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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 adhesions
 - 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 context 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 can-

cer, 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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