

# **SMALL INTESTINE**

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## ANATOMY

- Average length, from the ligament of Treitz to the ileocecal valve, 6m
- The upper half is the **jejunum**, the lower half is the **ileum**
- Is attached to the posterior abdominal wall by the 15cm long **mesentery** which starts at the duodeno-jejunal junction [L<sub>2</sub> level] and passes to the right sacroiliac joint. It contains the superior mesenteric artery and vein, lymph nodes and autonomic fibres
- **BRANCHES OF THE SUPERIOR MESENTERIC ARTERY**
  1. **Inferior pancreaticoduodenal**
  2. **Middle colic** [superiorly]
  3. 10-15 **small intestinal arteries** that pass to the left
  4. **Ileocolic artery** to the right which gives off:
    - a. **Right colic artery**
    - b. **Ileal artery** for the terminal ileum
- **DIFFERENCES BETWEEN JEJUNUM AND ILEUM:**
  - Thicker wall in the jejunum
  - Thicker, circular folds in the jejunal mucosa [**plicae circularis**]
  - The jejunum usually occupies the umbilical region while the ileum the hypogastrium and pelvis
  - The mesenteric fat folds that cover the mesenteric border of the bowel are thicker the more distal the bowel [**encroaching fat** of the ileum]
  - Greater diameter proximally than distally
  - The **mesenteric vessel arcade** consists of one or two arcades in the jejunum with long and relatively infrequent branches leading to the bowel, while the mesenteric vessels in the ileum form multiple arcades with numerous and shorter terminal branches.
  - The lymphoid tissue of the submucosa becomes more prominent in the ileum [**Peyer's patches**]
- **MICROSCOPIC ANATOMY**
  - **Serosa**
  - **Muscularis** [inner circular, outer longitudinal layers of smooth muscle]
  - **Submucosa** [strong, fibroelastic]
  - **Mucosa:** columnar epithelium with mucous producing goblet cells, forming **villi** and **microvilli**, as well as the crypts of **Lieberkuhn**, increasing thus the absorptive surface by 24 times

## PHYSIOLOGY

- **Primary functions: digestion and absorption**  
A total of 9 L of fluid enter the small intestine per day; of this, only 1-2L enter the colon.
- **MOTILITY**
  - To-and-fro motion to mix the chyme
  - Peristaltic wave to move food more rapidly
  - A strong peristaltic wave every 2 hours at the fasting stage to empty residual food
  - Parasympathetic stimulation promotes motility, sympathetic inhibits it

## ■ ABSORPTION

- **WATER:** passive absorption through all the small intestine
- **CALCIUM:** active transport [facilitated by vitamin D]
- **POTASSIUM:** absorbed by passive diffusion
- **SODIUM:** active transport
- **CHLORIDE:** follows passively sodium as a gradient develops
- **FAT:** absorbed mainly in the jejunum. Is digested by **lipase** and forms **micelles** with the **bile acids**, which enter the mucosal cells. There **monoglycerides** are released and fatty acids are re-synthesised, which assemble as **chylomicrons** and are transported into the lymphatics.
- **CARBOHYDRATE:** amylase breaks them down to fructose, galactose and glucose which are actively transported in the portal blood.
- **PROTEIN:** pepsinogen and pancreatic enzymes start digestion to tri-, di-peptides and aminoacids which are actively transported
- **VITAMINS:** ADEK [fat soluble] are absorbed with micelles. Most water soluble vitamins are passively diffused. C, thiamine and folic acid are actively transported. Vitamin B<sub>12</sub> is absorbed at the distal ileum as a complex molecule with intrinsic factor
- **IRON:** is actively absorbed in the jejunum in its reduced form [Fe<sup>2+</sup>]

## BLIND LOOP SYNDROME

- Is a broad term for **stagnation of flow** within any segment of the intestine which permits **bacterial overgrowth** and thus invasive infection
- Stasis may be a result of strictures, diverticulae, blind [poor emptying] loops or functional abnormalities [i.e. scleroderma]
- **Steatorrhoea**, diarrhoea, megaloblastic anaemia, hypocalcaemia and malnutrition
- Surgery and correction of the underlying cause is the treatment of choice

## SHORT BOWEL SYNDROME

- **Excessive bowel resection** leaving less than 100cm
- More common if the remaining segment is jejunum [the ileum can take over most of its absorptive functions]
- Diarrhoea, **malabsorption**, steatorrhoea, weight loss
- **Enteric hyperoxaluria** [formation of renal calculi due excessive absorption of oxalate from the colon]

## TREATMENT

- TPN is essential initially
- The bowel may adapt with time, compensatory increasing its absorptive capacity
- Elemental diet with low residue
- Adjunctive measures:
  - High calorie intake
  - Antiperistaltic agents
  - Control of gastric hypersecretion with H<sub>2</sub>-antagonists
  - Vitamin supplementation
  - Electrolyte supplementation

- Use of medium chain triglycerides [do not require micelles for transportation] instead of dietary fats
- Long-term TPN

## DIVERTICULAE

- Congenital ones are rare, but the incidence of acquired is 1.3%
- Multiple jejunal diverticulosis is a heterogeneous congenital disorder
- They usually occur in the jejunum and are true pouches [contain all layers]
- They rarely cause symptoms [pseudo-obstruction] because of inflammation
- Surgery is reserved for complications [enterectomy and primary anastomosis]

## CROHN'S

### [regional or granulomatous enteritis or ileitis]

- **DEFINITION:** a chronic transmural, progressive granulomatous inflammation that can involve any area of the gastrointestinal tract, resulting from the interaction of genetic and environmental factors
- **DISTRIBUTION:** Small bowel involved in 25%, large bowel in 25%, large and small in 50%. The **distal ileum** is involved in **70%** of cases
- **CLINICAL PICTURE**
  - **Diarrhoea**, usually not bloody, in 90%
  - **Recurrent abdominal pain**
  - Lethargy, fever, weight loss
  - **Anorectal lesions:** fissures, ulcers, fistulae and abscesses [20%]
  - **Extraintestinal manifestations:** sclerosing cholangitis, uveitis, arthritis, ankylosing spondylitis, erythema, thromboembolism, aphthous ulcers
  - **Acute onset** with RIF pain mimicking acute appendicitis. Only 15% of these will develop chronic disease
- **X-RAY FINDINGS**
  - Thickened bowel wall with segmental areas of stricture [**string sign**] separated by **skip areas**
  - **Cobblestone** appearance
  - Fistulae
  - Radionuclide scans [Indium<sup>111</sup> leukocytes or <sup>99m</sup>Tc-labeled phagocytes]
- **DIFFERENTIAL DIAGNOSIS**
  - Appendicitis [almost impossible in acute cases]
  - Ulcerative colitis [may be difficult to distinguish]
  - Specific enteritis [tuberculosis, Yersinia, campylobacter, salmonella]
  - Lymphoma
- **TREATMENT**
- **MEDICAL**
  - Rest, relief of emotional stress, low residue milk free and high protein diet
  - Prednizone 0.25-0.75 mg/kg/d, for acute stages

- Sulfasalazine, 6-10gr/day for acute, 3gr/day as maintenance treatment
- 5-ASA [mesalamine] is the active form of sulfasalazine
- Metronidazole 400mg bd
- **SURGICAL:** reserved for complications [obstruction being the commonest]
- Over the long term 70% of patients with Crohn's will require surgery. In 50% of these the indication will be obstruction
- The less the surgeon does the better [strictureplasty or enterectomy with end-to-end anastomosis for obstruction, bypass instead of removal of an infected mass]
- **PROGNOSIS**
- Fairly poor
- Recurrence rate is 50% within 15 years
- After surgery, recurrence is 50% at 5 years
- The long term risk of death is twice than normal

## RADIATION ENTERITIS

- **ACUTE PHASE** is due to mucosal injury
  - nausea, vomiting, diarrhoea, rarely bleeding
- **CHRONIC PHASE** [months or years later] is due to obliterative vasculitis
  - abdominal pain, malabsorption and diarrhoea
- **SURGERY** is indicated for complications [obstruction, perforation or haemorrhage]
  - technically difficult due to fibrosis and scarring [may resemble tumour]
  - resection or bypass is the treatment of choice
  - perioperative mortality is 10-15%
  - 5 year survival is 50%

## VASCULAR CONDITIONS

### 1. ACUTE MESENTERIC OCCLUSION

- Predominantly disease of the elderly
- **Severe diffuse abdominal pain**
- **Minimal physical findings**
- Presence of an underlying condition [MI, AF, intestinal angina portal hypertension, contraceptives]
- Intestinal bleeding, gross or occult [75-90%]
- Secondary toxicity in the course of the disease [later]
- **CAUSES**
  - Embolism, 30%
  - Thrombosis 25%
  - Miscellaneous, 20%
  - Mesenteric vein thrombosis, 25%
- **DIAGNOSIS** : Is usually late in more than 50%
  - **LABORATORY FINDINGS**

- Striking leukocytosis
  - Elevated serum amylase, 50%
  - Haemoconcentration
  - **X-RAY FINDINGS** [20% diagnostic]
    - Absence of intestinal gas pattern, diffuse distention with air fluid levels
    - Bowel loops that remain unchanged over several hours
    - Blunt circular folds, thickened wall
    - Signs of intra-abdominal fluid
    - Angiography, infusion of Xe<sup>133</sup> in the peritoneal cavity [not cleared by ischaemic bowel]
  - **DIFFERENTIAL DIAGNOSIS**
    - acute pancreatitis
    - strangulation obstruction
  - **Surgery should be undertaken as soon as possible**
    - Blood stained fluid is always present
    - In acute arterial occlusion there is segmental or diffuse ischaemia or infarcted bowel
    - Vascular reconstruction is feasible in less than 10%
    - In venous thrombosis the mesentery is oedematous and there is clot in the vessels when cut
    - **Resection of the infarcted** bowel and end-to-end anastomosis is necessary
    - A **second look laparotomy** is usually performed in 12-24 hours to detect bowel viability
    - **Anticoagulation**, antibiotics, massive volume support, electrolyte replacement
  - **PROGNOSIS**
    - **Often lethal** [overall mortality is 50%]
    - Mortality is about 30% for venous thrombosis
    - Intense nutrition and long term anticoagulation will be necessary for those who survive
2. **SEGMENTAL, NONOCCLUSIVE INTESTINAL ISCHAEMIA**
- Develops in conditions of **low flow state** [heart failure, sepsis, cardiogenic shock]
  - Venous thrombosis is the usual cause, but arterial shunting due to splanchnic vasoconstriction contributes
  - Operation is usually necessary to resect the infarcted bowel and exclude other causes
  - Mortality is high due to the underlying conditions
3. **MESENTERIC APOPLEXY**
- rare, caused by rupture of the mesenteric vessels
  - an aneurysm may be the cause
4. **VASCULITIS**
- Rare, associated with polyarteritis nodosa or lupus erythematosum
  - Present with perforation or intraluminal bleeding

## PNEUMATOSIS CYSTOIDES INTESTINALIS

### [gas cysts]

- **Subserosal gas filled cysts** located anywhere in the GI tract or its mesentery [**pneumatosis coli** if limited to the large bowel]
- **Primary in 15%.**
- The mechanism is excess production of hydrogen gas [bacterial fragmentation of carbohydrates, obstructive lung disease that impairs excretion of hydrogen]
- Symptoms are absent or non specific [discomfort, distention] or are related to the underlying condition in secondary forms [inflammatory bowel disease, COPD, diverticulosis, etc]
- Treatment: oxygen therapy

## INFLAMMATORY DISEASES

### 1. ENTERITIS, GASTROENTERITIS, ENTEROCOLITIS

- Usually self limited, caused by virus, bacteria, toxins
- Diarrhoea, nausea and vomiting usually precedes pain

### 2. MESENTERIC ADENITIS

- Young children
- Follows any form of infection [usually upper respiratory tract]
- Self limited

### 3. YERSINIA ENTERITIS

- May cause a variety of disorders, like acute gastroenteritis, ileitis [not Crohn's] lymphadenitis, autoimmune processes and hepatic/splenic abscess
- Responds to trimethoprim-sulfamethoxazole [Septrin]

### 4. CAMPYLOBACTER ENTERITIS

- Campylobacter jejuni [gram - rod] produces enterotoxin which results in diarrhoea
- Relapses in 20% of cases
- Erythromycin is the treatment of choice

### 5. INTESTINAL TUBERCULOSIS

- 1% of patients with pulmonary disease have intestinal disease as well
- The distal ileum is the most common site
- May cause hypertrophic reaction resulting in stenosis or ulcerative resulting in diarrhoea and perforation
- Surgery is required to establish the diagnosis or treat the complications
  - Resection is the preferred procedure
  - Bypass if abscess or fistulae are present
- Antituberculosis chemotherapy is essential

### 6. TYPHOID

- Ulceration at the distal ileum or cecum
- Bleeding or perforation are the indications for surgery

## TUMOURS OF THE SMALL INTESTINE

### 1. BENIGN

- 10 times more common than malignant, usually asymptomatic
- **POLYPS**
  - **Adenomatous**: rare
  - **Familial adenomatous polyposis [Gardner's syndrome]** that has a malignant potential
  - **Hamartomatous**, with no malignant potential
  - **Peutz-Jegher's syndrome**: familial condition with diffuse hamartomatous polyposis and skin hyperpigmentation
  - **Juvenile [retention] polyps**: hamartomatous that may bleed or obstruct, but usually autoamputate
- **Leiomyomas** [the commonest] lipomas, neurofibromas, fibromas: usually asymptomatic, but may bleed or obstruct

### 2. MALIGNANT

- Represent 75% of symptomatic tumours
- Present with bleeding, perforation or obstruction
- Adenocarcinoma is the commonest
- Surgical resection with 10cm margin is the preferred treatment
- **ADENOCARCINOMA [40%]**
  - Usually involves the proximal jejunum
  - Survival after resection is 25% [5 years]
- **CARCINOID [30%]**
  - Arises from **enterochromaffin cells [APUD]** in the distal ileum [less common than appendiceal carcinoids] and is actually an **apudoma**
  - **Carcinoid syndrome** [10%]: Flushing, bronchoconstriction, diarrhoea and tricuspid and pulmonary valve disease
    - Is caused by **serotonin** and other vasoactive hormones released by the tumour.
    - Only those with **liver deposits** may present the syndrome [the substances are cleared by the liver] or when they drain to systemic veins
  - If greater than 2cm, metastases are present in 80%. Metastasis is rare if less than 1cm
  - Diagnosis is made by the high levels of **5-hydroxy-indol-acetic acid [5-HIAA]** in the urine
  - Treatment consists in surgical resection
  - **Prognosis**: As they are slow growing tumours, survival after resection is 70% and for those with metastases 20-40%
- **PRIMARY LYMPHOMA [20%]**
  - may present with perforation or fever of unknown origin
  - treatment consists in surgery, whole abdominal irradiation and chemotherapy
  - 5 year survival is 40%
- **LEIOMYOSARCOMA [2%]**: the commonest sarcoma
  - tends to ulcerate and bleed
- **METASTATIC TUMORS [5-10%]**
  - Present in 50% of cases with diffuse malignant melanoma
  - Many other tumours may metastasise to the bowel
  - Surgery is undertaken only for palliation [bypass for obstruction, resection for bleeding]



## MECKEL'S DIVERTICULUM

- Is the remnant of the vitello-intestinal duct
- Is attached to the antimesenteric border of the bowel, usually 60cm from the ileocecal valve [range 15-350cm]
- May be:
  - a **diverticulum**, with or without a filament band connecting it to the umbilicus
  - a **fistula** or a **band** to the umbilicus
  - a **cyst**
- Often contains **peptic mucosa** with oxyntic cells
- Occurs in 2% of individuals, 2:1 M:F
- Clinical presentation
  - Mimics acute appendicitis
  - Sometimes present with massive bleeding [cranberry coloured or currant jelly stools] due to ulceration
  - Diagnosis is made at surgery or by radionuclide scan