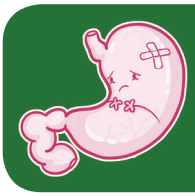

NOTES
INTESTINAL DISEASES

GENERALLY, WHAT ARE THEY?

PATHOLOGY & CAUSES

- Diseases preventing adequate digestive system function
  - Often involve inflammation, stasis, obstruction, necrosis
- Various structural, functional etiologies

SIGNS & SYMPTOMS

- Abdominal symptoms etiologically-dependent
- Abdominal pain, distension, constipation, bowel-habit change, hematochezia, nausea, vomiting
- Bulging abdominal mass (in hernia)

DIAGNOSIS

DIAGNOSTIC IMAGING

- CT scan, MRI, ultrasound

OTHER DIAGNOSTICS

- Right lower-quadrant pain common differential (see mnemonic)

TREATMENT

- See individual diseases

MNEMONIC: APPENDICITIS

Right lower-quadrant pain common differential

Appendicitis/ Abscess
Pelvic inflammatory disease (PID)/ **P**eriod pancreatitis
Ectopic/ **E**ndometriosis
Neoplasia
Diverticulitis
Intussusception
Crohn's Disease/ **C**yst (ovarian)
IBD
Torsion (ovary)
Irritable Bowel Syndrome
Stones

APPENDICITIS

osms.it/appendicitis

PATHOLOGY & CAUSES

- Lumen obstruction → vestigial vermiform appendix inflammation
- Located at cecum base (near ileocecal valve)
- Obstruction → intraluminal content stasis → ↑ luminal, intramural pressure → thrombosis, occlusion small vessels, lymphatic flow stasis → ischemia, necrosis
- Excessive multiplication (gut flora) behind obstruction → immune system response → fibropurulent reaction → parietal peritoneum irritation
- Visceral nerve fiber stimulation → abdominal pain

CAUSES

- Obstruction
  - Lymphoid hyperplasia (adolescence, viral infection), fecalith, foreign body (e.g. undigested seeds), pinworm infection, tumor (benign, malignant)

RISK FACTORS

- 10–30 years old, family history, biologically-male, cystic fibrosis comorbidity (children)

COMPLICATIONS

- Appendix-supplying vessel compression → ischemia → appendix wall necrosis → bacterial invasion (wall) → appendix rupture → bacterial invasion (peritoneum) → peritonitis
- Periappendiceal abscess, subphrenic abscess, pylephlebitis, portal venous thrombosis, sepsis

SIGNS & SYMPTOMS

- Abdominal pain
  - Often begins in umbilical area → McBurney's point (abdomen's right lower-quadrant; one-third distance from anterior superior iliac spine, umbilicus) → progressive inflammation
  - *Rovsing's sign:* left lower-quadrant palpated → right lower-quadrant pain
  - *Psoas sign:* right leg extended in left-side position → retrocecal appendix
  - *Obturator sign:* right leg internally rotated in supine position → pelvic appendix
- Fever, anorexia, nausea, vomiting, diarrhea/constipation
- In case of peritonitis
  - Rebound tenderness at McBurney's point
  - Abdominal guarding (peritoneal irritation)

DIAGNOSIS

DIAGNOSTIC IMAGING

CT scan with IV contrast

- Increased appendix diameter
- Increased wall enhancement
- Severe
  - Visible abscess, pus spillage

Ultrasound (pregnancy, children)

- Visible, noncompressible, dilated appendix
- ↑ blood flow in appendix wall
- Visible appendicolith
- Right iliac fossa fluid collection

LAB RESULTS

- Neutrophilic leukocytosis
  - ↑ with progression
- Mildly elevated serum bilirubin
  - Perforation marker

TREATMENT

MEDICATIONS

- Antibiotics
- IV fluids, no food/water orally (NPO)

SURGERY

- Removal (appendectomy)
- Abscess drainage

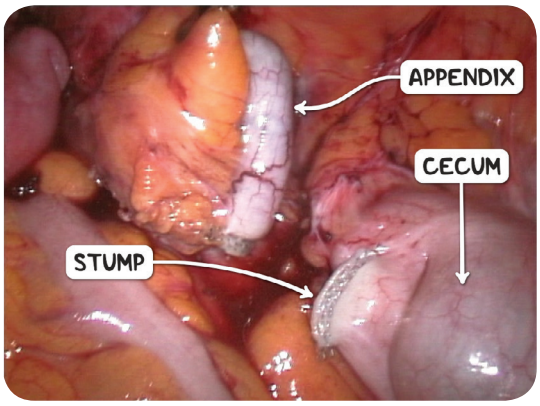

Figure 34.1 Camera view of a laparoscopic appendicectomy being performed. The appendicectomy has been performed and the stump is visible on the right of the image, with the severed appendix reflected laterally.

DIVERTICULITIS

osms.it/diverticulitis

PATHOLOGY & CAUSES

- Inflamed diverticula; microperforation of diverticulum

CAUSES

- Increased intraluminal pressure → erosion → inflammation, focal necrosis → micro/macro perforation

RISK FACTORS

- Diverticula present

COMPLICATIONS

- Stricture, intestinal obstruction
- Diverticulum perforation
  - Abscess, peritonitis
- Fistula formation
  - Bladder communication
  - Other organ communication (vagina, skin, other parts of bowel)
  - *Vesicoenteric fistula:* pneumaturia (air in urine), fecaluria (stool in urine)

SIGNS & SYMPTOMS

- Left lower-quadrant pain (often sigmoid colon); palpable abdominal mass; diarrhea/constipation; nausea; vomiting; fever; urinary urgency/frequency/dysuria (inflamed sigmoid colon → bladder irritation)

DIAGNOSIS

DIAGNOSTIC IMAGING

CT scan with contrast

- Inflammation → hyperdense tissue

Abdominal X-ray

- Bowel obstruction
- Bowel perforation
  - Free air

LAB RESULTS

- Leukocytosis

TREATMENT

MEDICATIONS

- Uncomplicated
  - Antibiotics, fluids, no food/water orally (NPO)

SURGERY

- Resection
  - Severe case/recurrence/complication

OTHER INTERVENTIONS

- High-fiber diet
  - Prevents recurrence

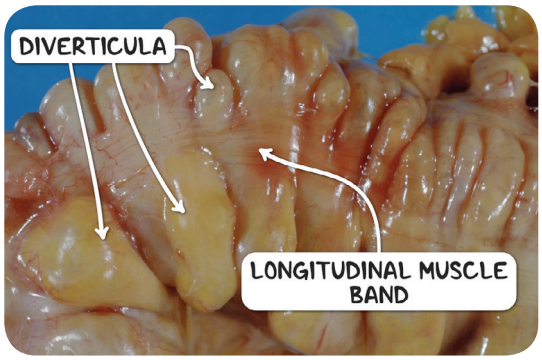

Figure 34.2 Gross pathology of sigmoid diverticulosis. Notice how the diverticula appear either side of the longitudinal muscle.

DIVERTICULOSIS

osms.it/diverticulosis

PATHOLOGY & CAUSES

- *Diverticulum (plural diverticula):* outpouching of hollow anatomical structure wall
  - Most frequent in large intestine (particularly sigmoid colon)
- *Diverticulosis:* multiple diverticula present

TYPES

True diverticulum

- All organ wall layers included (e.g. Meckel's diverticulum)

False (pseudo-) diverticulum

- Only mucosa, submucosa layers included
  - Most common
  - Colonic diverticula

CAUSES

- Multifactorial pathogenesis from abnormal colonic motility
- Abnormal/exaggerated smooth muscle contractions → unequal intraluminal pressure distribution → high pressure (some areas) → mucosa/submucosa herniation predisposed → diverticulum formation
  - *Sigmoid colon:* smallest diameter → highest pressure (Laplace's Law: $P \propto 1/D$), most common location
- *Outpouching:* tend to form where intestinal wall-supplying blood vessels (i.e. vasa recta) traverse muscle layer

RISK FACTORS

- *Lifestyle:* low-fiber diet, constipation; fatty food, red meat-rich diet; inactivity; smoking
- ↑ age ↑ risk
- Biologically-male
- Family history
- Obesity
- Connective tissue disorders
  - Marfan syndrome
  - Ehlers–Danlos syndrome
  - Autosomal dominant polycystic kidney disease

COMPLICATIONS

- Blood vessel surrounding weakened outpouching ruptures → large intestine blood loss → bloody stool
- Inflammation (diverticulitis)
- Segmental colitis

SIGNS & SYMPTOMS

- Often asymptomatic
- Vague abdominal pain, tenderness, bloating
- Occasional cramping
- Altered bowel habit (diarrhea/constipation)
- Rectal bleeding (hematochezia—fresh blood in stool)

DIAGNOSIS

- Often found incidentally

DIAGNOSTIC IMAGING

X-ray with barium enema

- Lower gastrointestinal series
- Directly shows pouches

CT scan

- Visualization of colonic diverticula, thickening of the bowel wall thickening (> 4mm), an increase in soft tissue density within pericolonic

OTHER DIAGNOSTICS

Colonoscopy, sigmoidoscopy

- Visible outpouching

TREATMENT

SURGERY

- Resection (if complications develop)

OTHER INTERVENTIONS

- Lifestyle changes
  - Diet (↑ fiber intake), avoid constipation, ↑ physical activity, smoking cessation

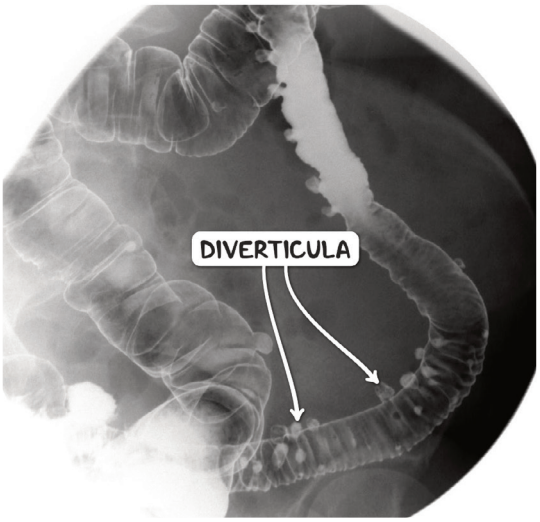

Figure 34.3 Barium study demonstrating multiple diverticula.

FEMORAL HERNIA

osms.it/femoral-hernia

PATHOLOGY & CAUSES

- Intestinal projection across femoral canal associated with femoral artery, vein; below inguinal ligament, lateral to pubic tubercle

CAUSES

- Congenital, acquired
- Weakness/abnormal fascial opening in abdominal wall
- Usually includes properitoneal fat/omentum edge/small bowel loop

RISK FACTORS

- Biologically-female, congenital disorder (embryological development → processus vaginalis obliteration failure), hernia (family history), obesity, pregnancy, frequent heavy lifting

COMPLICATIONS

- Narrow femoral canal
  - ↑ incarceration/strangulation risk
- Compression of femoral vein
- Bowel obstruction

SIGNS & SYMPTOMS

- Asymptomatic (commonly)
- Can manifest intestinal obstruction symptoms
  - Bulging mass, pain, discomfort
  - *Supine:* may resolve
  - *Valsalva maneuver (coughing/straining):* worsens
- Abdominal contents enter hernia → may precipitate intestinal obstruction
  - Most common cause worldwide
  - Incarcerated/strangulated; severe abdominal pain, tenderness, erythema, fever, nausea, vomiting

DIAGNOSIS

DIAGNOSTIC IMAGING

Ultrasound

- Variable echogenicity of tissue; movement of intra-abdominal structures in an inferior direction through the femoral canal

CT scan

- Visualization of characteristic funnel-shaped neck; protrusion through femoral ring

TREATMENT

SURGERY

- Repair
  - Open/laparoscopic (case-dependent)
- Early/elective repair
  - Uncomplicated, asymptomatic hernia
- Urgent repair
  - Complicated hernia (may require bowel resection)

GALLSTONE ILEUS

osms.it/gallstone-ileus

PATHOLOGY & CAUSES

- Gastrointestinal motility (peristalsis) disruption → impaired bowel content propulsion
- Blockage → progressive intestine dilation blockage-proximal, decompression blockage-distal
- Gas accumulation (swallowed air, bacterial fermentation) → ↑ bowel distention
- Bowel wall edema → ↓ bowel content absorption → luminal fluid sequestration
- ↑ capillary permeability → transudative fluid loss from intestinal lumen into peritoneal cavity
- Emesis → fluid, electrolyte (Na, K, H, Cl) loss → metabolic alkalosis, hypovolemia
- Bowel dilation continues → ↓ intestinal wall tissue perfusion → ischemia, necrosis, bowel perforation

TYPES

Onset

- *Acute:* factors such as torsion, intussusception → sudden onset
- *Chronic:* factors such as tumor growth → prolonged onset
- *Recurrent:* often caused by adhesions → intermittent obstructions

Extent

- *Partial:* some of intestinal lumen remains open
- *Complete:* total lumen obstruction

Location

- *Intrinsic:* obstruction within bowel wall—e.g. inflammatory stricture, edema, hemorrhage, foreign body (ingested, parasite accumulation, large biliary calculus)
- *Extrinsic:* obstruction outside bowel wall—e.g. torsion, compression (hernia)

Effect on intestinal wall

- *Simple:* no blood supply impairment
- *Strangulated:* blood supply cut off to bowel section
- *Closed loop:* obstruction occurs at each end of bowel section

Type of factor

- *Mechanical:* obstruction caused by gallstone, neoplasm, adhesion, stricture, hematoma, meconium (in cystic fibrosis), medical device migration (PEG tube)
- *Functional:* intestinal musculature paralysis caused by trauma (surgery, blunt abdominal trauma), peritonitis, medication (opiates, anticholinergics)

RISK FACTORS

- Surgery; bowel manipulation, anesthesia, postoperative opioids
- Hernia, neoplasm history, abdominal/pelvic irradiation, chronic inflammation, abdominal trauma

COMPLICATIONS

- Fluid/electrolyte/acid-base imbalance; bowel strangulation, necrosis; perforation; sepsis

SIGNS & SYMPTOMS

- Abdominal distension, cramping pain, constipation, nausea, vomiting
- *Dehydration:* tachycardia, dry mucous membranes, ↓ urine output
- Bowel sounds
  - *High-pitched "tinkling" sound auscultated:* acute mechanical bowel obstruction
  - *Muffled, hypoactive bowel sounds:* significant bowel distention association
- *Abdominal percussion:* hyperresonance/tympany

DIAGNOSIS

DIAGNOSTIC IMAGING

X-ray

- Small intestine, colon distension

TREATMENT

SURGERY

- Surgical intervention: e.g. release adhesions, complete obstructions, repair bowel

OTHER INTERVENTIONS

- No food/water orally (NPO)
- Fluid, electrolyte replacement
- Parenteral feeding → nasogastric decompression

Figure 34.4 A CT scan of the abdomen and pelvis in the coronal plane demonstrating a gallstone in the terminal ileum. If so large that it is unable to pass through the ileocecal valve, the gallstone will cause small bowel obstruction.

GASTROENTERITIS

osms.it/viral-gastroenteritis

PATHOLOGY & CAUSES

- Gastrointestinal tract viral infection (lasts 12 hours–3 days)
- Primary transmission
  - Oral–fecal route
- Viruses → epithelium damage → osmotic diarrhea (> three stools daily), vomiting

CAUSES

- *Children:* rotavirus (most common)
- *Adult:* norovirus (most common), astrovirus, adenoviruses

RISK FACTORS

- ↑ morbidity
  - Children, elderly, immunocompromised individuals
- Viral contact
  - E.g. daycare center, cruise ship, closed community outbreak; contaminated food/water

COMPLICATIONS

- Severe dehydration → altered mental status, weight loss

SIGNS & SYMPTOMS

- Watery diarrhea; nausea; vomiting; abdominal cramps, pain; fever; malaise; dehydration (dry lips, skin turgor, tachycardia)

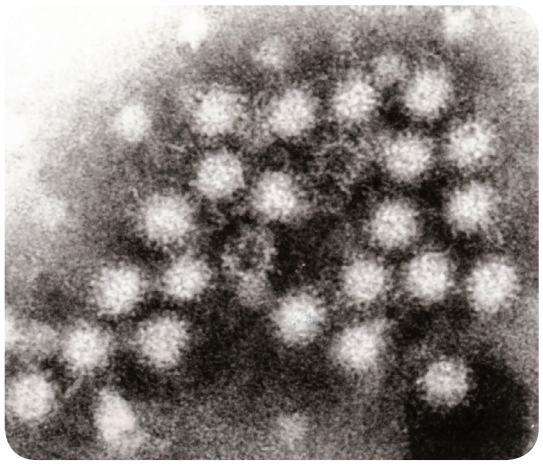

Figure 34.5 A scanning electron micrograph of a cluster of Norwalk virus capsids.

DIAGNOSIS

LAB RESULTS

- Stool sample
  - Excludes bacterial/parasitic etiology
- ↑ C-reactive protein (CRP), ↑ leukocytes
- Polymerase chain reaction (PCR)
  - *Stool, vomit:* enzyme-linked immunosorbent assay (ELISA) performed for rotavirus

TREATMENT

OTHER INTERVENTIONS

- Fluid replacement

Prevention

- Hygiene practices, rotavirus vaccine

INGUINAL HERNIAS

osms.it/inguinal-hernias

PATHOLOGY & CAUSES

Direct inguinal hernia

- Peritoneal sac; projects directly through inguinal triangle (AKA Hesselbach's triangle)
- Projects medially to inferior epigastric vessels, lateral to rectus abdominis, pierces parietal peritoneum
- *Hesselbach's triangle composition:* inguinal ligament (AKA Poupart's ligament), rectus abdominis muscle (lateral border), inferior epigastric vessels
- Covered by external spermatic fascia

Indirect inguinal hernia

- Most common hernia
- Intestinal projection through internal inguinal ring
  - *Location:* spermatic cord (biologically-male), round ligament (biologically-female) exit the abdomen
  - *Testicular descent path:* covered by three layers of spermatic fascia (three layers); external spermatic fascia (external oblique muscle fascia continuation); cremasteric muscle fascia; internal spermatic fascia (internal oblique muscle fascia continuation)

CAUSES

Indirect inguinal hernia

- Processus vaginalis closure failure (i.e. internal inguinal ring and processus vaginalis obliteration failure)

RISK FACTORS

Direct inguinal hernia

- Acquired, affects transversalis fascia
  - Chronic intra-abdominal pressure ↑ (e.g. obesity, chronic cough, constipation, heavy lifting—occupational/recreational)
- Abdominal wall musculature atrophy

(aging)
- Older, biologically-male individuals

Indirect inguinal hernia
- Biologically-male individuals > biologically-female individuals
  - *Biologically male:* late right testicle descent
  - *Biologically female:* asymmetric pelvis

COMPLICATIONS

Direct inguinal hernia
- Incarceration/strangulation potential

Indirect inguinal hernia
- Can form hydrocele
- May precipitate intestinal obstruction
- Most common cause worldwide

SIGNS & SYMPTOMS

- May be asymptomatic
- Bulging mass (indirect inguinal hernia, mass in groin), pain, discomfort
  - Valsalva maneuver cessation/prone: may resolve
- Valsalva maneuver: worsens projection
  - Coughing/straining

Direct inguinal hernia
- May precipitate intestinal obstruction
  - Most common cause worldwide
  - Incarcerated/strangulated: severe abdominal pain, tenderness, erythema, fever, nausea, vomiting

Indirect inguinal hernia
- Visible bulge
  - May be unapparent in biologically-female individuals
- Incarcerated/strangulated
  - Severe abdominal pain, tenderness, erythema, fever, nausea, vomiting

DIAGNOSIS

DIAGNOSTIC IMAGING

Ultrasound
- Direct inguinal hernia
  - Variable echogenicity of tissue; movement of intra-abdominal structures in an anterior direction through the Hesselbach triangle
- Indirect inguinal hernia
  - Visualization through abdominal wall in biologically-female individuals

CT scan
- Direct inguinal hernia
  - Visualization of a protrusion with compressing inguinal canal contents; inguinal canal pushed into a semicircle of tissue that resembles a moon crescent
- Indirect inguinal hernia
  - Identifies occult hernia/complications; hernia neck visualized superolateral to the inferior epigastric vessels

OTHER DIAGNOSTICS
- Indirect inguinal hernia
  - History, clinical exam; sufficient for majority of suspected inguinal hernias

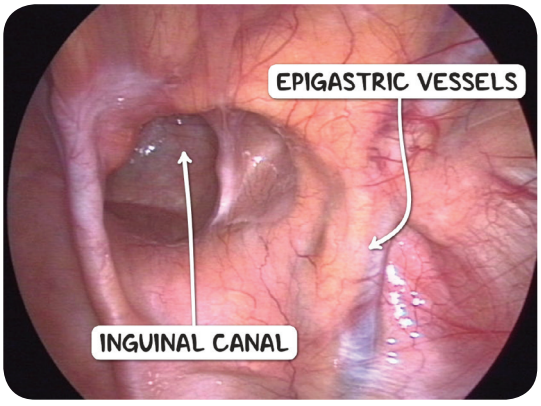

Figure 34.6 Intraperitoneal view of an inguinal hernia during a laparoscopic hernia repair. The peritoneal cavity extends into the inginal canal, lateral to the epigastric vessels, making this an indirect hernia.

TREATMENT

SURGERY

Repair

- Open/laparoscopic (case-dependent)
- Elective repair
  - Symptomatic hernias
- Direct inguinal hernia (asymptomatic)
  - Monitor, surgical repair preferred

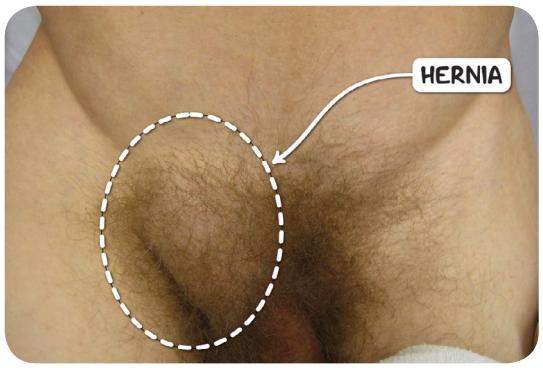

Figure 34.7 Clinical appearance of a hernia in the groin. It is often not possible to distinguish between a direct and indirect hernia on clinical examination alone.

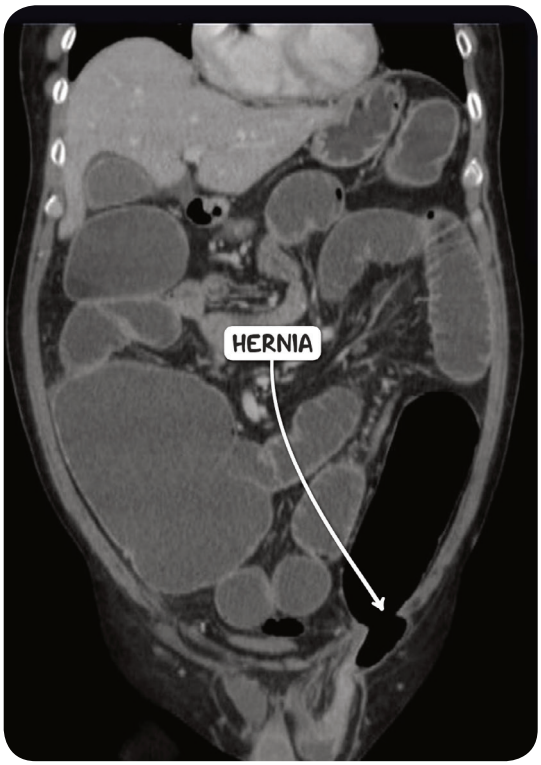

Figure 34.8 A CT scan in the coronal plane demonstrating an indirect inguinal hernia. The proximal bowel is dilated, indicating a strangulated hernia causing obstruction.

INTESTINAL ADHESIONS

osms.it/intestinal-adhesions

PATHOLOGY & CAUSES

- Fibrous tissue bands form physical attachment between intestines → ↓ intestinal motility
- Formed from scarred, post-trauma tissue
- Tissue injury → inflammation → fibrin deposits → fibrin connects parts left (similar to reconstructive "glue")
- Adhesions extend between tissue if both parts have been injured, close proximity
- Initial fibrous adhesions dissolved by fibrinolytic enzymes
- Injury prevents enzyme secretion → macrophages, fibroblasts deposit collagen into adhesion → permanent

CAUSES

- Surgery (most common), inflammation (cholecystitis, pancreatitis, peritonitis), endometriosis, pelvic inflammatory disease

COMPLICATIONS

- Bowel obstruction, intestinal wall volvulus/ischemia

SIGNS & SYMPTOMS

- Abdominal pain, vomiting, bloating, constipation

DIAGNOSIS

DIAGNOSTIC IMAGING

X-ray

- Detect obstruction; small intestine dilation

CT scan, ultrasound

- Exclude other obstructive causes

TREATMENT

SURGERY

- Surgical/laparoscopic adhesion excision

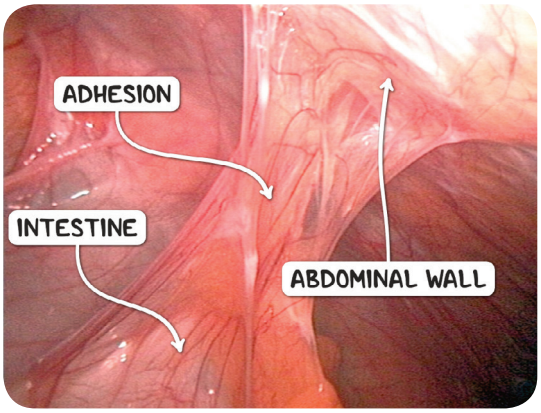

Figure 34.9 Intraoperative view of abdominal adhesions.

INTUSSUSCEPTION

osms.it/intussusception

PATHOLOGY & CAUSES

- Condition that occurs when part of intestine folds into adjacent section → obstruction
- Ileocecal region most commonly affected
- May be idiopathic/caused by abnormal structure (causes pathological lead point) → peristalsis causes one part of bowel to move ahead of adjacent section → bowel telescoping → ↑ pressure, impaired venous return → bleeding, bowel ischemia, infarction

CAUSES

- *Adults:* abnormal growth (e.g. polyp, tumor)
- *Infants:* post-infection lymphoid hyperplasia (Peyer's patches), Meckel's diverticulum

RISK FACTORS

- Most common < 24 months old, intestinal malrotation history, previous intussusception, intussusception in sibling, biologically male

COMPLICATIONS

- Peritonitis, sepsis

SIGNS & SYMPTOMS

- Intermittent abdominal pain (worsens with peristalsis)
- Guarding
- Straining efforts, draw knees toward chest
- Vomiting
- Sausage-like abdominal mass
- "Red currant jelly" stool (blood, mucus)

DIAGNOSIS

DIAGNOSTIC IMAGING

Ultrasound, X-ray, CT scan

- *Telescoped intestine:* visualized as classic bull's-eye image
- Intestinal obstruction signs

OTHER DIAGNOSTICS

- May be felt during digital rectal examination (children)

TREATMENT

SURGERY

- Free telescoped intestine portion → clear obstruction → remove necrotic tissue

OTHER INTERVENTIONS

- Reduction by air/hydrostatic contrast material enema (e.g. saline, barium)

IRRITABLE BOWEL SYNDROME (IBS)

osms.it/IBS

PATHOLOGY & CAUSES

- Chronic functional gastrointestinal system disorder; recurrent abdominal pain, impaired bowel motility
  - No microscopic, macroscopic irregularities
  - Constipation/diarrhea

CAUSES

- Pathology not completely understood; likely multifactorial
  - *Visceral hypersensitivity:* altered stimuli response
  - Fecal flora alterations; bacterial overgrowth
  - *Food sensitivity:* short-chain carbohydrates; ↑ water in bowel → smooth muscle spasm, diarrhea; metabolized by bacteria → gas → bloating, spasm, pain
  - Psychosocial influence
  - Genetic factor

RISK FACTORS

- Biologically-female (region-dependent), previous gastroenteritis, stress

SIGNS & SYMPTOMS

- Impaired bowel motility → diarrhea/constipation
- Recurrent abdominal pain
  - Bowel movement → improvement
- Bloating, nausea, mucus in stool

DIAGNOSIS

OTHER DIAGNOSTICS

- Based on predominant consistency of stool
  - Diarrhea predominant, constipation predominant, mixed stool pattern, unclassified
- Organic disease exclusion

"Rome IV" diagnostic criteria

- Abdominal pain ≥ one day weekly in last three months, associated with two/more of following
  - Defecation → lessened pain
  - Change in stool frequency
  - Change in stool consistency

TREATMENT

- No definitive cure

MEDICATIONS

- Symptom-guided therapy
  - *Diarrhea predominant:* drugs (e.g. loperamide)
  - *Constipation predominant:* fiber supplementation, adequate fluid intake, osmotic laxatives
  - *Spasm, pain:* antispasmodics

OTHER INTERVENTIONS

- Stress management
- Diet modification
  - Low fermentable oligo-, di-, monosaccharides/polyols diet (low FODMAPs diet)
  - Avoid gas-producing food (caffeine, alcohol)
  - Probiotics
  - Physical activity

ISCHEMIC COLITIS

osms.it/ischemic-colitis

PATHOLOGY & CAUSES

- Inflammatory, ischemic condition; affects colon, most often splenic flexure, rectosigmoid junction
- Sudden blood flow ↓ → insufficient perfusion, oxygen/nutrient delivery to bowel → compromised cellular metabolism → ischemia, inflammation, infarction, necrosis → possible perforation
- Damaged, gangrenous mucosa promotes fluid/electrolyte loss → dehydration, shock, metabolic acidosis

CAUSES

- Ischemia causes may be occlusive (embolic, thrombotic)/nonocclusive (↓ mesenteric circulation → severe hypotension, vasospasm)
  - Usually acute, may be chronic disorder for marathon runners

RISK FACTORS

- Any cause of ↓ perfusion/mesenteric arterial embolism, thrombosis/vasoconstriction
  - Risk ↑ with age/comorbidities
  - Hypercoagulable states (e.g. factor V Leiden)
  - Biologically-female individuals
  - Impaired perfusion (e.g. aortic surgery, myocardial infarction, hemodialysis)
  - Vasculopathy
  - Certain drugs (e.g. vasopressors)

COMPLICATIONS

- Gangrenous bowel, stricture, pancolitis, colonic perforation, peritonitis, sepsis, shock, metabolic acidosis, multisystem organ failure, reperfusion injury, potentially fatal

SIGNS & SYMPTOMS

- Symptomatology may be self-limiting
- Localized abdominal cramping, tenderness (usually left side)
- Loose, bloody stools, hematochezia
- ↓ bowel sounds
- Guarding, rebound tenderness
- Fever
- May develop shock signs (e.g. hypotension)

CHARACTERISTICS OF ACUTE BOWEL ISCHEMIA BY LOCATION

	SMALL BOWEL (MESENTERIC ISCHEMIA)	COLONIC ISCHEMIA
AGE	Presentation age varies with cause	Risk ↑ with age (> 60 years)
BLOOD SUPPLY	Superior mesenteric artery	Superior, inferior mesenteric arteries; internal iliac arteries
SIGNS & SYMPTOMS	Pain: severe; tenderness develops late in course Bleeding occurs late	Mild, crampy pain; tenderness present Prominent bloody diarrhea, hematochezia
DIAGNOSIS	Imaging, angiography, laparotomy	Imaging, colonoscopy

DIAGNOSIS

DIAGNOSTIC IMAGING

X-ray/CT scan

- Abdominal; visualizes obstruction, perforation, pneumonitis
  - *Thumbprinting:* segmented bowel edema/thickening pattern
  - *Double-halo pattern:* mucosa, muscularis hyperdensity
  - Pneumatosis coli, pneumoperitoneum indicates perforation

Colonoscopy

- *Visualizes ischemia:* edema, erythema, friable mucosa
- *Single-stripe sign:* linear ulcer seen along longitudinal axis
- *Submucosal hemorrhage:* bluish nodules
- *Biopsy:* transmural fibrosis, mucosal atrophy

LAB RESULTS

- Leukocytosis, thrombocytopenia, ↓ hemoglobin
- ↑ serum lactate, lactate dehydrogenase (LDH), creatine phosphokinase (CPK), amylase indicates tissue damage
- Stool culture
- Identifies infectious etiology

TREATMENT

MEDICATIONS

- Antibiotics
  - Perforation/infection

SURGERY

- Bowel resection
  - Necrotic tissue

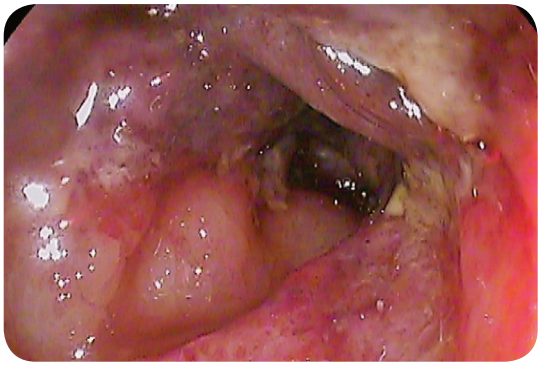

Figure 34.10 The endoscopic appearance of the colon in a case of ischemic colitis. There is mucosal edema and patchy erythema.

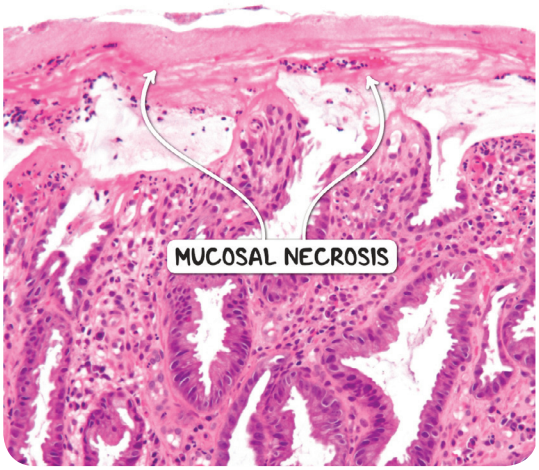

Figure 34.11 Histological appearance of the colon in an individual with ischemic colitis. There is mucosal necrosis, a sign that the condition is in its early stages at the time of biopsy.

OTHER INTERVENTIONS

- Circulatory support
  - IV fluids, electrolytes
- Supplemental oxygen
- Bowel rest

NECROTIZING ENTEROCOLITIS (NEC)

osms.it/necrotizing-enterocolitis

PATHOLOGY & CAUSES

- Severe intestinal disorder: inflammation, ischemic necrosis
  - Terminal ileum, colon (most often affected)
- Multifactorial pathology
- Preterm infants
  - Immature gastrointestinal tract characterized by ↓ intercellular junction integrity + ↓ mucosal barrier → triggering event → normal intestinal microbiome dysbiosis → ↑ pathogenic bacterial growth → exaggerated immune system response → release of host cytokines, chemokines → tissue injury → necrosis
- Term infants
  - Usually underlying condition adversely affecting intestinal perfusion

RISK FACTORS

- Gestational age < 32 weeks
- Low birth weight < 2kg/4.41lbs
- Dysbiosis-contributing interventions
  - Antibiotics, acid-reducing agents, feeding bovine milk formula
- Human milk promotes commensal bacteria growth, supports mucosal integrity
- Infections, gas-forming organism presence
- Underlying conditions
  - Term infants (e.g. fetal growth restriction, perinatal hypoxia, congenital heart disease, gastrointestinal disorders, sepsis)

COMPLICATIONS

- Bowel perforation, ileus, septic shock, metabolic acidosis, coagulopathy, respiratory failure
- Surgical complications

- Strictures, short bowel syndrome
- ↑ impaired neurodevelopmental development risk
- High mortality rate

SIGNS & SYMPTOMS

- Abrupt feeding tolerance change
- Abdominal distension, tenderness
- Erythema, crepitus, induration may also be present
- ↑ gastric residuals
- Vomiting (often bilious), bilious drainage from enteral feeding tubes
- Hematochezia
- Nonspecific findings
  - Temperature instability, lethargy, apnea

Figure 34.12 Gross pathology of necrotizing enterocolitis.

DIAGNOSIS

DIAGNOSTIC IMAGING

Abdominal radiography, ultrasound

- Pneumatosis intestinalis, pneumoperitoneum/hepatobiliary gas

LAB RESULTS

- Positive blood culture, ↓ platelets, ↓ red blood cells, disseminated intravascular coagulopathy evidence, ↑ serum lactate

OTHER DIAGNOSTICS

Surgery

- Through surgical/postmortem specimens
  - *Gross examination:* gangrenous necrosis, hemorrhage, subserosal gas collection
  - *Histological examination:* edema, hemorrhage, transmural necrosis, bacterial infiltration

TREATMENT

MEDICATIONS

- Empirical antimicrobial therapy

SURGERY

- Exploratory laparotomy, bowel resection
- Primary peritoneal drainage (PPD) → ↓ intra-abdominal pressure

OTHER INTERVENTIONS

- Address complications (e.g. metabolic correction/hematologic abnormalities)
- Bowel rest with nasogastric intubation decompression
- Supplemental oxygen/mechanical ventilation
- Fluid replacement
- Inotropic support
- Total parenteral nutrition (TPN)

SMALL BOWEL ISCHEMIA & INFARCTION

osms.it/ischemia-and-infarction

PATHOLOGY & CAUSES

- Serious small bowel condition; reduced blood flow, subsequent infarction; AKA mesenteric ischemia
  - Collateral circulation network → small bowel especially vulnerable to widespread ischemic injury
  - Hypoxia, subsequent reperfusion → tissue injury
- ↓ blood flow may be acute/chronic
  - *Acute:* sudden ↓ small intestine perfusion
  - *Chronic:* episodic ↓ digestion perfusion (often related to mesenteric atherosclerosis)
- Insufficient perfusion, oxygen/nutrient delivery to bowel → compromised cellular metabolism → ischemia, inflammation, transmural infarction, necrosis → bacterial transmigration + possible perforation
- Damaged, gangrenous mucosa promotes fluid/electrolyte loss → dehydration, shock, metabolic acidosis

CAUSES

- Ischemia causes
  - *Occlusive (arterial/venous):* embolic, thrombotic, tumor, volvulus, intussusception, hernia, atherosclerosis
  - *Nonocclusive:* severe hypotension, vasospasm → ↓ mesenteric circulation

RISK FACTORS

- Any cause of ↓ perfusion/mesenteric arterial embolism, thrombosis/vasoconstriction
- Cardiac disorders (e.g. arrhythmia, valvular disease → arterial emboli formation from heart; ↓ cardiac output, peripheral hypoperfusion)
- Procedures (e.g. cardiac catheterization, cardiopulmonary bypass surgery, hemodialysis → ↓ intestinal perfusion)
- Coagulative disorders
- Atherosclerotic occlusive disease
- Hypovolemia (e.g. dehydration, hemorrhage)
- Bowel strangulation (e.g. volvulus, incarcerated hernia)
- Vasoconstriction medications

COMPLICATIONS

- Ileus, shock, metabolic acidosis, multisystem organ failure, high mortality

SIGNS & SYMPTOMS

- Severe abdominal pain (often postprandial); nausea, vomiting; distended abdomen; guarding, rebound tenderness (develops later); ↓ bowel sounds; fever; feculent breath odor; rectal bleeding; may exhibit shock signs (e.g. hypotension)

DIAGNOSIS

DIAGNOSTIC IMAGING

CT/magnetic resonance (MR) angiography

- Detects acute mesenteric ischemia

Abdominal X-ray/CT scan

- Dilated bowel loops, bowel wall thickening, thumbprinting, intestinal pneumatosis, free intraperitoneal air

LAB RESULTS

- Leukocytosis with left shift, ↑ hematocrit (dehydration, hemoconcentration)
- ↑ serum lactate, amylase, alkaline phosphatase

OTHER DIAGNOSTICS
- Laparotomy
  - Abdominal exploration

TREATMENT

MEDICATIONS
- Antibiotics
- Circulatory support
  - IV fluids, electrolytes, inotropic medications

SURGERY
- Resection

OTHER INTERVENTIONS
- Pain management
- Bowel rest with decompression

VOLVULUS

osms.it/volvulus

PATHOLOGY & CAUSES

- Intestinal obstruction
  - Intestinal twisting/looping

TYPES
- Classified by location

Sigmoid volvulus (most common)
- Usually middle-aged/elderly individuals
- Causes include pregnancy, chronic constipation (e.g. Hirschsprung's disease), intestinal adhesions

Cecal volvulus
- Causes include impaired abdominal mesentery development, pregnancy, chronic constipation

Midgut volvulus
- Usually infants/young children
- Caused by anomalous intestinal development (e.g. intestinal malrotation)

COMPLICATIONS
- Mesenteric artery compression → intestinal wall ischemia, infarction
- Intestinal wall perforation, infection (e.g. diffuse peritonitis)

SIGNS & SYMPTOMS

- Abdominal tenderness, pain, distension, bilious vomiting, constipation, fever, auscultation (abnormal bowel sounds, often decreased), percussion (tympany), hematochezia (may indicate bowel ischemia, necrosis)

DIAGNOSIS

DIAGNOSTIC IMAGING

X-ray
- Asses volvulus shape
  - Bent inner tube sign ("coffee bean" sign)

Barium enema
- May show "bird's beak" shape (point of twisted bowel)
- Perforation suspected → barium contrast contraindicated

CT scan
- Twisted mesentery ("whirlpool" sign)

Figure 34.13 Abdominal radiograph demonstrating a massively dilated sigmoid colon in a case of sigmoid volvulus.

Figure 34.14 3D CT virtual colonoscopy demonstrating sigmoid volvulus.

TREATMENT

SURGERY

- In case of midgut volvulus/ischemia/necrosis; surgical resection if necessary

OTHER INTERVENTIONS

- IV fluid replacement
- Bowel decompression
  - *Sigmoid volvulus:* sigmoidoscopy
  - *Cecal volvulus:* colonoscopy