Chapter 13 – Alimentary System—II: Gastrointestinal Tract

**Fig. 13.8:** Development of the duodenum. (A) Part of the duodenum above the entry of the bile duct is derived from the foregut; and the part below this level is derived from the midgut. (B) & (C) At first the duodenum has a mesentery called the mesoduodenum. As seen in B, this is continuous, cranially, with the dorsal mesogastrium. The mesoduodenum later disappears (Fig. 13.9).

**Duodenum**

The superior (or first) part, and the upper half of the descending (or second) part of the duodenum are derived from the foregut. The rest of the duodenum develops from the most proximal part of the midgut (Fig. 13.8A). The part of the gut that gives rise to the duodenum forms a loop attached to the posterior abdominal wall by a mesentery (mesoduodenum) (Figs. 13.8B, C). Later, this loop falls to the right. The mesoduodenum then fuses with the peritoneum of the posterior abdominal wall with the result that most of the duodenum becomes retroperitoneal (Fig. 13.9). The mesoduodenum persists in relation to a small part of the duodenum adjacent to the pylorus. This is the part seen in radiographs as the duodenal cap.

In keeping with its development, the proximal part of the duodenum is supplied by branches of the coeliac artery, and the distal part by branches of the superior mesenteric.

**Fig. 13.9:** Scheme to show how the mesoduodenum disappears. The duodenum then becomes retroperitoneal.
Jejunum and Ileum

The jejunum and most of the ileum are derived from the pre-arterial segment of the midgut loop. The terminal portion of the ileum is derived from the postarterial segment proximal to the caecal bud (Fig. 13.12).

Caecum and Appendix

We have seen that the caecal bud is a diverticulum that arises from the post-arterial segment of the midgut loop (Fig. 13.10). The caecum and appendix are formed by enlargement of this bud. The proximal part of the bud grows rapidly to form the caecum. Its distal part remains narrow and forms the appendix (Fig. 13.11).
Fig. 13.12: Derivation of various parts of the gut.

During the greater part of fetal life, the appendix arises from the apex of the caecum (Fig. 13.11). Subsequently, the lateral (or right) wall of the caecum grows much more rapidly than the medial (or left) wall with the result that the point of attachment of the appendix comes to lie on the medial side (Fig. 13.11).

Ascending Colon

It develops from the post-arterial segment of the midgut loop (Fig. 13.12) distal to the caecal bud.

Transverse Colon

The right two-thirds of the transverse colon develop from the post-arterial segment of the midgut loop. The left one-third arises from the hindgut. This mode of origin is reflected in its arterial supply; the right two-thirds are supplied by the superior mesenteric artery and the left one-third by the inferior mesenteric.

Descending Colon

The descending colon develops from the hindgut.

Rectum

The rectum is derived from the primitive rectum, i.e. the dorsal subdivision of the cloaca. According to some authorities, the upper part of the rectum is derived from the hindgut proximal to the cloaca.
Fig. 13.13: (A) Anal membrane separates hindgut from anal pit. (B) Anal membrane disappears. (C) Scheme to show the parts of the anal canal in which the lining epithelium is derived from ectoderm or endoderm.

**Anal Canal**

The anal canal is formed partly from the endoderm of the primitive rectum and partly from the ectoderm of the anal pit or proctodaeum (Fig. 13.13). The line of junction of the endodermal and ectodermal parts is represented by the anal valves (pectinate line).

**ROTATION OF THE GUT**

We have seen that after its formation, the midgut loop lies outside the abdominal cavity of the embryo, in a part of the extra-embryonic coelom that persists near the umbilicus. The loop has a pre-arterial, or proximal, segment and a post-arterial, or distal, segment (Fig. 13.2C). Initially, the loop lies in the sagittal plane, its proximal segment being cranial and ventral to the distal segment (Fig. 13.14A). The midgut loop now undergoes rotation. This rotation plays a very important part in establishing the definitive relationships of the various parts of the intestine. The steps of the rotation must, therefore, be clearly understood.

1. Viewed from the ventral side the loop undergoes an anticlockwise rotation by 90°, with the result that it now lies in the horizontal plane. The pre-arterial segment comes to lie on the right side and the post-arterial segment on the left (Compare Figs. 13.14A and B).
2. The pre-arterial segment now undergoes great increase in length to form the coils of the jejunum and ileum. These loops still lie outside the abdominal cavity, to the right side of the distal limb (Fig. 13.14C).
3. The coils of jejunum and ileum (pre-arterial segment) now return to the abdominal cavity. As they do so, the midgut loop undergoes a further anticlockwise rotation.
4. As a result, the coils of jejunum and ileum pass behind the superior mesenteric artery into the left half of the abdominal cavity (Fig. 13.14D). The duodenum, therefore, comes to lie behind the artery and the coils of jejunum and ileum occupy the posterior and left part of the abdominal cavity.
5. Finally, the post-arterial segment of the midgut loop returns to the abdominal cavity. As it does so, it also rotates in an anticlockwise direction (Fig. 13.14E) with the result that the
Developmental Anomalies of the Gut

**Congenital Obstruction**

This may be due to a variety of causes.

- **Atresia**: The continuity of the lumen of the gut is interfered with as follows:
  - A segment of the gut may be missing (Fig. 13.16A).
  - A segment of the gut may be replaced by fibrous tissue (Fig. 13.16B).
  - A septum may block the lumen (Fig. 13.16C).

- **Stenosis**: The lumen may be abnormally narrow (Fig. 13.16D).
  
  (As a normal developmental process, there is epithelial occlusion of the lumen of gut in early stages of development. The gut later gets recanalised. Some cases of atresia, duplication and stenosis of gut may be due to abnormal recanalisation.)

- **Non-development of nerve plexuses** in the wall of a part of the intestinal tract may result in difficulty in the passage of intestinal contents through the part. Such a defect in the lower part of the colon gives rise to a condition in which the colon proximal to the defective segment becomes greatly distended with its contents. This condition is called **megacolon** or **Hirschsprung's disease** (Fig. 13.17).

- **Abnormal thickening of muscular wall**: This is seen typically at the pyloric end of the stomach (Congenital pyloric stenosis) (Fig. 13.18). The thickened muscle bulges into the lumen and narrows it. According to some authorities, the primary cause of this defect is the same as in megacolon.

- **External pressure** by abnormal peritoneal bands or abnormal blood vessels. Such bands are often seen in relation to the duodenum (Fig. 13.19). The duodenum may also be compressed by an annular pancreas (Fig. 13.20).

- **Imperforate anus**: This is caused by stenosis or atresia of the lower part of the rectum or the anal canal. Some varieties of this condition are shown in Figs. 13.21 and 13.23.
**Fig. 13.19:** Obstruction of duodenum by a cystocolic band passing from the gall bladder to the transverse colon.

**Fig. 13.20:** Annular pancreas surrounding the duodenum.

**Fig. 13.21:** Various types of imperforate anus. (A) Stenosis of anal canal. (B) Persistent anal membrane. (C) The proctodaeum is represented by a solid mass of ectodermal cells and there is a big gap between it and the hindgut (rectum). (D) Upper and lower parts of rectum separated by a gap.
Abnormal Communications or Fistulae

Parts of the gut may have abnormal communications with other cavities or with the surface of the body. These are most frequently seen in relation to the oesophagus and the rectum, and are usually associated with atresia of the normal passage.

**Tracheo-oesophageal fistula:** Atresia of the oesophagus is often accompanied by abnormal communications between the oesophagus and trachea as illustrated in Fig. 13.22.

**Incomplete septation of the cloaca:** The rectum may communicate with the urinary bladder, urethra, or vagina (Figs. 13.23A to C, E, F), or may open onto the perineum at an abnormal site (Figs. 13.23D, G). These conditions are associated with imperforate anus.

**Duplication**

Varying lengths of the intestinal tract may be duplicated. The duplicate part may form only a small cyst, or may be of considerable length. It may or may not communicate with the rest of the intestine (Fig. 13.24).

**Diverticula**

These may arise from any part of the gut. They are most common near the duodenum (Fig. 13.25).

Persistence of a part of the vitello-intestinal duct may give rise to the presence of a diverticulum attached to the terminal part of the ileum. This is called Meckel's diverticulum or diverticulum ilei. It is of surgical importance as it may undergo inflammation giving rise to symptoms similar to those of appendicitis. Meckel's diverticulum is also of interest as pancreatic tissue or a gastric type of mucosa may be present in its wall. (In such cases ulceration and perforation can occur in the diverticulum). Occasionally the whole of the vitello-intestinal duct, or its distal part alone, may be patent. The former conditions lead to a fecal fistula at the umbilicus. The latter condition leads to formation of an umbilical sinus. The vitello-intestinal duct may be represented by cysts (enterocystoma, or vitelline cyst), or by fibrous cords (Fig. 13.26). Fibrous cords constitute a danger in later life as coils of intestine may get twisted round them leading to strangulation. Remnants of the vitello-intestinal duct may also give rise to growths.

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**Fig. 13.22:** (A) Normal arrangement of trachea and oesophagus. (B), (C), (D) Various forms of tracheo-oesophageal fistulae.
Fig. 13.23: Various types of rectal fistulae in the male (A to D) and female (E to H). The fistula may be between rectum and urinary bladder (i.e. rectovesical) as in (A) and (F), between rectum and urethra (rectourethral) as in (B) and (C), and between rectum and vagina (rectovaginal) as in (G), (H) and (F). More than one type may be present at the same time (F). The rectum may open on to the perineum at an abnormal site (D), (E). In these cases the anal pit is formed at the normal site.
Fig. 13.24: Degrees of duplication of the gut represented by a cyst on the terminal ileum as in (A), and by duplication of the entire colon and terminal ileum as in (B).

Fig. 13.25: Sites at which congenital diverticula may arise from stomach and duodenum.
Fig. 13.26: Anomalies in relation to the vitello-intestinal duct (See arrows). (A) Meckel's diverticulum. (B) Patent vitello-intestinal duct. (C) Umbilical sinus. (D) Cyst attached to the abdominal wall. A cyst may also be seen attached to the gut, or embedded in the abdominal wall as shown in 'E'. (E) Stenosis of gut at the site of attachment of duct. (F) Vitello-intestinal duct represented by a fibrous cord. An umbilical growth arising from remnants of the duct is also shown.

Clinical Correlation contd...

Errors of Rotation

1. **Non-rotation of the midgut loop:** In this condition the small intestine lies towards the right side of the abdominal cavity, and the large intestine towards the left (Fig. 13.27A).

2. **Reversed rotation:** The transverse colon crosses behind the superior mesenteric artery, and the duodenum crosses in front of it (Fig. 13.27B).

3. **Non-return of umbilical hernia:** Sometimes, the coils of intestine that develop from the midgut loop remain outside the abdominal cavity. The child is born with loops of intestine hanging out of the umbilicus. This condition is called **exomphalos** or **omphalocele** (Fig. 13.28).

Loops of intestine, and other abdominal contents may also be seen outside the abdominal cavity for an entirely different reason. In **congenital umbilical hernia** the muscle layer and skin are absent in the region of the umbilicus, creating a defect in the abdominal wall through which abdominal contents can pass. Such contents are covered with peritoneum, but in exomphalos they are covered only by amnion.