

Nerve Supply of the Stomach and the Small Intestines

The Stomach Nerve Supply

There are two types of nerve supply of the stomach; **sympathetic and parasympathetic**. The sympathetic constricts the sphincters, however the parasympathetic is a secreto-motor and stimulate smooth muscles for peristaltic movement and induce evacuation. Therefore, to empty the pylorus, the sympathetic stimulation must be inhibited and the parasympathetic excited.

Distribution of the vagus innervation to the stomach; the right vagus nerve innervates the posterior portion of the stomach while the left vagus supplies the anterior part of the stomach (posterior gastric and anterior gastric, respectively).

A] Parasympathetic innervation of the stomach:

I-The anterior gastric nerve(left vagus):

1. mainly supplies the anterior portion of the body,
2. it also innervates the liver (hepatic branch),
3. and the laterjet nerve to the pylorus (which is specific to the pylorus to increase control on the emptying of the stomach).

II-The posterior gastric nerve(right vagus):

1. innervates a small portion of the anterior body,
2. a main fiber innervates the posterior body,
3. and another celiac branch which innervates all the small intestines, up until the lateral third of the transverse colon (innervates the medial two thirds), along with the pancreas,

(Note: the lateral third and the descending colon are innervated by parasympathetic fibers from S2, S3 and S4)

4. and a laterjet nerve to the posterior and anterior walls of the pylorus.

(Note: although the parasympathetic fibers pass the celiac and superior mesenteric ganglia, they do not synapse with other fibers till they reach the myenteric plexus)

B] Sympathetic innervation of the stomach:

Those fibers are mainly derived from T5-T9 spinal cords, and supply their targets by the splanchnic chain, which is a branch from the thorax ganglia that penetrates the diaphragm to the abdomen. They synapse in the celiac ganglia, or the superior mesenteric ganglia, which incapsulates the blood vessels **(the post ganglionic fibers pass the myenteric plexus without synapsing with it)**.

(Note: sympathetic stimulation has no direct effect on motility. i.e when parasympathetic system is activated, the sympathetic system is inhibited, therefore motility decreases. Sympathetic stimulation also causes vasoconstriction).

Sensation in the stomach is supplied by both sympathetic and parasympathetic fibers.

The vagus nerve contains 80% sensory fiber(afferent fibers) and 20% secretomotor fibers(efferent fibers). **Stomach ache is sensed by afferent fibers in the vagus nerve.**

Clinical Notes:

Gastric ulcers are always considered cancerous until proven otherwise(biopsy). They are commonly found in the lesser curvature of the stomach. On the other hand, duodenal ulcers(peptic ulcers) are always considered simple mucosal erosions unless proven otherwise(rarely seen as a malignant tumor).

Historically, ulcers were assumed to be caused by hyperacidity, and the usual treatment was vagotomy, either truncal vagotomy or highly selective vagotomy; the vagus is cut directly beneath the diaphragm, therefore motility, drainage and secretion are completely inhibited; or fibers innervating the body are only cut, sparing the laterjet nerve to retain drainage, respectively. Recently, however, it was found out that the most potent agent to cause ulcers is Helicobacter bacteria(causing up to 93% of all cases, the other 7% are caused by stress), which is normally found in the stomach, but under certain circumstances may become pathogenic. Its pathogenicity can be treated with triple therapy(two antibiotics along with an antacid; proton pump inhibitor) with a cure rate of up to 95% in a timespan of 21 days. Surgery is now only used for chronic ulcers and ulcers due to excessive parasympathetic stimulation or drug abuse.

Gastroscopy presently can be used for both therapeutic or diagnostic procedures; injecting specific drugs for certain diseases(esophageal varicosele can be treated by injecting coagulative material to prevent bleeding) or taking biopsies from erosions, respectively. Also, it can be used in Jaundice, where it is inserted through the oral cavity, all the way into the sphincter of Oddi, and if blocked by a stone, cutting the circular smooth muscle and retracting the stone via a basket will allow the bile to be secreted, however, if it was blocked by "mud", irrigating it will allow the bile to pour in.

(Note: reinfection by H.pylori is possible if pathogenic stimuli is still present, but the patient will stay healthy for some time until the effects of the therapy wear out)

Pyloroplasty(drainage) was used in procedures relating to vagotomy, were an orifice is made in the pylorus to increase the amount of drainage, as much as possible.

Gastrojejunostomy is ligating the lower part of the stomach directly to the jejunum. Ligating the stomach to the duodenum is not possible, because motility is needed for the accomplishment of this procedure; any retroperitoneal organ cannot be conveyed(duodenum).

Reminder: The sphincter of Oddi is made from smooth muscles, therefore is will regenerate after cutting after some time.

(Note: the accessory pancreatic duct might have no sphincter.)

Patients suffering from rectal or colonic cancer, have some part of their colon removed surgically along with its lymph drainage. To maintain drainage and evacuation of the chyme/feces, the rest of the colon must have an opening to the exterior of the body(colostomy).

Therefore,being mobile due to the presence of mesentery, the transverse colon is ligated with the anterior abdominal wall and connected to a sack outside the body.



The Small Intestine

The small intestine is divided into three major parts; the **duodenum**, the **jejunum** and the **ilium**. It has a length of about 6 meters.

1. **The Duodenum:** It is 10 inches in length with a “C” shaped appearance situated in the epigastric and umbilical region and is retroperitoneal, except for the first inch (because it is attached to the greater and lesser omentum around the pylorus) and last inch (because it is attached to the mesentery surrounding the jejunum). The head of the pancreas lies within the concavity of the duodenum. Paraduodenal folds/recesses might result in internal hernia. The jejunum might be crammed within these folds, increasing the pressure on its edge consequently cutting its blood supply, this type of hernia is called “strangulated hernia” and it requires an emergency operation. The duodenum is separated into four parts;
 - i. **First part:** 2 inches, which is after the pylorus. This portion of the duodenum is common place for peptic ulcer (duodenal ulcer). It starts at the pyloroduodenal junction at the level of the transpyloric line (also same level of L1). It runs upwards and backwards 1 inch to the right, towards the neck of the gallbladder. The right lobe (ALTHOUGH IN THE SLIDES IT IS WRITTEN AS THE QUADRATUS LOBE??) of the liver and the gall bladder are anterior to it. The epiploic foramen is superior and the head of the pancreas is inferior. *Posteriorly*, the portal vein, the lesser sack, common bile duct, the gastroduodenal artery, and the hepatic artery, are all situated in the lesser omentum. The inferior vena cava is posterior to the epiploic foramen also passing posterior to the first part. (*common question*)
 - ii. **Second part:** 3 inches, it is vertical and might reach to the disc between L3 and L4. Anterior to it, the transverse colon passes along with the right lobe of the liver and gall bladder. Posteriorly, the hepatic hilum, the right kidney and ureter. On its lateral side, the right colic flexure. The common bile duct along with the pancreatic duct open in its medial side in its midway; major duodenal papilla, which is surrounded by a sphincter of smooth muscles called “Sphincter of Oddi”. The sphincter is always closed, to allow bile to go back to the gall bladder and enhance water absorption to increase the biles concentration. It only opens when stimulated by hormones (CCK) or by stimulation of parasympathetic fibers, therefore inhibiting sympathetic stimulation hence opening the sphincter. This point separates the whole duodenum into the upper half (which shares the same blood supply as the foregut; celiac trunk via the gastroduodenal artery, which also indirectly supply the head of the pancreas) and the lower half (sharing the midguts blood supply; superior mesenteric artery). The pancreatic duct might have an accessory duct opening also in the medial side of the duodenum, 1 inch superior to the major duodenal papilla, called the “minor duodenal papilla”. Abnormalities might be encountered in the duodenum, where each duct has their own opening.

(Clinical note: when the common bile duct is blocked, by either a stone or “mud”, the patient is said to have “jaundice”, where their skin and the sclera appear yellow, and might also result in itching, due to discharging the bile into the blood . The only treatment was Cholecystectomy, this used to cause the direct secretion of diluted bile from the liver to the duodenum, however now the gastroscope is used in a simple procedure(*described previously*.)

(Note: anatomically; the superior mesenteric artery is medial and the vein is lateral.)

- iii. **Third part:** 4 inches, horizontal. The superior mesenteric vessels pass superficially to it embedded in the roots of the mesentery of the small intestine, and superiorly lies the head of the pancreas and cords of the jejunum. The abdominal aorta and inferior vena cava lie deep to it, also the right ureter and the right psoas muscle.
- iv. **Fourth Part:** 1 inch. It is intraperitoneal and succeeded by the jejunum. (Reminder: This part has recesses and foldings, which might cause internal hernia.) The junction (flexure) is held in position by the **ligament of Treitz**, which is attached to the right crus of the diaphragm. Posteriorly, the left psoas muscle and the left sympathetic chain (the right chain lies posterior to the inferior vena cava), and superiorly the uncinate process of the pancreas.

(Remember: the duodenum is divided into two halves by the major pancreatic papilla.)

Blood supply of the Duodenum

Arterial Supply:

1. Upper half: supplied by the superior pancreaticoduodenal artery, a branch of the gastroduodenal artery which is from the celiac trunk.
2. Lower half: supplied by the inferior pancreaticoduodenal artery, a branch of the superior mesenteric artery, which also supplies the midgut.

Venous Drainage:

1. Upper half: drained by the superior pancreaticoduodenal vein into the portal vein.
2. Lower half: drained by the inferior pancreaticoduodenal into the superior mesenteric vein.

Lymphatic Drainage

1. Upper half: via pancreaticoduodenal nodes to the gastroduodenal nodes finally the celiac nodes
2. Lower half: via pancreaticoduodenal nodes to the superior mesenteric nodes around the origin of the superior mesenteric artery.

Nerve Supply

Sympathetic nerve supply (did not mention their origin), an parasympathetic supply from the vagus nerve via the celiac and superior mesenteric plexuses.

2. The Jejunum: It is completely within the peritoneum (intraperitoneal), and it has a mesentery which starts from the anterior abdominal wall. Upper 2/5 is the jejunum, and the lower 3/5 is the ileum. Jejunum begins at the duodenojejunal flexure present at the level of L2 1 inch to the left (root of mesentery), and the ileum ends at the ileocecal junction in the right iliac fossa. The Small intestine is present in the umbilical region. People with intestinal colic complain from pain around the umbilicus in the umbilical region.

Mesentery of small intestine consists of 2 layers of peritoneum, it begins in the posterior abdominal wall and end in the abdomen. Its root is 6 inches (15cm) long, with width of 8 inches, and the free edge is 4-5 meters.

The root of the mesentery consists of 2 layers of peritoneum that contains fat, branches of superior mesenteric vessels, lymphatic vessels, lymph nodes and nerves (sympathetic and parasympathetic fibers). The root of the mesentery ends at the right sacroiliac joint, and begins at the level of L2 one inch from the mid line.

The large intestine begins at the cecum where the appendix is attached to it. Then it continues as the ascending colon, transverse colon (the only mobile part of the large intestine), descending colon, sigmoid, rectum and finally as the anal canal.

The small intestine (5-6 meters) is longer than large intestine (1.5 -2.5 meters), but the large intestine has a larger diameter than the small intestine. They differ histologically, anatomically and thus functionally; the large intestine has taenia coli, sacculations (تکیس), and there is also appendices epiploicae (tags of fat), all of which are not present in the small intestine.

***important (refer to table in slides) for the difference between jejunum and ileum.**

In surgeries the doctor can easily spot the difference in colour and thickness of the wall, but in anatomy we depend on mesentery (on the arcades and vasa recta) to differentiate between the jejunum and the ileum, because the use of formalin fix their walls and change their colours.

Blood supply

The superior mesenteric artery via the jejunal and iliac arteries. Lower part of the ileum and the colon (cecum) is supplied by iliocolic artery, and terminate into the anterior and posterior cecal arteries. The posterior will give rise to the appendicular artery. Arteries are medial to the veins, in the end the superior mesenteric vein drains into the portal vein.

Lymphatic drainage is through the superior mesenteric lymph nodes around the origin of superior mesenteric artery.

Nerve supply is by sympathetic and parasympathetic to the ganglia, which is superior mesenteric ganglia. Sympathetic origin is from the thoracic 6-9 ganglia, via greater splanchnic nerve, that has a synapse with the superior mesentery ganglia. Postganglionic goes to the myenteric, where as the vagus descends from the medulla and passes without synapse until it reaches the myenteric and has its synapse there. The vagus nerve provides parasympathetic innervation, the superior mesenteric plexus branches provides sympathetic innervation.

(refer to another source he was not clear regarding the nerve supply)

Meckel's Diverticulum is an ileum abnormality , caused by the remains of the vitelline duct of embryo. As we said when we talked about the processus viganalis that must be obliterated to avoid hernia, here the vitelline duct must be obliterated, and if not obliterated it can cause meckel's diverticulum, a pouch coming out of the small intestine. In this pouch inflammation might occur giving us the same image as the appendicitis, because its 2 feet away from the ilocecal junction, and the diverticulum is 2 inches long. It occurs in 2% of people, and is a congenital anomaly, and it contains gastric or pancreatic tissue. The patient come complaining of the same image of the appendicitis, but the inflammation is actually in the diervticulum, so when the doctor examines the appendix he will find that it is normal, he should take a look at the right side to see if there is a diverticulum that is causing the problem. Some of its complications might be inflammation, ulcers, perforation, and bleeding.

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