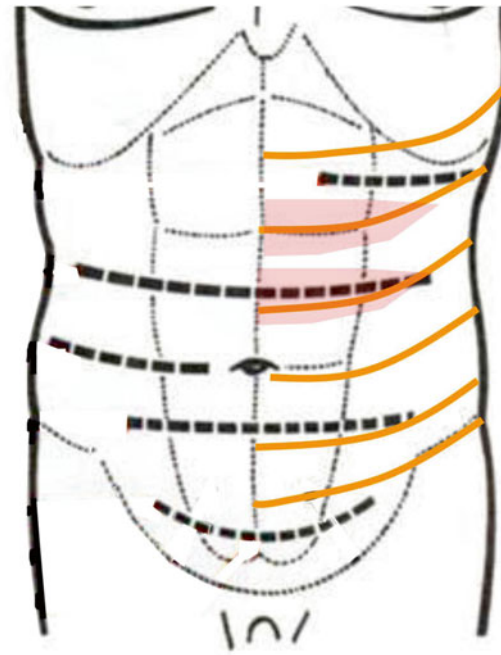

Fig. 8.3 Strictly transverse incisions preserve abdominal wall nerves

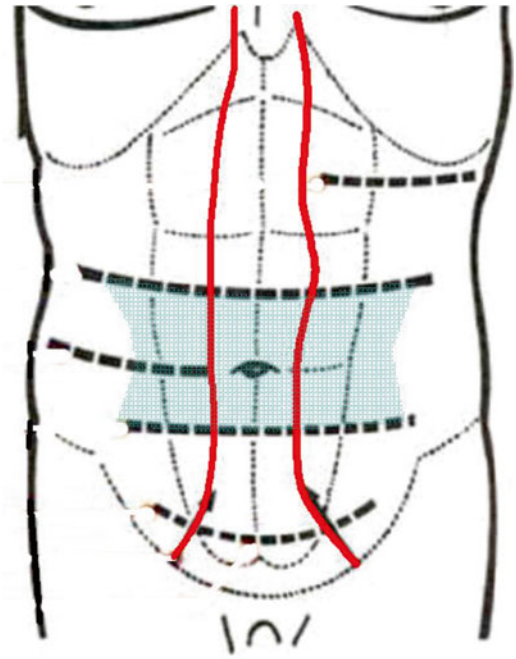

Fig. 8.4 Two parallel transverse incisions lead to abdominal wall inschemia between the incision lines

4. Use bipolar cautery or monopolar coagulation on forceps to selectively secure bleeding points.
5. Incise the fascia of the external oblique muscle and the anterior rectus sheath. If the incision is short, the fibers of the rectus abdominis can be retracted medially. If needed, cut the fibers with the scalpel and selectively coagulate the smaller vessels and ligate the larger vessels. The fibers of the internal oblique muscle can usually be separated, exposing the fascia of the transversalis muscle in continuity with the posterior rectus sheath.
6. Lift the transversalis muscle fascia with two Kocher clamps.
7. Create small hole in the fascia and closely attached parietal peritoneum.
8. Keeping the fascia edges lifted, enlarge the hole, introduce a curved finger up and down to ensure there is no adhesions under the incision.
9. In case of peritonitis (a midline incision would have been advisable),
   (a) Withdraw sample for analysis.
   (b) Protect the abdominal wall from contamination by placing wet pads on either side of the incision while enlarging the opening (fascia and peritoneum).
10. Place a wound plastic drape and remove the Kocher clamps.
11. Place self-retaining retractors.

8.2.3 McBurney Incision

- This incision, used on the right side for appendectomy and on the left side for the Bouilly-Volkmann procedure, is, in fact, a short oblique incision.
  - If performed laterally to the rectus abdominis muscle, and after dividing the fascia of the external oblique muscle, the fibers of the internal oblique and transverse muscles can be gently separated to give access to the peritoneum.
- As no muscle is cut (as long as the incision does not need to be extended), the risk of hernia is minimal.

Procedure

1. The classic McBurney incision is perpendicular to a line drawn from the anterosuperior iliac spine to the umbilicus, crossing this line at the junction of medial and lateral thirds. The Rocky-Davis incision is a horizontal variant, more cosmetic and easier to extend.
2. Incise the skin with the scalpel.
3. Cut subcutaneous fat, fascia superficialis, and deep fat layer with scissors.
4. Place Farabeuf-type (flat right-angled blades) retractors and expose the fascia of the external oblique muscle. Clean the fat with a pad.
5. Coagulate bleeding points as necessary.
6. Incise the fascia of the external oblique muscle parallel to its fibers. Remain strictly lateral to the rectus abdominis and do not open its sheath. If underlying fascia is visible, do not incise it: retract outward to expose muscular fibers of the internal oblique muscle.

7. Split the muscular fibers of internal oblique muscle by blunt dissection with large scissors. If underlying fascia is visible, do not incise it: retract outward to expose muscular fibers of transversalis muscle. Split the muscular fibers by blunt dissection with large scissors.
8. Gently place the retractors to maintain the opening down to the peritoneum, clear fat with a gauze.
9. Grasp the cleaned peritoneum with two curved clamps and pull it out through the hole up to the skin. Be sure that no viscus has been included in the grasp, and make a small hole with scissors.
10. By pulling on each clamp, enlarge the hole.
11. Pull the peritoneum up to the skin with clamps to protect the muscular wall from infection.
12. Leave the clamps attached to the peritoneal edge and place retractors in the peritoneum.

8.3 Exposure of Solid Organs and Hollow Viscus

8.3.1 Gallbladder

- When entering the peritoneal cavity through a midline incision, access to the gallbladder and right hepatic lobe is blocked by the ligamentum teres and falciform ligament; these structures must be divided as above.
- When entering through a transverse (or oblique) incision, division of the ligamentum teres is not mandatory.
- Apply gentle traction with a wet abdominal pad and flat blade retractor on
  - The transverse colon and the duodenum caudad
  - The stomach to the left
- Divide the cholecystoduodenocolic ligament whenever present to expose the subhepatic space.
- A third flat blade retractor placed at the inferior aspect of the liver left to the gallbladder may improve exposure.

8.3.2 Liver

- To get access to the liver, make a large right transverse subcostal incision, extended to left or midline. Proceed with ligamentum teres as for gallbladder exposure leaving about 5 cm of ligamentum teres attached to the liver allows for gentle traction if needed. Cut (with cautery) the falciform ligament above the liver as far to the rear as it remains thin (when it widens, middle and left hepatic veins are just behind). Place a fixed retractor. Cut the cholecystoduodenocolic ligament.
- Open the lesser omentum to get access to the bursa omentalis. Passing a finger behind the hepatic pedicle through the foramen bursae omentalis is the first step of the Pringle maneuver.
- To mobilize the left lobe, cut (cautery) the left triangular ligament, gently pulling the left lobe downward and medially. To protect the abdominal esophagus, place a wet pad behind the left triangular ligament before division. The triangular ligament widens as it continues to the right, becoming the coronary ligament. Cautiously continue the dissection to the right with scissors.
- To mobilize the right lobe, lift and rotate the right part of the liver medially, in order to stretch the right triangular and coronary ligaments and divide them (cautery) close to the liver cautiously as you progress to the left (use then scissors) where the inferior vena cava, accessory, and right hepatic veins will appear.

8.3.3 Abdominal Esophagus

- A nasogastric tube should be placed.
- Through an upper midline incision, proceed as explained before to mobilize the left hepatic lobe. Hold it to the right with a retractor.
- The esophageal hiatus of the diaphragm and the esophagocardial junction are exposed.
- Incise the peritoneum on the anterior aspect of the esophagus, caution being exercised not to injure the anterior vagal nerve.

- Proceed gently with blunt dissection of the abdominal esophagus. At the posterior aspect of the esophagus, the posterior vagal truck is palpable, and blunt dissection should pass behind it.
- Encircle the esophagus with an abdominal (vascular) tape.

8.3.4 Spleen

- The spleen is attached
  - To the stomach by the gastrosplenic ligament, which contains 2–10 short gastric arteries and veins in the upper part and left gastroepiploic artery and veins in the lower part, the lower part is continued by the gastrocolic ligament right and the splenocolic ligament left.
  - To the left colic flexure by the (short) splenocolic ligament.
  - To the tail of the pancreas by the pancreaticosplenic ligament (contains splenic artery and vein).
  - To the diaphragm and left kidney by an avascular fascia named phrenicosplenic and splenorenal ligaments.
- To mobilize the spleen, there are two options:
  - Ligation of the splenic artery before mobilization of the spleen
  - Mobilization of the spleen followed by ligation of the splenic artery
- Expose the operative field with a retractor under the left costal arch.

8.3.4.1 Ligation of the Splenic Artery First

1. Divide the gastrocolic omentum between the stomach and the gastroepiploic arcade near the left colic flexure.
2. Proceed dividing the avascular part of the gastrosplenic ligament right to the gastroepiploic vessels. The created window opens the bursa omentalis in front of the pancreatic tail.
3. Incise the parietal peritoneum at the upper border to expose the splenic artery.
4. Gently dissect and ligate the splenic artery.
5. Dissect each of the short vessels in the upper part of the gastrosplenic ligament, ligate, and divide them.
6. Dissect, ligate, and divide the left gastroepiploic vessels.
7. Ligate and divide the splenocolic ligament.
   - Ligation and division of the splenic vein before mobilization is an option.
8. Mobilize the spleen passing your left hand between the diaphragm and the spleen (easy of no adhesions) and rotate the spleen medially.
9. Incise the peritoneal reflexion in order to expose the posterior aspect of the tail of pancreas.
10. If not done previously, ligate the splenic vein.

Mobilization of the Spleen First

This procedure is preferred to remove a bleeding spleen or when repair of a damaged spleen is attempted.

1. Wrap the spleen with a pad and grasp it with your left hand.
2. Clamp the splenocolic ligament on the colic side and divide it.
3. Wrap the inferior pole of the spleen with the pad.
4. Rotate the spleen medially.
5. Incise the peritoneal reflexion (or force the way with your fingers) to divide the avascular splenophrenic ligament.
6. Expose splenic artery and vein at the posterior aspect of the tail of pancreas and clamp.
7. Mobilization of the spleen is terminated by putting wet pads in the splenic fossa to lift the spleen and dividing the gastrosplenic ligament (and ligated short vessels).

8.3.5 Right Colon

1. Expose the operative field with a self-retaining retractor.
2. Grasp the cecum and retract it medially, displaying the peritoneal reflexion.
3. Incise the peritoneal reflexion to open Toldt's fascia caudad to the right colic flexure. Caution is exercised to stay close to the colon, in order to avoid the ureter below and the duodenum above.

4. Divide the gastrocolic ligament below the vascular gastric arcade and get access to the bursa omentalis at the level of the distal antrum.
5. If present, divide cholecystoduodenocolic ligament.
6. Proceed from left to right to mobilize the right part of the transverse colon, ligating all epiploic vessels.
7. Clamp the right parietocolic ligament and divide it. Exercise caution when tracing the right colic flexure, not to tear the gastrocolic vein at the anterior aspect of the pancreatic head (hemostasis extremely difficult): gently tie and divide it.
8. Right colon is fully mobilized.

8.3.6 Pancreas

8.3.6.1 Mobilization of the Duodenum and Head of Pancreas (Kocher's Maneuver)

1. Expose the operative field with a self-retaining retractor.
2. Mobilize the right colic flexure caudad and medially (see right colon): this will expose the duodenum and the head of the pancreas.
3. Incise the peritoneum along the duodenum to open the Treitz fascia and lift the duodenum and head of the pancreas by blunt dissection while rotating them medially in order to expose the inferior vena cava.

8.3.6.2 Exposure of the Body and Tail of the Pancreas

1. Open the bursa omentalis by tying off and dividing the epiploic vessels from the level of distal antrum to gastrosplenic ligament. (Another option is to dissect greater omentum from the transverse colon to gain access to the bursa omentalis).
2. Divide the gastrosplenic ligament up to the short vessels.
3. Retract the stomach upward and divide the avascular folds between posterior aspect of the stomach and anterior aspect of the pancreas.
4. Incise the parietal peritoneum along the inferior border of the pancreas.
5. After identification of inferior mesenteric vein, detach the body and tail of the pancreas by blunt dissection.
6. According to the planned procedure, splenic artery and vein are lifted with the pancreas together with the spleen (see mobilization of the spleen), or separated from the pancreas by cautious blunt dissection and ligature of pancreatic branches and left with the spleen.

8.3.7 Left Colon

1. Lift the sigmoid colon medially and cephalad and free the colon from adhesions with parietal peritoneum and internal genital organs in female.
2. Incise the root of the sigmoid mesocolon on the left aspect and identify the ureter where it crosses the bifurcation of iliac artery.
3. Incise from caudad cephalad the peritoneal reflexion and open Toldt's fascia by blunt dissection, until mobilization of descending colon becomes difficult and dangerous for the spleen.
4. Create a window in the gastrocolic ligament below the gastric vascular arch, serially ligating the epiploic vessels from right to left until you reach the splenocolic ligament.
5. Divide the splenocolic ligament progressing alternately from right to left and left to right until left colic flexure is fully mobilized.

8.4 Source Control

8.4.1 Bleeding

- As in trauma surgery, stopping any bleeding is top priority.
- What differentiates nontrauma emergency surgery from trauma surgery is that the source of bleeding is often not evident once the abdomen is open, and therefore preoperative investigations as endoscopy or angio-CT scan are very useful.
- Surgery should be used as the last resource, once endoscopic procedures or angioembolization has failed.

– According to the physiological status of the patient, a definitive procedure can be performed, or the abdomen is left open, and definitive procedure is performed during a second operation.

8.4.1.1 Temporary Control of Bleeding

- Can be obtained by
  - Direct compression
  - Finger clamping of vessels
  - Direct suture with X stitches
  - Clamping of vessels (in that order of priority, to avoid blind damage/sutures/ligation of vital structures)
- Never proceed with an organ resection if temporary hemostasis has not been obtained.

8.4.1.2 Definitive Control of Bleeding

- Definitive control of the bleeding is generally obtained by a procedure that either removes the bleeding organ or part of organ (resection of Meckel's diverticulum, colectomy for bleeding diverticulitis or tumor, etc.) or is meant to prevent recurrence of bleeding (vagotomy or antrectomy for bleeding duodenal ulcer, etc.).

8.4.2 Contamination

- Possible origins of contamination of the peritoneal cavity are:
  - Perforation of a hollow viscus (perforated gastric or duodenal ulcer, sigmoiditis, appendicitis, cholecystitis, etc.)
  - Rupture of an abdominal abscess (liver, appendicular, sigmoid diverticular abscess, infected collection of pancreatic origin)
  - Direct contamination of peritoneal fluid by an infected viscus (appendicular generalized acute purulent peritonitis)
- Surgical strategy when operating for peritonitis:
  - Withdraw fluids for bacteriology.
  - Give IV antibiotics.
  - Control the source of contamination.
  - Wash the peritoneal cavity (see peritoneal toilet).
  - Treat the cause.
  - Rewash the peritoneal cavity.
  - Drain in selected cases.

8.4.2.1 Hollow Viscus Perforation

- Perforation of a hollow viscus can be dealt with as in damage control by simple drainage associated or not with direct suture (or closure by other means) of the perforation.
- The perforated portion is isolated by wet swabs and the peritoneal cavity is washed with warm saline irrigation.
- The cleansed peritoneal cavity is isolated with wet swabs and the lesion is treated.

Perforated Ulcer

- May be treated by direct suture, fibrin closure, completed or not by fixing a (vascularized) omental patch with few stitches.
- Gastric ulcer should be resected for histologic analysis; the defect is sutured and patched with omentum.

Perforated Sigmoiditis

- In case of fecal peritonitis (Hinchey IV), Hartman's procedure is indicated.

8.4.2.2 Ruptured Abscess

- Ruptured intraperitoneal abscess can be treated by:
  - Aspiration of the pus
  - Cleansing the peritoneal cavity
  - Drainage of the infected site (see drains)
- If the origin is appendicitis or sigmoiditis, the cause is treated by appendectomy or sigmoidectomy.

8.4.2.3 Direct Contamination

- Generalized peritonitis may occur by direct contamination from:
  - Appendicitis
  - Infected Meckel's diverticulum
  - Sigmoid diverticulitis even without previous development of an abscess or overt perforation
- In these cases, just cleanse the peritoneal cavity and treat the cause.
- Drainage is not indicated if the peritoneal cavity is left perfectly clean.

8.5 Bowel Obstruction

- Symptoms
  - Abdominal pain
  - Vomiting
  - Obstipation
  - Abdominal distension
- Diagnosis
  - CT is essential to determine the cause, the site (transition point, tumor, small bowel feces sign, etc.), and the severity of the obstruction (parietal ischemia, fluid, etc.).
  - CT moreover:
    Can guide the choice between nonoperative and operative management
    Can allow in some cases minimally invasive procedures (laparoscopy or CT-directed incisions)
- Treatment
  - *Nonmechanical obstructions* (postoperative ileus, peritonitis, bowel ischemia, spinal injury, drugs, hypokalemia): surgical only if the cause or the consequence is peritonitis or ischemia (see specific paragraphs).
  - *Mechanical obstructions* are in most cases surgical (except in the case of peritoneal carcinomatosis, where high-dose corticoids may be useful).

8.5.1 Adhesions

8.5.1.1 Two Potential Approaches

Classic Approach

1. Midline laparotomy
2. Division of all adhesions divided (the entire length of the involved bowel)
3. Retrograde emptying of the small bowel
4. Rearrangement of small bowel loops
5. Lavage of the peritoneal cavity
6. Complete exploration, mainly to be sure not to miss another cause of bowel obstruction as a small obstructive colon cancer associated with small bowel adhesions

8.5.1.2 Laparoscopy or CT-Directed Incision

When a unique band is the cause of obstruction, this can be divided laparoscopically or through a minilaparotomy guided by laparoscopy or by CT-scan findings.

8.5.2 Incarcerated Hernia

The ultimate risk of incarcerated hernia is segmental bowel ischemia, which requires resection and anastomosis. Incarcerated hernias are an absolute emergency.

8.5.2.1 Umbilical, Groin, and Incisional Hernias

See chapter on herniorrhaphies.

8.5.2.2 Rare Hernias

- These include:
  - Obturator
  - Ischiatic
  - Lumbar
  - Paraduodenal hernias
- Most can be diagnosed by CT or at explorative laparotomy.
- Treatment consists in reduction and obstruction of the defect by suture or mesh, or in case of right paraduodenal hernia, transpositioning of the right colon to the left.

8.5.3 Volvulus

- Intestinal segments involved:
  - Sigmoid
  - Cecum
  - Small bowel
  - Stomach
- The ultimate risks are:
  - Ischemia
  - Peritonitis, particularly severe in case of sigmoid perforation
- Volvulus, when suspected, is an absolute life-saving emergency.

8.5.3.1 Volvulus of the Sigmoid Colon

- Sigmoid colon volvulus may be derotated by:
  - Blind intussusception with a rectal tube (not recommended)
  - Derotation by rigid sigmoidoscope that allows to partially appreciate absence of gangrene
  - Complete derotation and deflation of the whole colon by coloscopy (best option)
- If these maneuvers fail, or if gangrene is present at endoscopy, laparotomy is mandatory.
  - When possible, the best option is the Bouilly-Volkmann procedure with:
    - An elective left McBurney approach
    - Exteriorization of the sigmoid
    - Sigmoidectomy
    - Confection of a double-barrel colostomy
  - If gangrene is extended, Hartmann's procedure is the second option.

8.5.3.2 Volvulus of the Cecum

- If presence of gangrene or cecum is preperforative, the unique option is an ileocecal resection with primary ileocolic anastomosis.
- If the devolvulated and deflated cecum is healthy, different treatments may be discussed (appendectomy, cecopexy, cecostomy, etc.). Currently, ileocecal resection with primary anastomosis is a safe option.

8.5.3.3 Volvulus of the Small Bowel

- Surgical derotation of small bowel volvulus is an absolute emergency, to save as much bowel as possible.

8.5.3.4 Volvulus of the Stomach

- Surgical derotation and deflation by a nasogastric tube is an emergency.
- If gangrene is present, atypical gastrectomy can be performed.
- In other cases, a gastropexy is an option that should prevent recurrence.

8.5.4 Intussusception

- Intussusception is a form of intestinal obstruction in which one segment of the intestine telescopes into the next.
- Intussusception is:
  - Most frequent in children less than 2 years of age
  - Also observed in adults, and in this case, a small bowel tumor is often present.
- The correct way to reduce intussusception is to "milk" the telescoped bowel segment in retrograde manner.
- If reduction is impossible or impacted bowel is necrotic, resection and anastomosis of the involved bowel segment is mandatory.

8.5.5 Neoplasms

- Available options depend on surgical/medical expertise:
  - Proximal diversion by a stoma
  - Resection with primary anastomosis, protected or not with diverting stoma or terminal stoma
  - Internal intestinal bypass in case of unresectable neoplasm
  - Radiologically or endoscopically placed stents, either permanent or a bridge to later surgery

8.5.5.1 Obstructive Right Colon Neoplasm

- Right hemicolectomy with primary ileocolic anastomosis is indicated (ideally).

8.5.5.2 Obstructive Left Colon Neoplasm

- The procedure depends on the location of the obstruction and the degree of upstream distension:
  - Segmental colectomy and formal colectomy are both acceptable.
  - Subtotal colectomy with primary ileocolic anastomosis may be necessary because of upstream distension (for single-stage operation).

8.5.5.3 Obstructive Rectal Neoplasms

- A diverting loop sigmoidostomy alleviates the obstruction and allows to manage the case electively, associating chemotherapy, radiotherapy, and then surgical resection.

8.6 Bowel Ischemia

- Bowel ischemia may result from:
  - Arterial obstruction (caused by thrombosis or embolism)
  - Venous obstruction (caused by thrombosis)
- Both may be caused by external compression by a band, a volvulus, or incarceration in a hernia.
- The result is gangrene and subsequent perforation with peritonitis.
- In case of external compression, once the cause alleviated, time must be left for revascularization of the involved gut segment before deciding resection.

8.6.1 Localized Bowel Ischemia

- Treatment is simple resection and primary anastomosis (ileoileostomy and ileocolostomy for small bowel).
- Resection and double-barrel stoma or Hartman's procedure (for the colon).

8.6.2 Diffuse Bowel Ischemia

- Typically occurs after thrombosis or embolism of superior mesenteric artery.
  - If diagnosed and operated very early, embolectomy/thrombectomy or vascular bypass may be attempted.
  - In most cases, the surgeon faces a patchwork of necrotized gut segments, viable gut segments, and large parts of in-between gut segments.
    The best option is a "damage control" procedure with planned second look:
    - Immediately
      - Nonviable segments are resected with staplers.
      - No anastomosis.
      - No stoma.
      - The closed gut segments are left in the peritoneal cavity.
      - Abdomen is left open and drained with a vacuum pack.
    - Next: resuscitation measures
    - One to 2 days later, a second look:
      - Viable and nonviable intestinal segments are clearly differentiated.
      - Resection of nonviable segments is performed and digestive continuity may be restored.

8.7 Peritoneal Toilet and Intra-abdominal Drains

8.7.1 Toilet

- The peritoneal cavity is cleansed, methodically, with warm (37–39 °C) isotonic saline, abundantly, until obtaining clear fluid, which is then completely aspirated (Fig. 8.5).
  1. Hepatodiaphragmatic space, right then left to falciform ligament
  2. Bursa omentalis if contaminated, through a window either in the lesser omentum, or in the gastrocolic ligament
  3. Morrison's space
  4. Right paracolic gutter
  5. Splenic fossa
  6. Right mesenteric gutter
  7. Left mesenteric gutter
  8. Left paracolic gutter
  9. Pelvic fossa and Douglas' cul-de-sac
- Swabs should not be used to clean the peritoneum (may damage the mesothelial layer and cause adhesions).
- Intraperitoneal antiseptics and/or antibiotics have not been proven to be effective (removal of blood and debris is much more effective).
- Inclination of the table helps for the final exploration and recovery of liquids.
- At completion, ensure that:
  - Exploration is complete
  - Adequate hemostasis has been obtained
  - No pads have been left

8.7.2 Drains

Goal: clear bile, pancreatic secretions, gastric and gut juice, collections

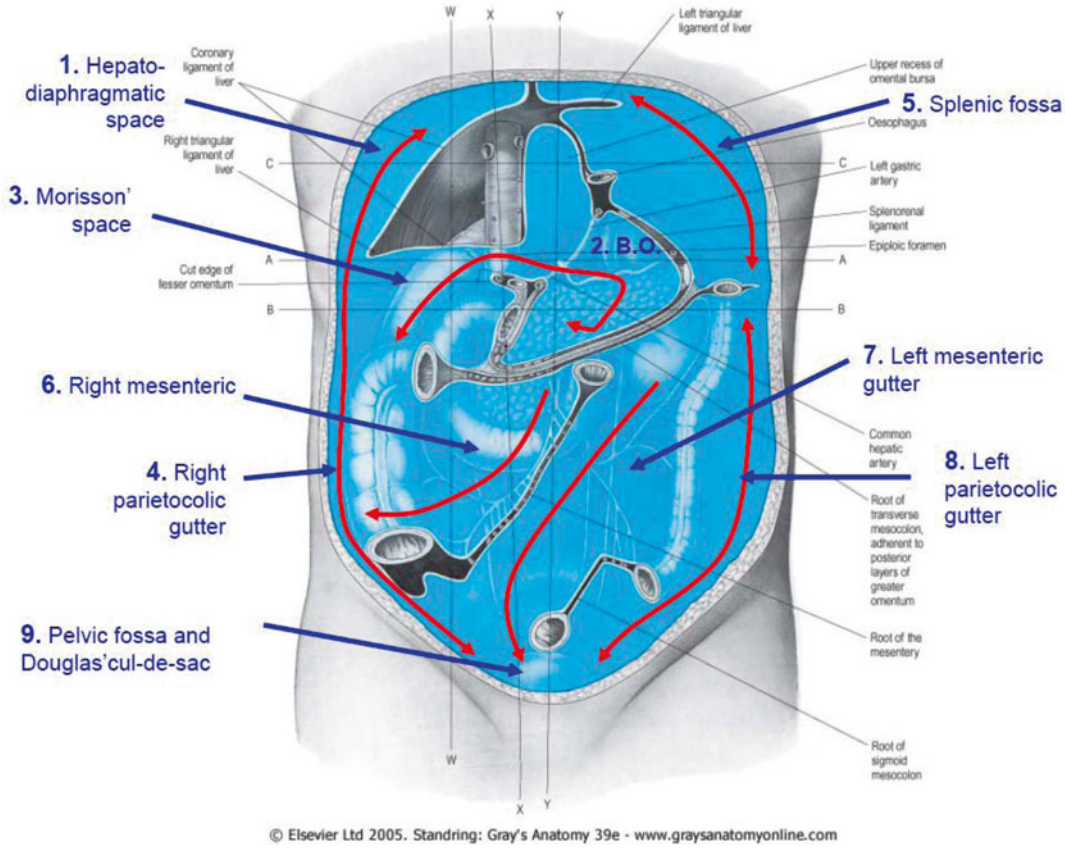

Fig. 8.5 Methodic cleansing of the peritoneal cavity

However: not always effective (can ultimately plug or be walled off), and drains have their own morbidity (as a foreign body, they can produce infection and digestive fistulas)

8.7.2.1 Passive Drains

- Based on capillarity, maintaining a communication between the peritoneal cavity and ambient air
  - Should be avoided in low-pressure zones (diaphragmatic cupolas) because of risk of infection by reversed current)
- Include
  - Fabric meshes
  - Corrugated sheet drains
  - Open tubes
  - Multitubular sheets
  - Tubes filled with mesh
- Rubber has been widely used but causes peritoneal inflammation that leads to drain exclusion. Modern drains made of polyvinyl or silicone induce less inflammation. Silicone drains are softer, cause less pain, and are more popular.

8.7.2.2 Mikulicz's Drain

- A passive drain whose efficiency can be increased by a central suction tube resulting in a hybrid system
- Procedure:
  - Cover cavity to be drained with the sack.
  - Place the retrieval thread to facilitate removal at the end of treatment.
  - Place a two-channel tube (irrigation and aspiration) in the middle of the sack and pack 3–5 numbered gauze tents.

- Maintain moisture by irrigation with isotonic saline (mandatory to allow progressive and nontraumatic mobilization of the gauzes).
- Mobilize first gauze, under analgesia, fourth to sixth POD.
- The whole system should be removed completely by the end of second week.

8.7.2.3 Active Drains

Active drains are negative pressure drains with or without air vent.

Open Drains

- These drains have an air vent and need aspiration (–30 to –100 cmH_2O).
- Negative pressure can be modulated and the air vent prevents drain obstruction by stagnation and coagulation of liquids or by impaction of surrounding tissues in the drain holes.
- Some variations are equipped with a bacterial filter on the vent (Shirley's drain) or a second irrigation channel (Vankemmel's and Worth's).
- Open negative pressure drains may be wrapped with a multitubular sheet to prevent obstruction of the drain holes by surrounding viscera.
- Negative pressure drains may be converted to passive drains by stopping the aspiration.

Closed Drains

- Have no vent and are connected to a vacuum bottle.
- Water and air tightness should prevent secondary infection.
- Some drains (Redon) may cause traumatic impaction of surrounding viscera and have been replaced by grooved channel, flat, or round drains.
- Close monitoring is mandatory to replace recipients when full.
- Association of a closed drain with an opened or a passive drain is illogical and must be avoided as air inlet will instantly lead to an inoperative drain system.

Vacuum Pack

- May be used when abdominal wall is left open either deliberately (severity of the infection, need of a second look, or abdominal wall infection/gangrene) or by necessity (abdominal compartment syndrome, impossibility to close the abdominal wall).
- Main advantage is effective drainage while preserving the abdominal wall.
- The operative technique includes [Brock, *Am Surg* 1995]:
  1. Placement of a fenestrated polyethylene sheet between the abdominal viscera and anterior parietal peritoneum
  2. Placement of a moist, sterile laparotomy towel over the polyethylene sheet
  3. Placement of two closed suction drains over the towel
  4. Placement of an adhesive backed drape over the entire wound, including a wide margin of surrounding skin
  5. Suction applied to the drains, creating a vacuum and rigid compression of the layers of closure material
- This creates a tight, external seal of the adhesive backed drape and facilitates drainage of the peritoneal cavity.
- When this device is used to drain peritonitis, adding pads or gauze tents too may be helpful.
- Commercial kits are available, provided with an autonomous suction pump that allows continuous controlled suction during patient transfer from OR to ICU.

8.7.2.4 Principles of Peritoneal Cavity Drainage

Some areas may be drained electively; others must not be drained.

Supramesocolic Space

- Easiest space to drain because only solid organs are present (spleen and liver) and there is absence of intestinal loops
- Five areas can be drained:
  1. Hepatodiaphragmatic space
  2. Splenic fossa
  3. Hiatus region
  4. Morrison's space
  5. Bursa omentalis (either through hiatus, either through a window in the gastrocolic ligament)

- Because of the obliquity of the mesocolic root, drains are best exteriorized through the right flank.

Inframesocolic Space
- Three areas may be drained without major iatrogenic risk:
  1. Right paracolic gutter (and right Toldt's fascia if right colon has been mobilized)
  2. Left paracolic gutter (and left Toldt's fascia if left colon has been mobilized)
  3. Douglas' cul-de-sac
- Placement of drains between intestinal loops must be avoided.
- Drains should be exteriorized through the shortest route possible.
- Drains should not be exteriorized through the incision.
- Drain orifices should be placed according to existing or possible stomas.

8.7.2.5 Indications of Drainage
- Prophylactic drainage is rarely indicated.
- Drains can be placed:
  - Surgically
  - Endoscopically
  - Via interventional radiology (guided by ultrasound or CT scan)
- Only objective bile or pancreatic leaks and nonresectable intra-abdominal infected sites need efficient drainage.

8.8 Abdominal Closure

8.8.1 After Incarcerated Hernia

- Emergency herniorrhaphy may be performed after surgical reduction of incarcerated gut.
- This is considered as a contaminated surgery, and use of prosthesis is not advisable.

8.8.1.1 Midline Incisional Hernia Repair
- After incision of the skin, control of incarcerated sac contents, and resection of infarcted bowel as necessary, the sac is dissected laterally up to the fascia and under the edge of the defect.
- If several defects are present, it is best to resect fascia between them in order to deal with only one large fascial defect.
- The peritoneum may be closed with a running suture, but some prefer not to suture the peritoneum.
  - If closure may be performed without tension, suture the linea alba in two layers in a vest-over-pants fashion.
  - If tension is present, prefer the component-separation technique (gain of length by vertical incision of the posterior aspect of the rectus, abdominis fascia, and/or incision of the aponeurosis of external oblique muscle laterally to rectus abdominis).

8.8.1.2 Umbilical Hernia Repair
- Small umbilical hernia can be repaired horizontally using a pants-over-vest technique.
- Large umbilical hernias are repaired in the same manner as midline-incision hernias.

8.8.1.3 Inguinal and Femoral Hernia Repair
- Suture repairs are preferred by most, but (absorbable) mesh repairs have their proponents. McVay, Bassini, and Shouldice repairs are efficient to repair both inguinal (direct and indirect) and femoral hernias. Open or laparoscopic techniques have been used.

Typically for Open Repair
1. Incise the skin 1 cm above inguinal ligament (line from anterosuperior iliac spine to pubic tubercle).
2. Incise the external oblique aponeurosis.
3. Identify the external ring and cut the external oblique muscle aponeurosis from the ring cephalad and laterally, parallel to fibers.
4. Identify the spermatic cord (or round ligament in female) and inguinal ligament.
5. The incarcerated hernia is either:
   - Within the spermatic cord (indirect)
   - Besides the cord (direct)
   - Below the inguinal ligament (femoral)

Indirect Hernia
1. Dissect the sac from cremasteric muscles on one hand and deferens and spermatic vessels on other hand, and resect the cremasteric muscle.
2. Open the sac and control incarcerated bowel.
3. If necessary, resect infarcted bowel.
4. Ligate and amputate the sac.
5. Incise fascia transversalis to expose pectineal ligament.

Direct Hernia
1. Open the sac and control incarcerated bowel.
2. If necessary, resect infarcted bowel.
3. Close the sac.
4. Dissect cremasteric muscles from spermatic cord and check for associated indirect hernia within spermatic cord.
5. Incise fascia transversalis to expose pectineal ligament.

Femoral Hernia
1. Incise fascia transversalis.
2. Incise underlying peritoneum.
3. Reduce the hernia and control incarcerated bowel.
4. If necessary, resect infracted bowel.
5. Then reduce and resect the sac to expose pectineal ligament, and close the peritoneum.

McVay Repair
1. Suture conjoined tendon to pectineal ligament with interrupted sutures lateral to femoral vein.
2. Then suture conjoined tendon to inguinal ligament laterally with interrupted sutures.
3. The last stitches calibrate the internal ring.
4. External oblique aponeurosis is sutured superficially to the spermatic cord calibrating the external ring.

8.8.2 Surgical Incision Closure

- Before closing a surgical incision, abundant lavage of the peritoneal cavity should be done to remove debris.
- Hemostasis of the operative field should be perfect.
- Adequate drainage, if needed, should be placed.
- Instrument and swab count should be correct.

8.8.2.1 Midline Incision

- Peritoneal closure:
  - Not necessary for some: there is no evidence that closing the peritoneum reduces adhesions.
  - Only possible if muscle relaxation is correct and there is no excessive intra-abdominal pressure.
  - Many surgeons change gloves, instruments, and clean draping once the peritoneal cavity is closed.
- Tissues are rinsed with isotonic saline and bleeding spots selectively coagulated.
- A running monofilament slowly absorbable (preferred) suture on the linea alba is usually performed by most surgeons (interrupted sutures may also be performed).
  - Bites should be thick enough to provide solid repair but not too thick not to create tension, ischemia, and consecutive weakness.
  - Bites have to be placed at sufficient interval not to be ischemic, but not too wide, not to shorten the length of the incision creating pain and excessive traction on the suture.
- Some approximate the subcutaneous fat (absorbable stitches), but this has never been shown to be of any real benefit.
- Skin is closed with stitches, staples, or continuous sutures (avoided in the case of massive contamination).

8.8.2.2 Oblique and Transverse Incisions

- The first layer is constituted by the peritoneum and the transverse muscle and aponeurosis.
- It is advisable to landmark the edges of internal oblique muscle and aponeurosis (external oblique muscle and aponeurosis) by angle stitches.
- Each plane is repaired by a continuous, slowly absorbable suture.

- When the incision crosses the rectus abdominis, the posterior part of rectus abdominis sheath is repaired in continuity with the transverse plane and the anterior with external oblique plane. Fibers of the rectus abdominis should not be sutured (but adequate hemostasis is necessary).
- Subcutaneous tissue and skin may be closed as above.

8.8.2.3 Delayed Skin Closure

- Delayed skin closure is indicated when the risk of subcutaneous infection (e.g., massive contamination in obese patients) is present.
- Fascia is closed but skin sutures are placed and left untied in the dressing.
- The stitches are tied 48–72 h later.

8.9 Special Situations

8.9.1 Decompressive Laparotomy

- Abdominal compartment syndrome (ACS) is defined as a sustained intra-abdominal pressure (IAP) >20 mmHg (with or without an abdominal perfusion pressure (APP) <60 mmHg), associated with new organ dysfunction or failure.
- ACS is confirmed by measure of IAP.
  - Intra-abdominal pressure is best measured via the urinary catheter with a transducer after inflation of the bladder with 50 ml of saline.
- ACS must be suspected in patients with a tense abdomen who become anuric, acidotic, or develop respiratory failure.

8.9.2 Open Abdomen Technique

- The vacuum pack (see drainage) in the poor man's or commercial variety has completely supplanted other techniques (Bogota bag or nonabsorbable membranes).
- If primary closure of the laparotomy is not possible, a variety of possibilities are available.

8.9.2.1 Isolated Skin Closure

- Only the skin is closed, resulting in an incisional hernia that will be repaired several months later.
- If the skin cannot be closed without excessive tension, skin-relaxing incisions in the flanks can be performed.

Absorbable Mesh Closure

- An absorbable mesh is sutured (with absorbable stitches) to the fascia.
- Granulation appears in few days from underlying omentum or gut.
- A skin graft may be performed when granulation is sufficient.
- Definitive repair of the resulting hernia is performed when the healing process is terminated.

8.9.2.2 Component-Separation Technique

- This should not be performed in a context of peritoneal infection because of the risk of abdominal wall gangrene.
- In absence of infection, this technique can be used for primary closure of small defects after laparotomy, otherwise, for larger defects, a two-stage procedure (component separation in the second stage) may be advisable.

8.9.3 Enterocutaneous Fistulas

- Occur often postoperatively or are consecutive to an intestinal disease (e.g., Crohn's disease)
- Diagnosis in clinic (presence of gastrointestinal fluid on or near skin incision)
  - Signs of local infection (inflammatory skin) and general infection (hyperthermia) are frequently associated.
  - Biology confirms inflammation.
  - Life-threatening signs of peritonitis or septic shock have to be sought.
    If present, urgent management is required.
  - Imaging such as CT scan, entero-CT, or entero-MRI can confirm diagnosis, show intraperitoneal fluid collections, localize

the exact origin of the fistula, and demonstrate downstream obstruction (findings are important for surgical strategy).

- Management is adapted to clinical and biological severity.
  - Septic shock commands urgent operative management to clean and drain the peritoneal cavity and most frequently divert the gut.
  - Fluid resuscitation and antibiotic therapy have to be started early.
  - In absence of peritonitis, surgical management may be delayed.
  - Effective skin dressings are important to prevent cutaneous complications.
  - The output of the fistula is important to consider.
    Low output (<500 ml/24 h): medical treatment based on diet, antisecretory drugs, parenteral nutrition, and sometimes antibiotics may suffice.
    High output (>500 ml/24 h): initial medical treatment usually fails (but helps restore nutritional status before surgery).
  - Goals of surgery: treat the peritonitis or abscess and dry the fistula
    In case of peritonitis, gut diversion is advisable.
    In absence of peritonitis, a simple resection of the fistulized gut and fistula track followed by anastomosis is the best option.
    - If resection is too difficult, internal bypass of the fistulized gut segment is advisable.
    - In case of complex and multiple early postoperative fistulae in a hostile abdomen, immediate upstream diversion is best to reduce fluid losses and denutrition.
    - Once local conditions have improved, and after complete work-up, a new operation is scheduled.

Pitfalls

- A nonadhering adhesive drape is worse than no drape.
- Do not use coagulation mode of the cautery to cut: this mode cuts poorly and the extended burn jeopardizes healing and favors infection.
- Too small and/or malpositioned incisions.
- Not choosing a damage control procedure in an exsanguinating or physiologically compromised patient.
- Not identifying an incarcerated groin or umbilical hernia preoperatively.
- Drains have their own morbidity; they do not compensate poorly performed surgery.
- Not recognizing an abdominal compartment syndrome.

Essential Points

- When in doubt, use a large midline incision.
- Do not proceed further if bleeding is not temporarily controlled.
- Incarcerated hernia is a common cause of obstruction.
- Complete peritoneal toilet is essential.

Selected Reading

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Lower Gastrointestinal Endoscopy

9

Halil Alis and Korhan Taviloglu

Contents

9.1 Introduction

- Although emergency endoscopy has clearly proved to be effective for both diagnosis and management of upper gastrointestinal tract emergencies, there is still debate regarding its use in patients with lower gastrointestinal tract emergencies.
- Irrespective of whether "emergency" refers to the first 24 h or the first 72 h, the two main goals of emergency endoscopy are diagnosis and management:
  - **Diagnosis**
    Essential to guide the management.
    Endoscopy provides necessary information for risk assessment.
    - High-risk patients may be referred to appropriate institutes.
    - Low-risk patients may be discharged earlier.
  - **Management**
    Endoscopy can be used as a potential therapeutic tool in selected cases.
    Therapeutic procedures include injection therapy, sclerotherapy, endoscopic clip application, argon beam cauterization, golden probe application, detorsion, tube placement, percutaneous endoscopic gastrostomy, and transcolonic and transrectal abscess drainage.
- **Indications**
  - Hemorrhage

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- Large bowel obstruction
- Foreign body extraction
- Treatment of anastomotic failure

- **Contraindications**
  - Absolute
    Suspicion of perforation
    Noncompliant patient
    Shock
    Respiratory distress
    Clear indication for exploratory laparotomy: diffuse peritonitis
  - Relative
    Coagulopathy (if life-threatening entity in which a diagnostic and/or therapeutic endoscopy is considered to be critical)
    Patients who have had a gastrointestinal tract surgery (low-pressure endoscopy after the fifth to seventh postoperative day)
    Pregnancy
- **Patient preparation**
  - Major limiting factor in emergency colonoscopy: lack of mechanical bowel preparation.
  - It is wise to avoid oral laxatives for mechanical bowel preparation in critically ill patients and in patients who may not tolerate dehydration: enemas should be preferred over oral laxatives in these patients.
    Of note, polyethylene glycol (Golytely) is a fast-acting (4 h) oral solution and is responsible for relatively mild fluid-electrolyte disturbance.
    Particular to emergency colonoscopy.
    - Likelihood of overlooking colonic lesions is considerably high, and it is usually not possible to advance the colonoscope into the cecum; therefore, the endoscopist should focus on identifying the emergency pathology instead of exploring the whole colon and should then carry out an elective colonoscopy to exclude additional pathologies.
    - Avoid administration of sedatives and analgesics as much as possible. Short-acting agents, such as propofol and fentanyl, should be preferred in exceptional situations, particularly if physical examination is thought to be crucial for follow-up of the patient.
  - Staff and equipment.
    Staff trained in emergency endoscopy.
    Adequate equipment for excessive irrigation.
  - **Complications**
    Higher incidence of complications in emergency endoscopy (0.9 %) when compared to elective endoscopy (0.1–0.3 %)
    Types
    - Cardiopulmonary complications (responsible for 50 % of deaths)
    - Infection
    - Hemorrhage
    - Perforation

9.2 Lower Gastrointestinal Bleeding

Definition, incidence, and population

i. Lower intestinal hemorrhage is defined as bleeding in the bowel distal to the ligament of Treitz and usually manifests with maroon stools or bright red blood per rectum.
ii. Incidence (not exactly known) but assumed to be 20–30/100,000 population.
   i. Twenty-five percent of all gastrointestinal bleedings.
   ii. Male predominance.
   iii. The rate of hospitalization also increases >200-fold between the third and ninth decade of life related to the increased incidence of diverticulosis and malignancy.
iii. Rarely massive (defined as exsanguinating or hemodynamically significant bleeding that persists and requires at least four units of blood over a period of 24 h).
   1. Most episodes are self-limiting and not hemodynamically significant and never have the precise site and cause established.
   2. However, older population (>65-year-old patients) and the patients with comorbidities warrant hospitalization because of high morbidity and mortality rates (10–20 %).

3. Up to 80 % of patients will stop bleeding spontaneously, and the recurrence rate reaches as high as 25 %.
4. Identification of the bleeding source remains a diagnostic challenge. Approximately 10 % of all patients will never have a source identified, and up to 40 % of patients with LGIB have more than one potential bleeding source.

iv. Causes.
1. Diverticula of the sigmoid colon and angiodysplasia are the two most common causes of major acute LGIB.
   (a) Bleeding from diverticula occurs more often in elderly patients, particularly in those taking NSAIDs or anticoagulants.
   (b) Bleeding from angiodysplasia can be massive and recurrent.
2. Ischemic colitis.
   (a) Seen in the elderly
   (b) Rarely presents with massive bleeding
3. Rectal cancer.
   (a) Bleeds overtly.
   (b) Often the patient may have a history of tenesmus and of episodic minor bleeding with the stools for some time.
4. Inflammatory bowel disease.
   (a) Almost never the first symptom of the disease
      i. Often preceded by diarrhea
   (b) Rarely massive
5. Proctitis and especially radiation proctitis and internal hemorrhoids may bleed significantly.

Immediate management

i. Initiate ABC rules as for all patients in the emergency setting. The goal is to determine hemodynamic stability.
ii. Appropriate laboratory values should be ordered including a complete blood count, coagulation profiles, and blood gases. An initial type and screen should be completed in anticipation that blood transfusion may be required.
iii. Determine whether the source of bleeding is upper or lower gastrointestinal tract.
1. Digital rectal examination

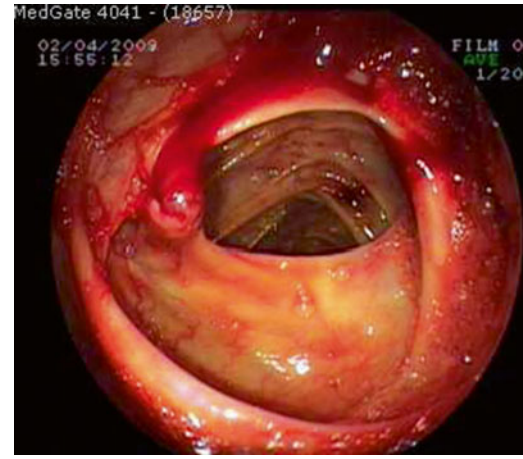

Fig. 9.1 Colonic bleeding in colonoscopy

2. Insertion of nasogastric tube
   (a) To rule out upper gastrointestinal bleeding and evacuate the gastric contents
   (b) Upper gastrointestinal endoscopy

iv. Recommended to carry out colonoscopy immediately in patients with third and fourth degree hypovolemia and within 12–24 h in patients with first and second degree hypovolemia (Fig. 9.1).
1. Early colonoscopy is superior to delayed colonoscopy in means of identifying the lesion, reduction of rebleeding rate, reduction of morbidity and mortality rates, and decreasing the necessity of blood transfusion and surgical intervention.
2. Mechanical bowel preparation is usually not necessary because of the purgative effect of intraluminal blood.
3. Therapeutic interventions during colonoscopy are required only in 20 % of patients with lower gastrointestinal bleeding.

9.3 Other Diagnostic Modalities in LGIB

Radionuclide scintigraphy

i. Involves either technetium-99m (Tc-99m) sulfur colloid or Tc-99m-labeled red blood cells to localize bleeding from a gastrointestinal source.

ii. Scintigraphy can identify bleeding as low as 0.1 ml/min and has been advocated as a safe, noninvasive, and accurate method identifying all types of gastrointestinal bleeding.
iii. No need for bowel preparation and repeat scans can be easily performed in cases of recurrent bleeding although limited by the half-life of the radiotracer used.
iv. Scintigraphy is now used at most institutions as a screening tool to determine the group of patients who would be optimal candidates for interventional angiography.
v. Negative scans may also be useful for screening as they are also associated with a low likelihood of requiring surgical intervention.

Angiography

i. This method allows for accurate localization of the source of bleeding at rates as low as 0.5 ml/min.
ii. Can be therapeutic by injecting vasopressin or by performing embolizations of bleeding vessels.

Multi-Detector Row Helical Computed Tomography (MDCT)

i. Allows for identification of extravasation of intraluminal contrast before it is diluted by intestinal contents.
ii. This modality has been used increasingly in the diagnosis of vascular diseases as it is capable of more precise imaging and 3-D formatting of vascular structures.
iii. MDCT demonstrates acute lower GI bleeding rates as low as 0.2 ml/min, lower than that for angiography and comparable to radionuclide scanning.
iv. Overall rates of detection and localization range around 30 % and is comparable to angiography.
v. MDCT may be a more reliable method of screening when compared to RBC scintigraphy.

Others

i. Push enteroscopy and capsule endoscopy have been investigated for the diagnosis of LGIB.
ii. Push enteroscopy uses a longer, thinner endoscope to examine the small bowel but only reaches approximately 160 cm past the ligament of Treitz, leaving most of the small bowel unexamined.
iii. Wireless technology have paved the way for capsule endoscopy, a pill-sized capsule that the patient swallows and travels the entire length of the GI tract by peristalsis. It is noninvasive and causes no patient discomfort.

9.4 Several Types of Possible Therapeutic Colonoscopic Interventions

Injection therapy:

i. Different types of liquid material can be injected around the bleeding lesion with an endoscopic needle
   1. Arrest of bleeding depends on two principles:
      (a) Compression of bleeding vessels by mass effect
      (b) Biochemical effects
   2. The most common biochemicals used are:
      (a) Epinephrine.
         i. The most preferred agent used worldwide
         ii. Injection of a 1:10,000 solution into four quadrants around the bleeding lesion
         iii. Leads to vasoconstriction
      (b) Sclerosing agents, alcohol sclerosing agents, and alcohol lead to endarteritis and subsequent occlusion of bleeding vessels.
      (c) Fibrin glue and fibrin glue-thrombin complex.
         i. Highly effective and less harmful
         ii. Costly
         iii. Leads to thrombus formation in bleeding vessels
   3. Success rate of injection therapy is about 90 %; however, rebleeding rate is 15–20 %.
      (a) Size of vessel is important (see below)

Heat therapy:

i. Principle: coagulation of bleeding vessels within the lesion by applying heat energy through direct contact

1. Heat energy transferred via probe pressed directly upon the lesion

ii. Types: monopolar and bipolar coagulation heat probe, laser coagulation, and coaptive coagulation
1. Bipolar coagulation and heat probe is effective in bleeding vessels up to 2.5 mm in size.

iii. Is as effective and safe as injection therapy in non-variceal bleeding

iv. Main disadvantage: not possible to control the depth of penetration of heat energy

Laser photocoagulation:

i. Coagulates the bleeding vessels by transferring heat energy to the bleeding lesion
1. Generally, Nd:YAG laser is used.
(a) With a 3–4 mm depth of penetrance, Nd:YAG is the treatment of choice in angiodysplasia, and the success rate is about 84 %.
2. Although it has the advantage of avoidance of direct contact between the cautery and the bleeding lesion, laser device is not portable and overall cost of the procedure is considerably higher.

Mechanical means:

i. Appliances include endoclips and endoscopic band ligation.
1. Work by mechanical closure of bleeding vessels
(a) Treatment of choice in major bleedings.
i. Suits bleeding vessels larger than 1 mm in size (usually refractory to injection therapy)
(b) Endoscopic band ligation is generally preferred in variceal bleeding and in apparently visible bleeding (Forrest 1A, 1B, 2A lesions and Dieulofoy's lesion).

The procedures mentioned above can also be used in combination.

i. Combined injection therapy and thermal therapy and injection therapy and mechanical tools has been demonstrated to be more effective than single therapy.

ii. The incidence of rebleeding is 15–20 % after therapeutic endoscopy.
1. Ongoing controversy between surgeons and endoscopists about whether rebleeding should be treated by surgical intervention or by second therapeutic endoscopy, most surgeons prefer surgery!

9.5 Acute Mechanical (Large Bowel) Obstruction

Colorectal cancer.

(a) Responsible for presentation in 30 % of patients with colorectal cancers
i. Rectal cancers account for 85 % of cases with acute mechanical obstruction of large bowel that undergo surgical treatment.

(b) Plain X-rays and computed tomography of the abdomen are the most common methods used for diagnosis.

(c) However, colonoscopy is extremely valuable for diagnosis and therapy in patients who do not have clinical signs of peritonitis.
i. The likelihood of the identification of the obstructing lesion by colonoscopy is greater than 90 %.
ii. May also serve as a therapeutic tool by the application of self-expendable (or expandable) metal stents.
1. Used to avoid emergency operation by decompressing the large bowel and, thus, offers a chance for the patient to have an elective procedure and serves as a bridge with lower risk (Figs. 9.2 and 9.3) and lowers the rate of stoma for critically ill patients
2. Best suited to locally aggressive or metastatic colorectal cancers, in patients who are poor candidates for surgery, obstructive metastatic colorectal tumors, and inoperable intra-abdominal tumors leading to extrinsic compression
3. Advantages/disadvantages
(a) Complications are possible.
i. Mal-positioning
ii. Perforation
iii. Bleeding

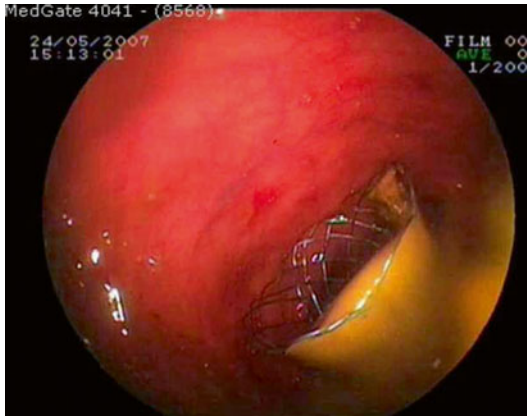

Fig. 9.2 Colonic stent in colonoscopy

Fig. 9.3 Colonic stent

iv. Migration
1. Less frequently seen with uncovered stents when compared with covered stents in acute mechanical obstruction of large bowel
2. May be asymptomatic or present with rectal bleeding and tenesmus

(b) Tumors of the right flexure and right colon are not suitable for colonoscopic stenting.

(c) Main reasons of failure in colonoscopic stenting are locally aggressive tumors that are fixed to adjacent organs and failure to pass the guidewire through the obstructive lesion.

Fig. 9.4 Sigmoid volvulus

(d) The rates of mortality, perforation, the migration of the stent, bleeding, and re-obstruction related to colonoscopic stenting were estimated to be less than 1 %, 0–7 %, 3–22 %, 0–5 %, and 0–15 %, respectively.

Sigmoid volvulus.

(a) Defined as an axial twisting of a portion of an organ around itself or a stalk of mesentery tissue to cause luminal and vascular obstruction.

(b) Most common site of colonic volvulus (43–71 %).
i. But can also be seen in the cecum, the right colon, the transverse colon, and the splenic flexure in decreasing frequency (Fig. 9.4)

(c) Endoscopic decompression should be the initial step.
i. Successful in 70–80 % of the cases with rigid endoscopy and >90 % with flexible sigmoidoscopy
1. Advantages of flexible sigmoidoscope (vs. rigid)
(a) Air insufflation mechanism facilitates the detorsion process.
(b) Aspirative function for removing the colonic contents after detorsion.
(c) Insertion of the rectal tube by placing a guidewire.
(d) Lower complication rate.

ii. Contraindication
   1. Signs of peritonitis
   2. After initial failure of endoscopic decompression
   3. Recurrent episodes of sigmoid volvulus

Detorsion.

i. If the mucosa is macroscopically viable, a rectal tube (40–60 cm in length) is inserted through the lumen of the endoscope or beside the endoscope and is advanced till it reaches the torsion site.
   1. Torsion site is gently cannulated without any rough movements.
   2. Rectal tube should be fixed to the perianal area with sutures and should be kept for 48 h.

Colonic pseudo-obstruction.

(a) Refers to acute dilation of the colon in the absence of any mechanical obstruction.
(b) Usually occurs in critically ill patients who have congestive heart failure, hypomagnesemia, hypercalcemia, and hypokalemia.
(c) Diagnosis is made by colonoscopy which shows no obstructing lesion in the entire colon.
(d) The initial step is to identify and to correct the underlying factor and to avoid medication with anticholinergic and sedative agents.
(e) Colonoscopic decompression and maintenance of colonic decompression with the insertion of a rectal tube is one of the specific treatments.
(f) Cecum should be reached during colonoscopy in order to rule out any obstructing lesion.
(g) Increasing number of studies in the literature suggest the use of percutaneous endoscopic cecostomy as an alternative.

Other various pathologies cause acute mechanical obstruction of large bowel.

(a) Metastatic tumors (stent)
(b) Extraintestinal pelvic tumors (stent)
(c) Diverticular disease (resection)
(d) Inflammatory bowel disease (medical treatment initially)

Fig. 9.5 Ischemic colitis

(e) Anastomotic strictures or due to anti-inflammatory drugs, ischemic colitis (Fig. 9.5), and radiation enterocolitis (resection)

Foreign bodies

(a) Usually enter the body via transoral or transanal route.
   i. In rare cases, the cause is the migration of transmural or therapeutic agents.
(b) Approximately 10–20 % of foreign bodies necessitate endoscopic intervention, while 1 % warrants surgery.
(c) Symptoms:
   i. Abdominal pain, nausea and vomiting, fever, rectal bleeding, and melena. Foreign bodies that reach the colon are usually spontaneously excreted with feces.
   ii. Specific problems.
      1. Batteries are especially hazardous because they contain toxic material such as caustic salts and alkalines; therefore, every effort should be made to extract the batteries.
      2. Sharp, long, or angled foreign bodies cause intestinal perforation in 15–30 % of cases. The most common sites of perforation are angled sites of the gastrointestinal tract such as the ileocecal valve and the rectosigmoid junction.

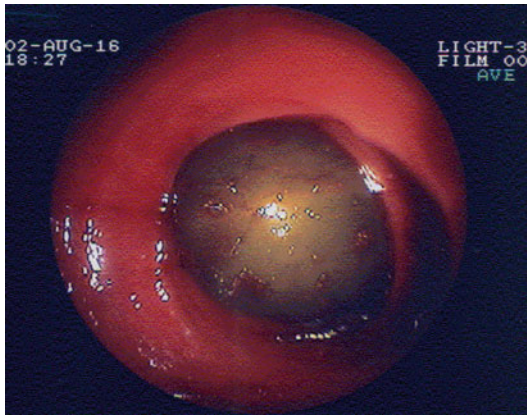

Fig. 9.6 Appearance of a cucumber in colonoscopy

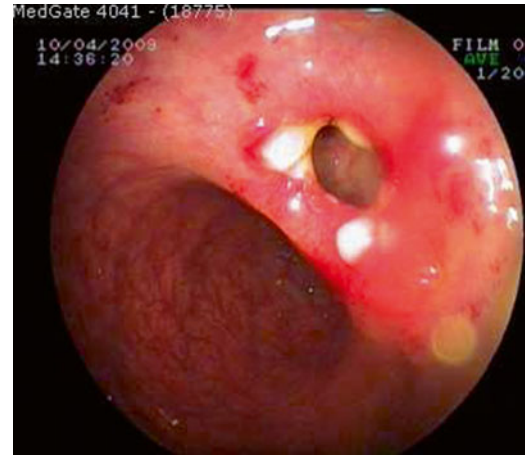

Fig. 9.7 Appearance of a colonic fistula colonoscopy

3. Body-packers are prone to anaphylactic shock in case of sudden inundation of drugs.

iii. Radiological investigation is also useful in patients who have atypical sexual behaviors, loose anal sphincter, and possible mucosal injury.
   1. Important to obtain plain or contrast-enhanced graphies after the procedure in order to exclude any possible complication

iv. Endoscopic extraction of foreign bodies greater than 6 cm in size is still controversial (Fig. 9.6).
   1. Various equipment such as endoscopic balloons, snares, alligator forceps, and baskets can be used during this procedure according to the shape, the size, and the property of the foreign body.
   2. Foreign bodies can be retrieved via transanal route by anoscopy.
   3. Risk of perforation during extraction is directly correlated with the experience of the attending surgeon.
   4. Foreign bodies inserted or extracted via transanal route may cause serious injuries in the anal sphincter complex or rectosigmoid that may necessitate a major surgery.
      (a) Fecal incontinence estimated at 10 % after forced transanal extraction
   5. Enterotomy becomes rarely necessary for the extraction of foreign body during surgical treatment.
   6. Fluroscopic guidance is recommended during the entire procedure, either surgical or endoscopic.

Anastomotic breakdown or leakage

(a) Defined as incomplete or complete disruption at the anastomotic line.
(b) Generally accepted that endoscopy can safely be carried out after the fifth postoperative day in patients who are not suspected to have an anastomotic complication (no clear evidence).
(c) Nowadays, colonoscopy is widely used for both diagnostic and therapeutic means in such patients (Fig. 9.7).
(d) Different endoscopic procedures have been defined for the management of such patients:

The closure of fistula tract

1. **Endoscopic debridement**:
   (a) First define the tract, the connections, the orifices, and the length by cannulation and radiological imaging studies
   (b) Removal of necrotic tissues by pressure, irrigation with physiological saline, or other agents of choice
2. **Fibrin glue**:
   (a) 1–4 ml of fibrin glue per session.
   (b) Mean duration for complete healing is 33 (4–365) days.
   (c) Success rate of 70–80 %.
3. **Clipping**:
   (a) Anastomotic defects up to 12 mm can be sealed by this procedure.

4. **Stenting**:
   (a) Extractable silicon, covered self-expendable metal, and biodegradable stents can be used.
5. **Endovac**: (abbreviation for endoscopic vacuum therapy)
   (a) Useful for complicated rectal and esophageal anastomoses.
   (b) Prior to the endoscopic procedure, pathological anatomy of the anastomotic complication should be defined by radiological studies.
   (c) First step is to identify the disruption site at the anastomosis.
   (d) Then, all connected pathological cavities are debrided endoscopically.
   (e) Insertion of an overtube under endoscopic guidance.
   (f) A piece of special foam (especially polyurethane) prepared in an appropriate size is introduced through the overtube and is applied to the cavity.
   (g) Continuous negative pressure is applied via the foam to promote healing.
   (h) The foam is changed every 2–3 days, and endoscopic debridement is repeated.
   i. Recent studies reported the mean duration of complete healing and the success rate for the procedure as 10–14 days and 96 %, respectively.

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Percutaneous Interventions

10

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Contents

Objectives

- To know the indications and learn the surface anatomical landmarks of the most common emergency percutaneous interventions
- To know the pitfalls and technical tricks for each procedure
- To learn how to deal with procedural complications

Acute care and emergency surgeons should be familiar with a few simple percutaneous procedures for their daily activity. Among them are central venous catheters, percutaneous tracheostomy, suprapubic catheterization, and peritoneal and chest tap. In this chapter, we will discuss the indications, techniques, pitfalls, and frequent complications of these procedures.

10.1 Central Venous Catheters

Can be inserted either peripherally or via a direct access

- Peripheral vein insertion
  - Requires the use of long catheters to gain access to the central venous system
  - May be difficult to perform in the emergency setting (venous collapse)

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- Central venous access (CVA)
  - Advantages: greater longevity without infection, line security, avoidance of phlebitis, larger and multiple lumens and route for nutritional support, long-term use antibiotics, and central venous pressure monitoring.
  - The most frequent emergency indications for CVA:
    Volume resuscitation, emergent venous access for IV treatment, and central venous pressure monitoring
  - Contraindications to CVA:
    Distorted anatomy (e.g., vascular injuries, prior surgery, or previous local radiotherapy), infection at insertion site, or uncooperative patient
    Relative: excessive overweight or underweight, anticoagulation, or coagulopathy (especially for the subclavian approach, where it is difficult to stop bleeding by compression)
  - Choice of site of catheter insertion depends on:
    Purpose and duration of use of the catheter
    Experience and known complications of the technique
    - Experience and comfort level with the procedure are the main determinants to the success of line placement
    - Internal jugular vein catheters have been reported to be associated with higher risk for infection than subclavian or femoral veins, but the level of evidence is low.
    - Generally speaking, lower extremity sites seem to be associated with higher risk for infection and femoral catheters are associated with higher risk for deep venous thrombosis than internal jugular or subclavian sites.
    - The risks and benefits of choosing a site to reduce infectious complications must be weighed against ease of access and the risk of mechanical complications (e.g., pneumothorax, subclavian artery puncture, subclavian vein laceration or stenosis, hemothorax, thrombosis, air embolism, or catheter misplacement).

Table 10.1 Complication rates of central venous catheterization approaches

	Internal jugular	Subclavian	Femoral
Arterial puncture	6.3–9.4	3.1–4.9	9–15
Hematoma	<0.1–2.2	1.2–2.1	3.8–4.4
Hemothorax	N/A	0.4–0.6	N/A
Pneumothorax	<0.1–0.2	1.5–3.1	N/A
Thrombosis†	7.6	1.9	21.5
Infection*	0.87	1.8	6.9

Data from McGee DC et al., †Merrer J et al. and *Lorente L et al.

Table 10.2 Recommendations to avoid complications of central venous catheterization approaches

Complications	Recommendation
Infectious	Use maximal sterile barrier precautions
	Choose subclavian access when possible
	Use antimicrobial impregnated catheters
Mechanical	Recognize risk factors for difficult catheterization
	Seek assistance from an experienced clinician
	Avoid femoral venous catheterization
	Use ultrasound guidance if available

  - Table 10.1 shows rates of more frequent complications for CVA. Preventive actions are shown in Table 10.2.
- *Knowledge of surface landmarks* are critical for success and safety.
  - Improper insertion position and inadequate landmark identification have been shown as common technical errors.
  - The use of ultrasound and fluoroscopic guidance decrease the rate of immediate complications.
    Ultrasound can detect thrombosed veins and allows safe puncture in patients with coagulopathy, avoiding arterial puncture. However, its use in the subclavian access has had mixed results in clinical trials.

A chest radiograph is mandatory after CVA placement to check the catheter position and to assess for pneumothorax or hemothorax in case of jugular or subclavian access (performed before switching to the contralateral site after failed insertion).

- *General principles*
  - Most insertions use the Seldinger or modified Seldinger technique
  - Whenever possible, explain the procedure, the benefits, and risks to the patient or relatives to obtain informed consent.
  - Check the equipment prior to starting the procedure.
    Central venous catheter tray (line kit) containing a 26 gauge needle for injecting anesthesia (may also serve as a finder needle), a 22 gauge needle to access the vein, syringe, flexible guide wire with J-tip, dilator, n° 11 scalpel, and single or multilumen catheter
    Antiseptic solution (2 % chlorhexidine in alcohol) with skin swab
    Sterile gloves, drapes, and gown
    100 ml of saline with heparin
    Lidocaine 1 %
    Gauze and dressing
  - Do not to use the patient as a table.
  - Infiltration of local anesthesia (1 % lidocaine) should be enough, but sometimes analgesia and sedation can be helpful (operator should be familiar with the most commonly used analgesics, sedatives, and reversal agents).
  - Put on mask, sterile gowns, and gloves, and drape the patient in a sterile fashion.
  - Flush the catheter with heparinized saline before insertion.
  - Insert the introducer needle while pulling on syringe piston, slowly advancing until reaching the clavicle and then slide underneath the inferior border of the bone.
  - When venous blood is aspirated copiously, disconnect the syringe, occlude the lumen of the needle with a finger, and insert the guide wire while observing the heart rhythm (retract it 4 cm if arrhythmias result from the guide wire being deep within the heart).
    If resistance is encountered, rotate the guide wire gently.
    Unsuccessful passing indicates misplacement and never use force to advance the wire.
  - Withdraw the introducer needle; make a small stab against the wire to enlarge skin entry site.
  - Maintaining constant control of the wire, thread the dilator over the wire with a firm and gentle twisting motion.
  - Remove the dilator and thread the catheter until wire exits the distal lumen.
  - Push the catheter to desired length while holding the wire.
  - Hold the catheter in place and remove the wire.
  - Aspirate blood and flush 2 cc heparinized saline in every catheter lumen.
  - Attach the catheter to skin with sutures; apply a clean dressing.

10.1.1 Subclavian Access

- Most common access because:
  - Simple
  - Consistent landmarks
  - Patient comfort
  - Low potential for infection
- Patient positioned supine, monitored, and Trendelenburg position (to reduce the risk of air embolism)
- Landmarks: sternal notch, angle of the clavicle
- Prepare the insertion site and the neck as well.
- Infiltrate skin, subcutaneous tissue, and clavicular periostium with lidocaine 1 %.
- The insertion site is 1 cm below the junction of the middle and medial third of the clavicle, at the deltopectoral groove or one finger-breadth lateral to the angle of the clavicle.
- Direct the insertion needle toward the sternal notch, parallel to chest wall (to reduce the possibility of pneumothorax).
- Attention:
  - If the vein is not reached, remove the introducer needle, flush the clots, and try again.

- Never change the needle position while inserted.
- Change insertion site after three unsuccessful attempts.
- Red pulsatile blood indicates arterial puncture.
- Aspiration of air bubbles indicates a pneumothorax.

10.1.2 Internal Jugular (IJ) Access

- Optimal patient position is Trendelenburg with head turned to the opposite side of insertion.
- Internal jugular vein lies underneath the triangle formed by the clavicle and the clavicular and sternal heads of the sternocleidomastoid muscle (Fig. 10.1).
- IJ is best localized at the apex of this triangle but can be also easily accessed cranially medial to the sternocleidomastoid muscle and external to the carotid pulse (anterior approach) or lateral to the muscle (posterior approach).
  - Ultrasound guidance with a high-frequency, high-resolution probe (7–15 MHZ) has decreased the rate of immediate complications.

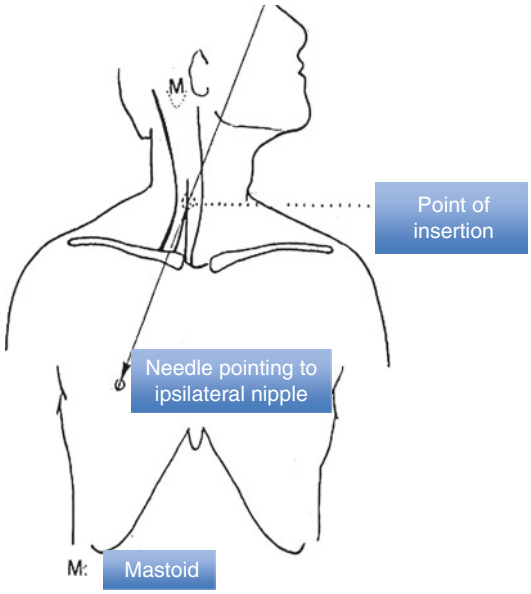

Fig. 10.1 Internal jugular vein catheterization landmarks

  Reduces failure rate and misplacement, especially in the obese (for the femoral route) or in hypotensive patients (absence of palpable adjacent (femoral) artery).
  But can increase the risk of pneumothorax in inexperienced hands (for subclavian access).
  Avoid excessive compression of the skin which will collapse the vein and distort surface landmarks.
  - Improper insertion position and inadequate landmark identification are common technical errors.
- Insert needle at a 45° angle to the skin, pointing to the ipsilateral nipple (or sternal notch with posterior approach)
- The line should be tunneled. It is preferable to avoid IJ insertion in patients with previous neck surgery.
- As above, beware of multiple attempts for the increased risk of damaging adjacent structures (trachea, esophagus, carotid artery).

10.1.3 Femoral Vein Access

- Advantages
  - Easiest if CVA is needed for resuscitation from shock,
  - Can be performed quickly.
  - The femoral artery is an immediate palpable landmark.
  - No risk for hemothorax or pneumothorax.
  - The site is directly compressible if bleeding or arterial cannulation occur.
  - Nerve damage is unlikely.
  - Local anesthesia may be omitted in an emergent situation.
- Disadvantages
  - Risk of deep venous thrombosis is increased sixfold, unrelated to duration of catheterization.
  - The perineum is always considered as potentially contaminated.
- Formal contraindication: known or suspected thrombosis.
- Patient position: supine with the hip in neutral position and the foot in moderate lateral flexion.

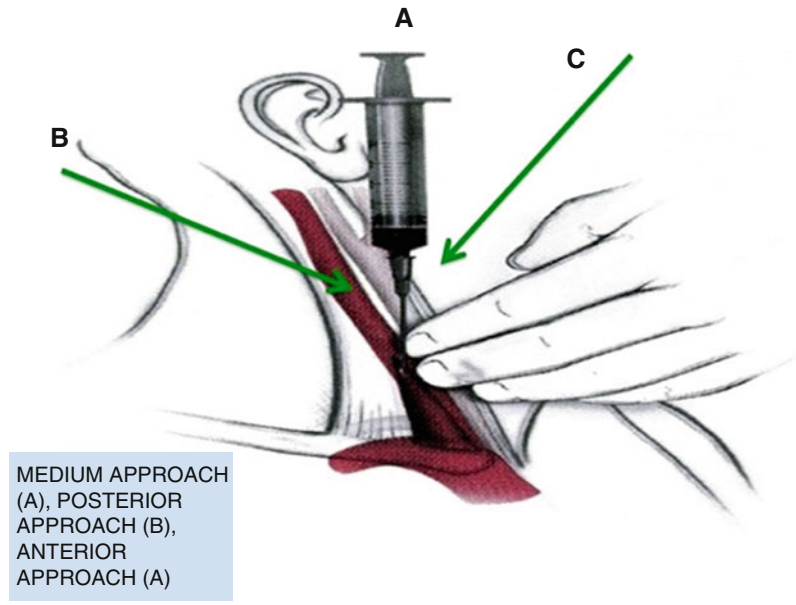

Fig. 10.2 Femoral triangle and femoral vein anatomic relations

- Vein lies in the femoral triangle formed by the inguinal ligament superiorly, the adductor longus muscle medially, and the sartorius muscle laterally (Fig. 10.2), medial to the (pulsating) artery.
- Insert needle 1 cm below the inguinal ligament, 0.5 cm medial to (pulsating) artery.
  - Enter the skin cephalad at a 45° angle with the 22-gauge needle.
- Most frequent complications:
  - Arterial puncture
  - Hematoma
  - Thrombosis
  - Femoral nerve injury
- Less frequent complications:
  - Pseudoaneurysm formation
  - Bowel puncture (beware of patients with inguinal hernias)
  - Bladder puncture
  - Psoas abscess
  - Osteomyelitis from bony puncture, especially in children

10.2 Percutaneous Tracheostomy (PT)

- One of the most frequently performed procedures in critically ill patients.
- Has replaced conventional tracheostomy because
  - Rapid
  - Simple
  - Can be performed at bedside
  - Smaller skin incisions
  - Cost-effective
  - Fewer intraoperative complications
    False passage
    Less tissue trauma
    Less intraoperative minor bleeding
    Pneumothorax
    Tracheal ring fracture
    Posterior wall injury
  - Lower incidence of wound infection
  - Lower mortality
- But a higher incidence of decannulation and obstruction
- All PT techniques show similar complication rates (10 % perioperative, 7 % postoperative): direct injuries to the vocal cords or recurrent laryngeal nerve or tracheal stenosis, the most important long-term complication, are uncommon
- Most common indications:
  - Need for prolonged mechanical ventilation (>7 days)
  - Airway obstruction
  - Need for improved pulmonary toilet

- Absolute contraindications:
  - Children
  - Emergency airway necessity
  - Coagulopathy
  - Cervical injury
  - Distortion of neck anatomy due to tumors, goiter, or high innominate artery
- Relative contraindications:
  - Obesity
  - Need for high positive end-expiratory pressure (PEEP >20 cm of water)
  - Evidence of infection in the surgical site
- Several techniques are available, all based on the use of a needle guide wire to gain airway access. However, each method requires specific equipment and has a different intraoperative procedural sequence
  - Common steps for all procedures include intravenous sedation, 100 % oxygen, hyperextension of neck, partial withdrawal of the endotracheal tube (ET) under bronchoscopic direct vision (recommended to place the balloon caudal to the vocal cords) but protection needed to avoid untoward movement, sterile skin preparation and draping, infiltration of the skin with 2 % lidocaine
  - The *percutaneous dilational tracheostomy* technique
    Starts with a 1.5–2 cm transverse skin incision on the level of the first and second tracheal rings
    Blunt dissection until reaching the trachea
    Insertion of a 22 gauge needle between first and second, or, preferably second and third tracheal rings
    When air is aspirated, introduction of guide wire and dilators (sequentially inserted from small to large)
    Insertion of tracheostomy tube
    Removal of guide wire and dilator
    Inflation of tube cuff
    Connection of breathing circuit
    Removal of ET tube
  - The *guide wire dilating forceps* technique
    Employs a modified forceps that is advanced through the soft tissues of the neck until resistance is felt, then opened to dilate the soft tissues anterior to the trachea, closed and reinserted over a guide wire.
    Loss of resistance occurs when tracheal membrane is pierced.
    Insertion of tracheostomy tube with obturator through guide wire.
  - The *Rapitrach* and the *Ciaglia Blue Rhino* techniques are variations of the previous with different dilator forceps. After the procedure, air entry to the lungs must be checked, excess of blood and secretions suctioned, everyday antiseptic wound care provided, and cuff pressure monitored.

10.3 Suprapubic Catheter Insertion (SCI)

- Common urological procedure
- Indicated in the emergency setting when transurethral catheterization is contraindicated or technically not possible for neuropathic bladder and urethral injuries or bladder outflow obstruction
- Contraindications
  - Absence of an easily palpable or ultrasound localized distended bladder
- Relative contraindications:
  - Coagulopathy, prior lower abdominal or pelvic surgery, or radiation (risk of bowel adhesions)
- Procedure
  - Obtain informed consent as possible.
  - Check for necessary equipment before starting the procedure.
    Sterile gloves, drapes, and gauzes
    Antiseptic solution
    Local anesthesia
    10 and 60 ml syringes
    18 and 25 gauge needles
    n° 11 scalpel blade
    Percutaneous suprapubic catheter set (needle obturator, Malecot catheter, connecting tube and one-way stopcock)
    Sterile urometer or urine bag
    Skin tape or suture
  - Prepare the insertion kit by inserting the needle obturator into the Malecot catheter,

twist and lock it into the port, and connect the 60 ml syringe.
- Patient positioned supine.
- Provide adequate parenteral analgesia (and sedation if necessary).
- Clean and shave infraumbilical abdominal wall skin.
- Palpate distended bladder and mark the insertion site at the midline and no more than 3 cm above the pubic symphysis.
- Use the 10 ml syringe with the 25 gauge needle and local anesthetic agent to infiltrate the insertion site.
- Alternating injection and aspiration, advance needle through the skin, subcutaneous tissue, linea alba, and retropubic space until urine enters the syringe.
- Make a 4 mm longitudinal stab with the blade along needle.
- Direct the tip of the obturator catheter into the skin incision with a 70° angle from the patient's legs.
- Stabilize the tip of the catheter with the nondominant hand while the dominant hand advances while aspirating until urine enters the syringe, and advance 4 more centimeters.
- Unscrew the obturator from the catheter and advance it 5 cm more.
- Remove the obturator.
- Connect the catheter with the tube and the stopcock to a urometer.
- Tape or (better) stitch catheter to the skin.
- Observe patient in the emergency department for 3 h after SCI.
- After the procedure, do not change the catheter for 1 month to allow the tract to be established and refer the patient to a urologist.
- Never remove the catheter unless under the direction of a urologist's indication or if it can be exchanged immediately.

- The complication rate of the procedure is 10–29 %; mortality is low (0.8 %).
  - Intraoperative complications include anesthetic-related, catheter malpositioning, exit site bleeding, and bowel injury; gross hematuria is typically transient.
  - Late complications include exit site infection, abscess or cellulitis, and occluded device.
  - Routine intravenous prophylactic antibiotics are recommended.
  - Simple irrigation with saline should resolve catheter obstruction.
  - If malposition or displacement is suspected, cystography may help the diagnosis.

10.4 Peritoneal Tap (PT)

- Indications
  - Diagnostic (obtention of peritoneal fluid sample for evaluation of ascites [malignant, infected, or chylous]) and culture
  - Therapeutic (peritoneal lavage, relieve abdominal hypertension)
- No absolute contraindications
- Relative contraindications (most can be corrected or circumvented if paracentesis is absolutely necessary)
  - Coagulopathy or thrombocytopenia, abdominal adhesions, severe bowel distension, or pregnancy
- Equipment includes dressing pack, sterile gloves, cleaning solution (iodine or chlorhexidine), lidocaine 1–2 %, 10 ml syringe and 21G and 25G needles, 60 ml syringe with 16G aspiration needle for diagnostic tap, paracentesis catheter, and tubes for samples
- Procedure
  - Explain the procedure to the patient and obtain informed consent if appropriate
  - Position the patient supine with the trunk elevated 45° and expose the abdomen
  - Percuss to identify the ascites (ultrasound guidance is rarely needed)
  - Prepare and prep the proposed site under sterile conditions
    Left lower quadrant preferred
    Avoid suprapubic area and sites of old scars or cellulitis
  - Infiltrate local anesthetic into the skin and subcutaneous always aspirating as the needle is advanced
    For "*diagnostic tap*"
    - Introduce needle through tissues; peritoneal cavity is entered (felt when the needle "gives" and confirmed when fluid freely enters the syringe)

- Withdraw 20 ml of fluid for culture and analysis (glucose, LDH, protein, amylase levels, and cytology)
- Remove aspiration needle
- Apply sterile occlusive dressing

For "*therapeutic drainage*"

- Ensure needle is in place (ascites aspiration).
- Slide catheter over needle into peritoneal cavity.
- Allow drainage up to 1,000 ml of fluid, as slowly as possible, over 2 h.
- Maximum drainage of 2 l/day is usually advised.
  - If unable to withdraw fluid, consider loculation of ascites; try to position the patient sitting and leaning forward.

- Fresh blood or fecal staining indicates vessel puncture or hollow viscus perforation.
- Incisional site bleeding or ascites leakage may require sutures.

10.5 Percutaneous Chest Tap (CT)

- Indications
  - Diagnostic (obtention of air signifies pneumothorax or infection), fluid sample for evaluation of pleuritis (malignant, infected, or chylous), and culture
  - Therapeutic (relieve dyspnea or respiratory distress due to air or fluid accumulation in the pleural space)
  - Most frequent indications: spontaneous pneumothorax, persistent pleural effusion, malignant pleural effusion, empyema, or complicated paraneumonic pleural effusion.
  - Relative contraindications: severe coagulopathy or agitated and uncooperative patient.
- Equipment includes dressing pack, sterile gloves, cleaning solution, lidocaine 1–2 %, a 28G intercostal drain or a 14G pigtail Kit, underwater seal or pleur-evac device, clamps for line and blunt dissection, 10 ml syringe, 11 blade scalpel, 1 or 3/0 suture, and gauze.
  - If kits are unavailable in an emergency situation, either a Foley catheter or nasogastric tube can be used.
  - Cut urine bag or glove finger can also be used to replace water-sealed or pleur-evac devices.
- Procedure
  - Explain the procedure to the patient and obtain informed consent if appropriate.
  - Patient in half-sitting position with ipsilateral arm abducted, ensuring continual monitoring of pulse oximetry.
  - Most common insertion site is the fifth intercostal space along anterior axillary line.

    In case of empyema or pleural effusion, both should be localized by percussion or ultrasound, and the needle should be inserted one to two fingerbreadths below the top of the effusion.
  - Insert needle through skin for anesthetic infiltration.
  - Continue insertion until air bubbles or fluid is obtained, and then infiltrate all wall layers while withdrawing the needle.
  - In the "*open approach*"

    Make a 2 cm transverse skin incision.

    Dissect the intercostal space bluntly over the lower rib through the pleura, spreading to widen the hole.

Insert chest tube superiorly in case of pneumothorax and inferiorly for hemothorax or effusion.

Clamp the drain and secure it before connecting it to the pleur-evac or other selected device.

- In the "*closed access*",

  Also effective and safe in uncomplicated air or serous effusions

  Same landmarks as the open approach

  Technique:
  - A pigtail is inserted by the Seldinger technique.
  - Insert needle into pleural space.

- Pass guide wire through needle without any resistance and then remove needle.
- Make 2 mm skin incision to pass dilator over guide wire.
- Pass 14G pigtail over guide wire.
- Remove dilator.
- Connect selected draining device.
- Suture the drain.

– A chest X-ray is compulsory after both procedures.
– Possible complications
Misplacement (most frequent): no drainage occurs, no oscillation of sealed water column when tube is inserted between the parietal pleura and chest wall
- More common in the obese

Injury to structures such as lungs, spleen, liver, or heart (more severe): no air or sudden unexpected fluid. Before the removal of a chest tube, be sure that it is indicated and be prepared to replace it immediately.

Pitfalls
- Breach of aseptic technique.
- False passages are not uncommon.
- Complications to nearby structures may be life threatening.

Essential Points
- Check the equipment before use.
- Know the anatomy and landmarks.
- Use aseptic technique.
- Each procedure has its proper complications.
- Consider contraindications and patient characteristics before starting the procedure.
- Be prepared for failure and keep in mind an alternative approach for the procedure.
- Have experienced help nearby.
- Whenever possible, explain the procedure to the patient and obtain informed consent.

10.6 Summary

Percutaneous procedures are part of emergency surgeons' daily activity. In this chapter, we explain the indications, contraindications, the necessary equipment, insertion techniques, landmarks and tricks, pitfalls, and frequent complications of some of these procedures. Most procedures are based on the Seldinger technique. To avoid complications, it is mandatory to know the anatomical landmarks, contraindications, and pitfalls for each procedure.

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Upper Gastrointestinal Endoscopy 11

Hakan Yanar and Korhan Taviloglu

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11.1 Upper Gastrointestinal (GI) Bleeding

- Common and potentially life-threatening problem
- Causes:
  - Peptic ulcer: 30–60 %
  - Gastroduodenal erosion: 8–12 %
  - Variceal bleeding: 6 %
  - Other less frequent causes include
    Mallory-Weiss tear
    Erosive duodenitis
    Dieulafoy's ulcer (and other vascular lesions)
    Neoplasm
    Aorto-enteric fistula
    Gastric antral vascular ectasia
    Prolapse gastropathy
- Requires endoscopy for diagnosis, assessment, and possibly to treat the underlying lesion
  - Within the first 24 h of is considered standard of care.
  - Patients with uncontrolled or recurrent bleeding should undergo urgent endoscopy to control bleeding and reduce the risk of death (in addition, one multicenter randomized controlled trial has shown that endoscopy within 6 h of admission reduces the amount of transfusions).

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  - Gastric lavage improves the view of the gastric fundus but has not been proven to improve the outcome.
  - Accuracy: 90–95 % for acute upper GI bleeding.
- About 25 % of endoscopic procedures performed for upper GI bleeding include some type of treatment such as injections of epinephrine, normal saline, or sclerosants, thermal cautery, argon plasma coagulation (APC), electrocautery, or application of clips or bands: all equally effective, and combinations of these therapies may be more effective than when used individually.
  - Endoscopic therapy
    Is recommended for patients found to have active bleeding or nonbleeding visible blood vessels, as outcomes are better with endoscopic hemostatic treatment than with drug therapy alone.
    - A recent meta-analysis found dual therapy to be superior to epinephrine monotherapy in preventing recurrent bleeding, need for surgery, and death.

    Stops the bleeding in more than 90 % of patients, but bleeding recurs after endoscopic therapy in 10–25 %.
  - Reversal of any severe coagulopathy with transfusions of platelets or fresh frozen plasma is essential for endoscopic hemostasis.
    However, coagulopathy at the time of initial bleeding and endoscopy does not appear to be associated with higher rates of recurrent bleeding following endoscopic therapy for nonvariceal upper GI bleeding.
  - Patients with refractory bleeding are candidates for angiography or surgery.
    However, endoscopy is important before angiography or surgery to pinpoint the site of bleeding and diagnose the cause, even when endoscopic hemostasis fails.
    A second endoscopic procedure is generally not recommended within 24 h after the initial procedure.
    - However, it is appropriate in cases in which clinical signs indicate recurrent bleeding or if hemostasis during the initial procedure is questionable (one meta-analysis revealed that routinely repeating endoscopy reduces the rate of recurrent bleeding but not the need for surgery or the risk of death).
  - Clinical scoring systems based on endoscopic findings along with clinical factors on admission can be useful (Table 11.1).
    These scoring systems are valuable for predicting the risk of death, longer hospital stay, surgical intervention, and recurrent bleeding (Fig. 11.1).

11.2 Foreign Body Removal

- Ingestion of foreign bodies may be accidental or intentional.
- Patients are generally distressed and cannot swallow.
- Endoscopy should be performed urgently under the following circumstances.
  1. Patients who cannot swallow saliva
  2. Impacted sharp objects
  3. Ingestion of button batteries (which can disintegrate and cause local damage)
- Removal of other foreign bodies is less urgent.
- Techniques:
  - At or above the cricopharyngeus, foreign objects can be removed with rigid instruments.
  - For small, slippery, pointed, or sharp objects (pins, razor, etc.), flexible gastroscopy is

Table 11.1 Forrest classification of the bleeding peptic ulcer activity

Classification	Lesion	Rebleeding rate
Grade Ia	Arterial spurting hemorrhage	High
Grade Ib	Oozing hemorrhage	High
Grade IIa	Visible vessel	High
Grade IIb	Adherent clot	Medium
Grade IIc	Dark base (hematin covered lesion)	Low
Grade III	Lesion without active bleeding	Low

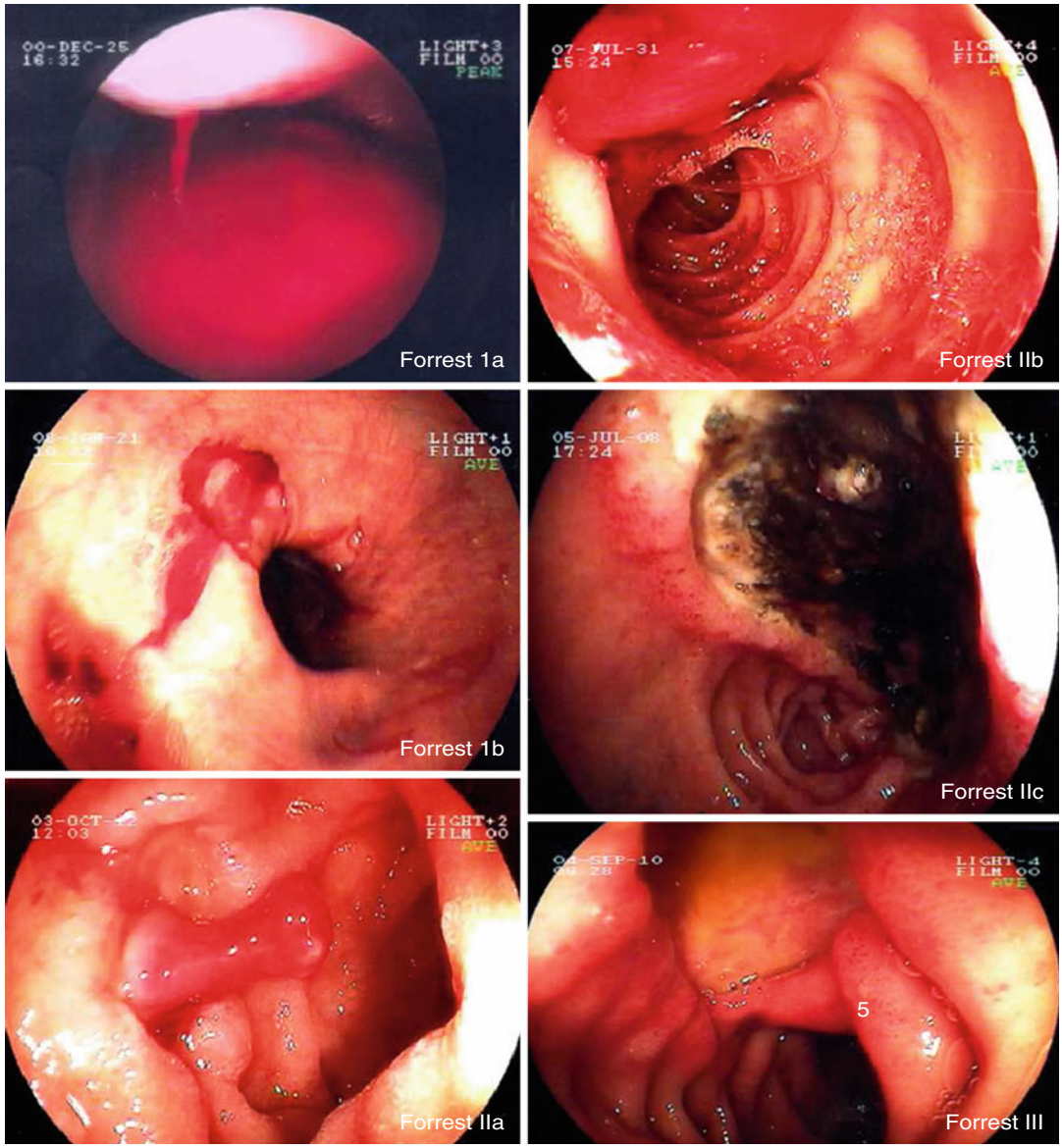

Fig. 11.1 Endoscopic appearance of various lesions according to Forrest classification

preferred: use of an overtube is recommended to avoid damage to the esophagus and pharynx (Fig. 11.2).

- Packets containing illicit drugs (plastic wrappings or tubes swallowed) can be removed with snare, care being taken to avoid damaging the covers.
- For gastric bezoars, large polypectomy snares are used to fragment the bezoar into smaller pieces so that these can pass spontaneously.
- Small batteries warrant immediate removal because of the high risk of local and systemic toxicity, and the smooth surface can be grasped with a basket.

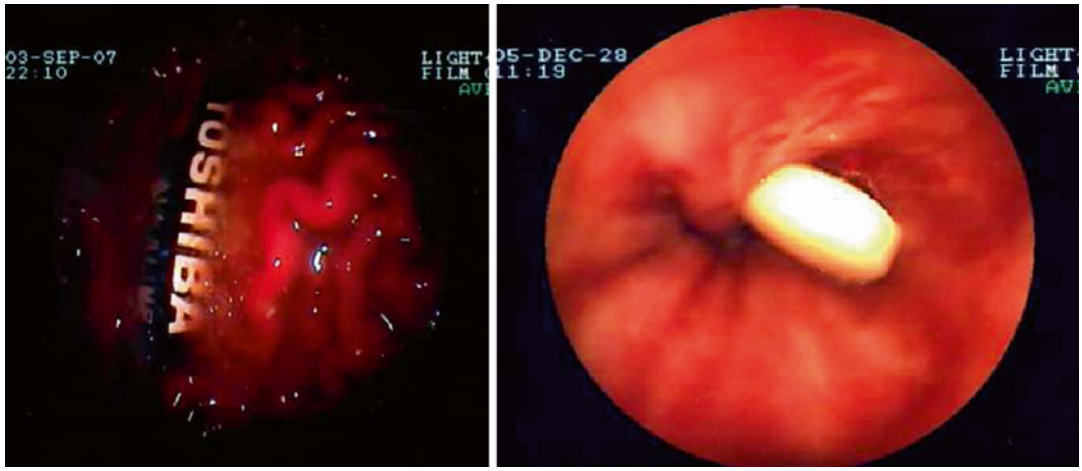

Fig. 11.2 Gastric (battery) and esophageal (pill) foreign bodies

11.3 Corrosive Injury of the Upper GI Tract: Esophageal Perforation and Stenting

- Ingestion of corrosive agents initiates a progressive injury of the upper gastrointestinal tract, the extent of which depends on the agent, its concentration, quantity, and physical state, as well as the duration of exposure.
- While plain films of the chest and the abdomen can reveal possible perforations of the upper gastrointestinal tract, early endoscopy remains the standard method of diagnosis and evaluation of the esophagus and the stomach.
  - Endoscopy is safe, but it must be performed by an experienced endoscopist and avoid unnecessary movements and too much insufflation of air.
  - Complete examination of the upper gastrointestinal tract is essential to evaluate the extent of injury and to find out the degree of injury in all areas involved.
- Management depends on the degree of injury, which is only defined by the means of endoscopy.
  - Most studies recommend endoscopy <24 h after ingestion.
    However, underestimation of severity is possible if performed *too* early.
  - Many studies advocate avoiding endoscopy between 5 and 15 days after caustic ingestion.
    Mucosal sloughing occurs 4–7 days after the initial injury and collagen deposition may not begin until the second week; the tensile strength of the healing tissue is low during the first 3 weeks.
  - Endoscopy alone, however, cannot detect extraluminal injury, and computed tomography should be the routine method for assessing injury to the adjacent structures.
  - Late formation of esophageal stricture after corrosive esophageal burn.
    Recently degradable esophageal stents have been recommended for the treatment of a corrosive esophageal stenosis.
    Esophageal intralumenal stenting has been used to decrease the likelihood of stricture formation in patients with corrosive esophageal burns for several decades.
- Esophageal perforations can be treated with stents.
  When diagnosed early, mortality is decreased greatly.
  Temporary esophageal stenting poses little threat to the patient and represents an alternative to surgery.

11.4 Metallic Stents in Malignant Duodenal Obstruction and Gastric Outlet Problems

- Malignant duodenal or pyloric obstructions are most commonly caused by direct invasion from local tumors or lymphadenopathy compression.
- Palliative internal (metallic) stenting is an option.
  - For patients unfit for surgical drainage (e.g., gastrojejunostomy), general anesthesia or in case of ascites and peritoneal metastasis.

11.5 Endoscopic Retrograde Cholangiopancreatography (ERCP)

- Main indication: obstructive biliary, pancreatic duct, or major-minor papilla disease
- Is widely used to replace surgical exploration of common bile duct and treat
  - Impacted stone at the papilla or in common bile duct causing acute biliary obstruction
  - Acute obstructive cholangitis (stones, malignant tumors)
  - Choledocholithiasis
  - Postoperative biliary surgery complications (leakage from cystic duct stump, bile duct injuries)
  - Acute biliary pancreatitis (selected patients such as predicted severe acute pancreatitis, associated cholangitis
  - Pancreatic duct injury due to trauma or pancreatitis
- Carries some risks including;
  - Pancreatitis (most common complication)
  - Retroduodenal perforation (reported in <1 % of endoscopic sphincterotomies)
    Can be treated conservatively in stable patients
  - Bleeding (most often results from sphincterotomy performed too quickly)
    Usually stops spontaneously
    If continues, injection of 1:10,000 epinephrine into bleeding sites
  - Repeat or de novo cholangitis (in case of retained stones)

11.6 Endoscopic Drainage of Pancreatic-Fluid Collections (PFCs) and Pseudocysts and Endoscopic Transmural Necrosectomy

- Indications include pseudocysts developing after acute pancreatitis or trauma associated with pain, infection, obstruction of the GI or the biliary tract, leakage, or fistulization of the collection.
- Is successful in the majority of patients (with an acceptable complication rate).

11.7 Fibrin Glue and Clips

- Esophageal and gastric anastomotic leaks
  - Acute or chronic
- Avoids complex surgical revision and repair

11.8 Percutaneous Endoscopic Gastrostomy (PEG)

- Goal: intentional formation of gastrocutaneous fistulae for the purpose of enteral feeding
- Used in patients unable to take in food by mouth for a prolonged period of time
  - Either normal or nasogastric feeding is impossible.
  - Patients with swallowing disorder.
- Two major techniques
  - Pull technique more commonly used than the push technique
- To decompress the stomach contents in a patient with a malignant bowel obstruction, called "venting PEmG"
  - Placed to avoid nausea and vomiting

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Part III

By Organ

Esophageal Emergencies

12

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Objectives

- To be familiar with anatomy and the microflora of the esophagus
- To assess and diagnose nontraumatic esophageal emergencies
- To apply initial treatment in esophageal emergencies
- To be familiar with surgical approach to the esophagus
- To recognize prognostic determinants in esophageal emergencies

12.1 Introduction

Esophageal emergencies are associated with life-threatening complications when overlooked or subjected to delayed management. Nontraumatic esophageal emergencies encountered by the acute care surgeon comprise mainly esophageal perforation, caustic ingestion, foreign body obstruction, and esophageal hemorrhage.

12.1.1 Anatomical Considerations

- The esophagus begins at the level of the sixth cervical vertebra/cricoid cartilage and extends to the cardia of the stomach, measuring 25–35 cm (40–50 cm from incisors) in length.

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  - The cervical esophagus lies behind the trachea, anterior to the cervical spine between the common carotid arteries.
  - At the thoracic inlet, the esophagus is located behind the great vessels and trachea. It gradually assumes an almost left paravertebral location in the lower left chest.
  - The abdominal esophagus passes through the esophageal hiatus to join the cardia of the stomach.
- Thyroid arteries, tracheobronchial arteries, branches of the descending aorta, left gastric artery, and splenic artery provide the arterial supply.
- Two sphincter muscles, the UES (upper esophageal sphincter) and LES (lower esophageal sphincter), prevent regurgitation.
- The esophagus has three major levels of constrictions; UES, aortic arch impression, and LES (Fig. 12.1).
- The absence of a serosal layer in the esophagus increases risk of perforation and, when perforation occurs, adds greater likelihood of bacterial contamination.

12.1.2 Esophageal Microflora and Appropriate Antimicrobials

- A mixed aerobic and anaerobic microflora inhabits the esophagus. Streptococci, Staphylococci, *Klebsiella pneumoniae*, and *Escherichia coli* predominate. The anaerobic species include Prevotella, Porphyromonas, Bacteroides fragilis, Fusobacterium, and Peptostreptococcus, in addition to frequent colonization with yeast found in obstructive diseases.
- The optimal antimicrobial treatment in esophageal perforation is broad-spectrum antimicrobials such as cefoxitin sodium, clindamycin phosphate, beta-lactamase-resistant penicillins, and antifungal agents when appropriate.

12.2 Esophageal Perforation

- The most frequent cause of esophageal perforation is instrumentation.
  - Diagnostic flexible endoscopy carries a relatively low overall perforation risk of 1:3000. Despite the low risk, it is a widely used diagnostic modality resulting in a significant number of esophageal perforations.
  - Diagnostic interventions such as Maloney bougienage, Savary pneumatic dilatation, through-the-endoscope hydrostatic balloon dilators, Sengstaken-Blakemore tube deployment, sclerotherapy, and banding in esophageal varices, and endotracheal intubation increase the risk of perforation, particularly in patients with esophageal pathology.
  - Dilatation in achalasia and strictures carry relatively higher perforation rates at 2–6 % and 0.3 %, respectively.
  - Esophageal perforation can occur also after surgical interventions such as fundoplication, esophageal myotomy, vagotomy, lung resection, thyroid surgery, tracheostomy, chest tube placement, mediastinoscopy, or spine surgery.
- Spontaneous rupture of the esophagus caused by voluminous vomiting or retching is named after Dutch physician Hermann Boerhaave who described the condition in 1724.
  - The classic presentation of spontaneous perforation includes sudden retrosternal pain radiating to the neck associated with tachycardia and tachypnea.
  - Hematemesis is rarely seen in spontaneous perforation which helps distinguish it from the Mallory-Weiss tear.
  - Spontaneous rupture has been observed following blunt chest trauma, severe coughing, weightlifting, and childbirth.

12.2.1 Assessment and Diagnosis

- The initial investigation includes history, examination, and chest radiography.

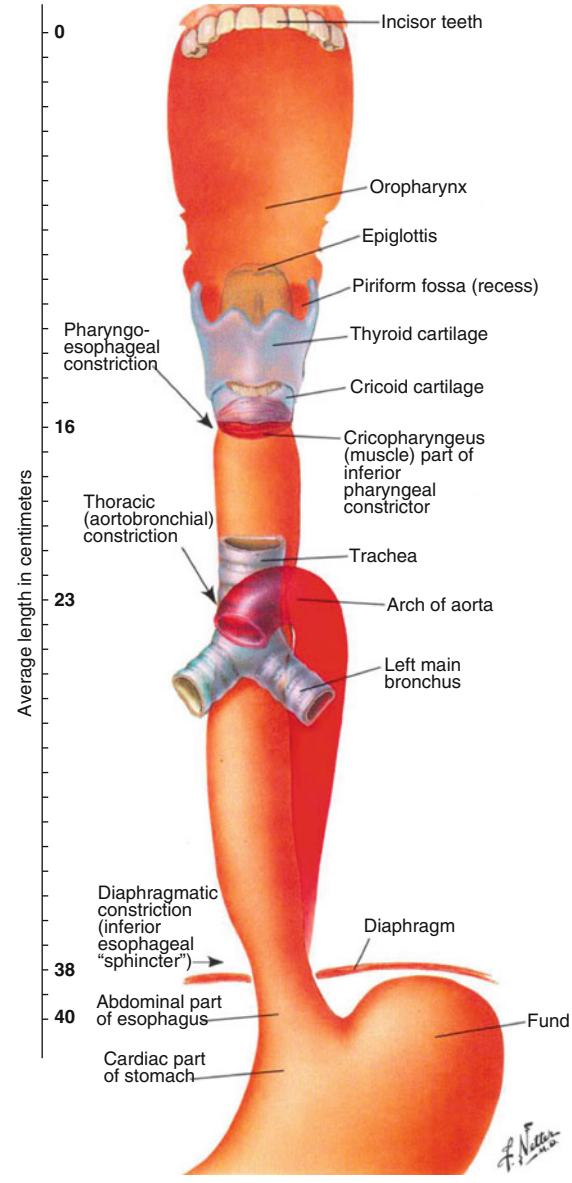

Fig. 12.1 Topography and constrictions of the esophagus (F. Netter. *Atlas of Human Anatomy*. 4th Edition, Saunders Elsevier, 2006, Philadelphia, PA. page 233)

- Signs and symptoms
  - Severe pain is the keystone manifestation of esophageal perforation.
  - Cervical or thoracic perforation is associated with sudden sharp pain in the neck or substernal area, respectively, shortly after the spontaneous perforation or esophageal instrumentation.
  - In addition, odynophagia, dysphagia, fever, subcutaneous emphysema, hemoptysis, or blood in nasogastric tube may be present.
- Chest X-ray
  - Shows nonspecific findings such as mediastinal emphysema or pleural effusion in majority of cases (90 %).

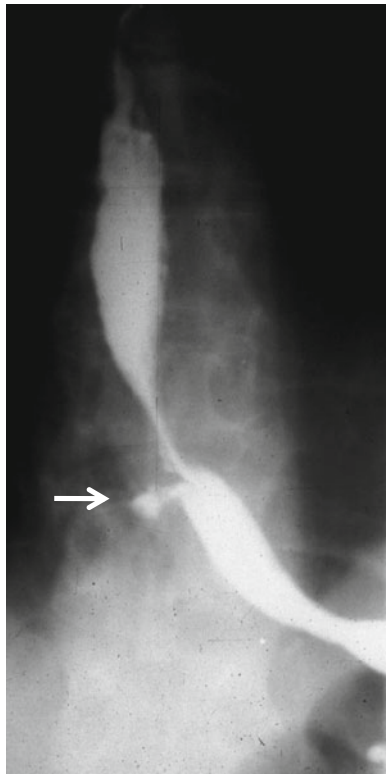

Fig. 12.2 Thoracic esophageal perforation noted on esophagography (*arrow*)

- An unexplained pleural effusion on chest radiography is suspicious for esophageal perforation.
- Commonly, the perforation is confirmed with contrast esophagography (Fig. 12.2). The study is performed initially with water-soluble gastrografin because it is less harmful if it leaks into the mediastinum. However, if aspirated into the tracheobronchial tree or leaks through a tracheoesophageal fistula into the lungs, gastrografin may cause severe pneumonitis.
- The optimal diagnostic accuracy is obtained with thin barium esophagography performed in decubitus position for slower-contrast transit time through the esophagus. Barium contrast has superior radiologic density and delineates mucosa better. With negative good-quality barium study, the perforation is unlikely.

- Multidetector computed tomography (MDCT) and MDCT esophagography has shown a high accuracy for esophageal perforations. Screening chest MDCT may depict mediastinal air, air-fluid collections communicating with esophageal air, or an abscess adjacent to esophagus. Directed MDCT esophagography may confirm perforation demonstrating leakage of contrast media into mediastinum or pleural space. In patients with empyema, thoracentesis may yield pus-containing food particles.
- In summary, a high index of suspicion must be maintained in suspected esophageal perforation because outcome depends entirely on timely diagnosis and prompt management.

12.2.2 Treatment

- Therapeutic options in esophageal perforation depend on the anatomical site of the perforation, underlying pathology, time to diagnosis, signs of severe sepsis, and extent of the perforation and leak.
- Although surgery is the gold standard in the management of esophageal perforation, not all esophageal perforations require operative management.

12.2.2.1 Nonoperative Management (NOM)

- Is feasible in patients suffering small, contained perforations with no signs of sepsis, especially in the cervical esophagus
- Criteria for NOM include intramural perforation, contained perforation communicating with esophagus, non-stricture and nonmalignant perforation associated with mild degree of sepsis.
- Some recent evidence advocates nonoperative "aggressive conservatism" that includes antibiotic treatment, aggressive drainage of mediastinal and chest collections, and sequential imaging
- The principles of NOM include restriction of oral intake, broad-spectrum antibiotics, CT-guided drainage of any fluid collections in the neck or the mediastinum, and parenteral nutrition.

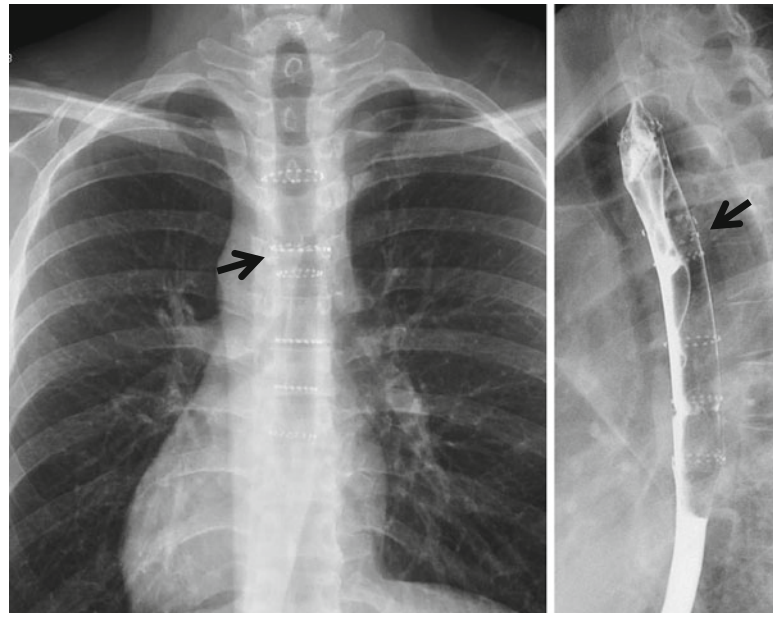

Fig. 12.3 Endoscopically placed stent in the esophagus (*arrow*)

- Endoscopically placed stents in selected cases have been used with good success (Fig. 12.3).

12.2.2.2 Operative Management

Surgery

- The cornerstone of therapy in uncontained perforations and in all patients with severe sepsis or septic shock.
- Options include drainage alone, primary repair, diversion, or esophagectomy depending on the site of perforation, pathology, severity of sepsis, and the interval from perforation to diagnosis. While immediate diagnosis of perforation without preexisting pathology allows primary repair, in those patients with preexisting disease or delay in diagnosis, primary repair will likely fail with devastating septic complications. Even after meticulous surgical repair, leak rates range from 25 % to 50 % mandating placement of closed suction drains near the repair.

Surgical Approaches

Cervical Esophagus

- The cervical esophagus is relatively easy to approach using the left unilateral sternocleidomastoid incision.
- Two-layer repair should be used: a running absorbable suture to the mucosa followed by an interrupted suture line to the muscular layer.
- It is crucial to extend the myotomy to assess the entire mucosal length of the defect.
  - The mucosal primary repair can be carried out over a large bougie.
- The sternocleidomastoid or omohyoid muscle can be placed over the repair
- There is no evidence that nasogastric tube following cervical esophageal repair provides diversion of saliva and may compromise the tenuous repair and healing of the wound.

Thoracic Esophagus

- Thoracic esophageal perforations are repaired through a right fourth to fifth or a left sixth to seventh intercostal posterolateral thoracotomy (Fig. 12.4).
- Running absorbable suture line for mucosa and interrupted absorbable for muscular layer is appropriate.
- In mid and lower esophageal repairs, a diaphragmatic buttress flap can be utilized.
  - For that purpose, rotation-flap constructed from the posterior aspect of diaphragm is sutured over the esophageal

repair. The diaphragmatic defect is primarily closed.

- In preexisting disease without significant contamination, resection of a tumor, myotomy for strictures, or antireflux procedure may be feasible.
- Esophagectomy with primary reconstruction.
  - May be successful in minimal contamination.
  - In severe contamination and inflammation, diversion is appropriate. Closure of the perforation with proximal and distal staple line, resection of the diseased segment, and a proximal esophagostomy is established with wide drainage and gastrostomy tube for feeding. Major esophageal reconstruction is required at later stage.
  - Another option includes closure of the wound over a 24-French T-tube drainage brought out to the chest wall and placement of chest drainage (Fig. 12.5).

Abdominal Esophagus

- Abdominal esophagus is accessed via laparotomy or more often via a thoracoabdominal incision.
  - A self-retaining retractor system is of great value for optimal exposure of the gastroesophageal junction.
- The defect with minor contamination is debrided and repaired in two layers added by buttressing with a stomach patch around the repair site. More destructive injuries may require resection of the affected segment, mobilization of the stomach, and esophagogastrostomy in the chest.
- In benign conditions with extensive tissue loss, resection of the esophagus and reconstruction with colon interposition may be needed.

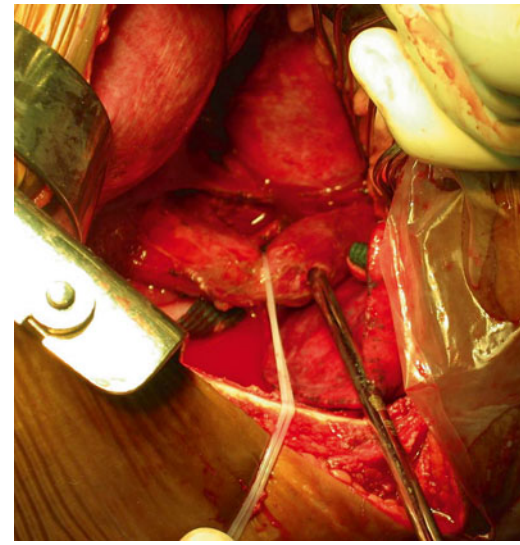

Fig. 12.4 Left posterolateral thoracotomy, suction tube passed through an esophageal perforation

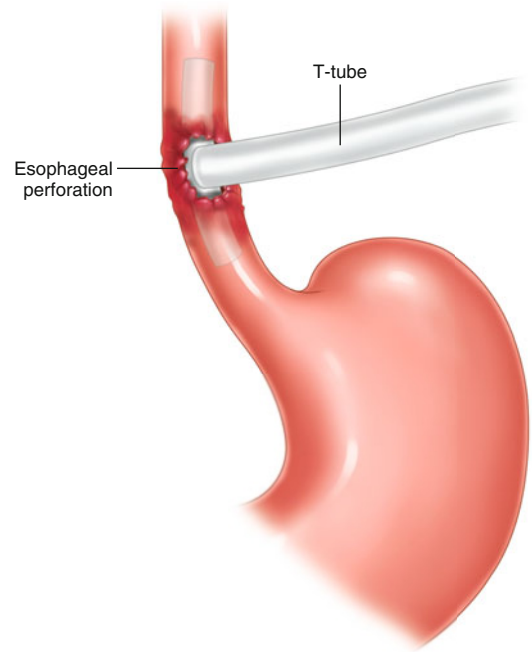

Fig. 12.5 Illustration showing T-tube drainage of an esophageal perforation not amenable for safe repair

12.3 Caustic Ingestion

- Most commonly encountered in children and in young adults when ingestion is accidental or intentional, respectively.
- The degree of injury depends on the nature of the ingested substance, concentration, quantity, and duration of the caustic agent exposure.
  - Hence, adults frequently sustain more severe injuries as the ingested volumes are larger.
- The most prominent sites of caustic lesions are the natural narrowings of the esophagus including UES, aortic impression, and LES.

- Alkaline agents cause liquefying necrosis resulting in deep burns, whereas acids cause coagulative necrosis resulting in eschar that limits deep tissue penetration.

12.3.1 Assessment and Diagnosis

- Signs and symptoms
  - The typical patient presents with oral pain, extensive drooling, and dysphagia.
  - Stridor and hoarseness are signs of impending airway obstruction.
  - Retrosternal and abdominal pain are signs of possible intrathoracic or intra-abdominal perforation.
  - Extensive supraglottic edema may require emergent tracheotomy.
- Investigations:
  - Chest and abdominal radiography are obtained to exclude extraluminal air.
  - Multidetector CT is more sensitive for mediastinal air indicating perforation.
- Indications
  - In established perforation, septic shock or peritonitis mandates immediate operative intervention.
  - All patients with stridor, intentional ingestion, and symptomatic children require endoscopy to evaluate extent of injury within 24 h.
  - Asymptomatic children and patients who require surgery precludes need for endoscopy.
  - Endoscopic evaluation classifies injuries into first degree (edema, hyperemia), second degree (ulceration), and third degree (black discoloration indicating full-thickness injury).

12.3.2 Treatment

- Immediate goal of therapy is airway assessment, fluid resuscitation, and careful monitoring.
  - No oral neutralizing agents have shown to improve outcomes, and nasogastic tube is contraindicated as it may cause perforation or emesis and aspiration.
- First-degree injuries
  - Require at least 24 h observation prior to diet advancement
- Second-degree injuries
  - More extensive second-degree injuries that do not require surgery should be treated with antibiotics and gastric acid suppression and monitored closely.
  - Deep second-degree caustic injuries develop strictures in 70 % and should be monitored for a minimum of 48 h (Fig. 12.6).
  - Patients who will be able to swallow saliva and show no signs of sepsis can advance diet as tolerated. Repeat swallow studies are planned 3 weeks, 3 months, and 6 months after injury.
  - Steroids are of no benefit, do not reduce the incidence or severity of late strictures in second-degree injuries, and may increase the risk of infectious complications.
- Third-degree injuries
  - Develop strictures in up to 90 % and progress to perforation in 25 % of cases.
  - Signs of full-thickness caustic injury include peritonitis, depressed mental status, shock, severe acidosis, and free air on abdominal film.
  - If surgery is indicated:
    The optimal approach to the esophagus is via the abdominal cavity as it allows evaluation of the stomach, resection of adjacent injured organs, establishment of feeding jejunostomy, and esophagectomy through a transhiatal approach.
    Cervical esophagectomy is performed through the neck incision.
  - Nutrition will be provided via gastrostomy/jejunostomy.
- Unlike other inflammatory causes of the foregut scarring, caustic scarring is aggressive and may progress beyond a year after injury.
- Options for delayed reconstruction are colonic interposition or gastric pull-up if the stomach sustained less significant insult.

Fig. 12.6 Caustic injury

12.4 Esophageal Foreign Bodies

- Acute care surgeons frequently encounter patients with foreign body ingestion or food impaction. The vast majority of swallowed material will pass the gut uneventfully. Nevertheless, 10–20 % will require nonoperative intervention, and 1 % or less will require surgery. Recent series have reported low mortality rates in these instances. However, overall 1500 individuals die worldwide annually due to ingested foreign bodies in the foregut. The history should focus on the type of foreign body and symptoms suggesting gut perforation.

12.4.1 Causes

- Foreign body
  - Occurs predominantly in children with the highest incidence from 6 months to 3 years.
    Battery ingestion with impaction in the esophagus requires emergent intervention (common in children) because of risk of direct alkaline injury to the esophagus.
  - In the adult population, there is a strong association with psychiatric diseases. Other risk factors for foreign body obstruction include dentures, bridge work, and preexisting esophageal pathology.
  - Impaction occurs in areas of esophageal narrowing; UES (15–17 cm from incisors), the aortic impression (23 cm), the left mainstem bronchus (27 cm), and the LES (36–38 cm).
- Food bolus impaction
  - A common esophageal emergency, especially in elderly people.

12.4.2 Food Impaction

- Meat bolus is the predominant offending agent causing 80–90 % of food obstructions.
- More frequently noted in elderly and in the edentulous.
  - Signs and symptoms
    Food bolus impaction in the cervical esophagus may present with stridor, dysphagia, odynophagia, or shortness of breath. The Heimlich maneuver is the treatment.
    More frequently, a complete obstruction occurs in the distal esophagus and the patient presents with significant sialorrhea and regurgitation.
    History should include preexisting esophageal conditions such as previous dysphagia or dilatation, Nissen fundoplication, gastric bypass, or stent placement.
  - Management
    Medical therapy utilizing glucagon is the initial modality. Glucagon relaxes the LES, decreasing the resting LES pressures up to 60 %. The common initial dose is 0.5 mg and can be increased to 2 mg intravenously. Some reports describe using glucagon and diazepam simultaneously with high success rates.
    Most patients with an impacted food particle require flexible endoscopy for extraction or push of the particle distally to the stomach. Early removal is recommended to avoid pressure-induced ischemia in the esophagus.
- Extraction of the food bolus is attempted first, particularly if the bolus is large and contains sharp particles such as bones or if a preexisting stricture is present.

- A Roth retrieval net can be used with the advantage of complete encompassment of the food bolus precluding aspiration.
- Another option for extraction is a polypectomy snare. In this setting, the endoscope along with snared food bolus is extracted to the level of UES and pulled against the endoscope while the patients' neck is extended and the endoscope is removed with food bolus.
- If extraction of the foreign body fails, push method is used.
  - Push method can be considered only when the bolus is soft and contains no sharp objects and no esophageal stricture is present.
  - In this technique, slight pressure can be applied to the right side of the food bolus as the bolus passes from right to left more easily.
- A combination of scope-pushing and intravenous glucagon has been reported as a successful intervention.
- In all instances, preexisting esophageal disease work-up is considered.

12.4.3 Indigestible Foreign Body Obstruction

- The variety of ingestible foreign bodies is extensive in the literature including bones, pills, dental hardware, toothpicks, safety pins, glass, coins, and batteries (Fig. 12.7).
- Signs and symptoms
  - A complete esophageal obstruction is rarely encountered and saliva can be swallowed.
  - Careful initial examination is mandatory to exclude esophageal perforation and impending sepsis.
- Diagnosis
  - The chest radiography may demonstrate a radiopaque foreign body.
  - Abdominal X-ray may reveal passage or previously ingested foreign bodies or free air.
- Management
  - Majority of ingested foreign bodies will pass in the stool; however, those obstructing the esophagus are lodged commonly in the proximal esophagus.
  - Objects found in the pharynx or UES are removed by direct or rigid laryngoscopy.
  - Foreign bodies in the esophagus without sharp edges such as coins, toothbrushes, and batteries can be extracted with flexible endoscopy.
    Batteries lodged in esophagus should in general be removed. Many batteries contain alkaline substances and can result in alkaline injury.
  - Endoscopy
    Use the largest scope suitable for the patient with the biggest suction channel for debris and saliva suction.
    Polypectomy snare, Roth retrieval net, or grasp forceps are utilized for extraction (Fig. 12.8). In difficult cases, a rigid scope may be more effective for the extraction. After the object is snared or grasped, the endoscope is extracted along with the object to the level of cricopharyngeal muscle, and then the object is snugly brought against the scope and extracted together with the endoscope. Neck extension may help, and care should be given not to lose the grasp as it may be aspirated into the airway.

Fig. 12.7 Illustration showing a toothbrush in the esophagus

Sharp objects in the esophagus must be retrieved because the perforation risk is considerable at 15–35 %. The sharp objects can be grasped with endoscopy forceps and removed through an overtube or with rotatable removal basket.

12.5 Esophageal Bleeding

- Rare
- The common etiology of esophageal hemorrhage includes gastroesophageal reflux disease (GERD), Mallory-Weiss mucosal tear, or variceal bleeding
  - GERD
    Although the hemorrhage due to GERD esophagitis is fairly uncommon, the relatively high overall incidence of GERD makes this clinical entity quite frequent (Fig. 12.9).
    The diagnosis and the extent of the disease are confirmed by endoscopy. Any bleeding source in the stomach and duodenum should be excluded.

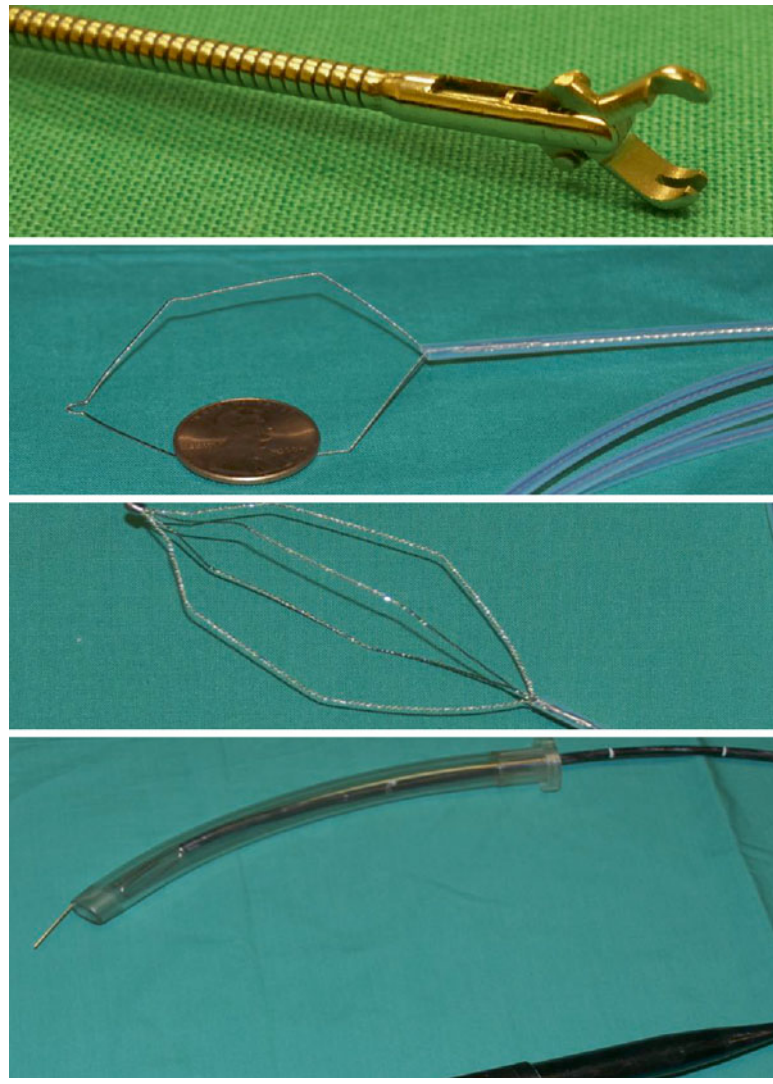

Fig. 12.8 Instruments for foreign body removal include rat-tooth forceps, polypectomy snares, rotatable baskets, and an overtube

Management

- Discontinue aspirin and NSAIDs and treat with proton pump inhibitors intravenously, in conjunction with resuscitation.
- The definitive treatment in GERD is abolishing the acid reflux either by prolonged proton pump inhibitors or fundoplication.

– Mallory-Weiss tear

More common in male patients.

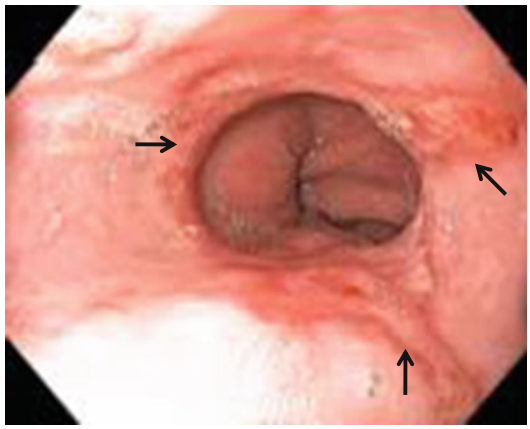

Fig. 12.9 Illustration showing reflux esophagitis (*arrow*)

Aspirin or alcohol use is frequently noted in the history (31–80 %).

The typical patient presents with hematemesis following retching or vomiting. In 5–10 % of cases, hemodynamic compromise and massive hematemesis are seen. The diagnosis is confirmed by endoscopy with the common finding a mucosal tear within 2 cm from the gastroesophageal junction (Fig. 12.10).

Other preexisting esophageal lesions are frequently observed at endoscopy.

About 90 % of patients with Mallory-Weiss hemorrhage stop bleeding without intervention.

– Esophageal varices (Fig. 12.11)

Diagnosis is easy in the context of liver cirrhosis.

Primary intervention includes airway protection, insertion of nasogastric tube, establishment of reliable intravenous access, transfusion of blood products, reversal of coagulopathy, proton pump inhibitor, and emergent endoscopy with sclerorotherapy and/or variceal ligation (Fig. 12.12).

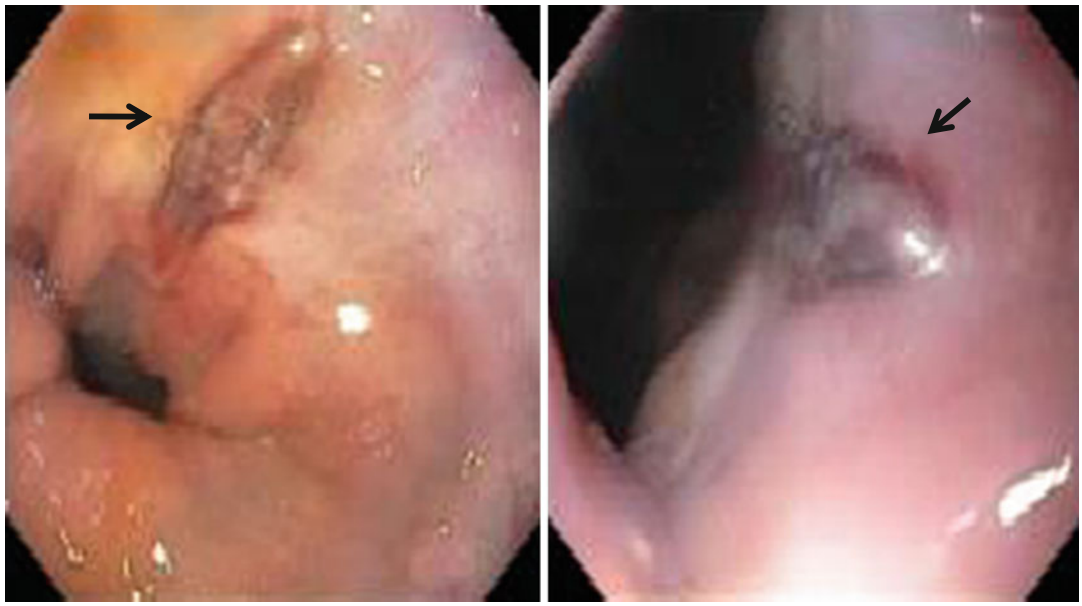

Fig. 12.10 Endoscopic view of Mallory-Weiss lesions (*arrow*)

Fig. 12.11 Illustration of esophageal varices

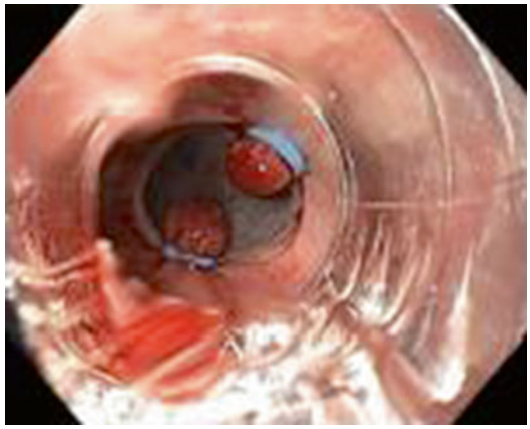

Fig. 12.12 Esophageal varices treated with banding

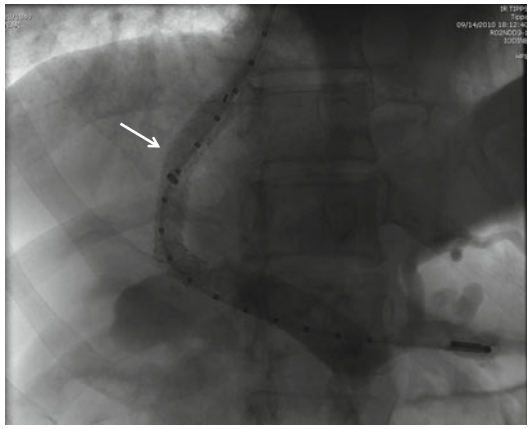

Fig. 12.13 Portosystemic shunting with TIPS (*arrow*)

Overall, 5–10 % of variceal bleeding is not controlled with endoscopic treatment and requires Sengstaken-Blakemore or Linton-Nachlas tube for hemorrhage control while considering interventional radiological percutaneous transhepatic embolization or transjugular intrahepatic portosystemic shunting (TIPS) (Fig. 12.13).

Adjuvant medical therapy with nonselective beta-blockers, vasopressin analogues, and octreotide may be considered.

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Stomach and Duodenum

13

Carlos Mesquita, Luís Reis, Fernando Turégano-Fuentes, and Ronald V. Maier

Contents

Objectives

- Describe the most frequent emergency surgery situations involving the stomach and duodenum (perforated and bleeding gastroduodenal ulcer disease)
- Describe the methods of surgical access and mobilization techniques of the different parts of the stomach and duodenum
- Underline the techniques used to protect a duodenal repair

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13.1 Stomach and Omentum

Gastric resections, even total, even functional, like in bariatric surgery, are well-tolerated procedures. The rich vascularization of the stomach, apart from being a potential source of problems, like in Dieulafoy's disease or portal hypertension-related varices, is also a window of opportunities, considering, for example, the therapeutic possibilities of angiography in bleeding ulcers. The greater omentum offers great possibilities of repair in defects of the stomach or other intra-abdominal structures. Adequately developed, a pedicle flap of omentum can reach the entire anterior surface of the trunk, the head and neck, and the proximal limbs.

13.1.1 Disease

- Peptic ulcer disease can be located in the prepyloric or pyloric area, as well as in the duodenal bulb (D1), with perforation and hemorrhage as the most frequent emergencies.
- Other purely gastric emergencies are, in general, more difficult to deal with, including postoperative bleeding, leaks and obstructions, variceal bleeding, gastric and omental volvulus, and malignant perforations, just to name the most common.
- Normal access to the stomach and the esophagogastric junction can be through laparoscopy or laparotomy (most often a midline incision).

13.2 Duodenum

The duodenum is divided into four parts: the first or postpyloric (D1), second or descending (D2), third (D3), and the fourth or ascending (D4). The arteries supplying the duodenum are the pyloric and superior duodeno-pancreatic branches of the hepatic artery and the inferior duodeno-pancreatic branch of the superior mesenteric artery. In 25–40 % of patients, a vascular critical area exists at the level of D4, and consequently, anastomosis should be avoided at this area.

- Urgent or emergency surgical procedures involving the duodenum are usually required for duodenal ulcer (DU) perforation, in upper GI bleeding from DU or varices, duodenal fistulae, obstruction (extrinsic) or tumoral, and iatrogenic injuries during surgical or endoscopic procedures.
- Complications related to the duodenal repair include suture line leaks, duodenal stenosis or obstruction at the suture line, and bleeding.

13.3 Peptic Ulcer Perforation and Bleeding

13.3.1 Gastroduodenal (G-D) Perforation

Peptic ulcer perforation, gastric or duodenal, remains a serious problem, despite the major revolution in medical management of peptic ulcer disease (development of anti-secretory drugs and recognition of the role of *Helicobacter pylori*). Morbidity and mortality remain high (20 % to more than 60 % and less than 10 % to more than 30 %, respectively).

- About 50 % of perforated peptic ulcers are located in the first part of the duodenum, 35 % in the pylorus, and 15 % in the stomach.
- Patients usually present with abdominal pain and signs of peritoneal irritation.
  - However, physical examination findings may be equivocal, and peritonitis may be minimal or absent, particularly in patients with contained leaks.
  - Patients presenting in extremis with altered mental status can further complicate an accurate physical examination.
- Laboratory studies tend to be nonspecific in the acute setting.

- Leukocytosis, metabolic acidosis, and elevated serum amylase are often associated with perforation.
- Free air under the diaphragm found on an upright chest X-ray is indicative of hollow organ perforation.
  Patients without pneumoperitoneum on chest X-ray should be evaluated with oral contrast-enhanced CT scan.

13.3.1.1 Management (Technical Details Are Described Later)

Surgical treatment is the gold standard for G-D ulcer perforation. Since the discovery of *Helicobacter pylori*, suturing the ulcer to close the perforation is all that is needed. However, simple suture can be problematic in giant (>2.5 cm) and/or chronic ulcers.

- For ulcers <2.5 cm in diameter
  - In most cases (90 %), simple suture is usually sufficient. Several duodenal closure procedures are possible (see later).
  - Treatment by antibiotics to eradicate *H. pylori* and PPI is essential to complete the management.
  - The laparoscopic approach can be used in low-risk patients.
  - The delay to surgery is critical: mortality increases proportionally as the interval before surgery increases.
- For ulcers (>2.5 cm in size)
  - Formal gastric resection (usually an antrectomy) with reconstruction, with or without vagotomy, is considered by many as the standard operation.
  - However, gastric body partition (GBP) with gastrojejunostomy, after simple closure of the perforation to prevent leakage at the closure site, has also been confirmed as a safe and fairly easy to perform procedure (Fig. 13.1).
- For gastric ulcers
  - While benign gastric ulcers can perforate, excision of the ulcer for pathologic examination is primordial to rule out the possibility of malignancy.
    Malignancy, although unusual, occurs in elderly patients.
  - During the emergency operation, it is often impossible to confirm the diagnosis, particularly when a frozen section is unavailable.
  - A two-stage operation can be preferred in this setting, with the initial operation being a damage control procedure directed to perforation and peritonitis.
    After recovery and histological confirmation of malignancy, adequate staging can be completed, and a radical oncological operation, if appropriate, may be planned.
  - Nonoperative management
    As many as 50 % of perforations will seal without formal surgical intervention, and nonoperative management (NOM) can be an option in these patients if:

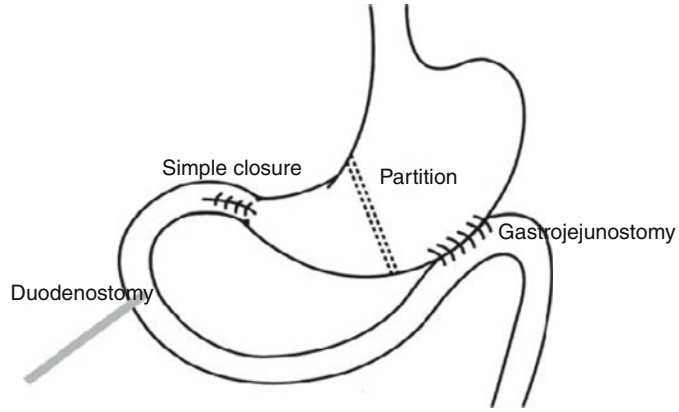


Fig. 13.1 Gastric body partition, gastrojejunostomy, and simple closure of the perforated peptic ulcer. A lateral duodenostomy may be added for bile drainage

- Hemodynamically stable
- Onset of symptoms of less than 24 h
- Minimal pain
- Absence of systemic signs of sepsis
- Age under 70
- Requires close observation and a low threshold for surgical intervention if clinical deterioration occurs

However, all patients with severe comorbidities, hemodynamic instability, onset of symptoms longer that 24 h in duration, peritonitis on physical examination, and systemic signs of sepsis and those who are age 70 or greater should be considered for early operative intervention.

13.3.2 G-D Bleeding

The most common causes of upper GI tract bleeding are gastric and duodenal ulcers (55 %), followed by acute gastric erosions (18 %), Mallory-Weiss tears (10 %), esophageal varices (6 %), and gastric carcinoma (6 %). Surgery for a bleeding ulcer is infrequent today but still necessary in some settings that do not respond to non-surgical alternatives.

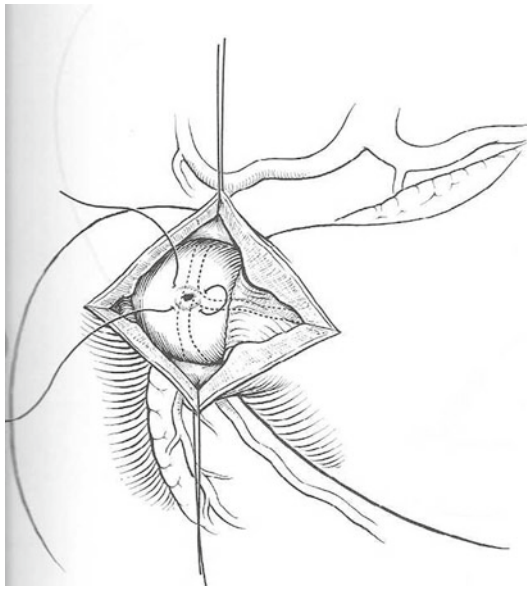


Fig. 13.2 Duodenotomy and suturing

- Patients bleeding from ulcers of the posterior wall of the duodenal bulb require surgical treatment when life-threatening hemorrhage cannot be controlled by endoscopic treatment (see upper GI endoscopy) or arterial embolization.
  - Direct suture (Fig. 13.2)
    Hemostasis is obtained via duodenotomy by underrunning the base of the DU (and bleeding vessel) with deeply placed sutures.
    Caution is warranted upon duodenotomy closure to avoid narrowing of the lumen.
  - Dubois' operation (antroduodenectomy without ulcer excision and gastroduodenal anastomosis) (Fig. 13.3a, b) is an alternative.

13.3.2.1 Risks

- Papilla is usually far away, further down.
- Common bile duct: an intraoperative cholangiogram should be performed in case of doubt.
  - Closure: the duodenotomy should be closed without constricting the lumen (prefer sutures perpendicular to intestinal lumen)
    For example, when duodenotomy is extended across the pylorus (Heineke-Mikulicz pyloroplasty)
  - In the rare cases of persistent bleeding after sphincterotomy by ERCP, a longitudinal duodenotomy in the second part will allow access to the papilla of Vater. After control by suture ligature, it is advisable to convert the sphincterotomy to sphincteroplasty.

13.4 Surgical Techniques

13.4.1 Access and Exposure

13.4.1.1 Incisions

- Both the stomach and duodenum can be reached easily via a midline laparotomy.
  - An extended transverse incision offers adequate duodenal exposure.

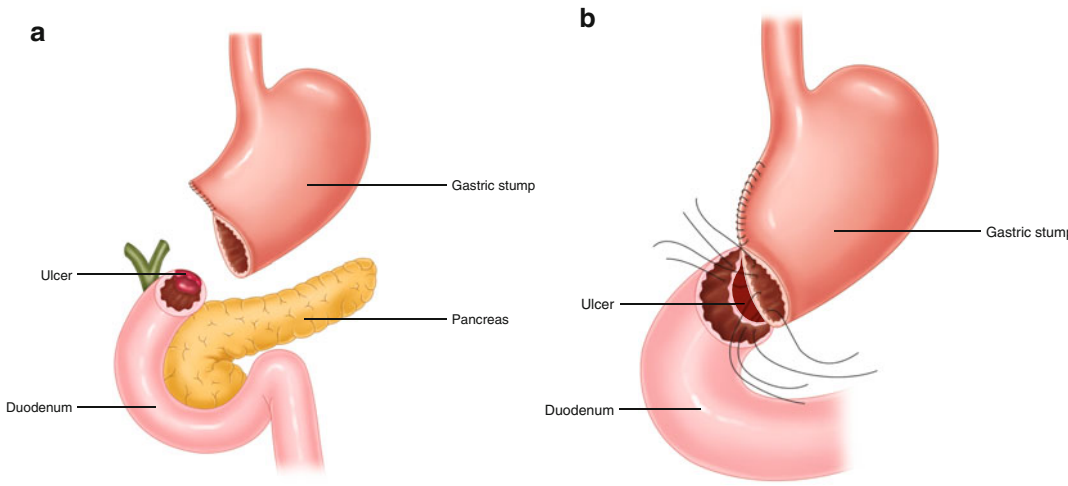


Fig. 13.3 (**a**) Antroduodenectomy, which respects the posterior ulcer without its dissection. (**b**) For the anastomosis, the posterior side of the gastric stump is applied to the anterior side of the ulcer

- For laparoscopic access, the trocar setup is similar to that for elective gastric (and hiatal) surgery, or for the duodenum, as for cholecystectomy.

13.4.1.2 Intraoperative Landmarks

- The pylorus is recognized by palpation in open surgery and by the pyloric vein of Mayo in both open and laparoscopic surgery.

13.4.1.3 Exposure

In open surgery, the posterior wall of D1 can be explored from the lesser sac, by opening a window in the gastrohepatic ligament and the greater omentum. The right index finger is placed to palpate the posterior wall.

- Complete exposure and mobilization of the whole duodenum can be achieved either through laparoscopy or laparotomy with two maneuvers:
  1. *Kocher's maneuver* (KM)
     KM0 allows access to the supra-mesocolic duodenum.
     - The retroperitoneum is opened lateral to the duodenal loop (D2).
     - The peritoneal incision continues through an avascular plane, extending from the lower part of the foramen of Winslow along the lateral border of D2 down to the right portion of the root of the transverse mesocolon, until revealing the right genital vein, inferior vena cava, and aorta (Fig. 13.4). This allows visualization of D3.
  2. The *Cattell and Braasch maneuver* (right medial visceral rotation) (Fig. 13.5)
     - The right and transverse colon and the root of the small bowel are moved to the left.
     - Small bowel is mobilized by sharply incising its retroperitoneal attachments from the right lower quadrant to the ligament of Treitz.
     - Incision of the ligament of Treitz allows mobilization of the duodenojejunal juncture and exposes D4.

13.4.1.4 Duodenal Decompression

- Rationale: protect the primary duodenal repair with the goal of decreasing the risk of duodenal suture dehiscence.
- Techniques
  - *Duodenostomy tube*
    The tube should exit the duodenum away from the suture line, preferably from the duodenal stump closed around the tube, and the site should be covered with the omentum. An external drainage should be placed next to the suture line.

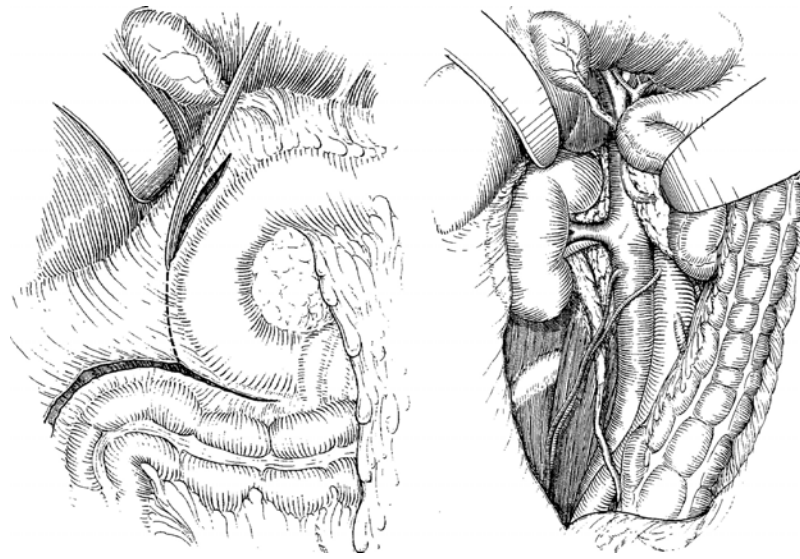


Fig. 13.4 Kocher's maneuver

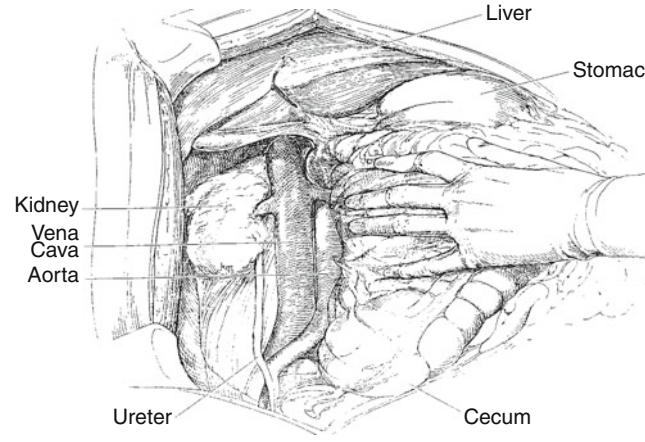


Fig. 13.5 The Cattell and Braasch maneuver

Different techniques of decompression have been used (Fig. 13.6):

- *Primary*, where the tube is inserted into the duodenum and the exit site is covered with a few stitches (*Witzel technique*)
- *Antegrade*, where the duodenum is proximally decompressed with a tube passed through a gastrotomy and across the pylorus
- *Retrograde*, where the tube is placed distally through the jejunum
- *Triple tube decompression* was introduced in trauma surgery as a "triple ostomy" (naso-gastric tube or gastrostomy, retrograde and antegrade tubes for duodenal decompression, and feeding jejunostomy, respectively). Disadvantages include new perforations in the gastrointestinal tract, lack of evidence as to the efficacy to decompress appropriately, and the possibility of accidental tube extraction.
- The duodenostomy tube stays patent for a few days and should not be removed until the tube path has been blocked, usually after minimum of 10–12 days (interval variable according to

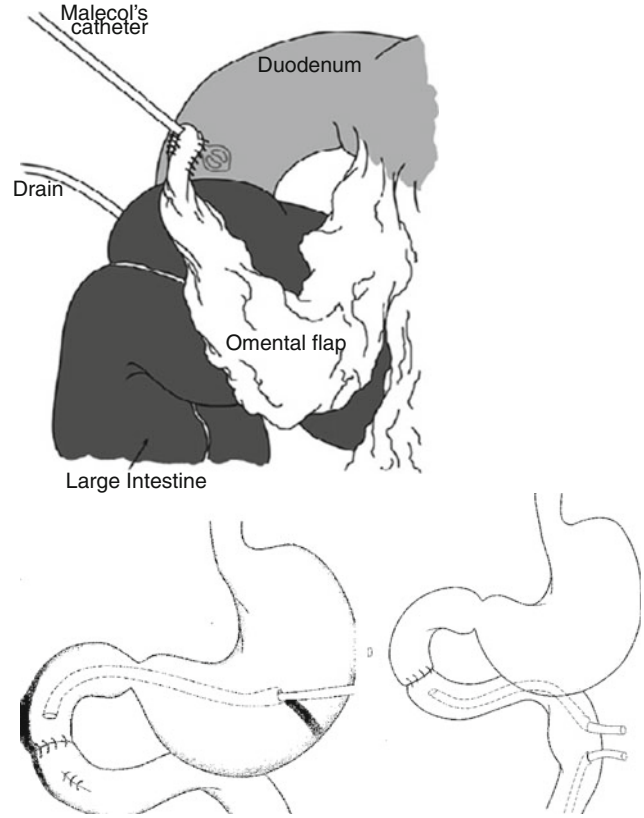


Fig. 13.6 Different techniques of duodenal decompression

the indication, the local and general conditions of the patient, bowel function recovery, and nutritional status).

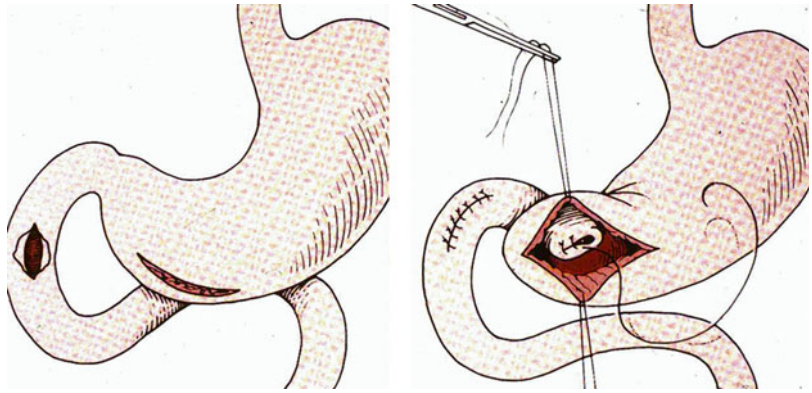
13.4.1.5 Duodenal Resection

- Very uncommon.
- Resection of D1 can theoretically be done in cases of complicated duodenal ulcers.
- Resection of D2 is not possible because of the shared vascular supply with the pancreas.
- Mobilization of the duodenum a few millimeters from the pancreas is necessary to avoid tension.
- Interrupted nonabsorbable 3/0–4/0 sutures are preferable.
- A drain should always be left in place, and depending on circumstances, a tube duodenostomy might be considered.
- In atypical resections, mainly in D2 and D3, when duodenoduodenostomy is not possible, several alternatives exist:
  - Roux-en-Y duodenojejunostomy (preferred)
  - Jejunal patch
- Special situation: hemorrhage from an aortoduodenal fistula.
  - D3 is fixed retroperitoneally and in close proximity to the aorta and therefore is the bowel segment most vulnerable to vascular impingement.
  - Besides aortic reconstruction with patch graft, a duodenorraphy or segmental duodenal resection might be necessary (access via Cattell and Braasch maneuver).

13.4.1.6 Pyloric Exclusion (Fig. 13.7)

- Devised in trauma setting as alternative to the more extensive duodenal diverticulization procedure (goals: shorten the operative time and make the procedure reversible)
- Indicated after large posterior iatrogenic duodenal perforations during ERCP and/or stent placement when the perforation (seen many

Fig. 13.7 Pyloric exclusion



hours after the insult) is not amenable to primary closure (induration and inflammation of the tissues)
- Technique:
  - After primary repair of the duodenal defect, if possible.
  - Gastrotomy along the greater curvature, in the antrum.
  - The pyloric ring is grasped and closed with a running slowly absorbable suture via the gastrotomy or closed by a linear stapler.
  - A gastrojejunostomy is fashioned at the gastrotomy site.
  - An alternative: Gastric body partition (Fig. 13.1).

13.4.1.7 Duodenal Diverticulization

- Includes a distal Billroth II gastrectomy, closure of the duodenal wound, placement of a decompressive catheter in the duodenum, and drainage of the duodenal repair. Truncal vagotomy and biliary drainage can be added. It is rarely performed today because of its complexity.

13.5 Stomal Ulcer Bleeding

- Usually self-limiting or amenable to endoscopic treatment.
- Persisting or recurrent hemorrhage in the high-risk patient should be approached through a small gastrotomy, perpendicular to the anastomosis, and the bleeding ulcer should be underrun with a few deeply placed absorbable sutures.
- Complicated reconstructive gastric surgery should be avoided.

13.6 Dieulafoy's Lesion

- Infrequent
- Is best managed by transgastric local excision or underrunning

13.7 Acute Hemorrhagic Gastritis

- Surgery is indicated extremely rarely.
  - Truncal vagotomy (TV) and drainage have a high rate of rebleeding.
  - Total gastrectomy has a prohibitive mortality rate.
  - Gastric devascularization (ligating the two gastroepiploic and left and right gastric arteries near the stomach wall) is a less aggressive alternative.

Bleeding esophageal or gastric varices

- Initial management is medical and endoscopic (see upper GI endoscopy).
  - Vasoactive drugs (e.g., vasopressin and somatostatin)
  - Endoscopy (banding, sclerotherapy)
  - If persistent bleeding: balloon tamponade with a Sengstaken tube

13.8 Bariatric Emergencies

- As bariatric operations are performed more and more often, postoperative complications are being seen increasingly. The most common cause of death following bariatric surgery remains pulmonary embolism (PE). The most common postoperative surgical complications include anastomotic leaks with peritonitis or abscess formation.
- Essentially, four types of postoperative complications occur in bariatric patients: bleeding, anastomotic leakage, marginal ulcer (MU) perforation or necrosis, and obstruction (the latter includes specific obstructive mechanisms such as internal hernia, acute gastric pouch or remnant dilatation, and, with gastric band placement, food intolerance, reflux, and band slippage).
- Particular to bariatric surgical emergencies
  - Bariatric patients do not exhibit the signs and symptoms that surgeons would normally expect.
  - Bariatric patients do not have a normal functional reserve when a complication occurs. Last, it may be problematic to perform imaging procedures such as CT scan in obese patients if the adapted equipment is not available.

13.8.1 Bleeding

- Acute postoperative bleeding occurs in less than 3 % of patients after Roux-en-Y gastric bypass (RYGBP), linear gastrectomy, and isolated or as a part of duodenal switch procedure and may be either intraperitoneal, with early signs, or gastrointestinal (GI), with late signs.
- Mesenteric transection, gastric remnant staple line, trocar site, or iatrogenic injury of the omentum or spleen are possible sites of intraperitoneal bleeding, whereas gastric remnant or gastric pouch staple lines, perigastric vessels, and gastrojejunal or jejunojejunal anastomosis may be the sites of intraluminal GI bleeding.
- Sites
  - Bleeding may exit through drains, but no bleeding through drains does not exclude this complication.
  - Blood exteriorized per oral usually originates from the proximal pouch, while rectal bleeding comes from the distal stomach or small bowel.
  - Bright red bleeding usually requires upper endoscopy or exploratory surgery.
  - Melena is more likely to be managed with replacement therapy and discontinuation of anticoagulants.

13.8.2 Leakage

- Anastomotic and staple line leaks occur in 1–8 % of cases with up to a 20 % mortality (second most common cause of death following obesity gastric surgery).
- Leaks occur most commonly at the gastrojejunostomy but can occur from any staple line, including the gastric pouch, the gastric remnant, jejunojejunostomy, or the gastric staple line in a sleeve gastrectomy.
- Symptoms and signs
  - The classic signs and symptoms of intestinal leakage are tachycardia, hypotension, tachypnea, abdominal pain, chest pain, and fever. Frequently, the first and only symptom of leakage can be unexplained tachycardia. A heart rate of greater than 120 bpm should be alerting, even if the patient otherwise feels good and appears well. In fact, some patients may demonstrate no signs of leakage and be completely asymptomatic.
  - Leaks can occur immediately postoperatively, may present 1–2 weeks postoperatively and can occur at any anastomosis or staple line, or can be due to iatrogenic lesions of the esophagus or any other part of the GI tract.
  - These leaks are potentially fatal and it is crucial to maintain a high index of suspicion. Diagnosis can be through an upper gastrointestinal tract water-soluble contrast radiography or an oral contrast medium-enhanced

CT scan, but initial contrast studies may not always demonstrate a leak (as it may require some time for ischemic tissue to progress to the point of disruption and gross leakage).
  - As in other operations with anastomoses or staple lines, drains are not 100 % foolproof. Most drains are excluded within 24–48 h.
- Management
  - Abscesses may be drained percutaneously.
  - If all other examinations are negative (40 %) and the suspicion remains, re-laparoscopy or laparotomy should be considered without delay.
  - In very select stable patients, a contained leak can be managed nonoperatively with adequate IR, stent placement (see upper GI endoscopy) or laparoscopic and/or percutaneous drainage, NPO, and antibiotics. Surgical treatment involves re-exploration, copious irrigation, leak control usually with omental patching rather than direct reanastamosis or repair alone, and wide drainage, along with broad-spectrum antibiotics +/– antifungal agents.

13.8.3 Marginal Ulcer (MU) Perforation

- The incidence of endoscopic-confirmed MU after RYGB reaches 16 %.
- The most common presenting complaints are bleeding – occult or acute – pain, nausea, and vomiting.
- The etiology of MU is multifactorial and may be related to gastric acid, tobacco, nonsteroid anti-inflammatory drugs, *Helicobacter pylori*, anastomotic tension or ischemia, foreign body (suture), and pouch size. Most of these risk factors are preventable.
- Perforated MU can occur without any antecedent symptoms, and its clinical presentation is similar to that of any other perforated viscus.
- Management
  - Is almost always surgical and involves repair of the perforation with the aid of an omental patch and placement of drains.
  - If the patient is stable with known chronic MU and the perforation is small with minimal contamination, definitive resectional surgery may be an option.

13.8.4 Obstruction

- Closed loop bowel obstructions and internal hernias can occur in gastric bypass patients.
  - Can be lethal if necrosis of the bowel develops
- Initial evaluation should include a flat and upright abdominal X-rays but often completed by abdominal and pelvic contrast-enhanced CT, an upper GI and small bowel series.
- Management
  - Via exploratory laparoscopy or laparotomy.
  - Adhesive or distal obstructions, unrelated to the bariatric procedure, must also be considered.
  - The abdomen must be completely inspected. The entire small bowel must be run from the duodenojejunal juncture to the cecum. A full view of the colon and intraperitoneal rectum should complete exploration.
  - When the surgeon does not know which bariatric procedure was performed and/or the anatomy is confusing, particularly in the face of internal hernias, it is best to begin distally at the cecum and work retrograde, inspecting and closing all mesenteric defects, and perform intraoperative endoscopy to rule out a stoma stenosis.
- Slipped bands
  - Gastric prolapse or slippage of the band distally with herniation of the stomach cephalad and enlargement of the gastric pouch above the band is not uncommon.
  - Immediate treatment includes emptying of the band contents.
  - Other major complication include erosion of the band into the stomach, which occurs primarily due to the gastrogastric sutures, placed to hold the band in place, being too tight and causing increased pressure on the inflexible band material.
  - These complications require reoperation, laparoscopic or open, repositioning or possible replacement of the gastric band, or

sometimes conversion to another operation, either during the same operation but most often as a staged procedure.

13.9 Gastric and Omental Volvulus

- Gastric volvulus is an extremely rare clinical entity that can be defined as an abnormal rotation of the stomach of more than 180°, resulting in incarceration and strangulation of the organ.

  More frequent in children and uncommon in adults before age 50, with males and females equally affected.

  Most often secondary to congenital diaphragmatic defects, such as paraesophageal hernias.

  Stomach rotation can be classified as organoaxial, mesentericoaxial, or combined.

  – Signs and symptoms

    Gastric volvulus can manifest as an acute abdominal emergency or as chronic intermittent problem.

    - Acute gastric volvulus: sudden onset of severe epigastric, left quadrant, or intrathoracic, chest pain (radiating to the left side of the neck, shoulder, arms, and back, mimicking myocardial infarction), sometimes with upper gastrointestinal bleeding due to mucosal ischemia and sloughing
    - The "Borchardt triad," consisting of pain, retching, and inability to pass a nasogastric tube, occurs in 73 % of cases.

13.9.1 Management

- In essence, this is a typical emergency surgery situation for which the goals are decompression, reduction, and prevention of recurrence.
- Surgical repair may consist of diaphragmatic hernia repair, gastropexy, or partial or even total gastrectomy, especially in cases complicated by necrosis.
- In poor candidates to surgery, endoscopic reduction may be attempted as a temporary measure allowing medical optimization prior to emergency or elective surgery but carries a risk of perforation.

13.9.2 Omental Volvulus or Torsion

Omental volvulus or torsion (greater omentum twisted longitudinally with resultant vascular compromise)

- Five or six times more common in middle age male adults than in children, more often primary than secondary
  – Primary torsion is unipolar, with one end of the omentum free.
  – Secondary torsion is bipolar, with the end opposite to the vascular pedicle fixed to adhesions or secondary to some other pathologic associated condition.
  – Omental torsion leads to hemorrhagic infarction and fat necrosis, with characteristic serosanguinous fluid extravasation.

  Right side of the omentum is most frequently involved.

  A rare cause of acute abdomen, omental torsion is often confused with acute appendicitis in these patients.

  Typically the diagnosis is only made at surgery, and surgical excision of the involved omentum is the treatment of choice.

13.10 Iatrogenic Injuries

Iatrogenic injuries from endoscopic interventional procedures are increasingly observed in clinical practice.

- Perforation rates from ERCP range from 0.1 to 0.6 %.
- Three distinct types
  – Guidewire-induced perforation
  – Periampullary perforation during sphincterotomy
  – Luminal perforation usually remote from the papilla

- Risk factors
  - Concomitant sphincterotomy
  - Previous surgery (Billroth II)
  - Difficult progress
  - Biliary stricture dilation
  - Malignancy
  - Precut access
- Diagnosis
  - Often diagnosed during the procedure
  - Otherwise: retropneumoperitoneum is the hallmark

13.10.1 Management

- Nonoperative (86 % success rate)
  - Aggressive biliary and duodenal drainage (nasobiliary and nasogastric tubes)
  - Broad-spectrum antibiotics
- Pyloric exclusion is an excellent indication in this setting (see above).

13.11 Aortoduodenal Fistula

- Rare
- Should be suspected and dealt with in cases of torrential bleeding in patients with previous prosthetic repair of the abdominal aorta
  - Aortic reconstruction with non-prosthetic patch
  - Duodenorraphy or segmental duodenal resection (access via Cattell and Braasch maneuver) (see above)

Pitfalls

- Incomplete exposure and mobilization of the duodenum for duodenal ulcer (perforation or bleeding)
- Failure to understand that a controlled and manageable fistula is always better than an uncontrolled fistula
- Failure to explore the distal duodenum in cases of unexplained torrential GI bleeding

13.12 Summary

The most common condition requiring access to the duodenum is perforated ulcer, ideally treated laparoscopically. With lesser frequency today, emergency surgical access to the duodenum can be required for bleeding duodenal ulcers. Tube decompression is considered a safe adjunct in the closure of a difficult duodenal stump. Iatrogenic injuries from endoscopic interventional procedures are increasingly observed in clinical practice, and pyloric exclusion is an excellent indication in this setting. The rare aortoduodenal fistula should be suspected and dealt with in cases of torrential bleeding in patients with previous prosthetic repair of the abdominal aorta.

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Cholecystectomy for Complicated Biliary Disease of the Gallbladder

14

Abe Fingerhut, Parul Shukla, Marek Soltès, and Igor Khatkov

Contents

Objectives

- Describe safe techniques of cholecystectomy
- When to start or convert to open cholecystectomy
- How to treat unexpected intraoperative findings or incidents
- How to manage complicated gallbladder disease

Complicated biliary disease of the gallbladder includes biliary stone-related complications (acute cholecystitis, empyema, gangrene, common choledocholithiasis with cholangitis or biliary pancreatitis, bilioenteric fistula) as well as complications without lithiasis such as acalculous cholecystitis, or other settings (with or without lithiasis) such as atrophic or sclero-atrophic gallbladder, liver cirrhosis, and/or cancer. Therapeutic procedures for complicated gallbladder disease include cholecystectomy, biliary drainage, subtotal cholecystectomy, removal of associated common bile duct stones, sphincterotomy, and treatment of biliary tract fistula.

14.1 Safe Cholecystectomy

Safe cholecystectomy means removal of the gallbladder without injuring the common bile duct or

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liver, undue bleeding, bile or stone spillage, or bile leak.
- Whether performed openly or through a laparoscopic approach, many of the steps are the same.
- The principles of "safety" are the same for all cholecystectomies, whether for simple, uncomplicated, or complicated disease.

• Exploration
  - First step: evaluation
    Determine:
    Degree of inflammation of the gallbladder.
    whether there is associated peritonitis by a complete, 360° exploration of the abdomen.

• Exposure and retraction
  - Take down adhesions between the gallbladder and omentum, Sometimes freeing a pocket of pus or infected bile.
  - Puncturing the gallbladder to empty some of the bile enables the surgeon to place a toothed grasper on fundus to properly retract the gallbladder fundus to the right, especially useful when gallbladder wall is thick or inflamed, or gallbladder is distended.
  - Exposure can be enhanced by suspending the liver (by placing a trancutaneous suture through the falciform ligament so when tied, the round ligament lifts the liver, best achieved when the suspension is to the left of the midline, and the suture is as close as possible to the liver without undue tension that might tear the liver).
  - Small intestine is retracted from field of view.
    Push down and hold by abdominal pads or retractors (open surgery).
    Incline the table to a reverse Trendelenburg's position with a left tilt (laparoscopy).
  - Initial traction should aim at exposure of the Calot's triangle.

• Caution (when freeing adhesions between the gallbladder and duodenum, small intestine, and the hepatic pedicle): look for fistula and do not create iatrogenic perforation.

• Several time-proven techniques of cystic duct identification:
  - Infundibular technique
    Not recommended because can be difficult or even hazardous in acute or chronic cholecystitis when cystic duct is short, or with large stone in Hartmann's pouch, or Mirizzi syndrome
  - Antegrade dissection
    Can be difficult in acute cholecystitis, as the acute inflammation increases bleeding and dissection takes place before ligation of cystic artery
    Increases risk of traction injuries to the common bile duct
  - Displaying lower confluence (cystic duct with the common hepatic duct)
    Can be difficult (and dangerous) in acute cholecystitis for same reasons
  - Identification of Rouvière's sulcus
    Cleft running to the right of the liver hilum, anterior to caudate process containing the right portal pedicle (visible in more than 75 % of patients), and accurately identifies the plane of the common bile duct. Dissection should always be anterior to the sulcus.
  - "Critical view of safety"
    Consists of identification of two (and only two) structures (cystic duct and artery) before any division, by initial dissection of the neck of the gallbladder, freeing the latter from the cystic plate (of the liver bed) (i.e., unfolding Calot's triangle)
    Safer to start dissection from behind (lateral), opening the peritoneum below the cholecystocystic junction and then moving to the anterior aspect of the triangle
    Difficult with:
    - Variant anatomy
    - Inflammation
    - When the cystic duct is:
      - Short
      - Stumpy

  - Hidden or effaced by a large stone
  - Hidden because of difficulty in retracting the gallbladder
- Infrared indocyanine green fluorescence
  Requires specific equipment
  Less irradiation than intraoperative cholangiography
  Quicker to perform
  Preventive measure that can be performed *before* dissection begins
- Intraoperative cholangiography
  Used routinely, reduces rate/severity of biliary injury
  - Early recognition
  - Prevents complete transection
  - Increases rate of good initial repair

  Better view of ductal variations
  Will only succeed if the cholangiogram is interpreted correctly
  - Complete upper bile duct fill essential, increases incidence of detection of biliary tract injury

  Disadvantages
  - Radiation
  - Extra time
- Intraoperative ultrasound
  Operator dependent

- Of note, the only techniques of cystic duct identification that can be performed *before* dissection begins include identification of Rouvière's cleft, infrared indocyanine fluorescence, and Introperative ultrasound
- Cystic artery and duct may now be divided safely (after correct identification of cystic structures, whatever the method).
- Close the distal stump with either absorbable clip or ligation.
  - Avoid metallic clips (because of electric dangers, possible migration, and stone formation in the common hepatic duct).
  - If the diameter of the cystic duct is greater than the length of the autolocking clip, it may be necessary to use an Endoloop or suture-ligate the duct – and double check that you are not dealing with the main bile duct.
- Dissection of gallbladder from its bed
  - Best by combined blunt and sharp dissection, in a retrograde fashion. There may be dense fibrotic or inflammatory tissues between the liver parenchyma and the gallbladder wall, making it difficult to find the correct plane of dissection.
- Place the gallbladder in retrieval bag.
  - To avoid any contamination of the abdominal wall during extraction.
  - If many stones and large diameter,
    Open the bag from the outside, and remove as many stones as necessary to reduce the volume and allow extraction of the gallbladder, rather than enlarging the extraction site, always possible.
    Remove the gallbladder from within the bag, rather than pulling on the bag which can tear.

14.2 Special Settings

14.2.1 Acute Cholecystitis

- Can be classed in three groups according to the 2007 Tokyo consensus guidelines
  - Grade I (mild acute cholecystitis): acute cholecystitis in a patient with no organ dysfunction and limited disease in the gallbladder, making cholecystectomy a low-risk procedure
  - Grade II (moderate acute cholecystitis): no organ dysfunction but extensive disease in the gallbladder, resulting in difficulty for safe cholecystectomy
    Elevated white blood cell count
    Palpable, tender mass in the right upper abdominal quadrant
    Duration of more than 72 h
    Imaging studies indicating significant inflammatory changes in the gallbladder
  - Grade III (severe acute cholecystitis): acute cholecystitis with organ dysfunction

14.2.1.1 Surgical Approach

- Open surgery has its proponents.
- Laparoscopic cholecystectomy may be considered an acceptable indication even in severe acute cholecystitis (gangrenous cholecystitis or empyema).
  - However, conversion is increased threefold.
  - Overall postoperative complication rate is higher.
  - Advisable to convert when you are no longer making progress in the operation or are uncertain of the anatomy (but not in case of suspected bile duct injury).

14.2.1.2 Caution

- Electric diffusion is increased and electrocautery less efficient in edema.
- If a large stone is palpated in the neck of the gallbladder, the surgeon should not hesitate to open the gallbladder, remove the stone, and then pursue dissection once the cystic orifice has been identified from within the open gallbladder.

14.2.1.3 Alternatives

- Cholecystostomy or subtotal cholecystectomy
  - Although there is no hard evidence that cholecystostomy or subtotal cholecystectomy is better, both have proponents in case of difficult dissection.
  - Useful (and safety measure) in case of difficulty in finding the correct plane of dissection between gallbladder wall and bed.
    Ligate cystic duct from within the open gallbladder (if not already done)
    Controversy exists as to whether to:
    - Coagulate mucosa in case of subtotal cholecystectomy (no evidence); suture the gallbladder walls (not recommended)
    - Coagulation of gallbladder bed
- Percutaneous drainage and secondary cholecystectomy

14.2.2 Acute Biliary Pancreatitis

- Of the three recent guidelines published on acute pancreatitis, one was solely dedicated to recommendations for laparoscopic management of acute biliary pancreatitis (Consensus Development Conference of the Società Italiana di Chirurgia Endoscopica e nuove tecnologie (SICE), Associazione Chirurghi Ospedalieri Italiani (ACOI), Società Italiana di Chirurgia (SIC), Società Italiana di Chirurgia d'Urgenza e del Trauma (SICUT), Società Italiana di Chirurgia nell'Ospedalità Privata (SICOP), and the European Association for Endoscopic Surgery (EAES)).
  - In gallstone pancreatitis, laparoscopic cholecystectomy is indicated to prevent disease recurrence.
    In mild pancreatitis, as soon as the patient has recovered and during the same hospital admission.
    In severe pancreatitis, cholecystectomy is delayed until there is sufficient resolution of the inflammatory response and clinical recovery (LE2b).
  - Timing for laparoscopic cholecystectomy
    In mild gallstone-associated acute pancreatitis, laparoscopic cholecystectomy should be performed as soon as the patient has recovered and during the same hospital admission (GoR B).
    In severe gallstone-associated acute pancreatitis, laparoscopic cholecystectomy should be delayed until there is sufficient resolution of the inflammatory response and clinical recovery (GoR B).
  - Apart from cases in which an emergency ERCP is indicated, common bile duct stone clearance should be obtained by preoperative ERCP or by laparoscopic removal of bile duct stones during cholecystectomy (GoR A).
    Two meta-analyses showed no differences when preoperative ERCP was compared to intraoperative removal of CBD stones (LE1b). The choice of treatment should be determined by local expertise, since lapa-

roscopic CBD exploration requires a significant surgical skill.

When pancreatic necrosis requires treatment (clinical signs of sepsis or multiorgan failure that do not improve despite optimal therapy), see pancreas chapter.

– The only indication for immediate surgery in acute pancreatitis is the presence of a compartment syndrome, which should be managed by surgical decompression (laparostomy or fasciotomy) (LE 4); laparoscopy is formally contraindicated in these cases.

14.2.3 Biliary Peritonitis

- Due to perforation of the gallbladder: indication for urgent cholecystectomy and drainage.
- Percutaneous cholecystostomy tube should be considered for poor surgical candidates, with consideration of referral later for cholecystectomy if clinical situation improves.

14.2.4 Acalculous Cholecystitis

- Occurs often in seriously ill patients with comorbidity where percutaneous cholecystostomy is an attractive alternative to major surgery
  - Can be performed at the bedside under local anesthetic and is suitable for patients in intensive care units and those with burns
  - May be definitive treatment or used as a temporizing measure to drain infected bile and delay the need for definitive treatment
- Otherwise, whenever possible, cholecystectomy

14.2.5 Cirrhosis

- No controlled studies, but case reports and series indicate that laparoscopic cholecystectomy is preferable in the cirrhotic patients
  - Less postoperative ascites (portacaval cutaneous anastomoses are preserved in laparoscopic surgery)

14.2.6 Bilioenteric Fistula

- Rarely responsible for an emergency setting except when stone migration gives rise to gallstone ileus (treated elsewhere in this manual) and local (right upper quadrant) phlegmon which has to be treated at the same time.
- Fistula usually results from inflammation associated with acute cholecystitis and occurs between the gallbladder and an adjacent hollow viscus.
  - A second mechanism is pressure necrosis from a large stone within the gallbladder lumen.
- Communication
  - The duodenum is the most commonly involved portion of the intestinal tract, accounting for approximately 75 % of these communications.
  - The colon is involved in approximately 15 % of cholecystoenteric fistulas.
- If ileus is the main symptom, it can be treated by stone extraction after milking the stone back from the point of obstruction. Resection is rarely necessary in the emergency setting.
- Caution: Do not tackle the right upper quadrant; i.e., do not take out the gallbladder, and do not attempt to take down the choleduodenal fistula if chronic and well established (which it generally is).
  - Ileal or colonic resection is rarely needed.
- Spontaneous closure of a cholecystoenteric fistula can occur, particularly when no distal obstruction is present, stones are no longer present in the gallbladder, and the acute inflammation has resolved.
  - The decision to perform cholecystectomy later is determined by patient status.
  - Asymptomatic patients in whom no persistent cholecystoenteric fistula is demonstrated by contrast study do not usually require elective cholecystectomy.
  - Persistence of symptoms or demonstrated failure of fistula closure suggests additional stones in the gallbladder and requires chole-

cystectomy, division of the fistula, and closure of the intestine (small or large intestines).

14.2.7 Sclero-atrophic Gallbladder and Cancer

- Rarely responsible for emergency presentation
  - Usually are intraoperative findings and warrant appropriate treatment as indicated elsewhere

14.2.7.1 Controversial Issues

- Subhepatic drainage
- Type and duration of antibiotics

Pitfalls

- Adhesions between the inflamed gallbladder and the duodenum
- Difficult access to Calot's triangle
- Inflamed gallbladder adherent to the hepatic pedicle as in acute cholecystitis
- Fistula between the gallbladder and neighboring structures
- Patient unfit for surgery
- Iatrogenic common bile duct injury

Essential Points

- Puncture the thick-walled, inflamed, distended gallbladder to correctly retract the gallbladder to expose Calot's triangle.
- Safe dissection of Calot's triangle and proper identification of the cystic duct and artery.

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Choledocholithiasis [Common Bile Duct (CBD) Stones]

15

René Fahrner and Abe Fingerhut

Contents

Objectives

- Describe the common clinical manifestations of common bile duct stones.
- Outline the management options of CBD stones.
- Explain the treatment strategies in different scenarios of CBD stones.

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15.1 Introduction

Choledocholithiasis is defined as the presence of gallstones in the common bile duct (CBD). An estimated 10–18 % of patients undergoing a laparoscopic cholecystectomy because of cholecystolithiasis (stones in the gallbladder) also have choledocholithiasis. The underlying pathology of choledocholithiasis is most frequently cholecystolithiasis; however, residual stones as well as denovo choledocholithiasis may also occur several weeks to several years after cholecystectomy.

Emergency treatment is necessary when signs and symptoms occur; choledocholithiasis is often clinically and biologically silent.

15.2 Diagnostic Pathways

15.2.1 Tools

- *Blood tests* may show elevated alkaline phosphatase, gamma-glutamyl transferase, and (direct) bilirubin.
- *Abdominal ultrasonography* (*US*) is inexpensive, without any side effects (e.g., radiation). Sensitivity in the detection of choledocholithiasis, although very operator dependent, ranges between 38 and 82 %. US helps diagnose concomitant cholecystitis.
- *Preoperative endoscopic retrograde cholangiography* (*ERC*) *offers* diagnostic and

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therapeutic options with high sensitivity and specificity; sometimes multiple procedures are necessary.
- *Magnetic resonance cholangiography* (*MRC*) is associated with sensitivity and specificity ranging between 93–100 % and 96–100 %. Although abdominal computed tomography is not the best diagnostic tool for choledocholithiasis, it is often used to eliminate other disease.

15.2.2 Leading Symptoms

Patients with choledocholithiasis can present with signs of incomplete or complete obstruction of the common bile duct or biliary pancreatitis.

- *Incomplete obstruction*: acute crampy abdominal pain associated with vomiting and nausea. The abdomen is usually soft without generalized or localized peritoneal signs and patients are afebrile.
- *Complete obstruction*: usually characterized by jaundice, fair stools, and dark urine, more rarely by itching.
  - *Cholangitis* is characterized by the classical triad of Charcot including right upper quadrant pain, fever, and jaundice.
    Acute cholangitis occurs as a result of bacterial infection superimposed on obstruction of the biliary tree.
    Severe cholangitis may be associated with hepatic microabscesses that usually carry a poor prognosis.
- *Biliary pancreatitis*: usually presenting with diffuse abdominal pain, elevation of pancreatic enzymes, signs of inflammation and – in severe cases – pancreatic necrosis and multiorgan failure (associated with high mortality).

15.3 Interventions and Indications

1. ERCP, usually performed with papillotomy.
   - Requires experienced endoscopist, sedation, or general anesthesia.
   - Post-interventional complications include:
     - Mortality: 0.5 %,
     - Bacteriemia: 13.3 %
     - Acute cholangitis: 4.1 %
     - Pancreatitis: 6.2 %
   - If impossible, surgery (ideally laparoscopic) is the best alternative.
   - In patients having undergone endoscopic removal of CBD stones, a laparoscopic cholecystectomy should be performed within 1 week after endoscopic treatment to avoid recurrent biliary complications and repeated hospital admissions.
2. Surgery (removal of CBD stones).
   - Can be performed laparoscopically or in open surgery.
   - Laparoscopic choledochotomy requires advanced laparoscopic skills but has good clearance rates and has been recently shown to be as effective as open surgery in the emergency setting.
   - Both require general anesthesia.
   - Extraction of stones can be performed via the cystic duct or choledochotomy.
     - Decision whether to perform vertical or horizontal choledochotomy depends on size of stone and CBD, inflammatory status, and also surgeon preference.
     - Extraction can be done either with a balloon dilatation (or Fogarty) catheter or, better with a Dormia basket catheter, inserted through the cystic or the choledochotomy, and for the latter, with or without a small-diameter choledochoscope.
   - Surgery may be hampered by aberrant anatomy, proximal stones, strictures, and large or numerous stones.
   - The open bile duct may be addressed with closure over a T-tube, an exteriorized transcystic drain, or primary closure with or without endoluminal drainage (preferred).
   - At the end of the procedure, a completion cholangiography should confirm that the common bile duct is free of stones.
   - If complete removal of CBD stones is not possible, alternatives include:
     - Conversion to open surgery (if initial laparoscopy)
     - Postoperative ERC
3. Laparoscopic cholecystectomy, the standard approach for the treatment of cholecystolithiasis

and cholecystitis, may be performed after or before ERCP or as part of a one-stage laparoscopic procedure.

- Several publications have demonstrated the feasibility and safety of simultaneous laparoscopic cholecystectomy and transcystic bile duct exploration and/or choledochotomy in elective surgery. The morbidity rate in these series was 7.5–12.6 % and included reoperations, biliary leakage, bleeding, wound infections, pancreatitis, liver dysfunction, and pulmonary embolism. Whether the same is true for emergency surgery remains to be shown.

4. In patients with prior gastric or intestinal operations, e.g., gastric bypass or gastric resection with Roux-en-Y reconstruction, the passage to the main bile duct via stomach is closed and special therapeutic approaches are necessary.
   - Laparoscopic-assisted ERC and papillotomy, relatively easy
     - The endoscope is passed through a 15 mm trocar inserted into the remnant stomach via an anterior gastrotomy, made watertight by a pursestring, and advanced to the papilla vateri for papillotomy and stone removal.
5. Indications

   In the absence of pancreatitis, three options are possible:
   1. ERCP, usually performed with papillotomy, followed or not by cholecystectomy
      (a) May be performed selectively before, during, or after cholecystectomy
         i. With little discernable difference in morbidity and mortality and similar clearance rates when compared to laparoscopic common bile duct exploration
      (b) Performed routinely preoperative ERCP will likely result in unnecessary procedures with higher mortality and morbidity rates
      (c) Performed *after* laparoscopic cholecystectomy (with intraoperative cholangiograms) rather than before minimizes costs and morbidity
   2. One-stage surgery, laparoscopic, or open
      (a) CBD exploration is at least as efficient as ERC, but less dangerous.
   3. Laparoscopic cholecystectomy followed by ERCP

   NOTE: Current data does not suggest clear superiority of any one approach; decisions regarding treatment are most appropriately made based on surgeon preference as well as the availability of equipment and skilled personnel.

15.4 In Biliary Pancreatitis

Early endoscopic sphincterotomy is NOT indicated in benign acute biliary pancreatitis, except in case of severe cholangitis associated with severe acute biliary pancreatitis (see chapter on Pancreatitis)

Pitfalls

- Failure to distinguish between common bile duct obstruction by choledocholithiasis and pancreatic head or duodenal malignancy.
- Rarely parasites are responsible for obstruction: treatment is not dissimilar.

15.5 Essential Points and Summary

In patients who present with jaundice and abdominal pain, choledocholithiasis must be included in the differential diagnosis. Diagnostic tools include blood test (increased bilirubin, alkaline phosphatase, and gamma-glutamyl transferase) and an abdominal sonography. Treatment consists of the removal of the stones from the common bile duct and subsequent cholecystectomy. Choosing between initial ERCP to remove the common bile duct stones followed by laparoscopic cholecystectomy or laparoscopic one-stage cholecystectomy and choledocholithotomy via laparoscopy, increasingly performed, depends on available surgical expertise, equipment, and

staff. Timing of cholecystectomy should be within 1 week after ERCP to avoid biliary complications.

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Small Bowel Emergency Surgery

16

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Contents

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Objectives

- To identify those patients with bowel obstruction who require an urgent operation because of bowel strangulation
- To recognize on a CT a mechanical small bowel obstruction and the location of obstruction and small bowel feces sign

The small bowel measures 6–7 m in length from pylorus to ileocecal valve. The jejunum begins at the ligament of Treitz. Jejunum and ileum are suspended by a mobile mesentery covered by a visceral peritoneal lining that extends onto the external surface of the bowel to form the serosa. Adhesions may limit the mobility of loops and lead to obstruction or internal hernia. Jejunum and ileum receive their blood from the superior mesenteric artery (SMA). Although mesenteric arcades form a rich collateral network, occlusion of a major branch of the SMA may result in segmental intestinal infarction. Venous drain is via the superior mesenteric vein, which then joins the splenic vein behind the neck of the pancreas to form the portal vein. Peyer's patches are lymphoid aggregates present on the antimesenteric border of distal ileum. Smaller follicles are present through all small bowel. Lymphatic drainage of intestine is abundant. Regional lymph nodes follow the vascular arcades and

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then drain toward the cisterna chyli. Jejunal and ileal walls consist of serosa, muscularis, submucosa, and mucosa.

16.1 Acute Band or Adhesive Small Bowel Obstruction

- Common surgical emergency and major cause of admission to emergency surgery departments
- Early diagnosis is essential to management
  - Principle symptoms are abdominal pain, absence of flatus or stool, nausea or vomiting, dehydration, and abdominal distension if the obstruction is not in proximal jejunum.
    Proximal obstruction tends to present with more frequent cramps, whereas distal obstructions cause less severe cramps with longer duration between episodes.
  - Laboratory tests:
    Elevated hematocrit because of intravascular volume loss.
    Significant leukocytosis is suggestive of strangulation.
  - Plain X-rays of the abdomen (not used in most places) reveals dilatation of the small bowel and air-fluid levels.
  - CT scan, with IV contrast, shows the dilatation of proximal bowel and the collapse of distal bowel.
    Bowel wall thickening, mesenteric edema, asymmetrical enhancement with contrast, pneumatosis, and portal venous gas are suggestive of strangulation.
    The zone between the presence and absence of small bowel feces may also help identify the site of obstruction.
  - Ultrasound may also be useful.
- *The key to management of small bowel obstruction is early identification of intestinal strangulation, because mortality increases from two- to tenfold in such cases*
- Therapy
  - Preoperatively
    Correction of depletion of intravascular fluids and electrolyte abnormalities.
    Nothing by mouth.
    Insert nasogastric tube in patients with emesis.
  - In patients with adhesive small intestine obstruction, water-soluble contrast medium (Gastrografin) with a follow-through study is not only a diagnostic tool but can also be therapeutic
  - Surgical intervention is mandatory for patients with complete small bowel obstruction with signs or symptoms indicative of strangulation or those patients with obstruction that has not resolved within 24–48 h of nonoperative treatment
    Laparotomy or laparoscopy can be used
    - Laparoscopy is best adapted to small bowel obstruction by bands, post appendectomy.
    - The open technique for first trocar insertion is mandatory.
    - Exposure may be difficult in case of massive bowel dilatation, multiple band adhesions, and sometimes posterior band adhesions, more difficult to treat laparoscopically.
    - Ischemia and/or necrotic bowel may require conversion.
    - Predictive factors for successful laparoscopic adhesiolysis include:
      - Less than three previous laparotomies
      - A non-median previous laparotomy (e.g., McBurney)
      - Unique band adhesion
      - Early laparoscopic management (possibly within 24 h)
      - No signs of peritonitis
      - Surgeon experience
    - Relative contraindication:
      - Three or more previous laparotomies
      - Multiple adherences
    - Absolute contraindications
      - Massive dilatation (more than 4 cm)
      - Signs of peritonitis
      - Severe cardiovascular or respiratory comorbidities
      - Hemostatic disorders
      - Hemodynamic instability

Goals of surgery
- Adhesiolysis
- Determination of bowel viability: two alternatives
  - Resection of non-viable intestine
    Extension of intestinal resection depends on demarcation between purple or black discoloration of ischemic or necrotic bowel from viable intestine, recognized also by mesenteric arterial pulsations and normal motility
  - Observation of limited ischemia after adhesiolysis for 10–15 min, applying warm saline, looking for possible improvement in the gross appearance of the involved segment

- Obstruction by inflammatory bowel (see Crohn's disease)
  - Secondary to inflammation, abscess, fistula
  - Requires resection or strictureplasty

16.2 Crohn's Disease

- Acute surgical emergencies are infrequent but may be life threatening
- Bleeding
  - Often localized
  - Caused by erosion of a blood vessel within multiple deep ulcerations
  - Indications for surgery:
    Severe hemorrhage, rare
    Recurrent bleeding or persisting after 4–6 units of blood
  - Preoperative localization of bleeding is difficult:
    Gastroscopy, angiography, and the use of a nuclear medicine labeled red cell scans
  - Resection and primary anastomosis is the gold standard surgical treatment.
- Perforation
  - Incidence 1–3 %
  - Often sealed
  - Treatment:
    Jejunal and ileal perforations: resection and primary anastomosis if possible.
    - Alternative: resection with intestinal diversion is necessary.
  - Usually laparotomy is necessary but laparoscopy has its adepts.
- Abdominal (intraperitoneal, intermesenteric) abscess
  - Interventional radiology is first line.
  - Surgical drainage.

16.3 Small Bowel Neoplasms

- Very rare (1 % of all gastrointestinal neoplasms and 0.3 % of all tumors).
- Most common modes of presentation: intestinal obstruction by the tumor itself or by intussusception and occult gastrointestinal hemorrhage; perforation and gross bleeding are rare.
- Usually located in the proximal small bowel, with the exception of adenocarcinoma in the contest of ileal Crohn's disease and NETs.
- Tumors can be benign (usually asymptomatic or pauci-symptomatic), malignant (often symptomatic), or intermediary, and these are represented essentially by gastrointestinal stromal tumors (GIST).
  - Benign small intestinal tumors include adenomas (jejunal or ileal) (either tubular adenomas with low malignant potential or villous adenomas with high malignant potential), leiomyoma, hamartoma or desmoid tumors, and lipoma, more frequent in the ileum.
  - Malignant neoplasms are dominated by adenocarcinoma (50 % of all small bowel malignancies), followed by lymphoma (10–20 %), and also leiomyosarcoma, and carcinoids or metastatic neoplasms.
    Treatment: resection and immediate anastomosis whenever possible, sinon diversion
    - Adjuvant therapy is recommended for patients with positive margins.
  - Gastrointestinal stromal tumors (GISTs)
    Symptoms: bleeding occurs in almost 50 % of GISTs.
    - Approximately 35 % of patients present with abdominal mass causing or not

symptoms, and 20 % of patients have abdominal pain.

– Main symptoms: chronic bleeding and mild obstructive symptoms
  - Usually do not metastasize beyond the gastrointestinal tract and the liver.
  - Prognosis varies and depends on the site of GIST origin, mitotic index, and size.
  - When GIST presents as an emergency, surgery is the mainstay and the goal is to completely resect the primary tumor, surrounding normal tissue, and all involved adjacent organs.
  - Because of their fragility, surgeon must handle GIST with great care to avoid tumor rupture.
  - GISTs are resistant to chemotherapy and radiotherapy.
– Gastroenteropancreatic neuroendocrine tumors (GEP-NET) are a heterogeneous group of uncommon malignancies occurring in the gastrointestinal system.
  Incidence: 2–3 per 100,000 people per year.
  Symptoms depend on the tumor cells of origin and the effects of secreted substances.
  - Small bowel NETs are the most common and occur more frequently in ileum than in jejunum.
  - About 10 % of patients with metastatic ileal NETs have classic carcinoid syndrome.
  - Occasionally, ileal NET presents with a massive gastrointestinal bleeding, secondary to sclerosis of vasa recta, due to hypersecretion of serotonin.
  - Sclerosis of arterial vessels may also provoke a bowel ischemia.
  - Otherwise, endoluminal growth of the cancer and mesenteric fibrosis are responsible for intestinal obstruction.
– Intestinal involvement of metastatic cancer is common, mostly in the form of peritoneal carcinomatosis.
  All abdominal tumors can lead to peritoneal carcinomatosis, particularly colorectal cancer, ovarian cancer, gastric cancer, and primitive peritoneal neoplasms.
  The diagnosis of peritoneal secondary tumors as the cause of small bowel obstruction is often difficult.
  - Obstruction typically never resolves completely and definitely by conservative treatment, and surgical intervention is almost always indicated: extensive cytoreductive surgery (CRS) and hyperthermic intraperitoneal chemotherapy (HIPEC).

16.4 Meckel's Diverticulum and Acquired Jejunoileal Diverticulosis

16.4.1 Meckel's Diverticulum

- The most common congenital malformation of the gastrointestinal tract (2–4 % of the total population)
  – Is localized on antimesenteric border of the distal ileum, usually 30–40 cm from the ileocecal valve.
  – A true diverticulum.
  Lined mainly by the typical ileal mucosa.
    - However, in 20 % of cases, ectopic gastric mucosa may be found: increasing the risk of complications two- to threefold.
      – Globally the incidence of complications ranges from 4 % to 16 %, three to four times more frequent in males.

  Is the most common cause of bleeding in the pediatric age group.
  The risk of complications decreases with increasing age.
    - In adults: most frequent complications are obstruction (intussusception or adhesive band), ulceration, diverticulitis, and perforation.
    - Technetium 99-m scan is the most common and accurate noninvasive investigation (when the diverticulum contains ectopic gastric mucosa).

- In the presence of symptoms, the treatment of choice is the surgical resection: diverticulectomy or, better, by the segmental bowel resection and anastomosis, especially when there is palpable ectopic tissue, intestinal ischemia, or perforation.

16.4.2 Acquired Jejunoileal Diverticulosis (JID)

- Is a rare entity often asymptomatic and treated conservatively.
- Incidence increases with age, with the peak occurring in the sixth and seventh decades of life.
- Are pseudodiverticula (herniation of mucosa and submucosa through the muscularis on the mesenteric border where paired vasa recta penetrate the bowel wall.
- About 55–80 % of diverticula occur in the jejunum, 15–38 % in the ileum, and 5–7 % in both.
- Two-third of patients have multiple diverticula and therefore a major risk of developing complications.
- Ten percent to 19 % of patients present with acute and emergent complications, and most complications require acute surgical care.
  - Diverticulitis occurs in 2–6 % of patients and can progress to gangrene with full-thickness necrosis and perforation associated with a mortality rate as high as 40 %.
    Perforation presents either with localized or generalized peritonitis, and the mainstay of treatment includes resection of the affected segment and primary anastomosis.
  - Obstruction occurs in 2–4 % of patients, due to adhesions, intussusceptions, volvulus, extrinsic compression from a fluid-filled diverticulum, or enteroliths.
  - Bleeding complications occur in 3–8 % of patients.
    Surgical resection of the affected bowel and anastomosis is mandatory.

16.5 Acute Mesenteric Ischemia

- Uncommon (less than 1 case in every 1000 hospital admissions)
  - Three times more frequent in females
  - Usually between the age of 60 and 70
  - Main cause: arterial embolism (40–50 % of cases), most often originating from the heart
    Location
    - Proximal superior mesenteric artery (SMA), just beyond the first jejunal branches (35 %)
    - At the origin of the SMA (15 %)
    - Distal to the middle colic artery (50 %)
      - Sparing proximal intestine and ascending colon
  - Presenting signs and symptoms
    Acute symptoms usually occur in patients with a long history of chronic mesenteric ischemia.
    - Pain and shock are the most common; diarrhea and red blood per anum are frequent.

    Diagnosis
    - High-quality computed tomography angiography has supplanted angiography.
    - Diagnostic laparoscopy is not widely accepted because it may miss areas of nonviable bowel.

    After initial resuscitation and stabilization of the patient
    - Revascularization may be tempted.
    - Resection as necessary (frank necrosis or perforation or peritoneal soilage).
      - Usually without reanastomosis

16.6 Miscellaneous Conditions

16.6.1 Gallstone Ileus

- Develops with the passage of gallbladder stones through a fistula to the duodenum.
- Obstruction in a narrow section of the distal small bowel which is generally terminal ileum.
- Aerobilia may be visualized on plain abdominal X-ray or CT.

16.6.2 Pneumatosis Intestinalis

- Defined as the presence of gas within the abdominal wall of the bowel
  - Sometimes incidental finding without any underlying pathology
    Is seen in patients with COPD, asthma, or pulmonary cystic fibrosis
  - Elsewhere the result of primary intestinal pathology requiring urgent surgery
    Results from necrosis caused by ischemia, infarction, neutropenic colitis, volvulus, and necrotizing enterocolitis obstruction or ischemia and usually require urgent surgery.
    Only the ischemic bowel segment must be resected.

16.6.3 Small Bowel Ulceration

- Usually the result of ingested medications like enteric-coated potassium chloride, nonsteroidal anti-inflammatory drugs, and corticosteroids
  - Clinical presentation: intermittent small bowel obstruction.
  - Preoperative localization is difficult (requires palpation of the small bowel at laparotomy or an intraoperative endoscopy).
  - Treatment is surgical resection rather than suture repair because of a high rate of suture breakdown.

16.6.4 Accidental or Intentional Ingestion of Foreign Bodies

- Not rare
- Symptoms:
  - Intestinal perforation is rare.
  - Resection is preferred over antibiotic treatment (associated with chronic infection or stricture formation).

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17 Colon and Rectum Emergency Surgery Techniques: Exposure and Mobilization, Colectomies, Bypass, and Colostomies

Pantelis Vassiliu, Irene Pappa, and Spyridon Stergiopoulos

Contents

Objectives

- Rapid access and operative ease
- Exposure and small bowel positioning
- Mobilization modules: ascending, transverse, descending, sigmoid, rectum
- Resection modules: right, left, sigmoid colon, rectum
- Anastomoses: alternatives, pros and cons, surgical technique
- Stomas: surgical technique, alternatives
- Internal bypasses: indications, technique
- Drains: indication, functional positioning, optimal timing of removal

17.1 Generalities

- Colonic contents: in emergency surgery of the colon, there is no time for colonic preparation.
  - If simple spillage occurs intraoperatively, fecal contents must be swiped out and the abdominal cavity washed with warm saline at the end of the operation.
  - To drain and give antibiotics for 24 h is optional.

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17.2 Access

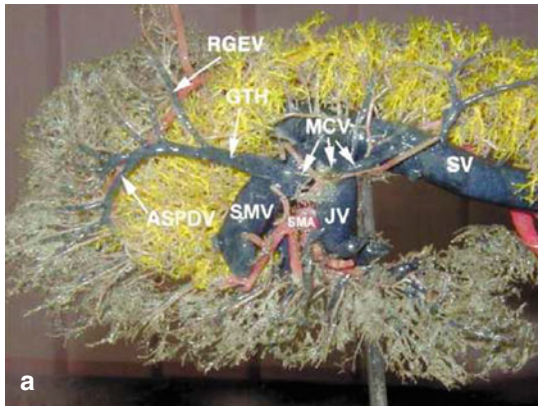
- Laparotomy
  - Abdominal midline incision is most commonly used; it should be long enough to enable visualization and mobilization of all parts of the colon.
  - If stoma formation is the only goal of an acute operation, a minimal skin incision on top of the mobilized bowel loop intended to be brought out is sufficient. The incision used for access is then used to fix the bowel to the skin.
- Laparoscopy
  - Several configurations are possible: the principle of triangulation, the scope, and all instruments directed toward the target must be respected to optimize the ergonomics.

17.3 Mobilization

- Dissection is based on natural avascular planes (between the Toldt and Gerota fascias).
- Any anatomic deviation sometimes caused by disease must be pursued with caution to identify and avoid damage to neighboring structures (essentially ureter).
- Whether performed through a classical laparotomy or through laparoscopy, the steps and precautions are similar, but the order may differ.
  - Two approaches are possible: the classical lateral to medial, which can be used both in open and laparoscopic surgery; and the medial to lateral, usually performed in laparoscopy.

17.3.1 Right Colon

- Make an incision from the mesenteric surface of terminal ileum, along the avascular line where the parietal peritoneum fuses with the mesentery.
- Continue around the cecum to the line of Toldt.
  - Facilitate your effort by retracting the ascending colon (grasper or with nondominant hand) against the parietal peritoneum.
- Dissection continues around the hepatic flexure, with caution taken to identify the duodenum.
- Division of the gastrocolic ligament
  - Danger: the gastrocolic trunk of Henle (a short vein arising from the right gastroepiploic, anterosuperior pacreatodudodenal, and right superior colic veins, draining into the superior mesenteric vein (SMV)) (Fig. 17.1), is vulnerable to undue or



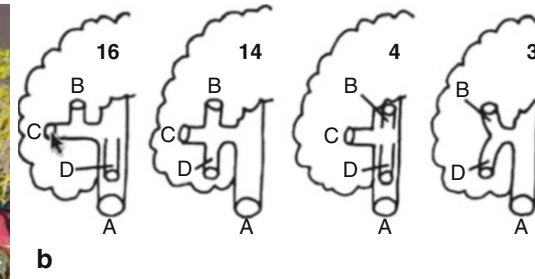


Fig. 17.1 A lethal danger spot in right colon dissection: Henle's gastrocolic trunk (Ignjatovic et al. 2004; Lange et al. 2000). (**a**) Demonstration of the gastrocolic trunk of Henle (*GTH*) with the corrosion cast method. *ASPDV*, anterior superior pancreaticoduodenal vein; *GTH*, gastrocolic trunk of Henle; *JV*, jejunal vein (prima); *MCV*, middle colic vein; *RGEV*, right gastroepiploic vein; *SMA*, superior mesenteric artery; *SMV*, superior mesenteric vein; *SV*, splenic vein. (**b**) Variations of Henle's gastrocolic trunk: the anatomy of venous tributaries of the superior mesenteric vein at the inferior border of the pancreas. Numbers indicate numbers of subjects *A*, Superior mesenteric vein; *B*, right gastroepiploic vein; *C*, anterior superior pancreaticoduodenal vein; *D*, right superior colic vein

untoward tension to the root of transverse mesentery and the root of greater omentum on the right, and source of often catastrophic, difficult to control bleeding

The only reasonable suggestion is to be gentle and avoid this injury.

- Hemostatic clamps and stitches complete dissection at this end of the gastrocolic ligament.

17.3.2 Transverse Colon

- Omental resection is optional.
- Particular attention should be paid not to tear the splenic capsule when dissecting near the splenic flexure and/or while ligating the left end of the gastrocolic ligament and/or splenocolic attachments.
  - Mobilization (without resection) of the spleen may facilitate this dissection, as well as a surgical swab placed gently above spleen and below diaphragm.
- A distended megacolon, or an inflammatory, diseased colon, is vulnerable to tears and/or perforation at or near the splenic flexure.

17.3.3 Left Descending Colon

The nondominant hand elevates the colon, extracting it out of the abdomen and to the patient's right, while the assistant retracts the abdominal wall to the left. In this manner, the white (Toldt) line comes into view under tension between the parietal and descending colon peritoneums. Cutting with cautery precisely on this line exposes the underlying alveolar tissue. Gentle traction and cautery free the descending colon, which now is attached only by its mesentery.

17.3.4 Sigmoid

The sigmoid root has a length of 5–10 cm; the sigmoid mesentery unfolds like a fan to 25–60 cm. The surgeon's and assistant's positions as well as traction are similar to those followed in descending colonic mobilization; the sigmoid is mobilized by continuing the cautery incision on Toldt's line at the outer aspect of the sigmoid. Alveolar tissue is exposed and can be pushed with a wet sponge down to the root of the sigmoid mesentery, care being taken to avoid injury to the left spermatic vessels, and visualizing the left ureter. The ureter lies on the posterior abdominal wall, crossing anteriorly the bifurcation of the internal and external iliac vessels. The ureter contracts with a gentle touch of an atraumatic instrument; no need to mark or tape it, just identify it to make sure to avoid it.

17.3.5 Rectum

As the sigmoid is pulled out of the abdomen, the peritoneal surface at the medial aspect of the mesosigmoid root is incised, from the aortic bifurcation caudally along the medial aspect of the right iliac vessels, and the incision is continued between the rectum and pelvic brim, rectum and bladder or uterus, as the assistant applies opposite traction to these organs. Parallel and superficial to the aortic bifurcation lie the hypogastric nerves (sexual function) (Fig. 17.2). Once identified, avoid traction on the nerves during the next step. Following the alveolar plane below the aortic bifurcation bluntly down to the pelvic cavity, the rectum/mesorectum can be dissected free from the presacral space, down to Waldayer's fascia (Fig. 17.3). If cancer is not the problem, mobilization is accomplished within seconds by gentle insertion of the dominant hand. Neither cautery nor ligation is needed. Avoid pressing against mesorectum with the tip of fingers, because this may perforate a fragile rectum, leading to troublesome bleeding and a source of potential contamination; use the palm of the hand. To complete rectal mobilization circumferentially, using (long shaft) cautery bursts dissect all connective tissues laterally from both sides freeing the lateral mesorectum from the pelvic fascia. Usually, no vessel is encountered: no need for ligation, as simple cautery forceps suffice. Finally the anterior rectal plane is incised and freed from its attachments to the uterus/vagina in women or bladder/seminal vesicles/prostate in men. Putting

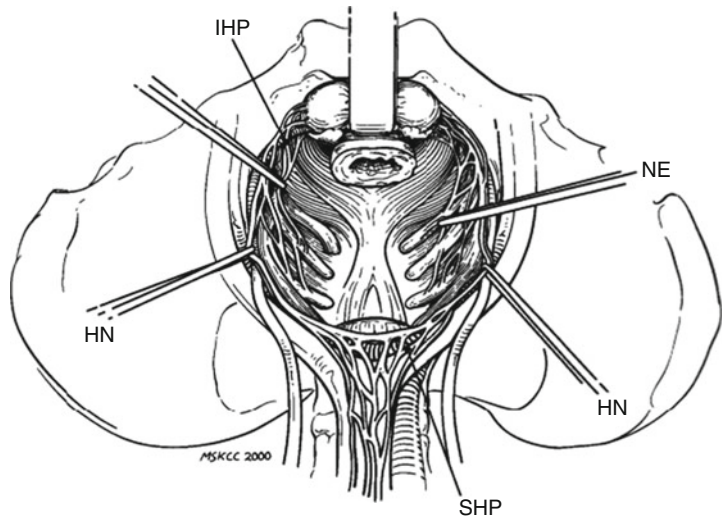


Fig. 17.2 The hypogastric plexus. Dissecting in the correct pelvic plane (see Fig. 17.3) preserves nerve and sexual function. *IHP* inferior hypogastric nerve plexus, *NE* nervi erigentes, *HN* hypogastric nerve, *SHP* superior hypogastric nerve plexus

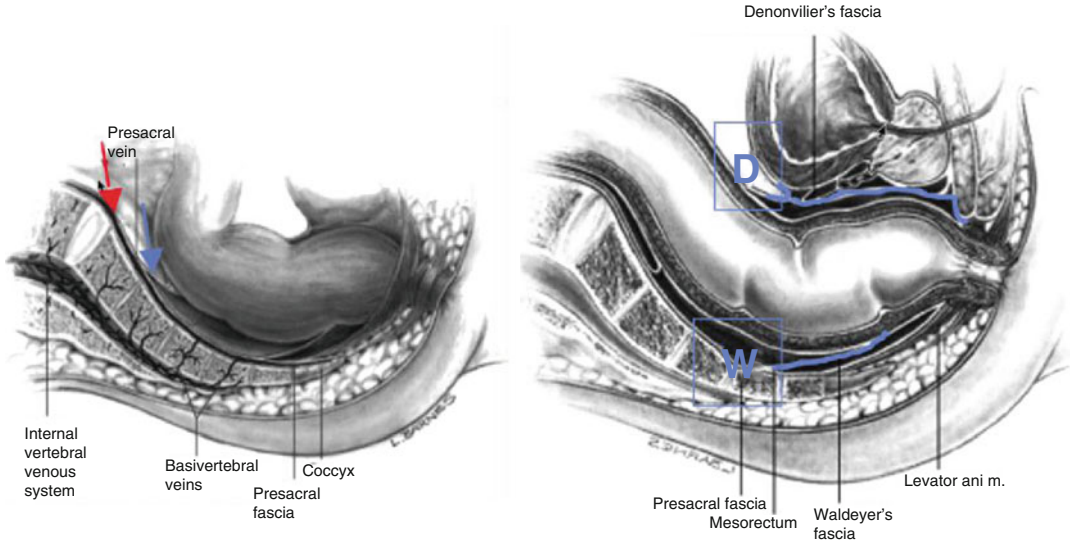


Fig. 17.3 Lateral pelvis view. The correct plane to start on mesorectum (left image, *blue arrow*) and continue the dissection (right image, *blue arrows*); avoids hemorrhage, nerve damage, injury to adjacent organs. Waldayer's and Denonvilier's fascias. False plane of pelvic dissection (*Red arrow*)

tension to rectum by posterior traction and contratension by pulling (e.g., with a St. Marks-type retractor), the anterior tissues (vagina, bladder, *etc*.) against the pubic bone, the correct plane is found (Fig. 17.3); it is essential to remain in the specific plane (Denonvillier's fascia) until reaching the deepest part of dissection, avoiding damage on nervi erigentes and its branches, responsible for sexual function (Fig. 17.2). In women, vision can sometimes be improved and working space increased by temporarily stitching the dome of the uterus to the pubic skin, elevating it out of the operating field.

17.4 Vessel Ligation

Vessel ligation differs according to the disease and what segment (right and left colectomy, sigmoidectomy, low anterior resection, or seg-

mental resection) is performed. The regional lymph nodes reside along the feeding vessels and can be removed as needed. In a non-oncologic emergency, just the diseased part of the colon along with a sphenoid part of its mesentery is all that has to be excised. The appex of this sphenoid part goes down to the mesenteric root, so there are fewer vessels to ligate, saving time. Energy-driven devices (which seal and cut vessels) are effective especially in areas with diminished working space (i.e., pelvis) and save time.

17.4.1 Right Hemicolectomy

Right hemicolectomy: Having mobilized the right colon the vessels to ligate include the ileocolic, right colic, and right branch of middle colic (retain main stem and the left branch) arteries.

17.4.2 Left Hemicolectomy

Ligation of the inferior mesenteric at its origin (extended left hemicolectomy) means that adequate vascular supply relies on the marginal artery (from the transverse colon) above, and requires excision of the sigmoid and extraperitoneal rectum with the specimen.

17.4.3 Sigmoidectomy

Sigmoid trunk ligation at the root usually suffices. The taenia coli disappear at the rectosigmoid juncture, forming a complete outer muscular layer in the upper rectum, which in addition is the narrowest part of the colonic lumen. This anatomic characteristic has been incriminated as responsible for diverticular disease, and is the rationale for mandatory resection of this portion in diverticular disease. Ligation of the superior rectal artery (continuation of the inferior mesenteric artery) is not mandatory, and some advise its preservation.

17.4.4 Low Anterior Rectal Resection

In low anterior rectal resection (defined as resection of the proximal two thirds of the rectum, leaving the sphincter mechanism intact, and anastomosis below peritoneal reflection) superior, middle, and inferior rectal arteries are ligated depending on the depth of resection of the rectum. Middle and inferior arteries are rarely visualized and safely sealed with cautery, or energy-driven devices. Retaining the rectal ampulla or an ileorectal anastomosis (for total colectomy) are important for quality of life.

17.5 Anastomoses

Prerequisites include:

1. Good blood supply to the bowel margins: this can be evaluated by the color of the divided bowel wall (in comparison with the adjacent distal colon), ample bleeding at the cut edge (or an nearby epiploic appendix), and also by Doppler and/or indocyanine green.
2. Avoid tension: a rule of thumb is that the two extremities must overlap each other for at least 2 cm, without traction in an end to end anastomosis. If not, further mobilization and/or mesenteric incisions are mandatory, even if it means occasionally sacrificing a major vessel. In a low rectal anastomosis where the rectum cannot be mobilized, further length should come from the descending colon (splenic flexure mobilization) with ligation and division of the inferior mesenteric vein under the pancreas along the ligament of Treitz, and the inferior mesenteric artery at its root, leaving intact the bypassing branches of the marginal artery of Drummond and the arc of Riolan supplying blood from the superior mesenteric artery (Fig. 17.4). Always be cautious when there has been previous operations (that have potentially occluded the arterial arcades), radiation therapy, atherosclerosis and diabetes, or even radical nephrectomy. Check colonic viability before ligating the main vessels by temporary vessel occlusion with a bulldog.

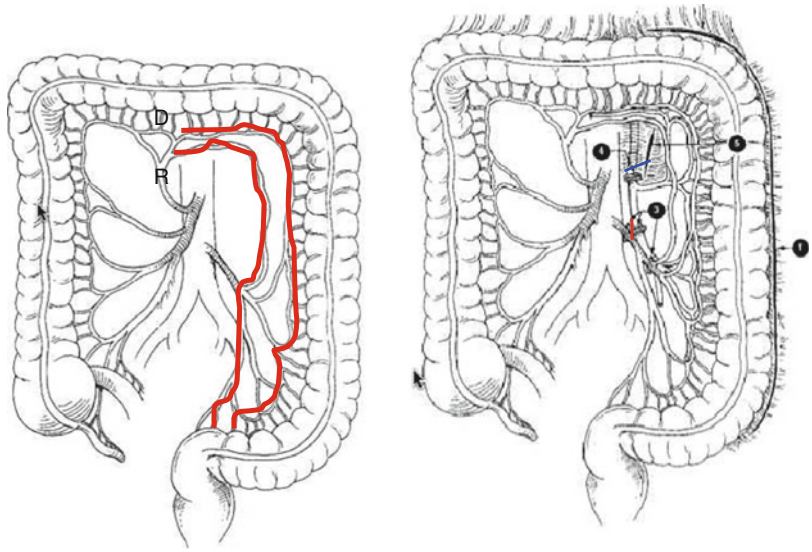


Fig. 17.4 Anastomotic arterial arc of Riolan, and marginal artery or Drummond, are the feeding arteries of a long descending colon graft formed after division of inferior mesenteric artery (*red line*) and vein (*blue line*) (*right image*)

3. Once completed, the anastomosis should be visually and palpably evaluated for tension. It should lie gently on the surroundings.
4. If a tension-less anastomosis is not possible, create a stoma or, if an anastomosis is already created, add a prophylactic ileostomy. Drains or delaying the patient's oral feeding will not heal an unsafe anastomosis.

Technical issues regarding anastomoses:

- Hand sewn: Hand sewn or stapled anastomoses can be performed according to personal preferences: there is no significant differences in leakage rates; however, the immediate risks of bleeding (should decrease with new multi (>2) staple lines) and the long-term risk of stricture are higher with the staples. Speed of construction depends on the operator, more than on the method. One layer, ideally extramucosal, is enough. Interrupted or continuous is also a matter of surgeons's preference and provide equally satisfactory results when well done.
- Staples are more expensive and can be associated with mishaps (misfirings, incomplete staple lines). Be aware of these and do not waste them.
- We describe herein, two of the most frequent applications:

Right hemicolectomy:

- Position the ileum and transverse colon side by side (Fig. 17.5) at the location where you intent to anastomose (antimesenteric border on ileum, taenia coli on transverse) in isoperistaltic position.
- Insert two stay sutures to hold them together.
- Insert the two staple legs into two holes created in each limb.
- Make sure that
  - The lumens are parallel
  - The stapler locks ideally at the antimesenteric edge, as in this location it creates minimal disturbance to the blood supply (Fig. 17.6)
- No other tissues are trapped in the staple line and *Wait 20 s* before you fire (to allow adequate tissue creep)

  Wait another 15/20 s before opening the jaws (hemostasis)
- Inspect the staple line for bleeding and achieve adequate hemostasis as necessary.

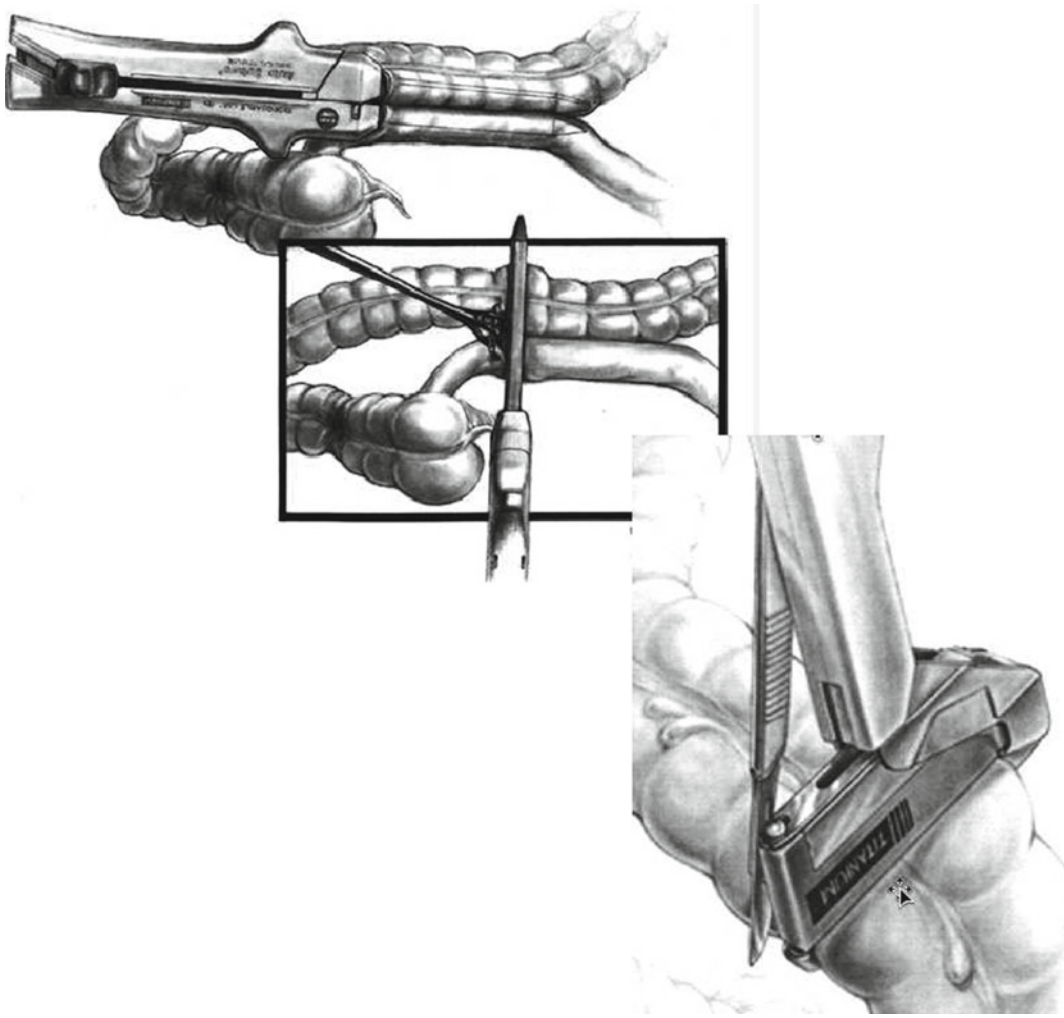


Fig. 17.5 Stapled ileotransverse anastomosis

- Occlude the remaining opening with three Allis clamps, and complete the anastomosis either hand-sewn or with a linear stapler.
- Additional reinforcement is usually not necessary.

Low anterior resection:

- Stapled anastomosis is the most widely practiced technique today although some prefer the "parachuting down" technique, which becomes more demanding as the anastomosis is performed deeper in pelvis.
- Most techniques involve a linear stapled closure of the distal rectal stump and an end-to-end circular stapled colo(ileo)-rectal anastomosis (circular stapler inserted via the anus: attention do not force the sphincter; dilate gently and progressively before inserting stapling gun or inject xylocaine in the sphicter muscles).
  - Vertical linear stapling or use of special linear staplers with angled arms (Roticulator®) or curved edge (Contour®) linear staples fascilitate a very low rectal stump closure deep in pelvis.

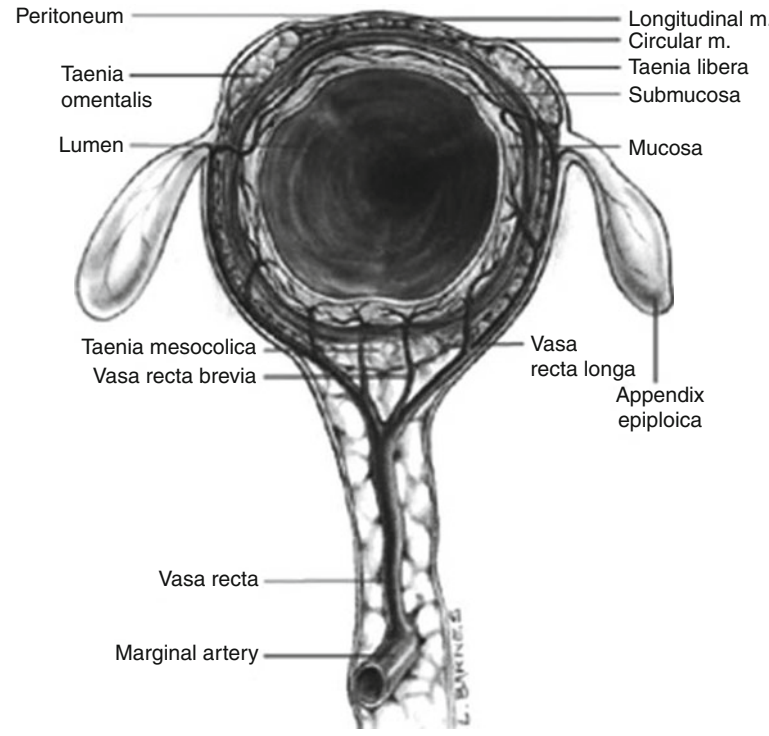


Fig. 17.6 Blood supply to the antimesenteric border

- Ideally, one firing, perpendicular to the intestinal lumen, is best (the leakage rate increases proportional to the number of firings) to close the rectal stump.
- Some prefer a side to end anastomosis, especially in case of diameter discrepancy (another possibility is to cut a fish mouth to enlarge the smaller lumen).
- No consensus as to the ideal diameter but best to use largest diameter compatible with lumen.

- In the emergency setting, the bowel may not be clean. Although still debated, few surgeons perform on-table lavage of the rectum. In the era of ERP (Enhanced Recovery Protocols) the elective bowel operations are performed without the use of pre-op laxative colon preparation. Despite that bowel is operated in full fecal content the infectious complication rate has not raise.
  - An alternative is to aspirate the air with a 16G needle perforating at a taenia coli, but not attempting to evacuate the fecal contents (Fig. 17.7). A curved bowel clamp occludes the lumen proximal and distal from the proposed anastomosis. The bowel is divided under suction 5 cm from the bowel clamp, and the clamps are released only after anastomosis is complete.

Advice:

- No proven need to close mesenteric defects.
- Always test the anastomosis for air-tightness (anastomosis under saline), do not use dye (e.g., methylene blue) but air.
  - Occlude the proximal lumen, pour saline in the pelvis to cover the staple line.
  - Inject, through the anus, with a large syringe attached to a Foley catheter, with the balloon blocked at the anus, at least 150 cc of air in the anorectal lumen, inspecting the fluid in the pelvic cavity.
  - If bubbles (leak) arise, oversew and retest, or redo the anastomosis, and if all is not perfect, entertain a stoma.
- No need to drain (except conditions dealt with later).

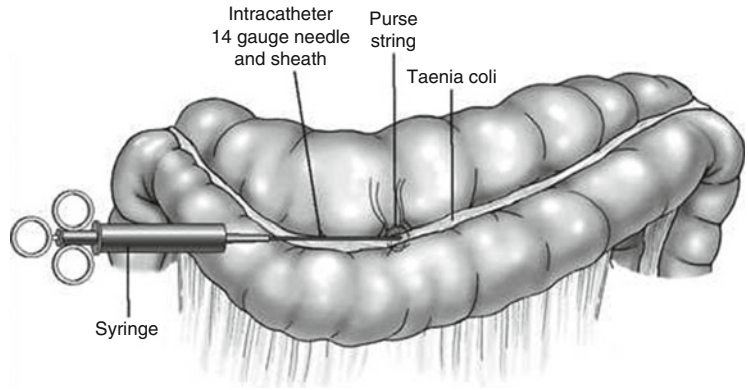


Fig. 17.7 Initial decompression of the colon is achieved by needle aspiration of air from the anterior aspect of the distended colon

17.6 Bypasses

Occasionally, the obstruction is unresectable and a bypass is needed.

- When it is not possible to mobilize the two extremities, entertain a diverting stoma.
- Side-to-side anastomosis is performed as in right hemicolectomy (see above).

17.7 Stoma

Stomas are created to *divert* the fecal stream in a high-risk anastomosis, when the anal sphincter is destroyed or functionally impaired, or to *decompress* an obstructed colon.

17.7.1 *Diverting* Stomas

High risk anastomoses include:

- Those when undue tension, ischemia, or inflammation are present and there is risk to compromise first intention healing.
- Infraperitoneal anastomoses.
- Patients with preoperative radiation (chemo) therapy (especially within 6 months prior to operation).

The main characteristics of a protective stoma are:

- Preserved blood supply to distal anastomosis (a sigmoidostomy may compromise blood supply to the more distal anastomosis)
- *Complete diversion* of the fecal stream
- Easily reversible
- Avoid irritation of peristomal skin

Ileostomy responds more adequately to these requirements

- Should be performed 15 cm from ileocecal valve (to allow for a drop of the intraluminal pressures developed close to the ileocecal valve, which after stoma reversal may compromise ileo-ileal anastomosis).
- The "Brooke" nipple technique (Fig. 17.8)
  - Allows bowel contents to drop into the stoma bag before it touches the skin
  - Accomplishes complete diversion of fecal stream
  - Prevents passage of contents to distal lumen through the difference in height between proximal and distal flat openings (Fig. 17.8)
  - Is easily reversed even under local anesthesia

Permanent stomas are also completely diverting. They are created when the distal part of the bowel is irreversibly impaired. They should be

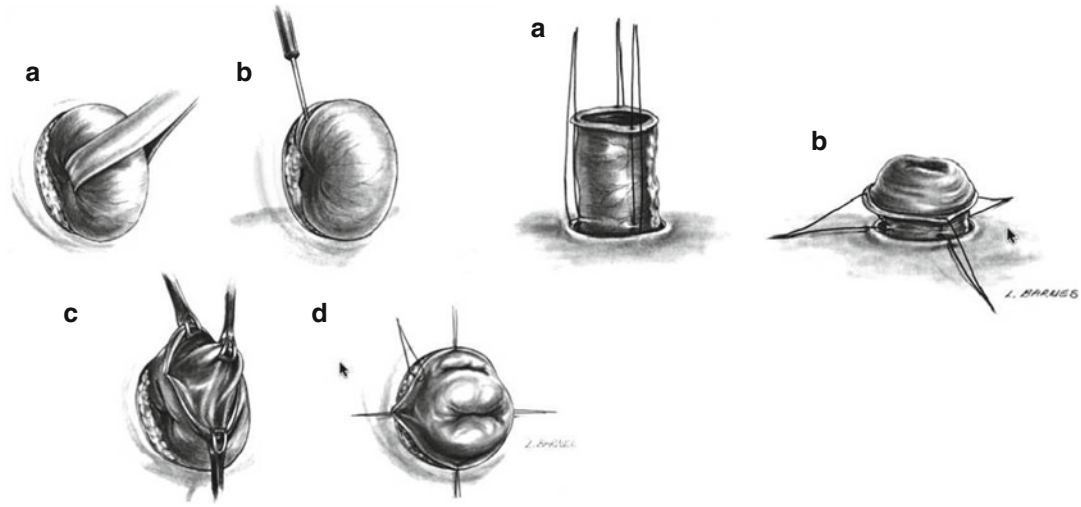


Fig. 17.8 Loop (*left*) and terminal (*right*) ileostomy: both constructed with the Brooke technique, which protects from parastomal irritation. *Left*: Loop ileostomy. (*A*) Exteriorization. (*B*) The distal limb is incised from mesentery to mesentery at skin level. Care must be taken to make certain which side is proximal. (*C*) Eversion. (*D*) Maturation. Illustration. *Right*: Maturation of ileostomy stoma. (*A*) Three sutures are placed, incorporating the seromuscular layer to facilitate eversion. (*B*) The sutures are secured, everting the bowel

created as distal as possible, to take advantage of colon's water absorption capacity. This stoma is formed with an anastomosis of the proximal bowel loop to the abdominal wall and a skin opening. The distal bowel loop is either nonexisting, or stapled and left within the abdominal cavity.

17.7.2 Decompressive Stomas

Stomas to decompress an intestinal portion proximal to an obstruction (e.g., in a patient too sick to tolerate formal surgery)

- The most frequent in the emergency setting
- Not vital to differentiate between proximal and distal stoma ends, because the fecal content is not intended to be completely diverted (Fig. 17.9)
- Can be performed in any mobile part of the colon (transverse, or sigmoid), or even to the fixed cecum, which is close to the skin

Cecostomy (Fig. 17.10)

- Make a small incision above the distended cecum
- Grasp and hold the cecum to the abdominal wall
- Incise lumen along a taenia coli
- Either pass a decompressing tube or anastomose the edges to the skin

Transverse colostomy (Fig. 17.11).

- Can be accomplished with a small incision on the midline, lower third of the distance between umbilicus and xiphoid
- The omentum should be incised below transverse colon to allow exteriorization of the colon.
- The steps hereafter are as in the cecostomy.

Sigmoidostomy

Could serve as *decompressive* or *diverting* (or permanent) stoma

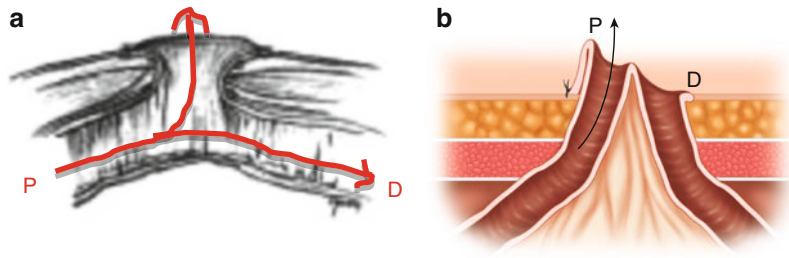


Fig. 17.9 Decompressing stoma is not indented to divert completely the fecal steam (*P* proximal lumen, *D* distal lumen): (**a**) decompressing stoma, (**b**) diverting stoma

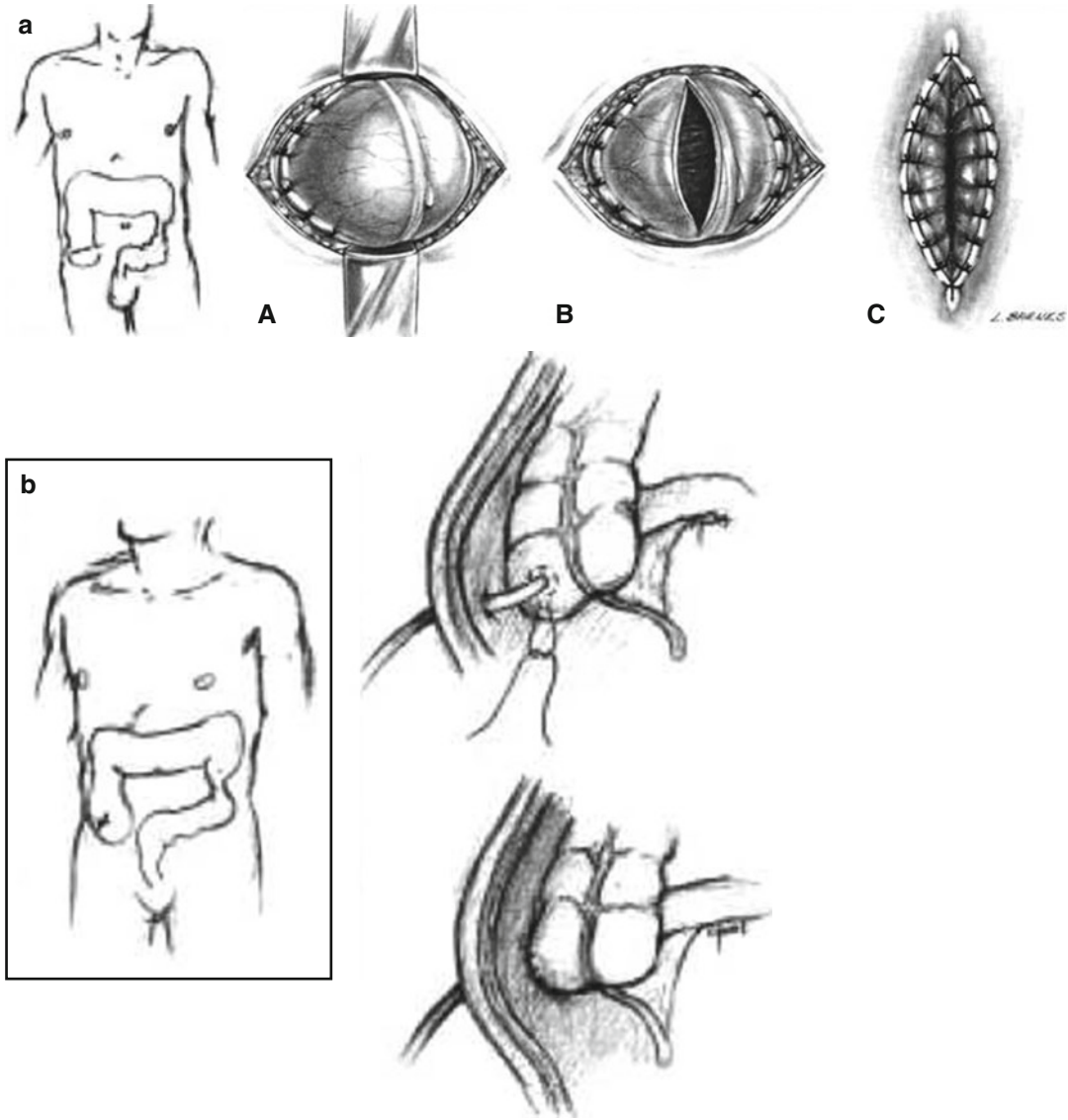


Fig. 17.10 Cecostomy. 10: (**a**) formal cecostomy. Technique of cecostomy. (*A*) Obliteration of the peritoneal opening by suture of the bowl wall to the fascia. (*B*) Opening of the cecum. (*C*) Primary maturation to the skin. (**b**) Tube Cecostomy.

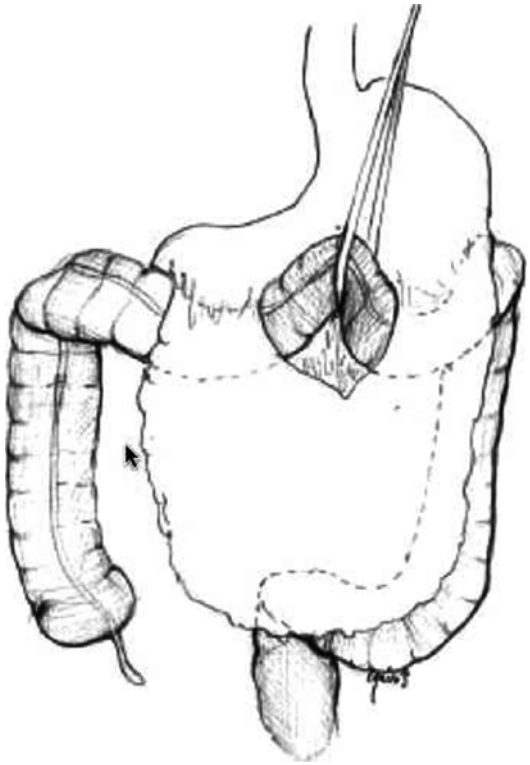


Fig. 17.11 Transverse colostomy

- Incise through the rectus abdominis
- Grasp the mobile sigmoid and bring it to the skin edge
- Open the lumen at a taenia coli
- Stitch to the skin

17.7.3 Advice

With the exemption of the cecum, which is fixed to the retroperitoneum, the rest of the locations (terminal ileum, transverse, sigmoid) can all be formed in either a decompressive or a diverting fashion if the appropriate surgical steps are followed.

In case that the technique of loop stoma is not mastered, a rod under the exstomosed bowel loop will create the diversion effect. (Fig. 17.12). The rod technique is originally suggested to secure a bowel loop (usually colon which is less mobile than teminal ileum) on the skin.

The standard size of the skin and abdominal wall opening to develop a stoma is two-finger aperture (Fig. 17.13).

17.8 Drains

- Currently, there is strong evidence against routine drainage in elective colorectal surgery, but extrapolation of these data to emergency surgery is controversial.
  - Their value to detect postoperative bleeding is questionable.
  - Drainage will not protect against the consequences of a high-risk or compromised anastomosis; create a protective ileostomy instead.
- Ascites, regardless of the volume drained, is not an indication to leave a drain.
- If used, drains should be placed below the site of operation (gravity will guide fluids to the drain in a patient lying in bed).
- Silicon tubes provoke the least inflammation and foreign body reaction; closed suction drains are associated with less infective complications. Drains are "cracked" (pulled out five centimeters) after passing flatus, and removed completely a day after, since no abnormal drain (p.e. faecal content) occurs.

17.9 Particularities of Colectomy Related to Disease

(a) *Inflammatory bowel disease or complicated diverticular disease*
- Resection of all diseased portions
  - In diverticular disease you resect the disease (fistula, stenosis, abscess) AND the "heart" of the problem the sigmoid (the part of the colon with the narrowest lumen and the strongest musculature -as the taenia coli join in sigmoid wall to a complete external longitudinal muscle). Diverticula prox-

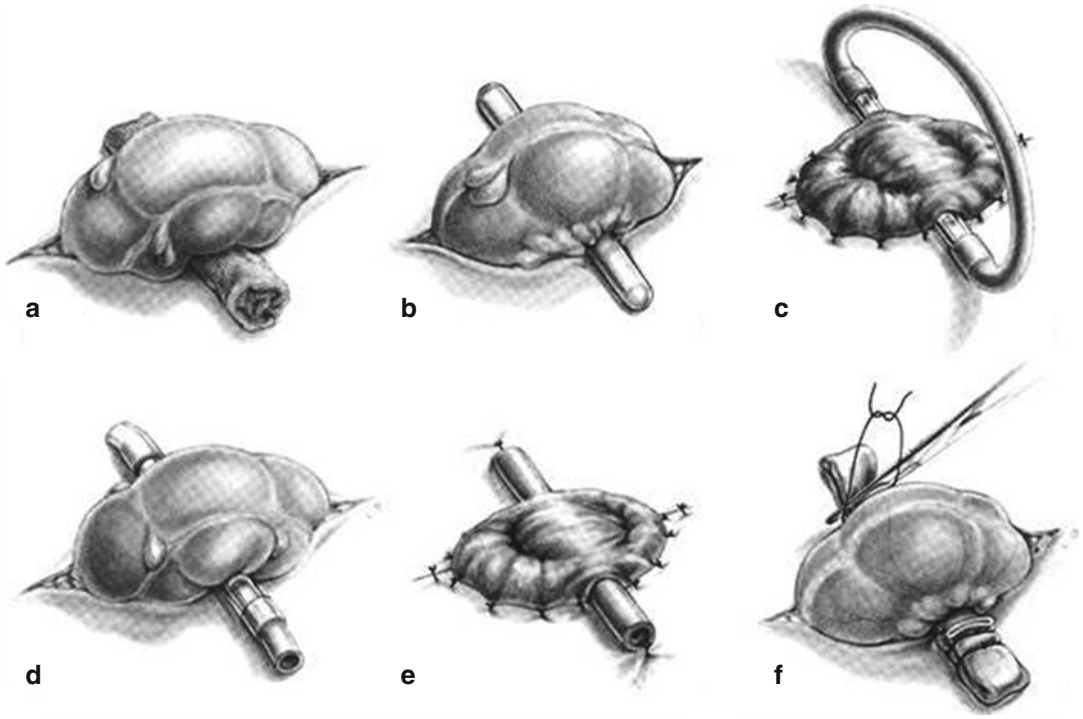


Fig. 17.12 The rod technique. Alteration for securing the loop of colon. (**a**) Rolled gauze. (**b**) Glass rod. (**c**) Glass rod with rubber loop. (**d**) Glass rod with rubber sleeves. (**e**) Rubber tubing (**f**) Folded tubing or drain

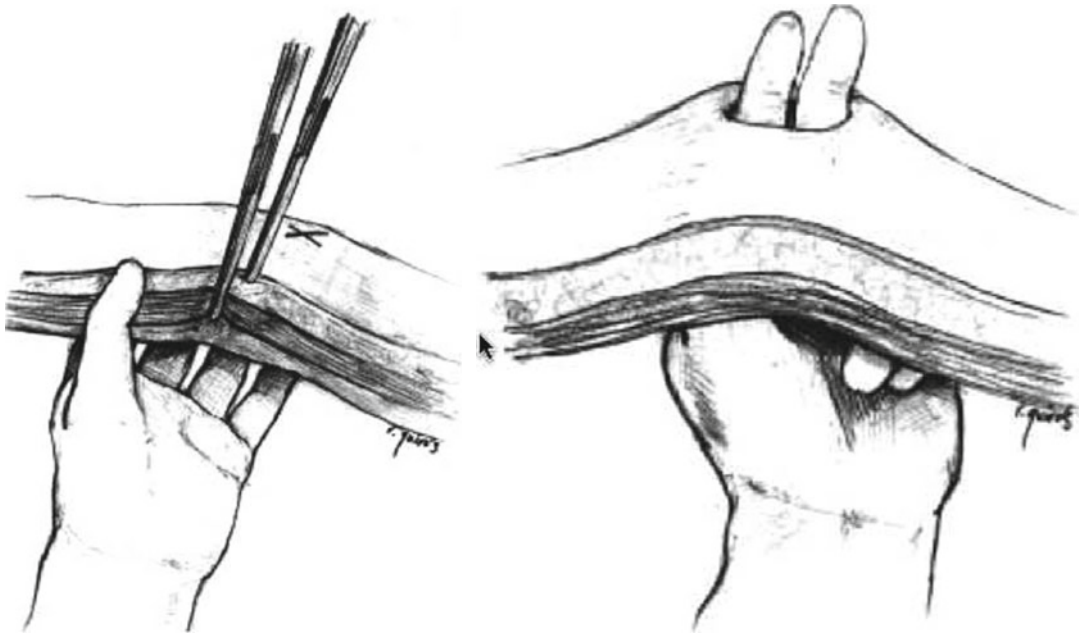


Fig. 17.13 The standard aperture on the abdominal wall before creation of a stoma

imal of sigmoid if present do not create problems as the afore mentioned factors are not present.
- Mesenteric dissection may be close to colon but marginal and rectal (superior rectal artery) vascularization must be preserved.

(b) *Cancer*
- Respect oncological principles: no-touch technique, primary high vascular ligation (debate still exists as to high or low ligation of inferior mesenteric artery), and adequate lymphadenectomy.

(c) *Ischemic colon (vascular origin, volvulus, strangulation)*
- Revascularization may be attempted only if ischemia is recent.
- Resection of all compromised colon
  - Preservation may be a possibility if detorsion of volvulus or reversal of incarcerated/strangulated bowel is accompanied by satisfactory recolorization and vascular patency.
- Volvulus and hernia require prevention of recurrence by appropriate cure of cause.

(d) *In case of associated upstream dilation whatever the cause*
- Dilated bowel means potential vascular compromise: resect as proximal as necessary to obtain well-vascularized tissues.

(e) *In all emergency surgery for colorectal disease*
- Upstream protective stoma will not prevent fistula but will decrease the morbidity associated with eventual leak.

Pitfalls
- Longer incision than required
- Eviscerate small bowel if not needed
- Tear of gastrocolic vessels or Henle's trunk
- Splenic flexure perforation or tear to splenic capsule
- Failure to identify (left) ureter
- Destruction of vasculature (Drummond, Riolan)
- Leaving sigmoid unresected in diverticulitis
- Injury to hypogastric plexus and nervi erigentes
- Deviate from avascular planes in pelvic dissection
- Anastomosis proximal to ileocecal valve or to irradiated bowel
- Anastomosis under tension, and suboptimal blood supply
- In hand-sewn anastomosis stitch-occlude the lumen when stitching the upper part of the bowel wall
- Failure to identify proximal and distal end in a protective ileostomy

17.10 Summary

Emergency colonic surgery requires individualization on the basis of hemodynamic status, acidosis, and septic symptoms. The operative strategy ranges from damage control principles in a patient in extremis, to the elective principles in a patient in stable condition.

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Appendix

18

Luca Ansaloni, Marco Lotti, Michele Pisano, and Elia Poiasina

Contents

18.1 Appendectomy

Objectives: To Describe

- The most common technique
- Technique for ectopic (retrocecal) appendicitis
- Management of pelvic abscesses and peritonitis
- Indications for conversion
- Open questions: treatment of the appendicular stump, drainage, optimal port sites, treatment of associated Meckel's diverticulum, resection of a normal appendix

18.2 Open Appendectomy

18.2.1 Positioning and Personnel

- The patient is placed supine and right arm tucked to the patient's side.
  - Urinary catheter insertion is optional (may be omitted if the patient has voided immediately before anesthesia).

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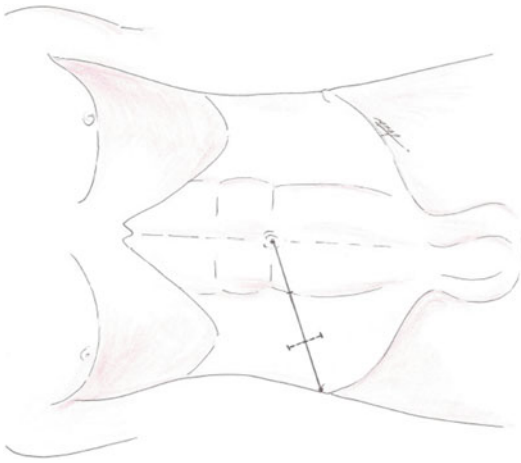

Fig. 18.1 Skin incision at the McBurney point

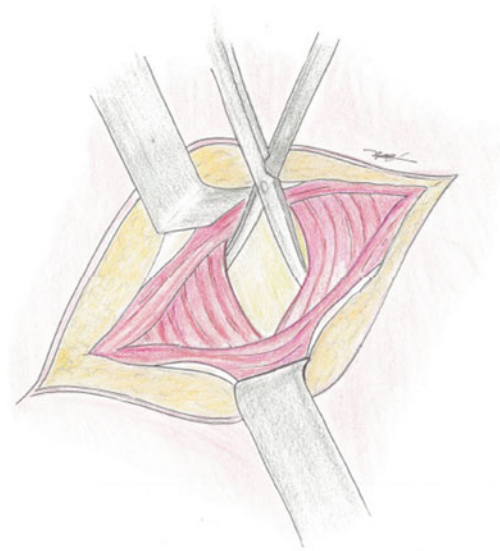

Fig. 18.2 Blunt separation of the muscle fibers

- The surgeon stands to the right of the patient, the assistant on the left, and if available scrub nurse (second assistant) on right, close to the legs.

Draping:

- Should allow extension of the incision (right iliac fossa or midline) as well as insertion of drain (laterally)

Skin protection.

Adhesive skin protector is ideal but not mandatory.

Antibiotic prophylaxis.

- As per local protocol

Access to the abdominal cavity

- 2–5 cm skin incision over McBurney's point, perpendicular to the line between the right anterior superior iliac spine and the umbilicus (junction one-third lateral, two-third from the umbilicus (Fig. 18.1))
- Some authors prefer a shorter incision, parallel to Langer's lines, located two fingerbreadths medial to the anterosuperior iliac spine.
  - Muscle splitting
    The external oblique fascia is sharply incised lateral to the rectus sheath according to the direction of its fibers.
    The internal oblique and the transversus abdominis muscles are bluntly separated, according to the direction of their fibers (Fig. 18.2).
- Opening the peritoneum
  - The peritoneum is grasped with forceps (caution being exercised not to pinch internal organs); a small incision is performed with scissors and then enlarged with finger guidance.
  - Retractors (handheld or autostatic) are placed.

18.2.2 Exploration

- Withdrawal of free fluid for bacterial identification.
- The wound is protected with moist gauze.
- The appendix is located, following the taenia coli toward the cecal base.
- Adhesions can usually be freed with blunt dissection.
- The cecum and the appendix are then exteriorized.

18.2.3 Mesoappendix Division and Appendectomy

- Division of the mesoappendix near the base of the appendix, either between clamps and ligation, or directly ligated with 2-0 absorbable suture
- Placement of two wide jaw clamps parallel to each other at the appendicular base
- Removal of the clamp close to the cecum
- Double ligation of the base of the appendix with 0 absorbable suture (Fig. 18.3)
- Division of the appendix with scalpel

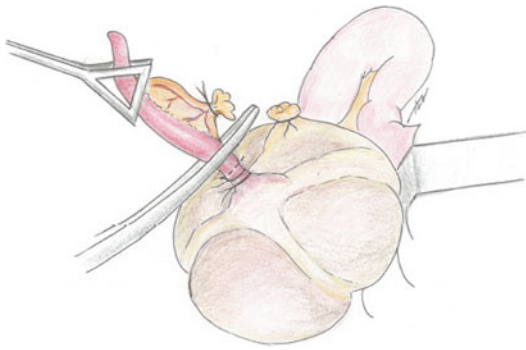

Fig. 18.3 Ligation of the appendix base

- Treatment of the stump
  - Several possibilities:
    Some electrocoagulate the mucosa.
    Others consider that this is dangerous and prefer to strip it with a scalpel or use bipolar cautery.
    Still others prefer to invert the stump using a 3-0 absorbable purse string suture (but there is no evidence to show that this prevents secondary blowout)
  - Any pus or blood collection is aspirated.
  - Irrigate only when needed, to reduce the risk of abdominal abscess.
  - Aspiration of fluid in the pelvis is advisable to avoid early postoperative development of fluid collections/abscesses.

18.2.4 Search for Meckel's Diverticulum

- Resection of an uninflamed Meckel's diverticulum should be avoided in case of appendicitis complicated with peritoneal abscess or peritonitis (see chapter on small intestinal pathology for more details).
- The decision for resection of an incidental Meckel's diverticulum should be discussed with the patient before the operation and informed consent obtained.

18.2.5 Drainage

- Drainage is unnecessary in case of limited phlegmonous or gangrenous appendicitis.

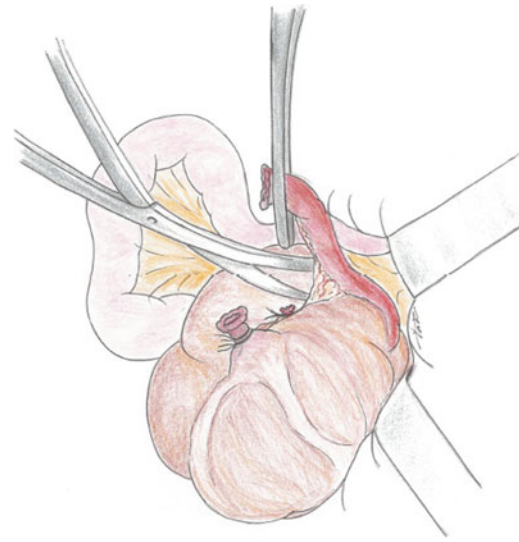

Fig. 18.4 Retrograde appendectomy

- In case of abscess or peritonitis, the utility of drainage is controversial type; open or closed may be used.

18.2.6 Abdominal Closure

- The peritoneum is grasped with four clamps and closed with 2-0 absorbable running suture.
- The transverse and the internal oblique muscles are approximated with two 2-0 absorbable stitches (figure of eight stitches should be avoided to limit muscle ischemia).
- The external oblique fascia is grasped with four clamps and then closed with 0 absorbable running suture.
- The skin is closed with interrupted sutures.
  - The incision may be left open in case of frank contamination.

18.2.7 Variations

18.2.7.1 Appendicitis in Ectopic Appendix

- In case of appendicitis in a long retrocecal appendix or in case of a difficult exteriorization of the appendix, retrograde appendectomy should be preferred (steps 7 and 6 are reversed; mobilization of the appendix is better done close to the appendicular wall (Fig. 18.4)).

- If needed, McBurney's incision can be enlarged.
  - However, especially in case of diffuse peritonitis, pelvic disease, or unusual position of the cecum, some prefer to continue with a midline incision, while others convert to laparoscopy ("reversed conversion").
  - The McBurney's incision can be closed or used for drainage.

18.2.7.2 Acute Perforated Appendicitis

- The inflamed appendix can usually be peeled off from adjacent adhering organs, but care must be taken not to disrupt the serosa.
- In case of localized abscess, the cavity must be washed abundantly and drained.
- Careful inspection of the abdominal cavity is required to search for and remove all contaminated material and/or fecalith.

18.3 Summary of Open Appendectomy

Open appendectomy is performed via McBurney's incision; the anterograde procedure is preferred (ligation of the mesoappendix, then division of the appendix at its base), except in long retrocecal appendicitis or fixed appendix where a retrograde approach may be preferred. No guidelines exist on the treatment of the appendix stump, drainage or skin closure when contamination is likely. In case of difficulty at any step, the McBurney's incision can be enlarged or access to the peritoneal cavity through a midline incision is also an option.

18.4 Laparoscopic Appendectomy

18.4.1 Equipment and Instruments

- A 10-mm Hasson trocar (or Veress needle and one 11-mm bladeless optical tip trocar), one 10-mm trocar, and one 5-mm trocar
- For dissection: 30-degree angled laparoscope, two 5-mm graspers, 5-mm hook electrocautery, bipolar coagulating forceps, 5-mm curved scissors, 10-mm curved dissecting forceps, 10-mm laparoscopic palpator, and 5-mm suction irrigator cannula
- For ligation and retrieval: two absorbable Endoloops, extraction bag, and 10-mm extraction tube
- Optional: one more 5-mm trocar, one 5-mm alligator grasper, 5-mm needle holder, laparoscopic 45-mm flexible endocutter with reloads, 10-mm clip applier, and 10-mm suction irrigator cannula

18.4.2 Positioning, Personnel, and Port Sites

- The patient is placed supine, secured by straps to prevent slippage during table position changes.
  - Left arm is tucked along the patient's side.
  - Urinary catheter insertion is optional (may be omitted if the patient has voided immediately before anesthesia).
- The surgeon stands on the patient's left; the assistant stands initially on the patient's right and then moves to the left of the surgeon once all the trocars are in place.
- The nurse is on the patient's left, toward the feet.
- The monitor is on the patient's right, facing the surgeon.

18.4.3 Port Site Placement

- For access: several setups are possible. Triangulation with the manipulation angle focused in the right lower quadrant is ideal.
- The open technique or visual-assisted technique for the first trocar should be preferred, especially in complicated appendicitis, where there is always some degree of ileus.
  - The first port is usually supraumbilical.
  - Alternatively, a Veress needle is placed supraumbilical in Palmer's point.
  - Or an 11-mm optical tip bladeless trocar is placed on the left side of the umbilicus.
- 12 mmHg pneumoperitoneum is established; then, the abdominal cavity is explored.

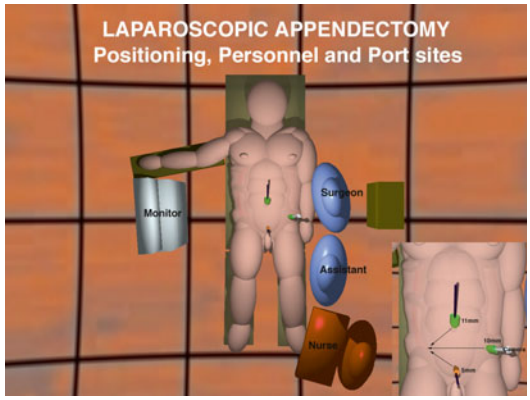

Fig. 18.5 Position of the personel and port sites position

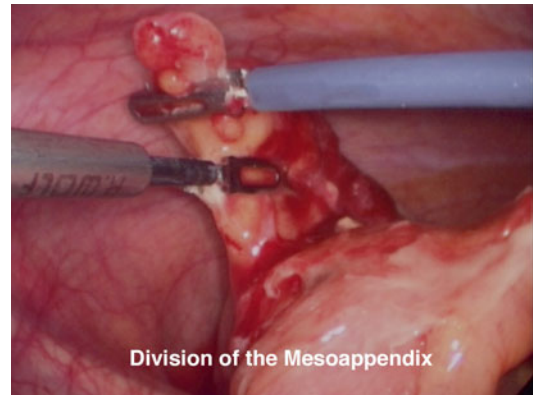

Fig. 18.6 Coagulation and division of the mesoappendix by bipolar forcep and scissors

- A second 10-mm trocar is placed under vision, two fingerbreadths medial to the left anterosuperior iliac spine, avoiding the epigastric vessels; a 5-mm trocar is placed in the suprapubic midline (Fig. 18.5).
- The gas tube is placed in the 10-mm trocar, coming straight from the column; the light and camera cables are fixed by Velcro straps on the left side of the operating field, to prevent tangling.
- The laparoscope is placed in the 10-mm trocar between the two manipulation trocars and held by the assistant.

18.4.4 Exploration

- In the presence of peritonitis, complete removal of pus before attempting isolation of the appendix should help avoid further contamination during patient's position changes.
- The abdominal cavity should be irrigated abundantly with saline and aspirated only if peritonitis is generalized; otherwise, local aspiration is usually sufficient (all fluids should be evacuated by suction).
- Inflammatory adhesions between the bowel and the peritoneal surface are best divided with the aid of the 10-mm palpator, also used to access intermesenteric spaces between the bowel loops, avoiding injury of the bowel.
- The appendix should be pursued only after clear identification of the cecum and the terminal ileus, completely freeing them from adhesions with adjacent viscera.
- During adhesiolysis, periappendicular abscesses are eventually opened and evacuated with the suction irrigator cannula.

18.4.5 Mesoappendix Exposure and Division

- The patient is positioned in Trendelenburg with table tilt to the left (right side up).
- The appendix is grasped with 5-mm grasper introduced through the periumbilical trocar and pulled upward to expose the mesoappendix.
  - The mesoappendix is then electrocoagulated with the bipolar forceps, introduced in the suprapubic trocar (Fig. 18.6), and then divided with scissors, proceeding from the free edge of the mesoappendix toward the base of the appendix. Accurate bipolar electrocoagulation is sufficient for control of the appendicular artery: caution should be paid not to injure the cecum or the terminal ileus during coagulation.
  - Alternatively, some surgeons prefer electrocoagulation and dividing the mesoappendix close to the appendicular wall, where only small vessels are encountered.

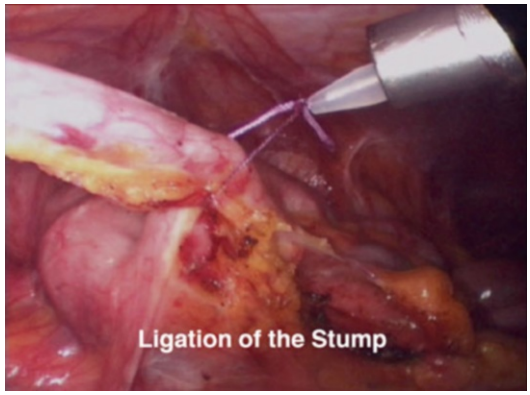

Fig. 18.7 Ligation of the appendix base

- The base of the appendix is squeezed gently with an atraumatic grasper to ensure easy ligation of the stump.

18.4.6 Appendectomy

- Simple or double ligation is performed at the base of the appendix using absorbable Endoloops (Fig. 18.7).
  - Endoloops are introduced in the periumbilical trocar, while the appendix is held with a grasper introduced through the suprapubic trocar.
- Ligation should be performed close to the cecum: leaving a long stump is a risk factor for developing stump appendicitis (as in open).
- After ligation, the appendix is grasped close to the point of division (using a grasper introduced in the suprapubic trocar), divided with scissors, and then placed in an extraction bag retrieved from the periumbilical trocar or extracted through one of the 10–12-mm trocars (without the need of an extraction bag).
  - Some surgeons favor closing the distal stump with a stapler (dilated, fragile appendix, inflammatory involvement of the base). Sutures should be used with caution, especially in case of local inflammation.
  - Others prefer to electrocoagulate the mucosa of the proximal stump with bipolar forceps (avoid monopolar) with the intent to prevent mucocele and the development of a postoperative pericecal abscess: caution should be paid, however, to avoid heat transmission to the stump sutures and the cecum.

Any collection of fluid or blood is then aspirated, and the base of the mesoappendix is checked for adequate hemostasis. Irrigation with saline is performed only when gross contamination is evident, quickly followed by aspiration to avoid fluid spreading to the abdominal cavity, due to gravity.

18.4.7 Drainage (As Above)

18.4.7.1 Wound Closure

- Trocars are removed under vision and pneumoperitoneum is released.
- Hemostasis on the port sites can be ensured by bipolar coagulation.
- Some surgeons advise to close only those port sites greater than 5 mm, and others do not close any.

18.4.8 Retrocecal Appendicitis

- Failure to identify the appendix should suggest a retrocecal position of the appendix. Conversion is not always necessary (to the contrary, the parietal insult is minimized by continuing via laparoscopy).
- Adequate cecal mobilization is mandatory to ensure correct identification of the appendix and treatment of a retrocecal abscess.
  - The parietal peritoneum is divided with sharp dissection in preference to hook electrocautery, while the cecum is pulled toward the midline.
  - Occasionally, mobilization of the terminal ileum is necessary to expose a retroperitoneal appendix: caution should be exercised not to injury the right ureter.
- An inflamed retroperitoneal appendix, adherent to the cecum and ascending colon, is better isolated via blunt dissection, with the aid of the suction irrigation cannula and a 10-mm palpator: in this case, another 5-mm trocar, inserted in the epigastrium, and a 5-mm atraumatic grasper inserted by the assistant to help

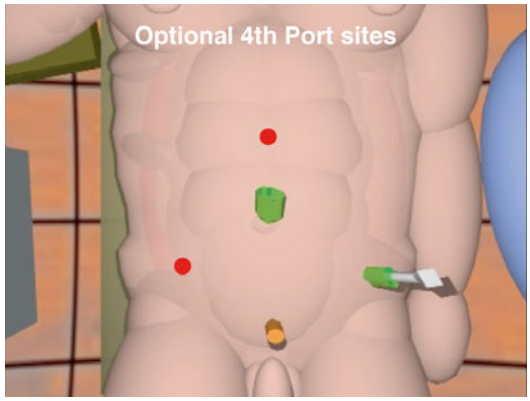

Fig. 18.8 Optional 4th port site

hold the cecum toward the midline may be necessary. Alternatively, a 5-mm trocar is inserted at the point of McBurney and used by the surgeon: in this case, the assistant uses the suprapubic port site to hold the cecum or the terminal ileum (Fig. 18.8).

18.4.9 Pelvic Abscess

- In this case, a change of trocar placement may be necessary: one supraumbilical 11-mm bladeless trocar (for first access), one 10-mm trocar placed where the transverse umbilical line crosses the right midclavicular line, and one 10-mm trocar placed where the intra-iliac line crosses the left midclavicular line (Fig. 18.9)
- Pelvic abscesses are usually covered by the sigmoid colon and small bowel adhering to the parietal peritoneum. Access is gained to the abscess via gentle blunt dissection with the 10-mm palpator to detach the sigmoid colon and the bowel loops without injuring the intestinal wall.
- Complete aspiration of pus and abscess is better achieved with the aid of a 10-mm suction irrigation cannula used in combination with the 10-mm palpator.
- The appendix often is found to adhere to the bowel or the pelvic peritoneum, and its removal follows the same steps as above.
- Before ending the operation, the surgeon must inspect the small bowel, to ensure that it is free of adhesions, not twisted, and that the serosa is not torn.

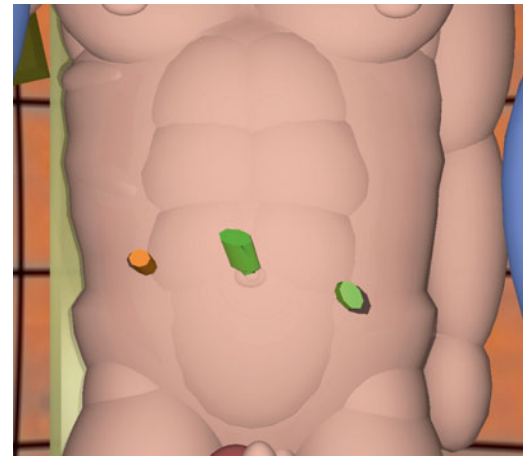

Fig. 18.9 Alternative port sites position

18.4.10 Retrograde Appendectomy

- In case of a long retrocecal appendix adhering to the posterior wall of the ascending colon, where the apex of the appendix can reach the liver and is difficult to identify, the retrograde technique is safer. Again, it is not usually necessary to convert, and the identification and management of retrocecal appendicitis is perfectly adapted to laparoscopy with adequate expertise.
  - The base of the appendix is dissected first and then divided either with sutures as above, or a linear stapler.
  - Dissection then proceeds close to the appendicular wall, where only small vessels are encountered, using bipolar coagulation in preference to hook electrocautery.

18.4.11 Normal Appendix

- Finding an apparently normal appendix should prompt the surgeon to carefully inspect the abdominal cavity for other causes of disease: clearly one of the advantages of laparoscopy.
  - Salpingitis, ruptured ovarian follicle, endometriosis, Meckel's diverticulitis, diverticulitis of the sigmoid colon, Crohn's disease, omental infarction, cholecystitis, and perforated gastroduodenal ulcer are the most frequent causes of pain mimicking acute appendicitis: accurate diagnosis is possible, and in most

cases, adequate treatment can be performed through laparoscopy.

- The decision to remove a normal appendix should be discussed with the patient before operation.
  - When the cause of the acute abdomen is clear, removal of a normal appendix is questionable. When accurate laparoscopic exploration of the abdominal cavity reveals no cause for acute pain, removal of a normal appearing appendix could be considered, especially in subjects with recurrent episodes of pain in the right iliac fossa.

18.4.12 Conversion

- Most frequently needed when a chronically inflamed appendix is tenaciously adherent to the cecum or is embedded in a retroperitoneal abscess and the surgeon lacks the necessary experience to accomplish the operation laparoscopically.
- Some surgeons prefer to convert to a large McBurney, or if needed, pararectal incision or median laparotomy.

18.4.13 Search for Meckel's Diverticulum (Via Laparoscopy and Laparotomy)

Resection of an uninflamed Meckel's diverticulum does not seem to be associated with increased perioperative morbidity, but there is no evidence of any benefit in routine removal. Resection of an uninflamed Meckel's diverticulum should be avoided in case of appendicitis complicated with peritoneal abscess or peritonitis. The decision to resect an incidental Meckel's diverticulum should be discussed with the patient before the operation and informed consent obtained.

Whether via laparoscopy or laparotomy, it is important to resect the base of the diverticulum as ectopic gastric or pancreatic tissue may be harbored there: simple diverticulectomy by mass ligation should be avoided.

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Emergency Surgery for Hydatid Cysts of the Liver

19

Chadli Dziri, Abe Fingerhut, and Igor Khatkov

Contents

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19.1 General Notions

- Hydatid disease remains frequent in many regions in the world such as Mediterranean countries, Asia, and Central America.
- Increasing travel has led to increased incidence in non-endemic areas.
- Emergency surgery is reserved for complicated hydatid cysts of the liver, representing one out of five patients.
- Rupture into the biliary tract with a large (>5 mm) bilio-cystic fistula (21–37 %), thoracic involvement (~2 %), rupture into the peritoneum (<2 %), vessels, and other organs (~1 %) represent the main complications. All these complications can be life threatening and call for immediate management.

Chapter aims to provide the appropriate management for each complication of liver hydatid cysts based on evidence-based surgery (level of evidence and grade of recommendation indicated whenever appropriate).

19.2 Goal of Management

To control the infection process, evacuate the contents of the cyst, and prevent recurrence

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19.3 Medical Treatment

- Appropriate antibiotics are mandatory to stop progression of infection.
- Adapted resuscitative measures.
- Control of metabolic disorders (e.g. diabetes mellitus).
- Postoperative antihelminthic drug treatment is mandatory for most authors: albendazole (10 mg per kg and per day) for 3 months, and especially after treatment of large biliocystic fistula (level IV; grade C).

19.4 Surgical Management

19.4.1 Surgical Approaches

- Laparotomy is the standard approach: right subcostal incision prolonged if necessary to the left.
- Laparoscopy may be considered in selected cases.

19.4.2 Common Surgical Techniques

- Removal of the cyst is usually described as "pericystectomy."
  - "Closed total pericystectomy" removes the cyst without opening it.
  - "Open total pericystectomy" sterilizes the contents with antiscolicidal agents, evacuates the contents of the cyst, then removes the pericystic tissue.
- Partial cystectomy, called also unroofing, involves sterilization of cyst contents, which are removed after opening.
- The unroofing procedure is preferable for endemic areas where the operations are performed by general surgeons.

19.5 Complications and Danger Points

- *Postoperative* deep abdominal complication (DAC) (prevalence 12–26 %)
  - Reasons: presence of a residual cavity or biliocystic fistula after unroofing
  - Blood or bile collections, potential sources of deep suppuration, and persisting bile leaks
  - Prevention:
    Drainage
    Closure of the edges (capsulorrhaphy) of the residual cavity without drainage
    Capitonnage
    Furrowing the margins of the cavity by "introflexion"
    Omentoplasty on the residual cavity (1 RCT, 1 meta-analysis) (level II evidence, grade A recommendation)

19.6 Specific Procedures According to Complications

Hydatid cyst ruptured into biliary tract

Methods

i. Common bile duct clearance via choledochotomy + intraoperative cholangiography and choledoscopy.
   1. After evacuation of all daughter vesicles, insertion of T-tube is recommended (level of evidence III, grade of recommendation A).

ii. Complete removal of cystic and pericystic tissue with simultaneous treatment of the fistulous tract is not easy to perform in the context of emergency with acute cholangitis and is reserved for cysts that are located peripherally.

iii. Management of large (≥5 mm) biliocystic fistula.
   1. *Suture*
      (a) With absorbable material
      (b) Indicated when edges of the fistula are soft
      (c) Contraindicated when edges are fibrotic or calcified
   2. Controlled fistula
      (a) External: insertion of a tube into the fistula through the liver parenchyma (according to Praderi and Perdromo)
      (b) Internal: remnant cavity/through fistula left opened/common bile duct and Oddi's sphincter associated closure of the remnant cavity edges

(capsulorrhaphy) by absorbable sutures

Indications

i. Common bile duct exploration (with intraoperative cholangiography and choledochoscopy) is always possible.
ii. Choice in management of large biliocystic fistula: suture, controlled external or internal fistulization depends on site (controlled internal fistulization best for posterosuperior segments II, VII, and VIII), size of the cyst (omentoplasty should be added to the other procedures except for controlled internal fistulization), proximity of vessels (do not remove the pericyst close to vessels), involvement of upper biliary confluence (controlled internal fistulization best), and pericystic fistula wall (soft: suture; fibrotic: suture; calcified: resection) (level IV; grade C)
    1. Postoperatively: endoscopic retrograde cholangiopancreatography (ERCP)
        (a) Combined with preoperative endoscopic sphincterotomy (ES) may decrease the incidence of the development of postoperative external fistula from 11.1 to 7.6 % (level IV; grade C)
        (b) Combined with postoperative ES may be indicated to manage postoperative external biliary fistulae (level IV; grade C).

Hydatid cyst involving the thorax

Methods

i. Thoracic approach
    - A posterolateral right thoracotomy in the bed of the fifth rib provides good access to the cyst through the diaphragm, when the surgeon is sure that the common bile duct is free from daughter vesicles preoperatively by US or CT scan.
ii. Abdominal approach
    - A right subcostal or bisubcostal approach offers adequate access to the liver, biliary tract, and common bile duct, and via the diaphragm, access to the communication with the thorax with safety.

Indications

- Depending on US or CT scan findings
    - Thoracotomy is indicated when an intrathoracic collection is present, adhesiolysis and treatment of the pleural lesions, pulmonary lesions (lobectomies, wedge resections, or decortications), are necessary and is sufficient when the biliary tract is disease free or already secured.
    - The abdominal approach is mandatory when common bile duct drainage is required or to treat a rupture into bronchi (level of evidence IV; grade C)

Hydatid cysts ruptured into peritoneal cavity

Methods:

i. Laparotomy to aspirate the intraperitoneal liquid, to perform peritoneal cleansing with hyper saline solution, and to treat the cysts: pericystectomy or partial pericystectomy (level IV; grade B)
ii. Medical treatment should be associated; albendazole is often preferred with 10–15 mg/kg/day during 3 months (level IV; grade B).

Indications

i. Ruptured hydatid cyst into the peritoneal cavity is an indication for immediate laparotomy (level IV; grade B).
ii. Abbreviated treatment is indicated when patient health status is very poor.

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Pancreas

20

Ari Leppäniemi

Contents

For information about the diagnosis and treatment modalities see:
Leading symptoms for pancreatitis
Common bile duct for biliary pancreatitis

Objectives

- Describe the main methods of surgical access to pancreas
- Outline the mobilization techniques of the different parts of the pancreas
- Describe the current terminology and definitions associated with necrotizing pancreatitis
- Describe standard open pancreatic necrosectomy
- Describe surgical management of bleeding splenic artery pseudoaneurysm

20.1 Access and Exposure of the Pancreas

All surgical emergencies of the pancreas require proper exposure, because limited exposure can lead to underestimation of the severity and extent of the disease process and inadequate surgical treatment. Due to its retroperitoneal location, access to pancreas requires a series of specific and well-defined steps. Complete

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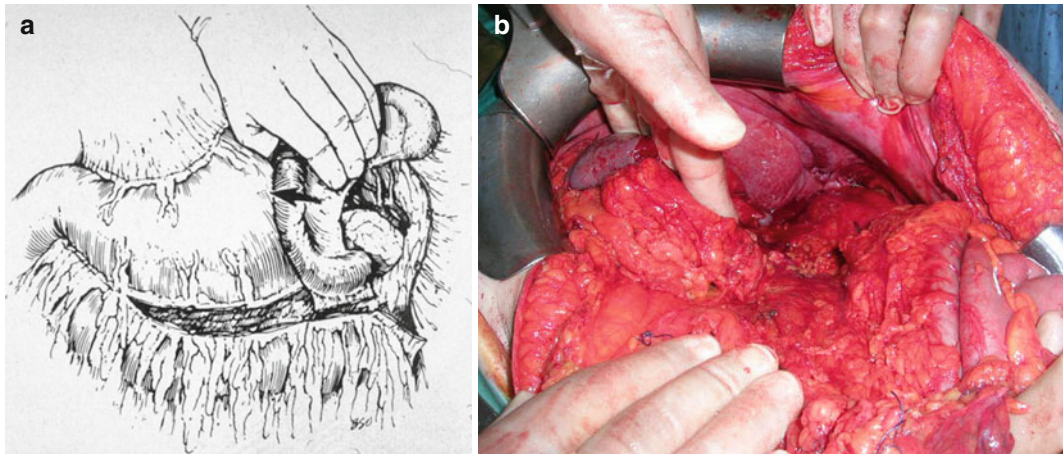

Fig. 20.1 Mobilization of the distal pancreas and spleen

exposure and mobilization of the different parts of the pancreas can be achieved essentially with three maneuvers.

20.1.1 Maneuver 1: Anterior and Distal

- Divide the gastrocolic ligament widely to expose the anterior surface of the body of the pancreas.
- Divide loose attachments to the posterior wall of the stomach.
- For additional exposure, extend dissection leftwards to completely mobilize the lower pole of the spleen away from the colon and drop the splenic flexure of the colon away.

20.1.2 Maneuver 2: Inferior and Posterior

- Mobilize the spleen laterally and superiorly and extend the dissection in the avascular plane posterior to the pancreas and anterior to the left kidney toward the midline including the splenic artery and vein.
- Beware of the inferior mesenteric vein flowing into the splenic vein when dissecting the inferior margin of the pancreas free from the retroperitoneum.
- With completion of this maneuver, the distal pancreas and the spleen are fully mobilized and can be rotated medially to inspect the posterior surface of the distal pancreas (Fig. 20.1).

20.1.3 Maneuver 3: Pancreatic Head

- Divide the lateral peritoneal attachment of the second part of the duodenum and mobilize the entire loop of the duodenum together with the head of the pancreas (Kocher's maneuver) (Fig. 20.2). Mobilization should be wide, to the aorta in the retroperitoneum. Remember the most lateral structure in the porta hepatis is the common bile duct, which must be identified and protected with a wide Kocher maneuver.
- Exposure can be considerably improved by freeing the hepatic flexure of the colon and extending the dissection to the loose avascular plane between the transverse colon and the proximal part of the transverse duodenum.

20.2 Pancreatic Necrosectomy

During the first 2 weeks into the disease process, extrapancreatic infections (bacteremia, pneumonia) are more common, whereas infected pancreatic necrosis peaks at 3–4 weeks. Fine-needle aspiration is no longer used for diagnosis of

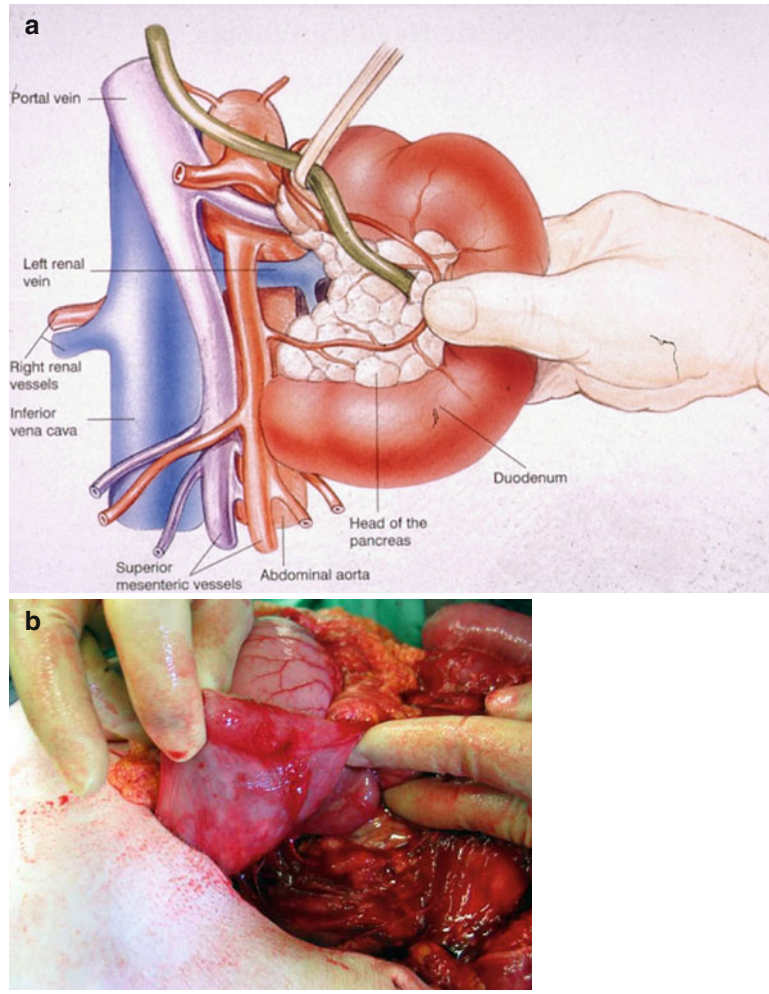

Fig. 20.2 Kocher's maneuver

infected necrosis and has been replaced with signs of clinical deterioration, increase in C-reactive protein (CRP) level, worsening organ failure, and CT findings (gas bubbles). CT findings of peripancreatic collections associated with necrotizing pancreatitis include acute necrotic collection (ANC) and walled-off necrosis (WON). ANC is seen during the first 4 weeks, and it contains variable amount of fluid and necrotic tissue within or around the pancreas. WON is a mature encapsulated collection of pancreatic or peripancreatic necrosis with a well-defined enhancing inflammatory wall requiring usually more than 4 weeks to form.

The indications for (surgical, radiological, or endoscopic) intervention in necrotizing pancreatitis include:

- Clinically suspected or documented infected necrosis with clinical deterioration or ongoing organ failure for several weeks
- Ongoing gastric outlet, intestinal, or biliary obstruction due to mass effect of WON
- Failure to thrive or progress: patient not getting better with WON but without infection (after 8 weeks)
- Disconnected duct syndrome (full transection of the pancreatic duct) with persisting symptomatic collection with necrosis without signs of infection (>8 weeks)

Technique for open pancreatic necrosectomy:

- Bilateral subcostal incision gives the easiest route to open pancreatic necrosectomy

Fig. 20.3 Necrotic distal pancreas removed during necrosectomy

(technique described below), but other alternatives including the retroperitoneal approach and minimally invasive techniques can also be used.
- Divide the gastrocolic ligament avoiding injury to the posterior wall of the stomach and the transverse colon, often adherent to the pancreas (or necrotic tissues) (maneuver 1).
- Suck out the liquid secretions and pus in the lesser sac (bacterial specimens).
- Extend the window to the patient's left as much as needed to see the hilum of the spleen.
- Scoop out the loose peripancreatic necrosis by blunt finger dissection exposing the transverse tentlike structure of the body and tail of the pancreas (which usually are viable and need not to be removed).
- Occasionally, when faced with frank extended necrosis of the gland, removal of necrotic parts of the pancreas can result in near-to-total distal pancreatectomy.
  - Blunt dissection is usually sufficient without mobilizing or removing the spleen (Fig. 20.3).
- If possible and identifiable, ligate the major pancreatic duct at the stump selectively (beware not to ligate the intrapancreatic part of the common bile duct in very proximal resections!).
- Use a recent CT scan as a map to identify other areas of peripancreatic necrosis (usually on the right side behind the head of the pancreas and right hemicolon and on the left side behind the left hemicolon).
- For additional exposure
  - On the left, mobilize the left hemicolon and create a plane between the descending colon anteriorly, and the left kidney and Gerota's fascia posteriorly to connect to the lesser sac.
  - On the right, mobilize the right hemicolon and limited Kocher's maneuver (beware not to injure the duodenum!).
- Necrosectomy should be as complete as possible without removing healthy pancreas.
- Irrigate the lesser sac.
- Secure hemostasis by temporary tamponade with laparotomy pads followed by individual ligation or electrocoagulation of the bleeders.
- Insert multiple, large bore closed suction silicon drains to the necrosectomy areas.
- Close the abdomen in layers unless there is a risk of abdominal compartment syndrome.

Authors' comments: *Recent guidelines mention recommendations for laparoscopic management of acute biliary pancreatitis.*

- *When pancreatic necrosis requires treatment (clinical signs of sepsis or multiorgan failure that do not improve despite optimal therapy):*
  - *Laparoscopic debridement can be done by infracolic or retroperitoneal approach while transgastric endoscopic pancreatic necrosectomy has also been reported.*
  - *Two recent prospective studies (one single arm and one randomized suggest that the presence of a well-demarcated necrosis can be treated using a step-up approach whenever possible (LE 1b).*
    The first step should be percutaneous drainage, followed, if necessary, by minimal invasive retroperitoneal debridement.
    Open surgery should be the last step, to be performed in cases where more conservative treatment has failed. This strategy has been associated with a significantly lower morbidity (diabetes, incisional hernias) and lower new-onset multiple organ failure when compared to open surgery as the first step.

20.3 Splenic Artery Pseudoaneurysm

In patients with chronic pancreatitis and pancreatic pseudocysts, expanding pseudocysts can cause bleeding from major arteries around the pseudocyst, most commonly originating either from the splenic artery or the gastroduodenal artery. The longer the pseudocyst is present and with larger size of the pseudocyst, the higher the incidence of such complications. Unless the patient is in severe hemorrhagic shock, the best treatment is early angioembolization, especially in pseudoaneurysms of the head of the pancreas, often from branches of the pancreaticoduodenal arteries. If angioembolization is not available or fails to stop major bleeding from a splenic artery pseudoaneurysm, surgical intervention is indicated.

- Bilateral subcostal incision gives the best exposure to the pancreas.
  - Can be extended more to the left in patients with splenic artery pseudoaneurysm
- Mobilize the entire distal pancreas together with the spleen by performing maneuvers 1 and 2 completely.
- As soon as pseudocyst cavity (no proper capsule) is entered (Fig. 20.4), either the lesion is still bleeding or is temporarily stopped by a blood clot.
  - Active bleeding: Identify the splenic artery feeding the bleeding pseudoaneurysm and apply pressure proximally before ligation.
  - Blood clot in place proceeds as follows:
- Select the resection line proximal to the lesion and remove the distal pancreas and the spleen together with the remnant walls of the pseudocyst.
- Ligate the splenic artery and vein proximal to the resection line.
- Ligate the main pancreatic duct selectively (figure of eight suture).
- Insert drain.
- Close the incision as above.

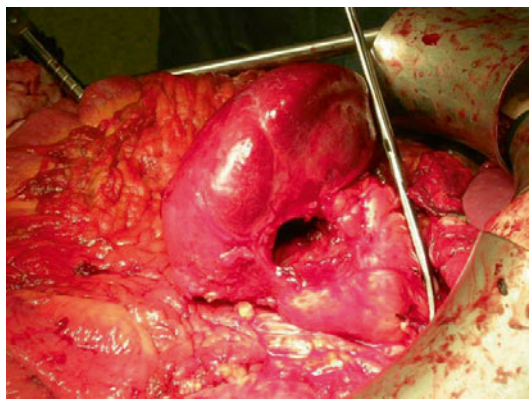

Fig. 20.4 Splenic artery pseudoaneurysm

Pitfalls

- Incomplete exposure and mobilization of the pancreas
- Iatrogenic lesions while mobilizing the pancreas
- Performing pancreatic necrosectomy too early or too late
- Incomplete or too aggressive necrosectomy
- Failure to identify the splenic artery lesion feeding the pseudoaneurysm

20.4 Summary

The key to successful surgical management of acute pancreatic emergencies is adequate exposure of the entire gland that can be achieved with three basic maneuvers. The best time for pancreatic necrosectomy is after 4 weeks from the onset of the disease when the necrosis is clearly demarcated and amorphic, easily removable by blunt dissection. Surgical management of a splenic artery pseudoaneurysm requires complete mobilization of the distal pancreas and spleen, distal pancreatectomy with splenectomy and adequate external drainage.

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Diaphragmatic Problems for the Emergency Surgeon

21

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Contents

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Objectives

- Understand basic diaphragmatic anatomy
- Understand when to operate urgently for paraesophageal hernia
- Know the four fundamental steps of paraesophageal hernia repair

21.1 Anatomy

- The diaphragm is a thin, sheet-like muscle which divides the thorax superiorly from the abdomen inferiorly.
- The muscle fibers originate on the chest wall and insert into the central tendon.
- Diaphragmatic excursion during respiration is significant.
  - Anteriorly can rise as high as the fourth intercostal space
  - Posteriorly extends as low as the L3 vertebral body
- The phrenic nerves, which originate from the third to fifth cervical nerve roots, supply motor innervation to the diaphragm, and the anatomy of their major branches must be appreciated to avoid injury.
- The esophageal hiatus is an elliptical opening, just to the left of midline at the level of the T10 vertebral body.
- The anterior and lateral borders are formed by the muscular arms of the diaphragmatic crura.

A. Fingerhut et al. (eds.), *Emergency Surgery Course (ESC®) Manual: The Official ESTES/AAST Guide*, DOI 10.1007/978-3-319-21338-5_21

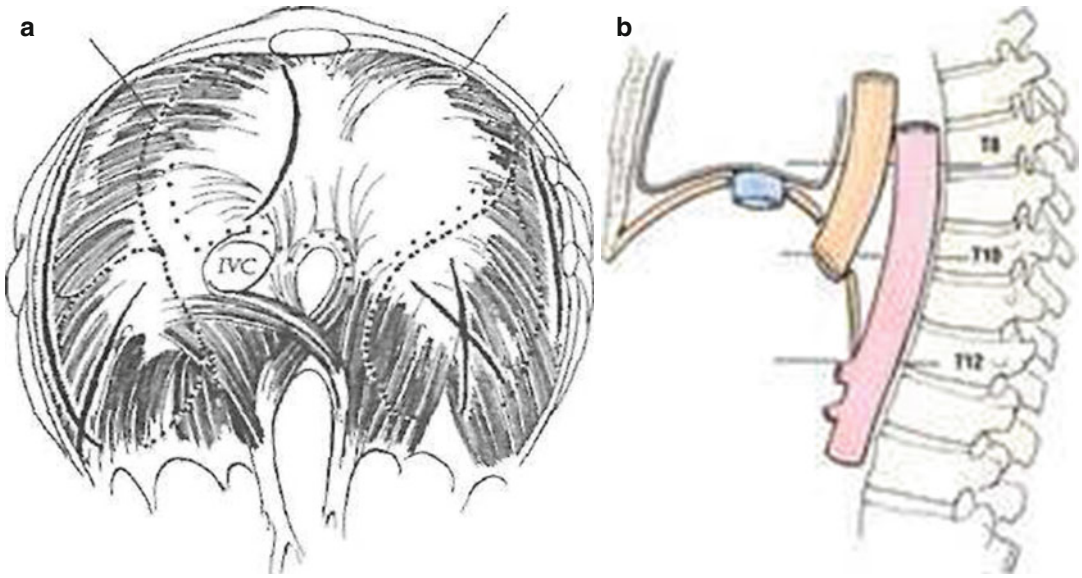

Fig. 21.1 Key anatomy of the diaphragm. (**a**) Diaphragm viewed from the abdomen. Heavy *dotted lines* show the paths of phrenic nerves. *Dark lines* show potential incisions which can be made without damaging the phrenic nerves (Thal ER, Friese RS. Traumatic rupture of the diaphragm. In: Fisher JE, editor. *Mastery of surgery*. 5th ed. Lippincott Williams and Wilkins; 2007). (**b**) *Single-headed arrows* show superior and inferior extent of the diaphragm. *Two-headed arrow* delineated the zone of diaphragmatic traverse (Fotosearch. http://www.fotosearch.com/LIF135/ga141002/)

- The median arcuate ligament contributes to the posterior border (Fig. 21.1).

21.2 Hiatal Hernia

21.2.1 Classification

Hiatal hernia occurs when the esophagogastric junction (EGJ) migrates intrathoracically through the esophageal hiatus. There are four general types of hiatal hernia (Fig. 21.2a). Type I seldom requires emergency management (bleeding), while types II to IV carry the potential for incarceration and strangulation requiring emergency surgical management.

- Type 1 or sliding hernia
- Most common type
  - The EGJ moves upward into the posterior mediastinum.
  - It is associated with gastroesophageal reflux disease.
  - Longitudinal axis of stomach is aligned with esophagus.
- Type II or paraesophageal hernia
  - Paraesophageal hernias are uncommon and include a peritoneal layer forming a true hernia sac.
  - Contributing factors include age and gender (more common in women) and obesity.
  - The EGJ and cardia remain in the abdomen, while the fundus and greater curvature protrude into the mediastinum.
- Type III or mixed hiatal hernia
  - Has components of both types I and II in that the EGJ is in the chest (as in sliding hernias), and the fundus and greater curve are also herniated.
- Type IV hernias are defined by the presence of organs other than the stomach in the chest, which herniate through the esophageal hiatus
  - Most commonly colon, omentum, or spleen.
  - Herniation occurs anterior to the esophagus.

21.2.2 Symptoms and Diagnosis

The most feared complications of paraesophageal hernia are incarceration and strangulation.

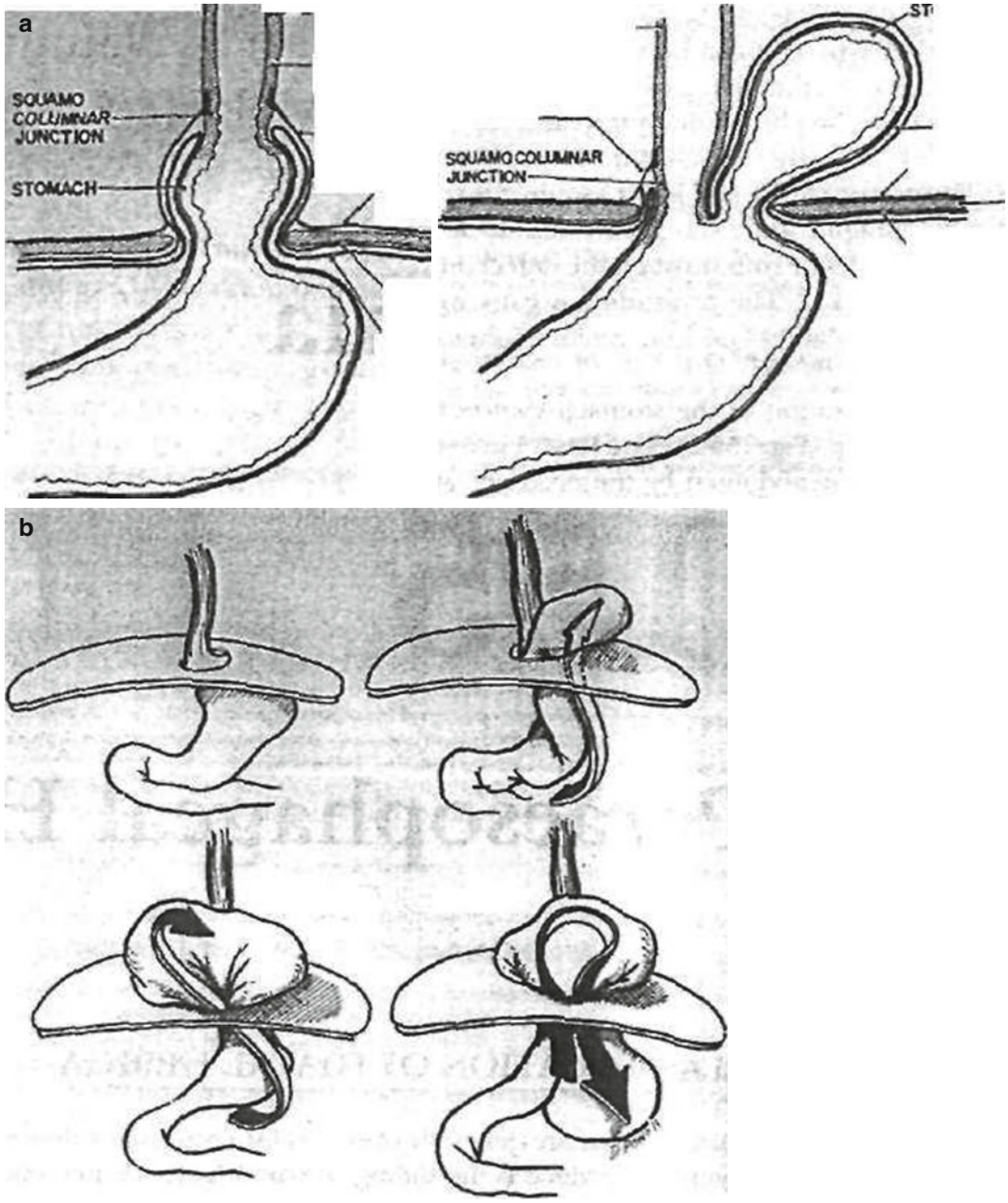

Fig. 21.2 Hiatal hernias and the mechanics of strangulation. (**a**) Type I sliding hiatal hernia. Type II paraesophageal hiatal hernia. (**b**) Mechanics of paraesophageal hernia strangulation (Naunheim KS, Edwards M. Paraesophageal hiatal hernia. In: Shields T, Locicero JI, Reed C, Feins RH, editors. *General thoracic surgery*. 7th ed. Lippincott Williams and Wilkins; 2009)

Twisting of the stomach within the hernia sac can result in closed-loop physiology (Fig. 21.2b) which ultimately leads to necrosis, perforation, and death if untreated.

- Symptoms
  - Slow progression of symptoms is usual. Dysphagia, nausea, vomiting, early satiety, regurgitation, and postprandial chest pain

are signs of an intrathoracic herniated stomach.

Anemia can result from chronic ulceration of the gastric mucosa, though hematemesis and melena are rare.

Large hernias may cause pulmonary symptoms such as postprandial breathlessness through compression of the lung.

It is important for the emergency surgeon to recognize whether a significant change in clinical symptoms or systemic signs of sepsis have occurred mandating emergency intervention.

– Patients with incarceration usually present in extreme distress.

Chief complaint of chest or epigastric pain.

Nausea with retching and an inability to vomit are typical.

Often a long history of chronic hernia symptoms can be elicited.

Borchardt's triad of substernal chest pain, retching with inability to vomit, and inability to pass a nasogastric tube is the classic clinical presentation.

If strangulation and necrosis of the intrathoracic stomach has already progressed, patients will present with systemic signs of sepsis and eventually septic shock.

- Diagnosis
  - Chest radiography should be the initial screening imaging modality and frequently shows a retrocardiac air bubble
  - A barium swallow is diagnostic and an usual part of the elective evaluation of suspected paraesophageal hernia.
  - Esophagogastroduodenoscopy and 24-h pH monitoring are other components of elective evaluation that are avoided under emergency circumstances.
  - In the emergency setting, computed tomography (CT) is often more readily available, may confirm the diagnosis, and is useful in the evaluation other potential causes of chest pain.

21.2.3 The Decision to Operate and Surgical Technique

- While watchful waiting is acceptable for asymptomatic or minimally symptomatic patients, especially older patients with significant comorbidities, the emergency surgeon should intervene promptly and effectively if complications occur
- Several approaches are possible, open transabdominal or thoracic, laparoscopic, or thoracoscopic.
- While most general surgeons will be more comfortable with a transabdominal approach, only very experienced laparoscopic surgeons should undertake laparoscopic repair of an incarcerated and possibly strangulated paraesophageal hernia
- Operative details

The basic steps are the same for all approaches: (1) reduction of hernia contents, (2) mobilization and resection of the hernia sac, (3) crural closure, and (4) eventually intra-abdominal fixation ± antireflux procedure.

1. Reduction of the hernia sac's contents
   - Exposure of the hiatus is aided by dividing the left triangular ligament and mobilizing segments 2 and 3 of the liver to the right.
   - While usually straightforward in the elective situation, hernia reduction can be difficult in patients with incarceration causing gastric distension and edema.
   - Excessive force should be avoided as partial- or full-thickness tears in the already compromised stomach can lead to postoperative leak.
   - Attempts should be made to guide a nasogastric tube into the dilated stomach to achieve decompression and ease reduction.
     – Some authors advocate advancing a soft rubber catheter around the viscera into the hernia sac and insufflating air to relieve the vacuum that may be generated when reduction is attempted.

- If after these maneuvers the contents of the hernia cannot be easily reduced, a small anterior incision can be made in the hiatus to allow reduction.

2. Mobilization and resection of the hernia sac
   - Has never been proven to be necessary but is recommended by most experts because:
     1. Removes the large potential space in the mediastinum
     2. Improves visualization of the GE junction,
     3. May improve crural closure healing by removing the interposed peritoneal layer
   - Care should be taken to avoid:
     – Stripping the endoabdominal or endothoracic fascia (this will leave bare muscle fibers which may not hold sutures well during crural closure)
     – Injury to the vagus nerves

     Must be repeatedly identified
3. Closure of the hiatal defect
   - Usually performed after adequate mobilization of esophagus, ideally 8–10 cm above the cardia, to allow the esophagogastric junction to reside easily in the abdomen without tension and allow posterior crural repair
   - Best to use three to six large, interrupted, number 0 nonabsorbable sutures on the crura posterior to the esophagus
     – Many surgeons use pledgets to reinforce these sutures.
   - Use of synthetic or biological mesh to reinforce crural closure is controversial.
     – Some retrospective studies have suggested reduced recurrence rates with synthetic mesh.
     – Polypropylene mesh has been associated with dysphagia as well as esophageal erosion and stricture.
     – Use of a biological prosthesis made of porcine intestinal submucosa resulted in decreased radiographically demonstrated hernia recurrence in short-term follow-up, but the durability and clinical significance of this result are still unknown.
     – Configurations for mesh or biological prosthesis application are shown in Fig. 21.3.
4. Intra-abdominal fixation of the stomach

   The options include (1) fundoplication, (2) tube gastrostomy, (3) simple gastropexy, or (4) no fixation.
   - In emergency patients who are stable, most surgeons prefer a (Nissen) fundoplication performed around a 56 Fr bougie.
     – Advantage: prevents gastroesophageal reflux, often a result of EGJ mobilization
   - In unstable patients, or frail elderly patients, tube gastrostomy should be preferred.

21.2.4 Postoperative Care and Complications

- A nasogastric tube is left in place (low wall suction).
- Most authors perform a gastrograffin study through the tube of D1, completed by a thin barium swallow if leak and normal gastric emptying.
- Diet can be advanced from liquids to soft solids to regular over several weeks.
- If gastric infarction, perforation, and subsequent mediastinitis or empyema occur, the mortality rate approaches 50 %. If intervention precedes this, the mortality is <3 %.
- Esophageal leak occurs in 1–3 % of cases.
- While radiographic hernia recurrence is not uncommon if routine contrast studies are performed, recurrence requiring reoperation is relatively rare (2–3 %).

21.3 Late Presentation of Traumatic Diaphragmatic Hernia

21.3.1 Mechanism of Injury

Diaphragmatic trauma may result from blunt or penetrating injury. Left-sided injury is more common, likely because it lacks the buffering provided to the right hemidiaphragm by the liver. Visceral herniation may not occur immediately or may be subtle, so the index of suspicion must be high to make the diagnosis during the acute phase.

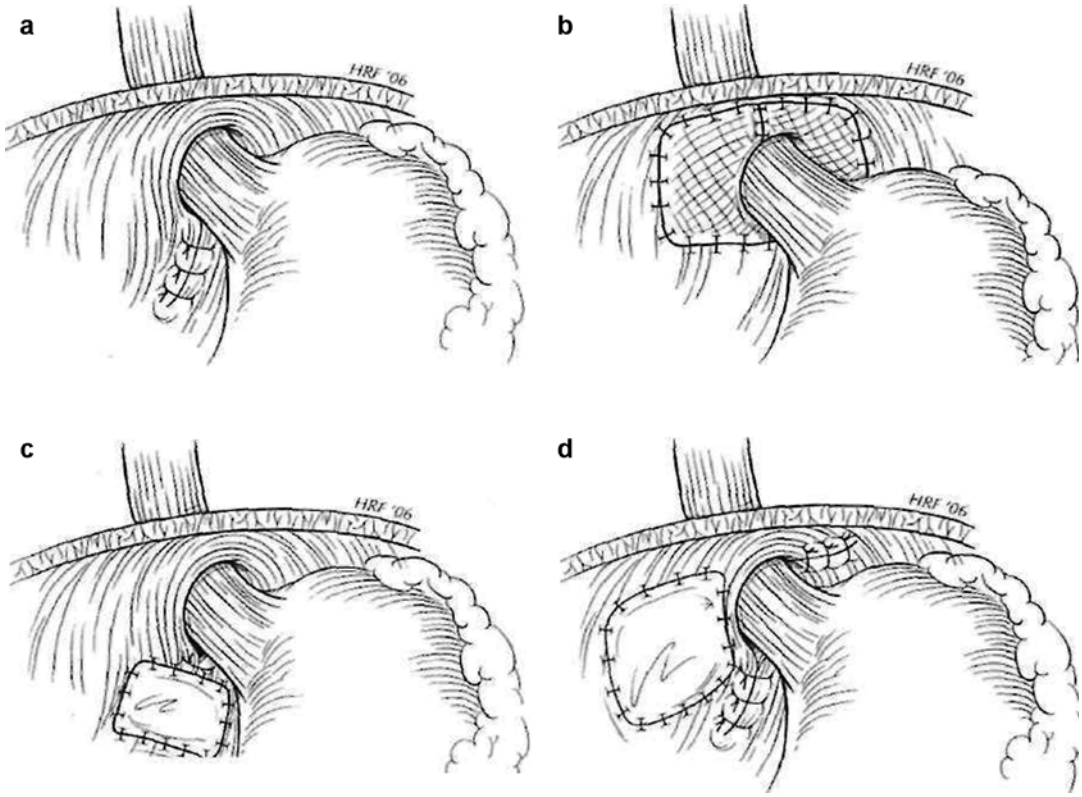

Fig. 21.3 Crural closure. (**a**) Primary closure, (**b**) Keyhole patch, (**c**) Posterior crural patch, (**d**) Lateral relaxing incision covered with patch (Critchlow J. Paraesophageal herniation. In: Fisher JE, editor. *Mastery of surgery*. 5th ed. Lippincott Williams and Wilkins; 2007)

21.3.2 Diagnosis

- While most posttraumatic diaphragmatic hernias are discovered in the acute setting, some patients present, sometimes many years later, with complications.
- Missed injuries tend to enlarge with time, as the diaphragm muscle fibers retract and negative intrathoracic pressure pulls abdominal viscera into the defect.
- Gastrointestinal incarceration and strangulation can occur and carry a high morbidity and mortality.
- Principles of repair are the same as for acute injuries, though these defects are usually too large to be closed primarily and typically require patch closure.
- Because long-standing herniation may result in adhesions from the hernia contents to the thorax, a transthoracic approach may offer an easier means of repair for long-standing hernias.

21.3.3 Surgical Technique

- Approaches: abdominal (open or laparoscopic) thoracic (open or thoracoscopic), depending on the experience of the surgeon and local resources
- Reduction of the hernia contents
  - Extreme caution is warranted
    Not to aggravate pending rupture
    To avoid spillage of hollow viscus contents into abdominal or thoracic cavity during this maneuver

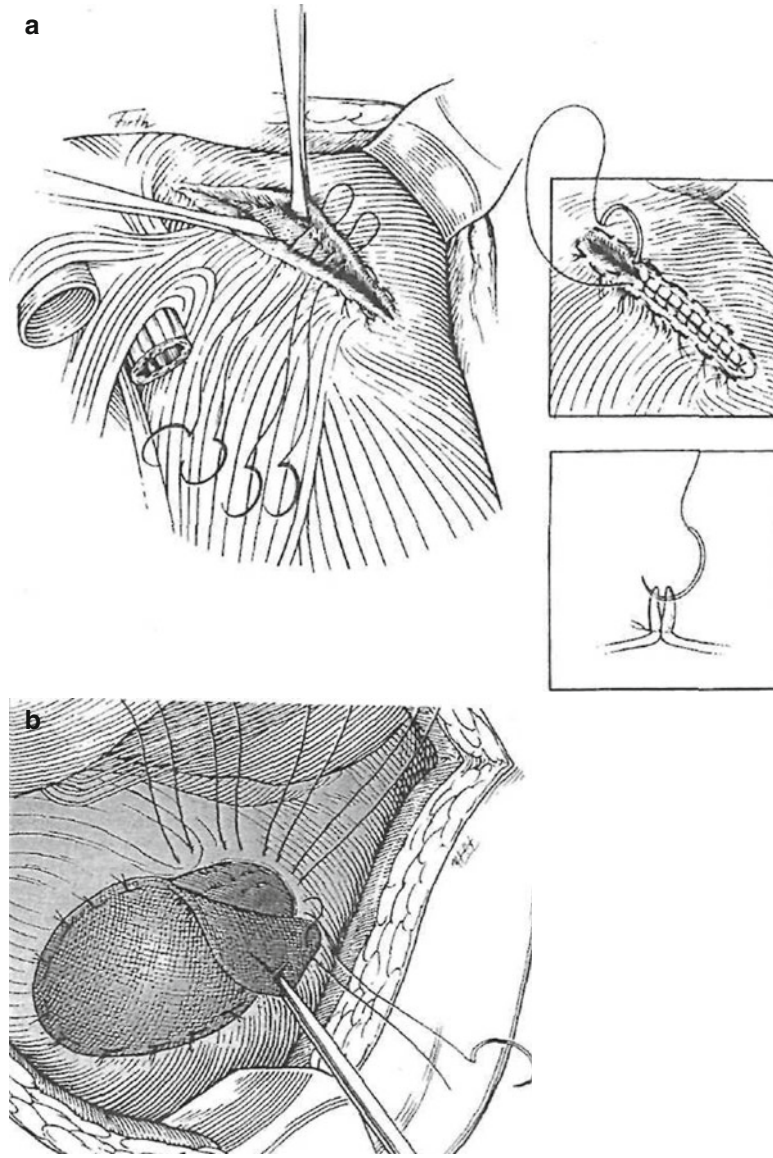

Fig. 21.4 Repair of traumatic diaphragmatic injury. (**a**) Running or interrupted and single- or two-layer repairs can be effective. (**b**) If primary repair cannot be accomplished, a prosthetic patch is necessary (Davis JW, Eghbalieh B. Injury to the diaphragm. In: Feliciano D, Mattox K, Moore E, editors. *Trauma*. 6th ed. McGraw Hill; 2008)

– The diaphragmatic injury should be closed primarily if it can be accomplished without tension, attention paid to the location of the phrenic nerves (Fig. 21.1).
  A variety of sutures (absorbable or nonabsorbable) and techniques (running or interrupted, simple or horizontal mattress, single layer or two layer) are acceptable (Fig. 21.4a). Synthetic mesh repair is often necessary because of the magnitude of the defect (Fig. 21.4b), but biological mesh repair may be a safer alternative in the emergency setting with septic potential
– If any enteric spillage has occurred, the hemithorax or abdomen should be irrigated and drained.

Pitfalls

- Mistaking chronic paraesophageal hernia symptoms for an emergency.

- Inadequate mediastinal dissection during paraesophageal hernia repair – sac not resected, esophagus not mobilized.
- Short esophagus not addressed during paraesophageal hernia repair – if adequately dissected and EG junction still on tension, perform lengthening procedure.
- Vagal nerve injury during paraesophageal hernia repair.

Essential Points

- Four-step repair for hiatal hernia: (1) reduce hernia, (2) resect sac, (3) close crura, (4) intra-abdominal fixation.
- Cannot rule out diaphragmatic injury radiologically – perform laparoscopy or thoracoscopy in patients at risk in the acute setting.

21.4 Summary

The emergency surgeon will occasionally need to evaluate and treat patients with diaphragmatic pathology. The skills required are well within the grasp of the general surgeon. Paraesophageal hernia can be easily diagnosed with routine radiologic tests. If the patient's symptoms and physiology suggest strangulation, there should be no delay in emergency operation, carried out according to the principles described above: complete reduction of the hernia with resection of the sac, secure crural closure, and intra-abdominal fixation of the esophagogastric junction. Complicated diaphragmatic injuries are usually challenging to diagnose and to repair: acute diagnosis and repair are easier.

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Gynecologic Considerations for the Acute Care Surgeon

22

George C. Velmahos

Contents

Objectives

- Familiarize with the clinical presentation of gynecologic emergencies that might require general surgical intervention.
- Identify the indications for surgical intervention in commonly encountered gynecologic infections.
- Familiarize with the pregnancy-induced physiologic changes and how these affect management of the female presenting a general surgical emergency.

22.1 Ectopic Pregnancy

- Definition: implantation of a viable embryo in a location other than within the uterine endometrium
- May present as a surgical emergency if the implantation site ruptures and hemorrhagic shock ensues and source of significant morbidity in females of reproductive age.
- Over 95 % of ectopic pregnancies occur in the fallopian tubes, less frequently in the cervix, ovaries, omentum, pelvis, or elsewhere in the lower abdomen.

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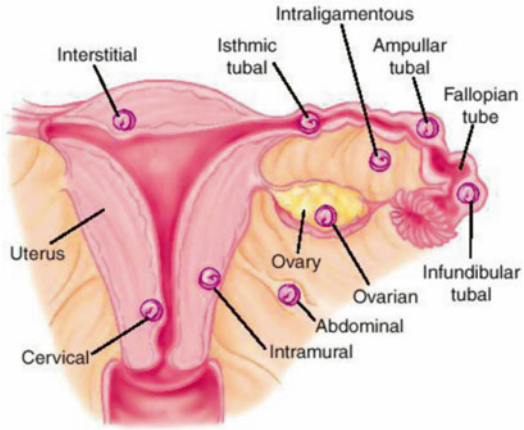

Fig. 22.1 Common sites of ectopic pregnancy

Fig. 22.2 Salpingotomy with retrieval of ectopic pregnancy

- Incidence: approximately 19 per 10,000 pregnancies
  - More common in women with history of ectopic pregnancy or pelvic inflammatory disease (PID).
  - Other risk factors include history of tubal surgery, smoking, presence of an intrauterine device, and pregnancy arising from assisted reproductive techniques (Fig. 22.1).

Symptoms and Signs

- The triad of amenorrhea, vaginal bleeding, and lower abdominal pain in sexually active women should raise the suspicion for an ectopic pregnancy.
- Clinical exam should include a bimanual pelvic examination that may reveal unilateral lower pelvic tenderness and an adnexal mass (depending on how advanced the pregnancy is).
- Initial screening should include a rapid urine pregnancy test, but a quantitative serum human chorionic gonadotropin (hCG) is needed for confirmation.
- Pelvic or transvaginal ultrasound is typically warranted and may reveal a gestational sac within the uterus or in the adnexa (occasionally even an embryo).
- If an intra- or extrauterine pregnancy is not seen with a highly suspicious clinical presentation and an hCG level of 1500 mIU/ml or less, the hCG should be repeated in 24–48 h.
- In a normal pregnancy, these levels typically double every 48 h, as opposed to ectopic pregnancies, where the rise is typically subtler.
  - If not, an absolute hCG level may not differentiate between a uterine versus an ectopic pregnancy. Rather, a trend should be followed over time.

Management

- The gold standard is exploration, with most experienced surgeons favoring the laparoscopic approach, unless the patient is in extremis.
  - If the patient is in shock or if the abdomen is distended with blood, emergent laparotomy is preferred.
  - The goal of exploration is to remove the ectopic gestation while preserving reproductive function.
    If the fallopian tube appears mildly affected, salpingotomy (Fig. 22.2) – in which the gestational sac is removed through an incision in its anti-ligamental aspect – might be possible
    If the tube is more extensively damaged, complete salpingectomy may be necessary.
- Carefully selected hemodynamically stable and reliable patients with pregnancies <3 cm, absence of embryonic cardiac activity, and serum hCG levels of <10,000 mIU/ml may also be considered for medical management.
  - Several regimens based on the cytotoxicity of methotrexate on the developing embryo have been proposed.

  - Consultation with an obstetrician gynecologist for follow-up is advisable.
- Expectant management of a documented ectopic pregnancy may also be an option in physiologically stable patients with minimal pain and with hCG levels <1000 mIU/ml and declining.
  - Patients must be counseled regarding the risks of rupture and hemorrhage, and emergency management must be readily available.
  - Serial serum hCG levels should be trended for appropriate decreases postoperatively or with medical management or observation.
  - Should at any point the pregnant female deteriorate clinically or become hemodynamically unstable, a trip to the operating room is warranted.

22.2 Ovarian Torsion

- Definition: torsion of the fallopian tube and ovary around the infundibulopelvic ligament compromising vascular supply to the torsed organ represents a surgical emergency that, if left untreated, may lead to ovarian infarction and diffuse peritonitis with significant morbidity.
- Causes: abnormal enlargement of the adnexa by neoplasms or more frequently by cysts.
- More commonly encountered in females in their early reproductive years but may also occur after menopause.

Symptoms and Signs

- Usual presentation:
  - Typically, severe unilateral lower quadrant pain of acute onset, frequently associated with nausea and vomiting
    Initially
    After episodes of milder localized pain, corresponding to partial twisting and spontaneous detorsion
  - Clinical exam: unilateral lower quadrant tenderness and rigidity (may be mistaken for acute appendicitis when it involves the right adnexa)
  - Laboratory markers
    Elevated CRP
  - Ultrasonography
    Typically demonstrates a mass in the affected region
    - However, arterial flow may or may not be noted even in the presence of torsion.
  - CT: mass in the affected quadrant with benign characteristics, with the uterus typically deviating towards the affected adnexa.

Management

- Emergency surgical intervention is warranted in all females with confirmed or suspected ovarian torsion.
  - Unless infarction has led to disseminated peritonitis and hemodynamic instability, this can be undertaken safely with laparoscopy.
- Principles of management:
  - Untwist the torsed adnexum
  - Assess viability
    If viability is satisfactory, some advocate securing the ovary onto the psoas (to minimize recurrence).
    If there is no evidence of reperfusion or if infarction has occurred, oophorectomy.
    Similarly, a gangrenous adnexum must be completely removed.
  - Ideally, removal of the cause of the torsion (cyst resection – if present) should be done at the time of the initial procedure.
  - However, cystectomy or partial oophorectomy may be very challenging in an inflamed and fragile ovary.
    In such cases, it may be best to reevaluate the patient in 6–8 weeks, and if the ovarian mass is persistent, schedule elective laparoscopic cystectomy.

22.3 Infections Requiring Surgical Intervention

22.3.1 Pelvic Inflammatory Disease (PID)

- Defined as any infectious process of the upper female genital tract caused by upward migration of pathogenic microorganisms, most commonly *Neisseria gonorrhea* and *Chlamydia*

trachomatis or less commonly *Mycoplasma*, *Ureaplasma*, or anaerobes from the lower urogenital tract.

- Is not a single disease entity, but rather represents a spectrum of infectious processes involving the uterus, fallopian tubes, and ovaries, resulting in endometritis, salpingitis, and oophoritis; it may also involve adjacent pelvic organs resulting in peritonitis, tubo-ovarian abscesses (TOA), and less frequently perihepatitis (Fitz-Hugh-Curtis syndrome).
  - Prompt diagnosis and treatment is of paramount importance in order to preserve fertility and avoid complications associated with PID, such as infertility, ectopic pregnancy, and chronic pelvic pain.
  - Patients are usually young, have a long sexual history typically with multiple sex partners, and lack of use of barrier contraceptives.
- Approximately 780,000 new cases of PID are diagnosed annually in the United States, but more likely many go unrecognized and untreated.

Symptoms and Signs

- Diagnosis can be challenging due to a wide range of presentations.
- Common symptoms include fever, nausea and vomiting, lower abdominal pain, and purulent vaginal discharge.
- Differential diagnosis includes appendicitis, inflammatory bowel disease, urinary tract infections, ectopic pregnancy, and ovarian torsion.
- Presence of cervical motion tenderness and uterine or adnexal tenderness should raise suspicion, while laparoscopy with directed biopsies remains the golden standard for definitive diagnosis.
- Positive laboratory findings include presence of white blood cells on cervical wet prep, elevated sedimentation rate and C-reactive protein, or positive serological testing for gonorrhea and/or chlamydia.
- Transvaginal ultrasonography and computed tomography typically reveal thickened, fluid-filled fallopian tubes with or without free pelvic fluid and/or organized infected fluid collections.

Management

- Medical: the Centers for Disease Control and Prevention recommend one of the following regimens:
  - Outpatient treatment options
    Ceftriaxone plus doxycycline (in the absence of pregnancy) with or without metronidazole, usually for 14 days
    Cefoxitin with probenecid plus doxycycline with or without metronidazole, usually for 14 days
    Newer-generation fluoroquinolone with or without metronidazole for 14 days
  - Inpatient treatment options
    Cefotetan every 12 h or cefoxitin every 6 h, plus doxycycline every 12 h or clindamycin every 8 h plus gentamicin every 8 h or ampicillin/sulbactam every 6 h plus doxycycline every 12 h.
    - After at least 24 h of intravenous antibiotics, oral antibiotics (doxycycline or clindamycin) continued at home after discharge from the hospital. Total treatment with medicine usually lasts for 14 days.
- Surgery
  - May be required for TOA (30 % of all patients hospitalized for PID)
    Suspected in the presence of lateralized lower abdominal pain that may mimic acute appendicitis and is typically identified in women with recurrent episodes of inadequately treated PID and chronically persistent symptomatology.
    Bimanual clinical examination: tender adnexal mass may be palpated.
    Pelvic or transvaginal ultrasound is typically confirmatory, as is computed tomography.
    If no response to trial of oral or intravenous antibiotics (third-generation cephalosporins plus doxycycline with or without metronidazole for 14 days) within 48–72 h, percutaneous or surgical drainage of the abscess is mandated.
  - May be necessary for ruptured abscesses
    High mortality rate if not recognized and managed promptly.

In addition to management of sepsis, total abdominal hysterectomy with bilateral salpingo-oophorectomy is the procedure of choice.

- However, a more conservative approach can be attempted in young patients desiring future fertility.

The abdomen should be explored for metastatic abscesses and any suspicious areas must be irrigated liberally and drained.

Laparoscopic approach may be attempted by experienced minimally invasive surgeons in the hemodynamically stable patient.

22.3.2 Bartholin's Abscess

- Bartholin's glands (great vestibular glands) are located at 4 and 8 o'clock at the vaginal orifice.
  - Rarely palpable in normal patients
  - Contains ducts lined with transitional epithelium that lead to Bartholin's cyst when obstructed from inflammation or abscess when cyst becomes infected
  - Bartholin's cyst
    Typically affects women in their third decade (2 % of women develop a Bartholin's cyst or abscess during their lifetime)
    May range in size from 1 to 3 cm
    Is detected on examination or recognized by the patient
  - Bartholin's abscess
    Typically results in discomfort and dyspareunia.
    Most commonly polymicrobial, but sexually transmitted *N. gonorrhea* and *C. trachomatis* are occasionally implicated.
    Usually presents as acutely inflamed, tender masses on the posterior vulvar vestibule, with expressed or spontaneous purulent drainage.
  - **Treatment**:
    Incision, drainage with a small balloon-tip catheter, for a few weeks to allow for formation and epithelialization of a new duct.

Fig. 22.3 Bartholin's cyst

Debridement should always be accompanied by appropriate antibiotic therapy.

Recurrent cysts or abscesses can be marsupialized or excised in their entirety (Fig. 22.3).

22.4 Emergency General Surgical Procedures in the Obstetric Patient

The acute care surgeon is not infrequently called on to assess and treat general surgical problems in the pregnant patient. Insightful knowledge of the normal physiologic changes occurring during pregnancy as well as the variations in presentation of surgical disease is imperative. Similarly, in order to ensure safety and well-being of both the mother and the fetus, the emergency surgeon should be well versed in the safety and utility of diagnostic tests and imaging modalities (Table 22.1).

22.4.1 Appendicitis in Pregnancy

- Most common non-obstetric indication for operation during pregnancy.

Table 22.1 Physiologic changes due to pregnancy

Physiologic changes due to pregnancy
Cardiovascular changes
Increased cardiac output
Increased blood volume
Decreased systemic vascular resistance
Decreased venous return from lower extremities
Respiratory changes
Increased minute ventilation
Decreased functional residual capacity
Gastrointestinal changes
Decreased gastric motility
Delayed gastric emptying
Coagulation changes
Increased clotting factor levels (II, V, VII, VIII, IX, X, XII)
Increased fibrinogen levels
Increased risk for venous thromboembolism
Renal changes
Increased renal plasma flow and glomerular filtration rate
Ureteral dilation
Increased bladder capacity early in pregnancy

- Average incidence: 1 in 1500 deliveries, quite similar to that in the nongravid females, but the pregnancy-induced anatomic and physiologic changes can make the diagnosis difficult.

Symptoms and Signs

- Location of pain depends on uterus volume.
  - Typical pain in the right lower quadrant is often replaced by periumbilical pain, later localized in the right lower quadrant, followed by nausea and vomiting during the first trimester.
  - Due to upward migration of the cecum later in pregnancy, the pain may be most prominent in the right upper quadrant, mimicking biliary disease.
  - Similarly, involuntary guarding of the abdominal wall musculature and tenderness on rectal examination from a low-lying appendix may be less pronounced if appendicitis occurs later in pregnancy, due to displacement by the gravid uterus of the abdominal wall anteriorly and the appendix superiorly.

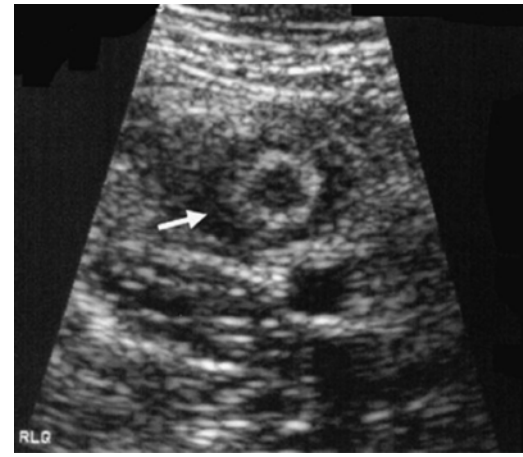

Fig. 22.4 Typical ultrasonographic characteristics of acute appendicitis: tubular structure with a diameter >7 mm and wall thickness >3 mm

- Low-grade fevers and mildly elevated white cell count may also be present, but the physiologic leukocytosis of pregnancy may mask this finding.
- Risk of ruptured appendicitis increased (because of delayed diagnosis related to atypical presentation of acute appendicitis as the pregnancy progresses).
  - 50% increased risk in the second trimester and as high as 70 % in the third
  - With subsequent preterm labor and potential of fetal loss

Diagnosis

- Ultrasonography is the study of choice: visualization of a tubular structure with a diameter >7 mm and wall thickness >3 mm is highly suggestive (Fig. 22.4).
- Increasing body of evidence supporting the use of CT:
  - Performed 10–20 min after administration of rectal contrast.
  - Appendiceal CT exposes the gravid abdomen to only one third the radiation of a regular abdominal CT.

    However, as the risk for teratogenesis, fetal loss, and subsequent carcinogenesis is not zero, its use is advocated only in high-risk pregnancies with equivocal clinical presentation, in which a negative laparoscopy might be detrimental.

Table 22.2 SAGES guidelines for laparoscopy during pregnancy

Guidelines for laparoscopic surgery during pregnancy
1. Defer operative intervention until the second trimester, when the fetal risk is lowest, whenever possible
2. Pneumatic compression devices must be used because of the enhancement of lower venous stasis with pneumoperitoneum and pregnancy-induced hypercoagulable state
3. Fetal and uterine status, as well as maternal end-tidal CO_2 and arterial blood gases, should be monitored
4. Use fluoroscopy selectively and protect the uterus with lead shield if intraoperative cholangiography is possible
5. Given enlarged gravid uterus, abdominal access should be obtained using open technique
6. Dependent positioning should be used to shift the uterus off the inferior vena cava
7. Pneumoperitoneum pressures should be minimized (to 8–12 mmHg) and not allowed to exceed 15 mmHg
8. Obstetric consultation should be obtained before operation

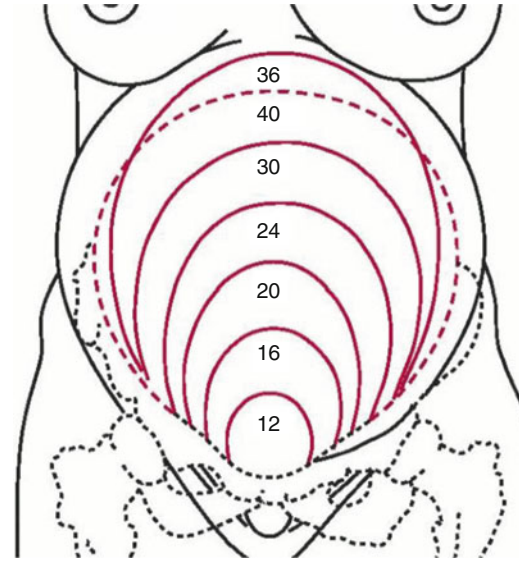

Fig. 22.5 Uterine size at various stages of pregnancy

- Magnetic resonance imaging
  - Generally considered safe in pregnancy
  - Disadvantage: limited availability
    Sparse publications

Management

- Once the diagnosis has been established, appendectomy may be undertaken.
  - Laparoscopy
    Pregnancy is no longer a contraindication to laparoscopy, provided one bears in mind the physiologic and anatomic variations of the gravid abdomen.
  - Precautions (specific to laparoscopy) (see Table 22.2):
    Continuous transvaginal fetal heart rate monitoring.
    Evidence of fetal distress should prompt desufflation.
    Rotation of mother to a left-sided position to decrease uterine compression on the inferior vena cava.
    Open Hasson technique (do not use blind access or a Veress needle) and trocar placement.
    - The latter has to be modified to account for the enlarged uterus (the hypogastric area should be avoided – the right upper quadrant may be a reasonable substitute for secondary trocar placement) (see Fig. 22.5).

    Lower levels of pneumoperitoneum (8–12 mmHg) (to prevent altered hemodynamics in the fetus).
    Insufflation, adequate hydration, prudent maternal ventilation, and serial blood gas monitoring (to prevent fetal acidosis with the peritoneal CO_2).
    External tocodynamometer placed on abdomen to monitor for uterine contractions (upon completion of the operation).
    Administer tocolytics only if uterine irritability or contractions are noted (never prophylactically).
    Early administration of corticosteroids for lung maturation at the earliest sign of premature onset of labor.
  - The open approach
    Preferred when laparoscopic approach might be difficult (later stages of gestation) or nonavailability of experienced minimal invasive team.
    A right-sided transverse incision over the area of maximal tenderness is best (incisions over McBurney's point, even early in pregnancy, are usually inadequate).

Precautions include perioperative fetal monitoring and early involvement of an obstetrician, as well as early administration of corticosteroids as above.

22.4.2 Pregnancy and Biliary Disease

Acute cholecystitis is the second most common disease process requiring surgical intervention during pregnancy, with an incidence of approximately 1–8 in 10,000 pregnancies.

Symptoms and Signs

- Symptoms similar to nonpregnant women:
  - Colicky right upper quadrant or epigastric pain typically after fatty meals often accompanied by severe nausea and vomiting.
  - Murphy's sign.
  - Low-grade fever.
  - Laboratory workup may be obscured by the normal leukocytosis and elevated alkaline phosphatase of gestation.
- Abdominal ultrasound confirms the diagnosis typically showing gallbladder wall thickening and pericholecystic fluid in the presence of cholelithiasis.

Management

- Should the pregnant patient present with symptomatic cholelithiasis (without acute cholecystitis), conservative management can be entertained to allow progression of the pregnancy into the second trimester (organogenesis is complete but the gravid uterus is not yet large enough to obstruct the critical view or hinder operative maneuvers).
- Laparoscopic cholecystectomy is safe in pregnancy and preferable to an open approach for acute cholecystitis, allowing earlier oral intake and mobilization, better pain control, shorter hospital stays, and, perhaps most importantly, less frequent preterm labor from less manipulation of the gravid uterus.
- Again,
  - Open Hasson technique for access
  - Supraumbilical incision to avoid pressure on the enlarged uterus

Pitfalls

- Any woman of childbearing age presenting with abdominal or pelvic pain should be considered pregnant until proven otherwise.
- Any woman presenting with pain and bleeding in early pregnancy should be considered to have an ectopic pregnancy until proven otherwise.
- In pregnant women, clinical signs of shock are initially subtle.
- Ovarian torsion is a surgical emergency; laparoscopy confirms the diagnosis and permits the treatment in time. CT is another high-achieving diagnostic tool that delays surgery and increases the workload of the pathologist.
- Dealing with appendicitis or cholecystitis in pregnant women, the risk of miscarriage is higher with ongoing intra-abdominal infection or peritonitis than with early laparoscopy.
- A pregnant woman on the operation table should be rotated on the left side to decrease uterine compression on the inferior vena cava.
- Open laparoscopy is the gold standard. Pregnancy modifies abdominal anatomy; therefore, in pregnant women, open laparoscopy is the platinum standard and any blind access a malpractice.

22.5 Summary

- Gynecologic causes of acute abdomen include ruptured ectopic pregnancy, ovarian torsion, pelvic inflammatory disease, and tubo-ovarian abscess.
- Whenever a female of reproductive age presents with abdominal or pelvic pain, pregnancy should be ruled out.
- Ectopic pregnancy may present as a surgical emergency in case of rupture or uncontrolled bleeding; however, in carefully selected

females with the condition, a conservative approach could be attempted.

- Ovarian torsion represents a surgical emergency with high morbidity if not treated promptly. Should the cause of the torsion not be treated in the same setting, follow-up should be established to address the issue.
- Tubo-ovarian abscesses may be managed with oral or intravenous antibiotics first in the nontoxic patient. Patients who are not improving should be offered surgical exploration.
- Laparoscopy is typically safer than the open approach in the treatment of acute appendicitis and cholecystitis during pregnancy in experienced centers. Fetal monitoring and early obstetrician involvement should be the mainstay of any surgical condition for which the gravid female seeks surgical attention.

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Acute Proctology

23

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Contents

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For all patients presenting with swelling, pain, tenderness, itching, and bleeding symptoms of the anal region:

- Take a thorough history.
- After obtaining informed consent, examine the patient usually in the left lateral or the Sims position, and more rarely in prone jackknife position.
- Rectal examination should detect external hemorrhoids, fistula, anal carcinoma, anal condylomas, anorectal abscess, and anal discharge.
- Anorectal examination may reveal anal stenosis, anal sphincter problems, gross blood, and anorectal abscess.

23.1 Lower Gastrointestinal Bleeding

- Incidence: assumed to be 20/100,000 and constitutes 25 % of all gastrointestinal bleedings with a male predominance
- Defined as bleeding from the bowel distal to the ligament of Treitz
- Usually manifests with maroon stools or bright red blood per rectum
  - Bright red blood per rectum strongly suggests a lower gastrointestinal (GI) source of bleeding.
  - However, hemorrhage may originate from a source proximal to the ligament of Treitz in which case the patient is usually unstable.

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- Diagnosis
  - After digital rectal examination.
  - Place a nasogastric tube to rule out an upper GI source of bleeding.
  - Order immediate colonoscopy, the urgency depending on the degree of hypovolemia. Should detect the source of bleeding in 69 % (48–90 %) of patients
  - Elderly (older than 65 years) and the patients with comorbidities warrant hospitalization because of high morbidity and mortality rates (10–20 %).
  - It is strongly recommended to carry out an upper gastrointestinal endoscopy if a bleeding site cannot be detected during colonoscopy.

23.2 Anal Pain

- Causes: acute anal fissures, thrombosed hemorrhoids, herpesvirus infection, anal condylomas, anorectal abscess, and proctalgia fugax
- Treatment: warm sitz baths, diltiazem, glyceryl trinitrate ointment, and nonsteroid anti-inflammatory drugs (NSAIDs) (helpful in 60–70 % of cases)

23.3 Acute Anal Fissure

- Signs: severe anal pain and rectal bleeding with defecation.
- Initial treatment: pain relief, anal hygiene, and warm sitz baths. Topical application of anesthetic jelly, 0.2–0.4 % nitroglycerin ointment or glyceryl trinitrate, diltiazem, nifedipine, or L-arginine; bulking and softening the stool with psyllium seed are useful in acute conditions.

23.4 Acute Hemorrhoidal Disease

- Signs: bleeding, usually red and usually after defecation, and masses of dilated venules.
- Grading of hemorrhoids (Table 23.1).

Table 23.1 Grading of hemorrhoids

Degree	Description
I	Hemorrhoids prolapse beyond the dentate line on straining
II	Hemorrhoids prolapse through the anus on straining but reduce spontaneously
III	Hemorrhoids prolapse through the anus; require manual reduction
IV	Prolapsed hemorrhoids cannot be manually reduced

- If untreated, prolapsed hemorrhoids may end up with ulceration and necrosis.
- Presentations and treatment.
  - Thrombosed external hemorrhoids
    Cause unknown
    Usually preceded by abrupt onset of anal mass and pain within 48 h
    - Pain diminishes after the fourth day and if left alone dissolves spontaneously in a few weeks.

    Treatment:
    - Pain relief
    - Excision under local or general anesthesia
      - Quicker recovery than with medical treatment
      - Prevention of recurrent thrombosis
      - Prevention of residual skin tags

23.5 Strangulated Hemorrhoids

- Usually arise from prolapsed grade 3 or 4 hemorrhoids that cannot be reduced due to excessive swelling
  - Edema may progress to ulceration or necrosis if not treated with urgent three quadrant hemorrhoidectomy.
  - Stapled hemorrhoidopexy without decompressing the edematous tissue is associated with more immediate pain (vs conventional hemorrhoidectomy technique in the immediate postoperative period) but subsides within 6 weeks.

23.6 Hemorrhoids in Pregnancy

- Thrombosed or strangulated hemorrhoids due to hormonal changes and the pressure of the fetus on pelvic veins can cause a serious problem in pregnant and postpartum women.
- Mild laxatives are helpful in the last 3 months of pregnancy.
- Traumatic deliveries, such as perineal tear and heavy babies, are associated with thrombosed external hemorrhoids.
- Requires hemorrhoidectomy under local anesthesia, ideally in the immediate postpartum period.

23.7 Hemorrhoids and Portal Hypertension

- Quite common (almost 60 %).
- Often associated with large esophageal varices but bleed less.
- Bleeding from anorectal varices can be controlled with absorbable running sutures.
- Bleeding hemorrhoids in patients with portal hypertension must be distinguished from anorectal varices, true consequence of portal hypertension.

23.8 Hemorrhoids in Inflammatory Bowel Disease

- The treatment of hemorrhoids is accepted as safe in patients with ulcerative colitis, whereas is relatively contraindicated in patients with Crohn's disease.
- Hemorrhoidectomy may be performed in patients with Crohn's disease in a quiescent stage.

23.9 Hemorrhoids in Leukemia

- Surgery
  - May be difficult because of:
    Abscesses
    Poor healing
  - Indicated to relieve pain and sepsis usually caused by *Escherichia coli* and *Pseudomonas aeruginosa*
  - Does not increase the mortality in these high-risk patients

23.10 Proctitis

- Defined as inflammation limited to the rectum
- May cause bleeding and mucous secretion
- Signs and symptoms:
  - Diarrhea is more frequent than constipation.
  - Urgency.
- Untreated, may spread proximally (as proctocolitis)

23.11 Anorectal Abscess

- More common in men than in women (ratio of 2:1–5:1)
- Most common cause: obstruction and infection of anal glands and crypts
  - Predominant organisms are *Escherichia coli*, *Enterococcus*, and Bacteroides fragilis
- Signs and symptoms
  - Initial sign is usually severe anal pain, swelling and tenderness.
  - Pus may be seen exuding from a crypt.
- Location
  - Perianal, intersphincteric, ischioanal, intersphincteric, and supralevator
- Confirmation of diagnosis in difficult cases: intrarectal ultrasound (IRUS), endoscopic rectal ultrasound (ERUS), pelvic magnetic resonance imaging (MRI)
- Treatment:
  - Anorectal abscess require prompt drainage which is favored. The abscess may be drained under local or general anesthesia according to conditions. Detailed rectal examination under general anesthesia may reveal the problem. Neglect only allows extension of the abscess and may lead to ischioanal and supralevator abscesses and

possibly to horseshoe extensions, with each of these conditions more difficult to manage than the simple intersphincteric abscess. If an abscess is detected, preferably it is drained via the anal canal or by removing a skin anal region or placing a mushroom catheter (Thompson-Fawcett). Lay-open technique may end up with several complications. Antibiotics are not generally necessary if the abscess is drained adequately; however, in patients with Crohn's disease, immune deficiency, and cardiac valve abnormalities, antibiotics should be administered.

Anal canal involvement is present in 30–70 % of patients with Crohn's disease; however, only 3–5 % require surgical intervention.

23.12 Fournier's Gangrene

Necrotizing fasciitis of the perineal area (Fournier's gangrene) is a rare soft tissue infection, primarily involving the superficial fascia and resulting in extensive undermining of the surrounding tissues. The incidence of such extensive infection has been estimated as less than 1 % of all anorectal sepsis. If untreated, it is invariably fatal, and thus a high index of suspicion for the diagnosis is required. Mortality remains still high in necrotizing fasciitis despite the use of modern powerful antimicrobial drug regimens and advances in the care of the critically ill patients. Overall mortality ranges from 25 to 73 % in the published literature. The disease's manifestation can range from a fulminant presentation to a subtle and insidious development. After initial fluid and electrolyte corrections and administration of broad-spectrum antibiotics, radical debridement involving extensive excision of all involved skin, fascia, and muscles is performed. Extension may reach the abdominal wall, thighs, chest wall, and axilla. Testicular involvement is rare and the only indication for orchiectomy is testicular gangrene. Repeat exploration should be conducted as necessary until the necrotizing process has been interrupted.

Fig. 23.1 Strangulated hemorrhoids

23.13 Perianal Sepsis in Immunocompromised Patients

Perianal infection in patients with acute leukemia has been associated with mortality rates of 45–78 %. If the granulocyte counts are increased above 1000 cell/mm^3, the postoperative course was uncomplicated, otherwise; if surgery is performed with severe granulocytopenia (<500 polymorphonuclear leukocytes/mm^3), the survival rate does not increase (Fig. 23.1).

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Necrotizing Soft Tissue Infections

24

Eric J. Voiglio, Guillaume Passot,
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Contents

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Objectives

- Differentiate dermatitis, subcutaneous gangrene, and myositis
- Define the treatment of these three entities
- Know how to perform a vacuum dressing

- Acute necrotizing soft tissue infections (ANSTI) are challenging diseases, which threaten cosmesis, function, and vital prognosis.
- ANSTI may occur as a complication of a surgical procedure or instrumentation (e.g., Foley catheter).
- Because of their rarity, diagnosis can be difficult; any delay in the treatment, mainly surgical, severely affects the prognosis.

From the anatomic point of view, three different layers must be distinguished from superficial to deep (Fig. 24.1):

1. Skin
2. Subcutaneous tissue
3. Muscles (separated from subcutaneous tissue by fascia or aponeurosis)

Three anatomic layers correspond to three types of infective diseases:

1. Infectious dermatitis
2. Subcutaneous gangrene
3. Myositis

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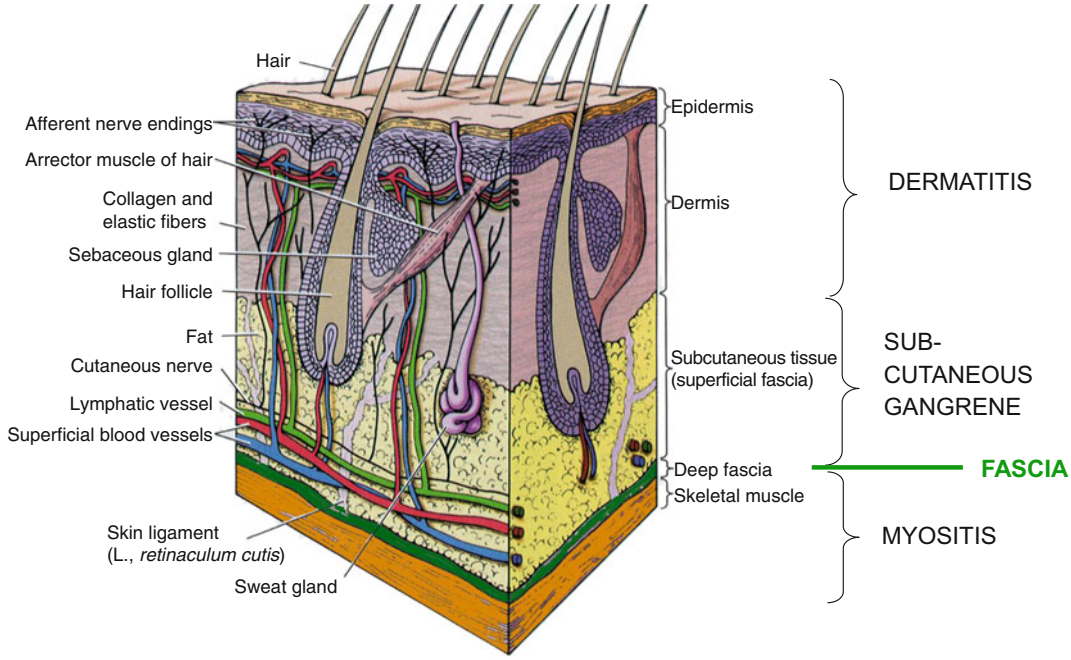

Fig. 24.1 Type of infective disease according to anatomical layer

Nota bene: Subcutaneous tissue is frequently referred to as "*superficial fascia*" and aponeurosis to "*deep fascia.*" These terms are confusing as is the term "*fasciitis*": Aponeurosis is a barrier to spread of infection and should be preserved when treating subcutaneous gangrene.

24.1 Dermatitis

Infectious dermatitis may be caused by:

- Gram+ cocci alone
  - Impetigo
  - Ecthyma
  - Erysipelas
- Several anaerobic and anaerobic bacteria, Gram+ and Gram – acting in synergy
  - Fournier's gangrene

24.1.1 Impetigo

- *Highly contagious pyoderma*
- Children younger than 6 years most frequently affected
- Primarily caused by *Staphylococcus aureus* (sometimes by *Streptococcus pyogenes*)
- Painless lesions on the face, scalp, arms, and legs
- Begins as vesicles evolving to pustules then to honey-colored crusts
- Usually without associated general signs of infection

24.1.2 Ecthyma

- *Ulcerative pyoderma.*
- Caused by *Staphylococcus aureus* or by *Streptococcus pyogenes.*
- *May be caused by Pseudomonas.*
- Different stages of lesions may coexist.
- Painful.
- Begins as a pustule that evolves into a deep ulcer covered by a crust.
- Satellite lymph nodes are swollen.
- Heals, leaving definitive scars.

24.1.3 Pyoderma Gangrenosum

- *Not an infection*

- Results from an immune system dysfunction as in inflammatory bowel disease, myeloma, or rheumatoid arthritis.
- Begins as a papule, followed by a vesicle ending as a necrotic ulcer.
- Different stages of lesions may coexist.
- Treated by corticoids.

24.1.4 Erysipelas

- Acute streptococcal dermatitis.
- Associated with general illness and fever.
- Erythematous skin lesions enlarge rapidly.
- Sharply demarcated raised edge.
- Red streak and swollen lymph nodes may be present.

24.1.5 Fournier's Gangrene

All gangrene of the genitalia are not Fournier's gangrene.

- Caused by mixed aerobic and anaerobic bacteria.
- Begins suddenly with fever and deep general illness.
- Inoculation occurs after a wound or operation.
- Lesion consists of superficial skin necrosis, typically (but not always) with border between necrotic and healthy skin.
- Crepitus may be present.
- Necrosis heals as a deep second-degree burn.
- Surgery is required to remove necrotic tissues.

24.2 Subcutaneous Gangrene (SG)

24.2.1 Hemolytic Streptococcus Subcutaneous Gangrene (HSSG)

This disease was described by F.L. Meleney in 1924 as "haemolytic streptococcal gangrene." The subsequent terms of suppurative or necrotizing fasciitis must be avoided, as they are confusing:

> the deep fascia or aponeurosis is a barrier that generally prevents deeper extension of the infection.

Fig. 24.2 Hemolytic streptococcus subcutaneous gangrene (HSSG)

Fig. 24.3 Infection undermines through subcutaneous fat under apparently healthy skin

- Caused by a *Streptococcus pyogenes* group A, B, C, or G inoculated through a skin wound.
- General illness is profound.
- Red swollen area with no demarcated edge (contrary to erysipelas) (Fig. 24.2).
- Infection undermines through subcutaneous fat under apparently healthy skin (Fig. 24.3).
- Mainly affects males, mean age 50 years.
- Diabetes, venous insufficiency, and obesity are promoting factors.
- Concomitant NSAID administration is frequent.
- Surgical excision of infected skin is the urgent treatment.
- Mortality (if well managed) is 25 %.

24.2.2 Anaerobic Bacteria Subcutaneous Gangrene (ABSG)

- Little pain and little general illness initially.
- Erythematous or necrotic lesion.
- Foul odor.


Fig. 24.4 Hemolytic streptococcus myositis

- Crepitus may be present.
- Polymicrobial infection: *Clostridium perfringens*, *Bacteroides fragilis*, *Actinomyces*, *Escherichia coli*, *Proteus*, *Klebsiella*, *Enterococcus*, etc.

24.3 Myositis

24.3.1 Hemolytic Streptococcus Myositis (HSM)

- Severe general illness, toxemia, shock.
- Excrutiating muscular pain, swollen muscles.
- No crepitus.
- Sometimes associated with HSSG.
- Urgent surgical exploration needed.
  - Fasciotomy and resection of dead muscles are mandatory (Fig. 24.4).
- May be the consequence of a septic metastasis after ENT streptococcal infection, sometimes inappropriately treated by nonsteroid anti-inflammatory drugs (NSAID).
- Mortality is over 50 %.

24.3.2 Gas Gangrene

- Occurs when *Clostridium* or *Bacteroides* infects dead muscle.
  - Often after insufficient surgical exploration, debridement, or trimming of contaminated wounds
- Severe general illness, toxemia, shock.
- Excruciating pain of the involved area.
- Crepitus and foul odor confirm the diagnosis.
- Urgent surgical treatment mandatory.

24.4 Treatment

Dermatitis	Antibiotics
Subcutaneous gangrene	Excision of infected tissues superficial to fascia
	Dressing, (vacuum dressing)
	Skin grafts
	Antibiotics
Myositis	Excision of infected tissues
	Vacuum dressing
	Antibiotics

24.4.1 Surgical Treatment

24.4.1.1 Dermatitis

- Antibiotics
- When doubt exists between and erysipelas and HSSG: surgical exploration by incision targeting the swollen, erythematous area

24.4.1.2 Subcutaneous Gangrene

- Surgical excision of dead subcutaneous tissues and overlying skin.
- Surgical exploration until reaching healthy subcutaneous tissues (because of undermining).
- Dressing of raw area (vacuum dressing is a good option).
- Adjuvant antibiotics.
- Iterative surgery at 24 h (or earlier if the infection progresses) with iterative excision of dead tissues.
- Once infection has resolved, the raw area is managed as a third-degree burn by skin graft.

24.4.1.3 Myositis (HSM and GG)

- Surgical treatment.
- Selective resection of all dead muscles usually allows limb preservation, as, most often, not all muscles are involved.
- Crepitus and gas sometimes present between healthy muscles, so simple opening of the compartments is sometimes sufficient.
- Amputation only considered after surgical exploration of the infected compartments, even if the presentation is dramatic. Uncommonly necessary.
- Vacuum dressings very effective.
- Iterative surgery at 24 h (or earlier if the infection progresses) with iterative excisions of dead tissues.
- Dressings allow progressive closure of the wound and healing, once the infection is healed.
- Skin graft – if skin has been resected because of an associated SG.

The treatment of GG should be preventive:

- *Wound debridement*
- *Exploration of wounds*
- *Complete excision of dead tissues* (*trimming*)
- *Drainage*
- *No tight wound closure*

How to perform a vacuum dressing:

- Cover cruentous areas with calcium alginate dressing (this helps hemostasis and prevents damaging granulation tissue when the dressing is changed).
- Option 1: Use a commercial device (foam, adhesive drape, tubing, and suction device according to the notice of use provided).
- Option 2: Use the "poor man's vacuum dressing":
  - Apply four layers of gauze compress packs.
  - Insert one or two multiperforated drains (Redon or small chest tube, etc.).
    The last layer of gauze compress packs can be attached to the borders of the wound with skin staples.
    If the dressing is applied on a limb segment, the last layer can be replaced by soft band bandage (beware not to create a tourniquet effect).
    - External fixators may be totally included in the dressing (Fig. 24.5).
  - Apply adhesive drape with an overlap of at least 5 cm on healthy dry skin (in case of a limb, try to keep fingers out of the dressing). In difficult areas (groin, perineum, etc.), apply protective stoma skin barrier paste stoma on healthy skin.
  - Attach exit of tube(s) by creating a meso with the drape.
  - Beware: The tube must never be in contact with the skin (risk of pressure ulcer).
  - Connect the tubes to a suction device with a liquid collector (−250 cm H_2O, contrary to the open abdomen, there is no morbidity associated with strong suction).
- Redo the dressing the following day and then, according to the evolution, every 2 days and then every 3 or 4 days.

Fig. 24.5 Vacuum dressing with totally included external fixator

24.4.2 Hyperbaric Oxygen (HBO)

- No evidence of any effect of HBO on the prognosis of soft tissues infections.
- HBO can be harmful when surgical treatment is delayed or limited because of this controversial technique.

Pitfalls

- Delaying surgery performing radiologic evaluation
- Delaying surgery doing HBO
- Inadequate follow-up and insufficient trips to the operating room for debridement

24.5 Summary

- Surgery mandatory in case of severe illness associated to skin infection (even without necrosis).
- Vacuum dressings should be widely used.
- Skin grafts allow healing once infection has been eradicated by surgical excision of dead and infected tissues

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Surgical Emergencies Related to Abdominal Wall Hernias

25

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Contents

Objectives

- Understand the basic anatomy associated with hernias
- Gain an insight on basic epidemiologic facts
- Understand the signs and symptoms and diagnostic steps for incarcerated or strangulated hernias
- Know the basic approaches to various types of incarcerated and strangulated hernias
- Avoid basic pitfalls associated with the diagnosis and treatment of these diseases

25.1 Surgical Anatomy

25.1.1 Abdominal Wall

- Layered structure extending from the xiphoid process and the costal margins superiorly to the pubic symphysis inferiorly
- Musculature:
  - Two *recti abdominis* muscles
    Each runs from the xiphoid process to the pubic symphysis, and its lateral border has a convex shape, which gives rise to the *linea semilunaris*.
  - Lateral abdominal muscles
    Includes three muscles from superficial to deep: the external oblique, the internal

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oblique, and the transversus abdominis muscles.

Medially, continue as tendinous aponeuroses, which, after forming the rectus sheath, end in the midline, where they interwine with the aponeurotic fibers of the contralateral musculature forming the *linea alba*.

The inferior edge of the external oblique aponeurosis gives rise to the inguinal ligament (of Poupart).

The inferiormost fibers of the internal oblique fuse with the lower fibers of the transversus abdominis muscle to form the conjoined tendon.

Deep to the lateral abdominal muscles lies the *transversalis fascia*, just superficial to the parietal peritoneum.

– An important landmark of the anterior abdominal wall, which signifies a transition point in the layers of the rectus sheath, is the *arcuate line*, located midway between the umbilicus and the symphysis pubis.

The rectus sheath is divided in an anterior and a posterior portion.

- Up to the level of the arcuate line:
  - The anterior rectus sheath is formed by the external oblique aponeurosis and the external lamina of the internal oblique aponeurosis.
  - The posterior rectus sheath is formed by the internal lamina of the internal oblique aponeurosis, the transversus abdominis aponeurosis, and the transversalis fascia.
- Below this point:
  - Anterior rectus sheath contains the aponeuroses of all three lateral abdominal muscles.
  - The posterior rectus sheath contains only the transversalis fascia.

Blood supply

- Derived from the superior artery and inferior epigastric arteries, which travel in either posterior rectus sheath and meet approximately at the level of the arcuate line.

25.1.2 Inguinal Region

- Inguinal canal: cone-shaped canal, approximately 4–6 cm long, extending from the deep (internal) to the superficial (external) inguinal ring
  - Deep inguinal ring: opening in the transversalis fascia located approximately halfway between the anterior superior iliac spine and the pubic tubercle
  - Superficial inguinal ring: opening in the medial aspect of the external oblique aponeurosis, just above the pubic tubercle
  - Boundaries:
    Anteriorly, the external oblique aponeurosis and internal oblique muscle laterally
    Posteriorly, the fusion of the transversalis fascia and transversus abdominis muscle, although the latter may be absent in up to one-fourth of subjects
    Superiorly, fibers of the internal oblique and transversus abdominis muscle and their conjoined tendon
    Inferiorly, the inguinal ligament
  - Contains
    - Ilioinguinal nerve
    - The spermatic cord in men
    - The round ligament of the uterus in women
- The *iliopubic tract*: band of connective tissue located deep and parallel to the inguinal ligament, extending from the anterior superior iliac spine to the superior pubic ramus, where it forms the *lacunar ligament* (*of Gimbernat*)
  - Separated from the inguinal ligament by the transversus abdominis and the transversalis fascia
  - Passes below the deep inguinal ring, forming eventually the superior border of the femoral sheath
- Cooper's ligament or pectineal ligament:
  - Extends from the lateral portion of the lacunar ligament
  - Runs laterally for about 2.5 cm along the iliopectineal line and is fused to the periosteum of the pubic tubercle

  - Lies posterior to the iliopubic tract and forms the posterior border of the femoral canal
- Hasselbach's triangle is bounded by:
  - The inguinal ligament inferiorly
  - The lateral border of the rectus abdominis medially
  - The inferior epigastric vessels superolaterally

25.1.3 Femoral Canal

- Bounded by:
  - Iliopubic tract anteriorly
  - Cooper's ligament posteriorly
  - Femoral vein laterally
  - Lacunar ligament medially

25.2 Definitions: Classification of Hernias

- Definition: abnormal protrusion of intra-abdominal contents through a fascial defect in the abdominal wall
  - If the contents of the sac return to the abdomen spontaneously or with manual pressure when the patient is recumbent, the hernia is reducible.
  - If the contents of the sac cannot be returned to the abdomen, the hernia is incarcerated (incarceration does not always imply strangulation).
  - If the blood supply to the incarcerated hernia contents is compromised, leading to necrosis and/or perforation, the hernia is strangulated.
- Special types of hernias include Richter's, Littre's, Amyand's and sliding hernias.
  - Richter's hernia: only part of the circumference of the bowel becomes incarcerated or strangulated in the fascial defect.
  - Littre's hernia: contains Meckel's diverticulum.
  - Amyand's hernia: incarcerated inguinal hernia that contains the appendix.
  - Sliding hernias: a part of the wall of the hernia sac is formed by the peritoneum of an intra-abdominal viscus (typically colon or bladder).

25.2.1 Groin Hernias

- Classifications:
  - Numerous classification systems for groin hernias exist, such as the Nyhus classification, but they are not used in the clinical setting and serve primarily for academic purposes.
  - Based on their location, one defines

    Indirect inguinal
    - Sac passes through the deep inguinal ring, lateral to the epigastric vessels, and crosses the inguinal canal.
    - If the hernia exits into the scrotum by way of the superficial inguinal ring, it is termed *complete*.

    Direct inguinal
    - Visceral protrusion through a weakness in the posterior inguinal wall.
    - The base of the hernia sac is the Hesselbach's triangle, medial to the epigastric vessels.

    In *combined* (*pantaloon*) hernias, direct and indirect hernias coexist.

    Femoral hernias
    - Visceral protrusions through the femoral canal.

25.2.2 Abdominal Wall Hernias (Also Known as *Ventral* Hernias)

- May be congenital or acquired
  - Acquired ventral hernias are further subdivided into incisional and nonincisional (or true ventral hernias).

    Some examples of nonincisional hernias include epigastric, paraumbilical, umbilical, spigelian, and obturator hernias.

25.3 Epidemiology

25.3.1 Groin Hernias

- Comprise approximately 75 % of all abdominal wall hernias.
  - Approximately 96 % are inguinal and 4 % are femoral.
    Inguinal hernias are more common in men than in women (9:1).
    Femoral hernias are more common in women (4:1).
  - The lifetime risk of developing a groin hernia is approximately 25 % in men and 2 % in women.
    Two-thirds of inguinal hernias are indirect.
  - Incidence of an occult contralateral inguinal hernia discovered during laparoscopy may be as high as 22 %.
- 36 % of patients with femoral hernias underwent emergency surgery versus 5 % of those with inguinal (recent study from Sweden).
  - Bowel resection due to compromised perfusion was performed in 22.7 % of emergent femoral repairs and 5.4 % of emergent inguinal.
  - Incarcerated or strangulated femoral hernias increased mortality tenfold.

25.3.2 Abdominal Wall Hernias

- Approximately 10–15 % of abdominal incisions dehisce (incisional hernia)
  - Highest incidence among patients undergoing midline laparotomy with wound infection (up to one-fourth of afflicted patients)
  - May be single or multiple defects
- Umbilical hernias
  - Very common in childhood, especially among African Americans.
  - The vast majority regresses spontaneously in the first 2 years of life.
  - Incarceration or strangulation is relatively common; however, it involves almost always preperitoneal and omental fat – very rarely bowel.
- Paraumbilical hernias (acquired in over 90 % of patient)
  - Major risk factors include obesity, multiparity and cirrhosis.
- Epigastric hernias
  - Estimated incidence of 3–5 %.
  - More common in men.
  - May present as multiple defects along the linea alba.
  - Incarceration occurs very rarely.
- Spigelian hernias
  - Relatively rare but up to 20 % may cause incarceration.

25.3.3 Diagnosis

- Incarcerated and strangulated hernias remain a diagnostic and therapeutic challenge with non-negligible morbidity and mortality.

25.3.3.1 Signs and Symptoms

- Incarcerated hernias
  - May present as an irreducible bulge in the groin or the abdominal wall, usually accompanied by intense local pain.
    Of note, the presence of a bulge may be difficult to appreciate in obese patients.
    It is necessary to carefully examine the entire length of the linea alba or the incision for the presence of additional defects.
  - If there is no obstruction, incarcerated hernias are not considered surgical emergencies per se and, therefore, can be repaired electively.
  - However, can progress to strangulation with bowel obstruction, necrosis, or perforation.
  - If the hernia sac has intestinal contents, the classic signs and symptoms of small bowel obstruction include:
    Colicky, midabdominal, and epigastric pain
    Nausea, and/or vomiting
    Inability to pass flatus and constipation
  - Of note, presence of bowel movements or passage of flatus *does not* exclude bowel obstruction, as there may be residual feces

in the bowel segment distal to the site of obstruction.
  - As the condition deteriorates, patients may gradually develop signs and symptoms of dehydration due to third spacing.
- Eventually, perfusion of the incarcerated segment of bowel may be compromised leading to strangulation and necrosis, manifesting with:
  - Constant and more localized pain
  - Fever
  - Peritoneal signs (abdominal distention, rebound tenderness, and rigidity)
  - And hemodynamic instability
- Locally, at the site of the hernia sac, there may be:
  - Intense pain,
  - Tenderness
  - Erythema
- Diagnostic pitfalls:
  - Richter' hernia (may present with a clinical picture of partial bowel obstruction and still progress to gangrene of part of the bowel wall).
    Consequently, the necrotic portion may perforate, and the rest of the bowel may return spontaneously to the abdominal cavity, leading to peritonitis.
  - Littre's and Amyand's hernias may not cause complete bowel obstruction (and may present with a clinical picture similar to appendicitis, if there is a delay in diagnosis, necrosis may ensue with loss of the integrity of the bowel wall, predisposing the patient to the development of peritonitis).

25.3.3.2 Laboratory Tests: Imaging

- Classically, metabolic acidosis and/or elevated WBC count have been considered as indicators of ongoing strangulation and/or necrosis.
  - However, WBC >12,000 alone has a sensitivity of 45 % and a specificity of 74 % in predicting strangulation, meaning that in more than 50 % of cases, the patient may have WBC <12,000.
- Radiographic findings on plain X-ray (first investigation to perform, and if suggestive, these patients require immediate surgery without further investigations) include:
  - Air-fluid levels of differential height in the same loop
  - Air-fluid width ≥25 mm
- However, if radiography is equivocal or negative, other diagnostic imaging modalities must be sought.
  - Computerized tomography (CT) with IV and PO contrast (investigation of choice).
    Not only demonstrates obstruction with a greater sensitivity and specificity compared to plain abdominal radiography
    But can also aid in the diagnosis of strangulation of the bowel
    - The most significant independent predictor of bowel strangulation is the CT finding of reduced wall enhancement (sensitivity 56 %, specificity 94 %).
    - A combination of guarding, WBC >12,000, and CT showing reduced bowel wall enhancement has a 100 % specificity but is not commonly found.
  - Lastly, abdominal ultrasound is considered less sensitive and specific than CT.

25.3.4 Treatment

- Sliding, incarcerated, and especially strangulated (within 4–6 h) hernias are considered surgical emergencies.
  - Studies have shown a significant increase in bowel resections as well as morbidity and mortality after the first 6 h from the onset of strangulation.

25.3.4.1 Preoperative Management

- Every effort should be made to maximize preoperative resuscitation of the patient (even in strangulation), including:
  - Nasogastric tube placement
  - IV resuscitation

– Preoperative broad-spectrum antibiotics case of suspected perforation but not routinely

25.3.4.2 Operative Management

- The principles of repair (of incarcerated and strangulated hernias) are the same regardless of the type of hernia and include:
  1. Identification of the hernia sac
  2. Opening the sac and examination of contents
  3. Excision of nonviable segments of bowel followed by immediate end-to-end anastomosis (in the absence of peritonitis)
  4. Reduction of contents
  5. Excision of the hernia sac
  6. Closure of the defect
- Most surgeons advocate the open approach for the repair of incarcerated or strangulated hernias.
  – The preperitoneal approach should be reserved only for patients in whom bowel necrosis is ruled out with 100 % certainty. Since this is usually not the case in emergency surgery, we recommend that the hernia sac is always opened to examine bowel viability and integrity.
- Recent publications have advocated the use of laparoscopic techniques for the treatment of incarcerated hernias. However, only small case series or case reports have been published so far, which precludes extraction of safe and meaningful conclusions applicable to everyday practice.

Specific Indications and Techniques According to Type (Site) of Hernia

- Inguinal and femoral hernias
  – The open approach allows for direct visualization of the afflicted bowel segment as well as for a better assessment of viability through a single incision.
  – Of particular concern: spontaneous reduction of the hernia contents into the abdomen upon induction of general anesthesia and relaxation of the abdominal muscles.

  While, on occasions, the bowel can be retrieved and examined through the hernia defect, routine exploration of the abdominal cavity is recommended to avoid the catastrophic consequences of a missed bowel perforation.
    - Either by laparoscopy or by laparotomy, both are performed after hernia repair.
  – During hernia repair, the constricting ring, once identified, can be incised to allow for better mobilization of the herniated contents.

  When the incarcerated contents of a femoral hernia cannot be reduced, dividing the lacunar ligament can be helpful.
  – Repair options include:
    1. Tension-free mesh repair
       - The standard of reference in the absence of contamination.
       - Lichtenstein technique is not indicated for femoral hernia repair; the iliopubic tract should be approximated to Cooper's ligament.
    2. Primary tissue repair (Shouldice, Bassini, or McVay technique)
       - Preferred when contamination exists
    3. Biologic meshes
       - Provide excellent tolerance to infection.
       - But the long-term durability is unknown.

  No level 1 evidence
    - Sutures versus biological glue
    - Sutures versus staples or tackers

Incisional Hernias

- Same two main options for repair:
  – Primary tissue repair

  Mode of preference if the defect is less than 2–3 cm and has viable surrounding tissue.

  If larger, recurrence is frequent and mesh repair should be considered.

  Can be achieved by:
    - Simple suture repair
      – Inspect the entire length of the incision to eliminate the presence of multiple defects.

  - Freshen the edges of the fascia.
  - Interrupted nonabsorbable sutures.
- Or mesh repair
  - Prosthetic mesh in non-contaminated environments
  - Biologic mesh in contaminated cases
    However, remember that recurrence and costs are high.

Umbilical and Other Hernias

- Primary tissue repair continues to constitute the standard of care, especially in the case of small incarcerated hernias such as epigastric, umbilical, and spigelian hernias.
- Regarding the type (site)
  - Umbilical hernias: sac is opened and excised; the fascial edges are freshened and approximated with nonabsorbable suture.
    One prospective randomized study from the Netherlands has shown that a mesh leads to less recurrences compared to primary suturing without increasing the likelihood of wound infections.
  - Epigastric hernias
    Typically contain only preperitoneal fat or omentum
    Are small and can easily be fixed primarily with a few interrupted sutures
  - Spigelian hernias
    Require a transverse incision over the defect and are almost always repaired primarily.
    Laparoscopic repair offers a better visualization of the defect.

Giant Ventral Hernias (Usually Defined as a Defect That Is Larger Than 10×10 cm^2)

- Usually results from long-term management of the open abdomen (rare causes include severe infection of the abdominal wall requiring extensive debridement; multiple small defects (Swiss cheese), requiring coverage of the entire area; and recurrent or neglected hernias).
- Rarely complicated.
- Two main repair techniques exist (in isolation or in combination).
  - The component separation technique
  - Use of mesh
    Prosthetic in the absence of contamination
    Biological in the contrary case

25.3.4.3 Postoperative Care and Complications

- Mortality is primarily related to the presence of serious comorbidities and the necessity for bowel resection in the case of necrosis.
- Complications associated with the procedure include:
  - Short-term complications
    Hematoma
    Seroma
    Mesh and wound infections
    Chronic neuralgia
    Orchitis
    Various pain syndromes
  - Long-term complications
    Recurrent or persistent seroma formation
    Chronic pain
    Hernia recurrence

Pitfalls

- Omission of thorough examination of the groin and abdominal areas in any case of suspected small bowel obstruction
- Unnecessary delay in surgical treatment of suspected strangulation for more than 4–6 h
- Attempting to reduce an incarcerated hernia if suspecting strangulation
- Failure to promptly recognize Richter's hernia
- Relying only on WBC count or CT scan for the diagnosis of strangulation
- Inadequate mobilization of the ilioinguinal and iliohypogastric nerves and the spermatic cord during repair of inguinal hernias

Essential Points

- Cannot rely on WBC count for the diagnosis of strangulation – <12,000 in more than half of the cases.
- Use of a mesh in inguinal hernias is the preferred method of repair, unless severe contamination of the operating field is present.
- Must proceed to surgical treatment of suspected strangulated hernias immediately, to decrease the incidence of necrotic bowel excision.
- Giant abdominal hernias have increased in frequency. The techniques of component separation and large mesh use should be included in the armamentarium of the emergency surgeon.

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Thoracic Emergencies

26

François Pons and Federico Gonzalez

Contents

Objectives

- Recognize patients requiring a needle thoracocentesis or an emergency chest tube insertion
- Perform safe thora(co)centesis or chest tube insertion
- Recognize when a patient needs an emergency pericardiocentesis
- Perform a subxiphoid pericardial window

Every general surgeon should be able to manage the following non-trauma chest emergencies:

- Tension pneumothorax
- Pleural effusions (compressive or empyema)
- Cardiac tamponade

26.1 Pneumothorax

26.1.1 Tension Pneumothorax

26.1.1.1 Causes

- Pneumothorax may occur spontaneously in non-trauma patient without apparent chronic lung disease (primary). This is usually subsequent to ruptures of small pulmonary blebs.

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- Pneumothorax may also occur in patients with chronic lung disease ("secondary"); e.g., emphysema, tumors. In that case, the rupture involves bullae or diseased pulmonary parenchyma.

26.1.1.2 Diagnosis

- Main symptoms:
  - Chest pain and shortness of breath
  - High-pitched sounds on percussion
- Chest X-ray: confirmation of pneumothorax and determination of volume
- Tension pneumothorax (one-way air leak)
  - Rare
  - May lead to respiratory distress, oxygen deprivation, tachycardia, hypotension, tracheal deviation, and cardiac arrest
    Specifically when there is preexisting impaired lung function

26.1.1.3 Indications

- When symptoms are severe, urgent insertion of chest tube is needed.
  - Initial management by needle decompression is easy and allows to gain time.

26.2 Liquid Pleural Effusions

26.2.1 Types of Effusion and Causes

- Blood: primary spontaneous hemothorax (can occur in patients under anticoagulant treatment).
- Pus: thoracic empyema (or pyothorax) can be responsible for poor clinical status and respiratory failure.
- Serous liquid: secondary to pulmonary infection, pulmonary embolism, cancers, etc.

26.2.2 Diagnosis

- Relies on symptoms (dyspnea, chest pain), chest percussion, chest X-ray, and CT scan.
  - Symptomatology depends on the volume of the collection.
- Pleurocentesis can identify the nature of the aspirate (blood, pus, serous liquid, transudate, exudate, etc.)

26.2.3 Indications

- Most pleural effusions can be managed initially by medical physician's referral to thoracic or cardiovascular surgeon and may be necessary according to the type and nature of the pathology.
- Two circumstances require urgent treatment:
  1. Respiratory failure (dyspnea, cyanosis, hypoxemia, etc.); insert a chest tube promptly
     - Pleurocentesis can improve the clinical status of the patient before the chest tube is inserted.
  2. Purulent collections found on pleurocentesis or empyema
     (a) Definitions:
        i. Empyema means pus in a natural cavity.
        ii. Thoracic empyema means pus in the pleural cavity.
     (b) Diagnosis can be
        i. Frank pus is found
        ii. Or demonstration of organisms by direct examination or culture
        iii. And/or biochemical criteria such as pH <7.2, WBC >15,000, LDH >1,000 IU/ML, and glucose <400 mg/l
- Chest tube thoracotomy with IV antibiotics
  - Thoracocentesis constitutes the first step of the treatment.
    May be sufficient (success rate is 70 %)
  - Should be followed by drainage thoracostomy
    To allow complete evacuation of accumulated pus
  - In case of failure (multiloculated effusion) and according to the stage of the empyema, surgery is necessary.
    To clean the pleural cavity
    To perform decortication as needed (Fowler-Delorme procedure)
    - Can be performed via VATS or thoracotomy
    - Referral to specialized centers and/or surgeon preferable

26.2.4 Thoracentesis (Also Called Thoracocentesis or Pleurocentesis) and Chest Tube Insertion

26.2.4.1 Thoracocentesis or Pleurocentesis (Pleural Tap)

- Equipment:
  - 20 cc syringe
  - Intramuscular (IM) needle
  - Xylocaine
  - 20 gauge catheter or better, a Veress needle
    Longer and reaches the pleural collection easily when the chest wall is thick.
    Retractable tip limits the risk of lung puncture.
- Puncture site
  - Pneumothorax best exsufflated in second costal interspace, just anterior to the midclavicular line.
  - In obese patients with thick chest wall, lateral approach in the fourth costal interspace anterior to the midaxillary line is preferred.
  - Fluid collection best treated by a posterior approach, just in the middle of area of matted percussion with patient sitting upright on the bedside and leaning forward on a table and arms over a pillow.
- Procedure
  - Anesthetize the chest wall from the skin to rib cage.
  - Infiltrate periosteum along the top edge of the selected rib.
  - Maintain continuous aspiration on the syringe when entering the pleural space.
    *Aspiration of air or pleural liquid confirms the correct position of the needle.
- Safety measures
  - Pleurocentesis safe at the upper edge of the rib since the interspace vessels are at distance.
  - It is critical that the patient holds his/her breath to avoid piercing the lung.

26.2.4.2 Chest Tube Insertion

- Equipment:
  - A straight drain (silicone or PVC) is generally used.
    Drains can be inserted with or without trocar and different devices exist.
    - The Joly-type trocar
      - Made of a sharp and large needle inserted in the drain lumen.
      - The whole device acts as a trocar and is inserted in the pleural space.
      - Is dangerous as the tip of the trocar is sharp and an uncontrolled push may puncture the lung, therefore the use of this device should be avoided.
    - The Monod-type trocar
      - Trocar sheath contains a blunt needle allowing the insertion of the device safely deep inside the pleura (devices with sharp needle should be avoided).
  - Some specific medical devices can be placed under ultrasound control by the Seldinger technique (Pleurocath®, Pigtail catheters).
  - The size of the tube remains empiric.
    Current trend is to use smaller guidewire-inserted drains, but randomized studies are required to confirm safety and efficacy.
    Classical tube sizes are 20 F or 24 F for pneumothorax and 28 F or 32 F for empyema.
- Site of drainage:
  - Typically inserted in the third or fourth interspace on the midaxillary line.
  - When collection is not dependent, a CT or ultrasound scan can help locate the optimal site of drainage.
- Procedure:
  - Patient supine, arms in abduction
  - Table prepared for the sterile equipment.
  - Drains, trocars, connecting tubes, and water seal packs are checked, prepared, and should be ready to be connected before the skin incision.
  - Landmarks and anesthesia:
    Identical to those for pleurocentesis
    Adapt length of needle to chest wall thickness (long needle needed for obese)

Beware of absence of dependence of pleural effusion due to pleural adhesions
- Withdrawal of blood mixed with air means lung puncture.
  - Change to another site

– Drain introduction
1.5–2 cm skin and subcutaneous fat incision parallel to upper edge of selected rib
Create channel through muscles with blunt forceps (Kocher or Roberts) until reaching the elastic and firm consistence of the pleura
- This step may be slightly uncomfortable for the patient despite the local anesthesia.

Push closed forceps a few millimeters more in a firm but controlled manner, then open to enlarge the pleural opening and the muscular chest wall track
Retrieve forceps retrieved
Enlarge channel, clear potential adhesions, and control sudden issue of fluid with gloved finger
Insert trocar (Monod) or tube perpendicularly then guided posteriorly and upward
Retrieve blunt shaft
Clamp the proximal end of thoracotomy tube
Advance tube into pleural space to the desired length (10–15 cm)
Remove trocar sheath, maintaining drain in place
Connect drain to water seal container before releasing clamp and applying controlled depression (20 cm water)
Fix drain to skin with a mattress "U" stitch (as effective as a purse-string stitch and will make a more cosmetic scar)
- Add stay stitch to close the skin for the drain removal.
- Extra stitches will ensure fluid or air tightness if necessary.
- Have an assistant carefully maintain the drain in place while stitching it to the skin and connecting to the water seal container.
- Follow-up: chest X-ray and CT scan are systematically performed.
- Pitfalls and difficulties:
  - Abutting on the cage rib and insertion of tube out of the chest cavity or between the pleura and the rib cage make progression laborious and painful.
    Many types of visceral injuries have been reported (lung, heart, liver, etc.).
  - Aspiration of liquid or air in the pleural space during local anesthesia.
  - Adequate length of skin incision guarantees for a safe and appropriate placement of the chest drain.

26.3 Pericardial Effusion and Cardiac Tamponade

26.3.1 Causes

- May be seen in association with cancer, infections (viral or bacterial), or various inflammatory conditions.
- Neoplastic and bacterial pericarditis are the most common causes of cardiac tamponade.

26.3.2 Diagnosis

- Development may be progressive and asymptomatic despite a large volume.
- Rapid development is poorly tolerated (even for small volumes) and can lead to tamponade.
  - Cardiac tamponade is suspected on signs like pulsus paradoxus, tachycardia, venous pressure elevation, hypotension, diminished heart sounds, low voltage ECG.
  - The chest X-ray can show an enlarged pericardial sac.
  - But diagnosis relies on echocardiogram.

26.3.3 Indications for Emergency Pericardial Drainage

- Not all pericardial collections require emergency drainage.
- Cardiac tamponade requires urgent treatment.
  - Pericardiocentesis grounded on echocardiogram (even in the absence of clinical tamponade)

And especially with signs of right ventricular diastolic collapse and/or right atrial collapse

- Optimal treatment of symptomatic pericardial effusions remains controversial.
  - Different procedures may be used.

Percutaneous pericardiocentesis:

- Blind pericardiocentesis carries a risk of myocardial injury.
  - Should be reserved for patients with life-threatening hemodynamic instability and absence of echography
  - Best performed under ultrasound or electrocardiography
  - Requires presence of trained and expert personnel
    - Cardiologist or a surgeon knowledgeable in echocardiography

    Needle site entry can be subxiphoid or transthoracic.
  - Advantage: avoids general anesthesia
  - Drawback: is associated with an increased recurrence rate (60 % according to some authors) and does not allow visualization and biopsy of the pericardium

The subxiphoid approach

- The most common approach
  - Insert 18 gauge catheter attached to 20 ml syringe through skin incision made a few millimeters inferior and to the left of the xiphoid process
  - Direct needle to posterior aspect of left shoulder, at approximately 30° angle

    Goal: enter the pericardium underlying the right ventricle
  - Flashback of pericardial fluid in the syringe means the needle has entered the pericardial sac.
- After pericardiocentesis, a drain may be inserted into the pericardial sac using a guidewire and a dilator as needed.

26.3.4 Pericardial Drainage (or Pericardiostomy)

- Allows
  - Placement of a larger tube
  - To break loculations with a finger or a suction device
  - Pericardial biopsy (useful to guide further treatment)
- Associated with lower recurrence rate
- Can be done via a subxiphoid (local anesthesia if necessary) or transthoracic approach (anterior thoracotomy or VATS)
- Aim: evacuate the collection, improve heart function, and sometimes ensure the diagnosis with pericardial biopsies and lab tests on the aspirate

26.3.4.1 Patient Position and Operative Setup

- Skin preparation and draping can be performed with patient sitting (semi-Fowler position), arms hanging, and when declivity is not well tolerated.
  - Operating field runs from the abdomen to the neck allowing a sternotomy if necessary.
  - Operator stands on the right with assistant opposite.
  - Surgical equipment:

    Langenbeck-type retractors.

    Toothed clamps (Bengolea or Kelly).

    Scissors.

    Dissecting forceps.

    N°11 scalpel blade on a long handle.

    A Veress needle will be of help to perform pericardiocentesis.

    Sternotomy instruments should be available in the room.
  - Anesthetic induction is a critical phase with a risk of sudden cardiac arrest specifically during intubation: all should be ready to intervene rapidly if necessary (clear leadership and calm and effective communication between the anesthetist team and the OR nurses are paramount.
  - In some circumstances, pericardiocentesis under local anesthesia is the first step allowing to optimize patient hemodynamics and safer anesthetic induction.

26.3.4.2 Procedure

- 6–8 cm incision centered on the xiphoid appendix, involving the lower part of the sternum and the upper part of the linea alba.

- Open linea alba.
- Blunt finger dissection keeping close contact with posterior aspect of xiphoid process, cephalad then to the left and laterally until reaching the yellowish pericardial fat covering the underlying grayish pericardial sac.
  - Place Langenbeck-type retractors placed under the sternum and the ribs to lift rib cage.
  - If recognition unclear, progressive, careful palpation (searching for heart beats) or cautious pericardial puncture (Veress needle).
  - Muscular insertions may be coagulated.
  - Depending on the patient anatomy, appendix may have to be resected (by electrocautery, scissors, or gouge forceps) when access to the pericardium is impaired.
- Inform anesthesiologist when opening the pericardial sac as patient hemodynamics may change dramatically.
- Grasp pericardial sac between two forceps, creating a fold which is incised with the tip of the scissors or the scalpel.
- Retrieval of liquid for culture, cytology, and chemistry.
- Create wide pericardial window (2 × 2 cm) to:
  - Aspirate all pericardial contents (false membranes and pockets of fluid may occur in infected pericarditis)
  - Explore the sac (nodules, vegetations, etc.)
  - Inspect external aspect of the heart
  - Insert silicone pericardial drain (20–24 French gauge)
- Retrieve sufficient specimen for histology.
- Leave pericardium open.
- Drain exits through a counter incision at either lateral aspect of the initial incision and connected to a dependent non-aspirating collector.
- Close linea alba and skin.
- Of note: opening the peritoneum is of no consequence.
- Postoperative prescriptions include:
  - Chest X-ray or an ultrasound scan
    Residual collection is frequent and should not worry the surgeon nor the patient.
  - Removal of drain on day 2 (some authors advocate day 4 or 5 in case of neoplastic pericardial effusion)

Nota Bene

- Both echocardiography-guided pericardiocentesis or pericardial open drainage are best dealt within a thoracic or a cardiovascular environment.
- When specialized surgeon is not available, pericardial drainage must be performed by a general surgeon.
- Secondary evacuation of a patient with cardiac tamponade is very dangerous with high risk of en route death.
- If the echography-guided pericardiocentesis is impossible, or not efficient, or if the surgeon is more comfortable with a surgical approach, the most common and simple procedure is the subxiphoid pericardial window.

Pitfalls

- Needle thoracocentesis: needle is too short = use Veress needle
- Chest tube: pleural adhesions, puncture of the lung = change site, use ultrasound
- Empyema: thoracocentesis alone is not enough
- Pericardial effusion and tamponade: failing to evacuate patient to a specialized center
- Not performing surgical open drainage in absence of expertise in echocardiography
- Insufficient exposure in subxiphoid pericardial window: routine resection of the xiphoid appendix

26.4 Summary

Non-trauma thoracic emergencies are pneumothorax or pleural effusion with impaired breathing, thoracic empyema, and pericardial effusions with cardiac tamponade. Tension pneumothorax or pneumothorax with respiratory failure (underlying lung disease) requires urgent drainage sometimes after needle thoracocentesis. Pleural effusions can contain blood (spontaneous hemothorax), serous fluid, or pus (empy-

ema). Urgent drainage is indicated in case of respiratory failure. Chest tube insertion with IV antibiotics constitutes the first step for emergency treatment of thoracic empyema. Non-trauma pericardial effusions are associated with cancer, infections (viral or bacterial), or various inflammatory conditions. Symptomatic pericardial effusions (clinical and/or echocardiographic signs of cardiac tamponade) require urgent pericardial drainage that can be performed either by a percutaneous pericardiocentesis (echocardiography guided) or by a surgical pericardial window: optimal treatment remains controversial, but subxiphoid pericardial window is the most common and most simple procedure for a general surgeon, especially if not knowledgeable in echocardiography.

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Vascular Emergencies

27

Luis Filipe Pinheiro

Contents

Objectives

- Define peripheral vascular emergency
- Identify a non-trauma vascular emergency
- Identify manifestations of acute blocked arteries
- Discuss the best management by a general surgeon
- The ruptured abdominal aortic aneurysm and the general surgeon

General surgeons who do not perform elective vascular surgery may be concerned about dealing with vascular emergencies, because clinical governance will no longer support surgeons practicing outside their normal scope of practice. This may be why simple vascular procedures are no longer taught in general surgery training in many European countries. However, there are not enough vascular surgeons to provide formal emergency care in most hospitals. On the other hand, the evolution of endovascular therapies has had an extraordinary impact on vascular surgery, widening and transforming the horizons of surgery.

The management of acute arterial occlusion remains a challenge for vascular (and nonvascular) specialists. Surgical thromboembolectomy and bypass grafting were the mainstays of therapy for many years. Subsequently, thrombolytic

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therapy and percutaneous transluminal angioplasty (PTA) have become treatment options for selected patients.

Despite these advances, the morbidity, mortality, and limb loss rates from acute lower extremity ischemia remain high. Thus, regardless of the treatment modality used, early diagnosis and rapid initiation of therapy are essential in order to salvage the ischemic extremity.

General surgeons must be prepared to face vascular emergencies in hostile environments and adverse circumstances, in order to guarantee patient and limb survival. The most severely ischemic (no audible arterial Doppler) limbs require emergent treatment if significant permanent damage is to be avoided.

Most of the data for transfer of patients with leaking aneurysms have shown no adverse effect of transfer time or distance on survival. Transfer is likely to select out the patients most likely to survive, and specialty units have reported good results when dealing with patients who have survived transfer over long distances. Nevertheless, general surgeons and hospitals must be prepared to manage ruptured abdominal aortic aneurysms (AAA) when hemodynamic stability cannot be achieved.

Acute limb ischemia and ruptured AAA are probably the most common vascular emergencies that arrive at an emergency service.

27.1 Acute Ischemia

- Cause: sudden deprivation of adequate blood flow to the distal parts of the extremity.
- If untreated, leads to a definitive compromise of tissue viability which threatens the limb or the patient's life.
- The etiology of ischemia determines the management.
  - Embolism is usually best treated by embolectomy.
  - Arterial thrombosis may require more sophisticated vascular techniques.

Table 27.1 Summary of some clinical findings differentiating the etiology of the two entities

Embolism	Thrombosis
No previous symptoms	History of claudication
Obvious source of emboli (atrial fibrillation, myocardial infarction, aorta, popliteal aneurysm)	No source of emboli (atheromatosis, vessel stenosis)
Sudden onset	Long history
Normal contralateral pulses	Lack of pulses
Severe ischemia	Less severe ischemia
No signs of chronic ischemia	Signs of chronic ischemia

27.1.1 Embolism and Thrombosis

- Embolism
  - Usually occurs in healthy arteries, with an identified embolic proximal source (cardioarterial or arterio-arterial)
  - Causes immediate limb or life-threatening ischemia and requires urgent restoration of blood flow
- Thrombosis
  - Typically occurs in an extremity (leg) with previous chronic arterial disease (atherosclerotic or inflammatory), often multi-segmental, with well-developed collateral circulation
- However, if an embolus lodges in an atherosclerotic artery, this makes embolectomy more difficult with higher risk of early arterial obstruction and limb loss (Table 27.1).

27.1.1.1 Clinical Signs and Symptoms

- Irrespective of the presence of embolism or thrombosis, the symptoms and signs of acute ischemia are usually associated to the "6 Ps," whose intensity, particularly related to sensory and motor function, correlates quite well with the severity of the ischemic process.
  - **Pain** – Severe, continuous, and localized initially more distally in the extremity.
  - **Pallor** – The ischemic extremity is pale and appears to be "empty" with skinfolds,

Table 27.2 Classification of severity of ischemia

	Limb	Sensibility	Motor function	Arterial Doppler signal	Venous Doppler signal
I	Viable	Normal	Normal	Audible (>30 mmHg)	Audible
IIa	Marginally threatened	Decreased or normal in toes	Normal	Not aud.	Audible
IIb	Immediately threatened	Decreased even in toes	Moderately affected	Not aud.	Audible
III	Irreversibly damaged	Extensive anesthesia	Paralysis rigor	Not aud.	Not aud.

but may become cyanotic with worsening ischemia.
- **Pulseless** – When in doubt, as in diabetic or obese patients, an ankle blood pressure can be measured with a continuous Doppler device.
- **Paresthesia** and **paralysis** – The nerve fibers (sensory and motor) are very sensitive to ischemia, and loss of motor function must be interpreted as a sign of marked severity or eventually irreversible ischemia.
- **Poikilothermia** – Low skin temperature remains constant regardless the surrounding temperature (Table 27.2).

27.1.1.2 Decision Making

- If limb is irreversibly damaged, the best option is urgent amputation.
  - For evaluation of irreversibility, do not rely on time of ischemia, but rather on motor function and venous Doppler signal.
- If the limb is viable or marginally threatened, consider to treat or transfer the patient to a vascular specialized unit, depending on the local resources and individual experience.
  - If the limb is immediately threatened, the patient should be prepared for emergent operation.
  - When there is no cyanosis and motor function is normal (marginally threatened extremity), there is time for immediate angiography followed by thrombolysis or operation.
  - The surgeon needs to be aware of the need to perform a complete vascular reconstruction. Bypass to the popliteal artery or a calf artery will be required to restore circulation particularly in cases of thrombosis.
    In the vast majority of cases of embolism, embolectomy is usually the procedure of choice.
  - In cases requiring a transfer to higher level of care, initiating systemic heparinization prior to transport is indicated.

27.1.1.3 Embolectomy

- Embolectomy with balloon catheters (Fogarty catheters)
  - One of the most common emergency vascular operations.
  - Does not require experience in complex vascular procedures.
  - Before using, check the balloon by insufflation of a suitable volume of saline.
  - External markers of the relationship between the catheter length and important anatomical structures should be recognized.
    For example, the aortic bifurcation is located at the level of the umbilicus.
    The popliteal trifurcation is located approximately 10 cm below the knee joint.
    The catheters have centimeter markings, which simplify the orientation.
- Principles are the same for upper and lower limb.
- Incisions.
  - For the upper limb, the brachial artery
    Is exposed by medial incision, middle third of the arm, parallel to the biceps gutter

Is controlled proximally and distally with vessel loops or Rummel tourniquets
Make a transverse arteriotomy

– For the lower limb, the common, superficial, and deep femoral arteries
Are exposed by longitudinal incision in the skin
Make a short longitudinal arteriotomy (about 15 mm)
  - Placed over the origin of the profunda artery so it can be inspected and cleared
  - Longitudinal arteriotomy preferable because it can be used as the site for the inflow anastomosis of a bypass

For proximal embolectomy, a # 4 or 5 Fogarty catheter is used.

- Insert the catheter proximally; prevent excessive bleeding via the arteriotomy by applying tension on the vessel loop or by a thumb–index finger grip over the artery and the catheter.
- The catheter should be inserted both proximally (beware of immediate gush) and distally (#3 or #4 catheter is recommended).
  – Typically, an embolus can be passed with only slight resistance.
  Traction must be gentle, parallel to the vessel axis.
  Repeat the maneuver until
    - The catheter no longer retrieves embolic material.
    - There is an acceptable backflow from the distal vascular bed
- After successful embolectomy, flush proximally and distally with 20 cc of heparinized warm saline
- Arterial closure: 5/0 polypropylene, with a running suture, catching the distal intima to avoid further dissections
- Completion on table angiogram highly recommended

27.1.1.4 Postoperative Management

Anticoagulation

- Intravenous or low molecular weight heparin
  – Helps prevent recurrent embolization and the propagation of thrombus in small vessels not directly cleared by the embolectomy catheter
- Continue systemic heparin anticoagulation until the patient is fully ambulatory.
- Oral warfarin anticoagulation is also initiated 5–7 days before heparin administration is discontinued and continued indefinitely unless the primary embolic source has been definitively corrected.
- All efforts should be attempt to uncover a potentially correctable source of the embolus.

Reperfusion Syndrome

- Can be expected after every successful revascularization, particularly in advanced situations (prolonged ischemic times)
  – Venous effluent contains greater amounts of myoglobin, free hemoglobin, creatine kinase, potassium, and lactic acid that can lead to acute renal failure, acidosis, and hyperkalemia with arrhythmia.
- The best prevention is urgent restoration of flow.
- In selected cases, techniques of controlled reperfusion can be used.
  – Principle:
    1. Proximal femoral artery/vein occlusion
    2. Cannulation of saphenous/femoral junction and superficial femoral artery
    3. Infusion of arterial bed with 1,000-cc heparinized (10.000 U) warm saline
    4. Retrieve blood and small vein clots from the venous bed (±1,000 cc)

5. Simple ligate saphenous/femoral junction and open clamp
6. Close the arteriotomy and remove clamp. The patient must be closely monitored after this procedure.

Compartment Syndrome

- Secondary to acute inflammation in the muscle after reperfusion
- Typical signs and symptoms: intense pain, diminished sensation, tension, taut and bright skin, excruciating pain, or impossible movement
  - If the patient is anesthetized or in ICU, an intracompartment pressure measurement should be performed.
  - Fasciotomy is advised with pressures around 25–30 mmHg.
  - In case of doubt, the decision to perform a four compartment fasciotomy should be based on clinical suspicion.

Technique of Fasciotomy

- Medial incision, 25–30 cm long, about 1–2 cm posterior to the medial border of the tibia: this leads to opening the superficial and deep posterior compartments widely and separately
  - Attention should be paid to the great saphenous vein.
- Anterolateral incision, 25–30 cm long, about 2 cm anterior to the shaft of the fibula: this leads to open widely the anterior tibialis muscle fascia and the lateral compartment separately.
  - Leaving a cutaneous bridge of 10 cm with the previous incision.
  - Attention should be paid to the superficial peroneal nerve that lays immediately below the fascia.
- The incisions must be left open with moisture dressings.

27.2 Ruptured Abdominal Aortic Aneurysm (rAAA)

- Generalities
  - Likelihood of rAAA influenced by:
    Aneurysm diameter (risk increases markedly when greater than 5.5 cm)
    Rate of expansion (the quicker, the higher the risk)
    Gender (more common in males)
  - Although evidence shows that outcomes are better when these patients are treated by vascular specialists, all general surgeons have to operate on cases of rAAA some time in their careers.
- The table below should guide management.

Pain	Hemodynamic instability	Pulsatile mass	Clinical diagnosis	Measures
Yes	Yes	Yes	Ruptured AAA (classic triad)	OPERATE!
Yes	Yes	No	Rupture suspected History of AAA	Consider US, CT OPERATE!
Yes	No	Yes	Possible rupture Inflamatory aneurysm?	TRANSFER TO A VASC. UNIT
Yes	No	No	Contained rupture? Dificult exam?	TRANSFER TO A VASC. UNIT

- Manage volume depletion initially with intravenous crystalloids, caution taken not to overhydrate the patient or dramatically increase the systolic blood pressure.
- After diagnosis is made or a decision to operate is made, it is advisable to start blood component transfusion immediately (red cells and plasma) instead of continuing with crystalloid resuscitation only.
  - Goal: maintain systolic blood pressure at 70–90 mmHg
    Perfusion of the heart, brain, lungs, and kidneys, but not causing any newly formed clot to rupture
  - But, if the patient is unstable, transfer immediately to the OR.
    Aim: control the bleeding as a damage control procedure or as the first stage of definitive treatment

27.2.1 Operation

- Prep from neck to knees
- Check and have ready:
  - Adequate blood supply
  - Dacron prosthesis 16–22 mm, straight and bifurcated
  - Aortic clamp (Satinsky type)
  - Double-armed Prolene 3/0
  - Excellent light
  - Complete general surgery and vascular instrument sets
  - Assistants
- Place gastric tube and urinary catheter
- Perform a long midline xipho-pubic incision

27.2.1.1 Proximal and Distal Control

- Proximal
  - Eviscerate the small bowel to the right
  - Incise the retroperitoneum up until the left of the ligament of Treitz (divided as necessary) until reaching the white and smooth surface of the aorta
  - Expose the aneurysmal by blunt dissection on both sides of the aorta with the index and the middle fingers until just below the renal arteries
    Identify the left renal vein
  - Apply aortic clamp above the aneurysm
- If profuse bleeding occurs during dissection, temporary control can be obtained by:
  - Manual compression of the aorta against the spine
  - Proximal occlusion with a 24-French Foley catheter with 15–20 ml of saline
  - Clamping the subdiaphragmatic aorta through the lesser omentum (caution: esophagus and the vagus nerves may be at risk and within the hematoma)
- Distal: locate and clamp both iliac arteries with angulated or straight DeBakey clamps or with Foley balloon occlusion

27.2.1.2 Definitive Repair

- Open aneurysm longitudinally.
- Remove mural thrombus.
- Suture ligate the lumbar artery ostia (usually three pairs) with simple figure-of-eight sutures.
- Anastomose Dacron prosthesis of adequate size proximally with double-armed 3/0 Prolene (running suture).
- Move clamp from the aorta to prosthesis.
- Before closing distal anastomosis, release iliac clamps to allow clearing of clots and debris.

27.2.1.3 Postoperative Care (in the ICU)

1. Avoid hypothermia
2. Antibiotic prophylaxis (pre-op and 72 h postoperatively)
3. Control coagulation
4. Control acidosis and electrolyte imbalance
5. Optimize renal function
6. Monitor intra-abdominal pressure
7. Avoid ACS (abdominal compartment syndrome)
8. Check for distal pulses frequently

Pitfalls

- Failed embolectomy – embolism vs. thrombosis.
- Intimal lesion during the procedure.
- Early reocclusion – technical error? Hypercoagulation status?
- Delayed fasciotomy.
- Failure to control hemorrhage in ruptured AAA.
- Abdominal compartment syndrome after ruptured AAA repair.
- General surgeons must have training in elective vascular procedures.

27.3 Summary

- Recognize a threat to limb or life
- Identify the type of acute occlusion
- Always get proximal and distal control
- Always try to get some experienced help
- Check for "palpable" results after repair
- If in doubt, use on table angiography

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