I. Introduction & Anterior Abdominal Wall

A. Introduction

- The abdominal cavity is the cavity enclosing most of the abdominal viscera and related structures.
- Its superior boundary is the diaphragm which separates the abdominal cavity from the thoracic cavity, and may extend as high as to the 4th intercostal space (nipple position in a non-pendulous breast) after expiration.
- Structures needing to pass between the two (2) cavities will either need to pass posterior to the diaphragm (e.g. the descending aorta at the T12 vertebral level) or through a hiatus in the central tendon of the diaphragm (e.g. the oesophagus at the T10 vertebral level).
- The diaphragm also protects some abdominal viscera under its dome. These are most of the liver, the gallbladder, stomach, spleen and the transverse colon.
- Inferiorly, the abdominal cavity is continuous with the pelvic cavity because the peritoneum lining the abdominal cavity is continuous with that of the pelvic cavity.
- The advantages of this feature are that the distended bladder and the pregnant uterus can painlessly expand superiorly from the pelvic cavity into the abdominal cavity.
- Unfortunately, this feature also means that infections in one region can spread freely into the other.
- Abdominal viscera include the major elements of the GIT. These are the caudal end of the oesophagus, the stomach, small and large intestines, the liver & gallbladder and the pancreas. It also includes the spleen, suprarenal (adrenal) glands, components of the urinary system such as the kidneys and ureters, as well as major neurovascular structures such as the aorta, inferior vena cava (IVC), splanchnic nerves and the pre-aortic ganglia.
- The lower limb receives communication from the abdomen. These structures include the femoral artery and vein which underwent a nominal change after passing beneath the Inguinal Ligament of Poupart, the femoral nerve (L2,3,4), lymphatics and the distal ends of the psoas major and iliacus muscles, which act as hip flexors.
- Abdominal viscera are either suspended in the peritoneal cavity by a mesentery (intra-peritoneal) or sandwiched between the peritoneal cavity and the posterior musculoskeletal wall (retro-peritoneal). Organs can become secondarily retroperitoneal if secondary fusion of their mesentery to their body wall occurs.
- The mesentery is a thin sheet of tissue suspending organs of the gastrointestinal tract (GIT).
- Massive longitudinal growth of the gut tube, rotation of selected parts of the tube and secondary (2º) fusion of some viscera & their associated mesenteries to the body wall all participate in generating the adult arrangement and position of the abdominal organs.
Intraperitoneal | 2° Retroperitoneal | Retroperitoneal
---|---|---
Stomach | Duodenum (except the 1st inch) | Kidneys
Jejunum | Pancreas | Suprarenal Glands
Ileum | Ascending Colon | 
Caecum & Appendix | Descending Colon | 
Transverse Colon | Rest of rectum | 
Sigmoid Colon | 
Superior part of rectum | 
Liver | 
Spleen | 

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<th>Hindgut</th>
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<th>Table 1: Position of Abdominal Viscera</th>
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- The three (3) main arteries of the GIT are unpaired; namely the **Coeliac Trunk**, **Superior Mesenteric** and **Inferior Mesenteric** arteries.
- The **Coeliac Trunk** supplies the **foregut**, and arises from the abdominal aorta at the upper border of the L1 vertebral body.
- The **Superior Mesenteric artery** supplies the **midgut**, and arises from the abdominal aorta at the lower border of the L1 vertebral body. This is the largest of the three arteries.
- The **Inferior Mesenteric artery** supplies the **hindgut**, and arises from the abdominal aorta at the L3 vertebral level. This is the smallest of the three arteries.

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| Table 2: The division of the GIT into foregut, midgut & hindgut |

\(^1\) The ventral part of pancreas, liver and gallbladder developed from ventral mesentery. The rest of the GIT developed from dorsal mesentery.

**B. The Anterior Abdominal Wall**

- The abdomen may be divided into four (4) sections using the **four-quadrant pattern**, by a vertical line drawn through the midline and an intersecting one drawn horizontally through the umbilicus. The four named regions are the **right upper**, **right lower**, **left upper** and **left lower quadrant**.
- The abdomen may also be divided into nine (9) sections using the **nine-region pattern** with two vertical lines drawn from the right & left **mid-clavicular lines** to their respective **mid-inguinal points**, and two horizontal lines—one drawn at the **trans-pyloric plane** or **subcostal plane** and another in the **inter-tubercular plane**.
• The ilio-inguinal nerve (a branch of L1) supplies the anterior surface of the scrotum/labia majora & sends a small cutaneous branch to the thigh.

**Blood Supply and Drainage**

**Superficially:**
1. Musculophrenic Artery (from the Internal thoracic artery, ITA) → Superiorly
2. Superficial Epigastric Artery (from the Femoral artery) → Infero-medially
3. Superficial Circumflex Iliac Artery (from the Femoral artery also) → Infero-laterally

**Deeper:**
4. Superior Epigastric Artery (from ITA) → Superiorly
5. The 10th & 11th intercostal arteries + the subcostal (12th) artery → Laterally
6. Inferior Epigastric Artery (from the External Iliac Artery) → Infero-Medially
7. Deep Circumflex Iliac Artery (from the External Iliac Artery also) → Infero-Laterally

• The **Superior & inferior Epigastric arteries** both enter the rectus sheath posterior to the rectus abdominis muscles throughout their course and anastamose with each other.
• Veins bearing the same names follow these arteries and are responsible for venous drainage.

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**Lymphatic Drainage**

**Superficially:**
1. Axillary Nodes (the pectoral group) → Above the umbilicus, lymph drainage goes superiorly
2. Superficial Inguinal nodes → Below the umbilicus, lymph drainage goes inferiorly

**Deeper:**
1. Parasternal Nodes (run along the ITA, also called the internal mammary artery)
2. Lumbar Nodes (along the abdominal aorta)
3. External Iliac Nodes (along the external iliac artery)

**NOTE:** Deep lymph nodes follow arteries.
The development sequence is concluded in both sexes when the processus vaginalis obliterates. A completely obliterated processus vaginalis forms the tunica vaginalis, a serosal covering derived from peritoneum that has a parietal and a visceral layer deep to the internal spermatic fascia. Between both layers of tunica vaginalis is a potential space.

If this obliteration does not occur or is incomplete, a weakness in the anterior abdominal wall results and an inguinal hernia may occur. Since this structure was wider in males than females to transmit the testis, the risk of an inguinal hernia (or ‘bosun’ as it is called in Jamaican rural areas) is higher in males than in females. This is the most common type of hernia.

In males, only the proximal region of the processus obliterates, however, as the distal end will expand to enclose most of the testis in the scrotum: tunica vaginalis.

Therefore, the cavity of the tunica vaginalis in men forms as an extension of the developing peritoneal cavity but becomes separated off during prenatal development.

NB- The internal oblique muscle & associated fascia contributes the cremasteric fascia which contains the cremaster muscle, formed from musculature of the internal oblique muscle.

This cremaster muscle is responsible for the cremasteric reflex in males. When the upper medial thigh of a male infant is stroked, the testes will contract allowing for confirmation of the descent of the testis into the scrotum at birth. It is possible for one or both testes to not adequately descend into the scrotum which has implications on fertility in later life if not corrected. This reflex may disappear with age.

The Inguinal Canal

This is a 4cm long, slit-like passage found above & parallel the Inguinal Ligament of Poupart that is directed inferiorly, medially & forwards (Mnemonic: I.M.F.).

DO NOT confuse with the femoral canal that runs below the inguinal ligament.

It begins and ends at the deep and superficial inguinal rings.

Contents: 1. Genital branch of the genito-femoral nerve (in women, because this nerve branch travels within the spermatic cord itself in men)

2. Spermatic cord (men) or the round ligament of uterus (women)

3. Ilioinguinal nerve (L1); passes through it only partly, exiting through the superficial inguinal ring along with the other contents.

The deep inguinal ring is found midway between the ASIS & the pubic symphysis (mid-inguinal point). It is immediately lateral to the inferior epigastric vessels. This marks the start of the tubular evagination of the transversalis fascia that forms one of the spermatic cord’s coverings (internal spermatic fascia in men) or the round ligament of the uterus in women.

The superficial inguinal ring is a triangular shaped opening in the external oblique’s aponeurosis found superior to the pubic tubercle. Its apex is held together by intercrural fibres to prevent further widening of the ring, its medial end is attached to the pubic symphysis while the lateral crus is attached to the pubic tubercle. Its base is the pubic crest.

Dimensions of the Inguinal Canal:

1. **Anteriorly**: External Oblique aponeurosis & the lower internal oblique muscle fibres
V. Peritoneum & Peritoneal Cavity

- The **peritoneum** is a thin serous membrane that lines the wall of the abdominal cavity (parietal peritoneum) and covers much of the viscera (visceral peritoneum).
- Between the parietal and visceral peritoneum is a potential space known as the **peritoneal cavity**. It is fully closed in men but has two (2) openings for the uterine (fallopian) tubes in women.
- The peritoneal cavity can be subdivided into 2 sacs—the **greater sac** which accounts for most of the peritoneal cavity, and the **lesser sac** or **omentum**.
- Superiorly, the **greater sac** is limited by the diaphragm and inferiorly continues freely into the pelvic cavity, while the **lesser sac** (omentum) is found posterior to the stomach & liver. The greater and lesser sacs are continuous through the omental or epiploic foramen of Winslow.
- Abdominal viscera are either suspended in the peritoneal cavity by a **mesentery** (intra-peritoneal) or sandwiched between the peritoneal cavity and the posterior musculoskeletal wall (retro-peritoneal). Organs can become secondarily retroperitoneal if secondary fusion of their mesentery to their body wall occurs.
- A **mesentery** is a thin sheet of tissue suspending organs of the gastrointestinal tract (GIT) from the body wall. **Mesenteries, omenta and ligaments** are all peritoneal derivatives.

**Omenta** (singular: omentum)

- Consist of two (2) layers of peritoneum which pass from the stomach & 1st inch of the duodenum to other viscera. There are 2 omenta—the greater & lesser omenta.

1. The Greater Omentum
   - Derived from the **dorsal mesentery** and is really 4 layers of peritoneum folded on itself to form a double-leafed sheet
   - It attaches to the stomach’s greater curvature & the 1st inch of the duodenum, drapes inferiorly over the transverse colon, jejunum & ileum then turns posterior & become adherent to the:
     - Peritoneum on the superior surface of the transverse colon, &
     - Anterior layer of the transverse mesocolon before arriving at the posterior abdominal wall.
   - Usually a thin membrane but has an accumulation of fat which can become quite substantial in some individuals.
   - It acts as the “policeman of the abdomen” by moving to and curtailing the spread of infection from one part of the abdomen throughout the rest of the abdomen.
   - There are 2 arteries with accompanying veins between the 2 layers just inferior to the stomach’s greater curvature to supply it, namely, the **right and left gastro-omental vessels**.

2. The Lesser Omentum
   - Derived from **ventral mesentery**
   - Extends from the lesser curvature of the stomach & the 1st inch of the duodenum to the inferior (visceral) surface of the liver
   - Divided into a: **Medial hepato-gastric ligament** (passes between the stomach & liver)
     - **Lateral hepato-duodenal ligament** (passes between the 1st inch of duodenum & liver); serves as the anterior border of the omental/epiploic foramen of Winslow.
   - Encloses the hepatic artery proper, bile duct & hepatic portal vein which travel towards the porta hepatis to enter or leave the liver. Thus, by an index finger inserted into the omental foramen, blood supply to the liver can be cut off during surgery or following trauma to the liver to minimize bleeding. This procedure is known as the **Pringle’s Manoeuvre**.
   - It also encloses the **right and left gastric vessels** slightly superior to the stomach’s lesser curvature to supply it.
   - There is a space between the liver and right kidney known as the hepato-renal pouch of Morrison. It is significant in haemorrhage or appendicitis rupture, in which fluid collects once the patient is supine. If not drained, it can result in the development of infection.
The anal canal may be regarded surgically or anatomically. The length of the surgical anal canal is 4-5 cm, while the anatomical anal canal is 2.5-3 cm and begins at the pectinate or dentate line.

The pectinate or dentate line is a squamocolumnar junction which histologically shows the transition between rectum and anus. The rectum has the columnar epithelium featured throughout most of the GIT, while the anatomical anal canal features stratified squamous non-keratinized epithelium. It is known as a watershed line because blood supply and drainage, innervation and lymphatic drainage are different above and below this line.

Figure 27: The Lateral Flexures of the Rectum

Figure 28: Pectinate Watershed Line (Sym.=Sympathetic, Parasymp.=Parasympathetic, NS=Nervous System, Inf.=Inferior, A.=Artery, Int.=Internal)
• The **anal columns of Morgagni** are 6 to 10 permanent longitudinal folds formed by a duplication of the mucosa including muscularis mucosa. They contain radicals of the superior rectal vessels and the internal rectal venous plexus found in the submucosa.

• The **AV shunt of Haller** present in the stomach’s submucosa is also present here which is clinically significant in that it causes the bleeding of bright red blood from haemorrhoids (‘piles’).

• In between the anal columns of Morgagni are the **anal sinuses**. Into these anal sinuses open the **anal glands of Ball**, which have columnar epithelium with goblet cells for lubrication. The mucosa in this area is plum red.

• The crescentric mucosal folds connecting the lower ends of Morgagni’s anal columns are the **anal valves**. Their free margins are directed superiorly and it is this margin that appears wavy & is called the pectinate or dentate line.

• The **Anal Sphincters**:  
  o The **circular muscle layer** goes to form the **internal anal sphincter** which ends distally at Hilton’s Inter-sphincteric Groove.  
  o The **longitudinal coat** blends with the puborectalis muscle and goes into the formation of the **external anal sphincter**. It splits into 3 septae and has fibroeleastic tissue which it sends to the anal lining in between the 3 external anal sphincters & to the anal verge.

• **Muscles associated with the anus are**:  
  1. **Levator Ani**—consists of 3 groups of muscles: puborectalis, pubo-coccygeus & iliococcygeus.  
  2. **Pelvic Diaphragm**—consists of the 3 muscles of levator ani & the coccygeus muscle  
  3. **Internal Anal Sphincter**  
  4. **Deep External Anal Sphincter**—Bends into puborectalis  
  5. **Superficial External Anal Sphincter**—Gives a posterior extension to form the anococcygeal ligament  
  6. **Subcutaneous External Anal Sphincter**—Has an anterior attachment to the perineal body  
  7. **Corrugator Cutis Ani**

• The rectum receives several supports, namely, the puborectal sling of the levator ani, the pelvic floor, Waldeyer’s pre-sacral fascia, pelvi-rectal & ischiorectal fat & Denonviller’s Fascia.

• **Blood Supply to the Rectum & Anal Canal (2 unpaired & 2 paired arteries)**:
  1. **Superior Rectal Artery**: An unpaired branch from the **inferior mesenteric artery** which divides into a right & left branch. The right branch then divides into anterior & posterior branches. AV Shunts of Haller from branches of this artery in the anal columns of Morgagni will drain into radicles of the superior rectal veins at the 3, 7 & 11 o’clock position when the patient is lying on his or hers left side. These are the three (3) primary sites of primary or internal haemorrhoids.  
    o Left Branch→ 3 o’ clock position  
    o Right Branches→ 7 & 11 o’ clock position.  
  2. **Middle Sacral Artery**: An unpaired posterior branch of the abdominal aorta  
  3. **Middle Rectal Artery**: Exists in 1/5 people, is poorly developed & travels in the lateral rectal ligaments (condensations of tissue). When present, it is a branch of the **internal iliac artery**.  
  4. **Inferior Rectal Artery**: A branch of the **internal pudendal artery** (from the internal iliac)
Appendix 1: Glossary of Named Structures

Head and Neck
1. **Stensen’s Duct** - Parotid Duct which pierces the buccinator muscle, buccal fat pad, buccopharyngeal fascia and the cheek mucosa to empty into the oral vestibule above the 2nd upper molar teeth on either side
2. **Wharton’s Duct** - The duct of the submandibular gland
3. **Ducts of Rivini** - The ducts of the sublingual gland

Anterior Abdominal Wall
4. **Spigel’s Line** - Semilunar Line; shallow groove found on each side lateral to the rectus abdominis and possible site of hernia (Spigelian Hernia)
5. **Arcuate Line of Douglas** - where the posterior rectus sheath ends ¼ above the distal origin of rectus abdominis at the pubic crest, tubercle and symphysis
6. **Interfoveolar Ligament of Hesselbach** - (Iliopubic tract) Lower ¼ thickening of the transversalis fascia (thickens to lie directly against rectus abdominis below the arcuate/ semilunar line of Douglas)
7. **Inguinal Triangle of Hesselbach** - Site of direct inguinal hernias (indirect inguinal hernias are found lateral to this triangle); **Boundaries**: Laterally Inguinal Ligament of Poupart, Medially free edge of External Oblique & Inferiorly arching fibres of internal oblique and the iliac crest
8. **Lumbar Triangle of Petit** - Rare but possible site of hernia; **Boundaries**: Lateral Latissimus Dorsi, Medially free edge of External Oblique & Inferiorly arching fibres of internal oblique and the iliac crest
9. **Pectineal Ligament of Astley Cooper** - An extension of the lacunar ligament that runs on the pectineal line of the pubic bone.
10. **Lacunar Ligament of Gimbernat** - Ligament connecting the psoas ligament to the pectineal ligament, near the point where they insert on the iliac crest.

Groin/ Inguinal Area
11. **Howship-Romberg Sign** - False sign for an obturator canal hernia; when there is inner upper thigh pain on internal (medial) rotation of the hip.
12. **Inguinal Ligament of Poupart** - Inferior thickening of the external oblique’s fascia

Oesophagus
13. **Zenker’s Diverticulum** - Out-pouching of oesophagus found at the pharyngo-oesophageal junction

Cardio-Oesophageal Junction
14. **Angle of His** - Cardial Notch (sharply acute to prevent reflux)
15. **Barrett’s Oesophagus** - Metaplasia of the Cardio-oesophageal Junction

Stomach
16. **Troisier’s Sign** - Enlargement of Virchow’s Node (in stomach and other abdominal cancers, testicular/ovarian cancer)
17. **Virchow’s Node (Signal Node)** - Left Medial Supraclavicular Node
18. **Foramen of Winslow** - Epiploic/ Omental Foramen
19. **Collar of Helvetius** - Where the innermost oblique and inner circular fibres of the stomach blend at the cardiac notch
20. **Trans-Pyloric plane of Addison (L1)** - Marks the site of the pyloric orifice, hila of the kidneys, duodeno-jejunal Flexure and the body of the pancreas (in line with the medial epicondyles when pt. lies supine in the anatomical position).
21. **Pre-Pyloric Vein of Mayo (L1)** - Marks the location of the pyloric orifice in surgery
22. **AV Shunt of Haller** - Shunts oxygenated blood from the stomach’s submucosa to the veins when the stomach is not distended by chime
23. **Ant. & Post. Gastric Nerves of Latarjet** - Nominal change of the anterior (Left, branched) and posterior (Right, unbranched) Vagus Nerves
24. **Criminal Nerve of Grassi** - Nerve posterior to the fundus of the stomach from the posterior gastric nerve of Latarjet
References

Notes

Texts

Journal Articles

Internet Sources
8. http://www.gpnotebook.co.uk
11. https://www.watilearned2day.blogspot.com/2014/03/mnemonics-contents-of-spermatic-cord.html?m=1