



# GI system

## Physiology

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## Gastrointestinal motilities

Chewing: once you introduce the first bolus to the mouth you started what we call chewing reflex (centers in hypothalamus and cerebral cortex are stimulated by smell and taste to cause chewing of food in the mouth).

- reflex appears by muscle stretching caused by drop of the lower jaw (due to the presence of food bolus in the mouth). This will result in a rebound of the lower jaw by activation of stretch reflex.

1) mixes food with saliva which lubricates the food to move more easily through more distal portions of the digestive tract and begins to be digested by salivary enzymes. 2) grinding forms the food into a bolus that is suitable for swallowing.

- Chewing is normally a voluntary act having some mixing behaviour

Two stages of deglutition:

- Voluntary stage: in which tongue is pressing food by upward and backward movement against soft palate, which results in squeezing food bolus into pharynx.
- Involuntary stages: reflexes initiated by introducing food into pharynx will result in contraction of pharynx and then esophageal peristalsis that induce movement of bolus along esophagus. In these reflexes, swallowing receptors at the pharyngeal mucosa and swallowing centers in the brain are involved.

The involuntary stage is subdivided into:

- Pharyngeal stage: duration is about 2 sec. In this stage respiration is interrupted, soft palate is pulled upward to close posterior nares and larynx is pulled upward and anteriorly which results in closure of epiglottis. In addition to these complex events, the upper esophageal sphincter (pharyngoesophageal sphincter) is relaxed and esophageal opening is enlarged. This will end in enforcing bolus to move into esophagus.

- Esophageal stage: conduct the bolus along esophagus to the stomach.

We have the same pattern of motor movement (contraction up relaxation down)

1) Primary peristaltic contractions: Simply , those are continuation of the peristaltic wave that begins in the pharynx and spreads into the esophagus during the pharyngeal stage of swallowing. This wave passes all the way from the pharynx to the stomach, initiated by drinking water "The wave of contractions passes along esophagus in about 8-10 second".

. 2) Secondary peristalsis: those peristaltic waves result from distention of the esophagus itself by the retained food . If the primary peristaltic wave fails to move all the food that has entered the esophagus into the stomach. (as if the esophagus is reinitiating its contraction). these waves continue until all the food has emptied into the stomach. Represented by intrinsic (within myenteric plexus) and extrinsic (through afferent and efferent vagus fibers) reflexes

- Note: Pharynx and Upper third of the esophagus is striated muscle and controlled by glossopharyngeal nerve. The lower third is smooth muscle and controlled by the vagus nerve as extrinsic control
- At the lower part of the esophagus we have sphincters which become relaxed by the internal nervous system .

Peristaltic wave of the esophagus ends with relaxation of **gastroesophageal sphincter** (lower esophageal sphincter) and receptive relaxation of the stomach. The relaxation is caused by the activation of the inhibitory neurons from the lower part of the esophagus. These neurons induce inhibition of the tonic contraction of the sphincter and the relaxation of the stomach is achieved

Failure of the sphincter to relax may result in a pathological condition known as *achalasia*. In which the ability of myenteric plexus to cause relaxation of the sphincter has failed.

Gastro-esophageal sphincter is equipped also by valve like closure at the distal opening of the esophagus to prevent reflux of food from the stomach. The failure of this system may result in esophageal reflux (Return of gastric content toward esophagus).

Gastric motilities:

- Usually the stomach has a very small capacity which can be dilated 50ml up to 1000ml. This dilation begins with receptive relaxation and the

intervention of vago-vagal reflex that decreases the muscular tone of the stomach upon the presence of food in the stomach

1) "receptive relaxation movement" in which the contraction is at a lower tone. • Therefore

those are weak peristaltic constriction waves, called mixing waves, These activities appear in the mid portion of the stomach at frequency of 3/min and move toward the antrum. The frequency is determined by the frequency of basic electrical rhythm (BER) of gastric smooth muscle. These contractions are very intense as they approach the antrum and they are forming *constrictive rings*. At the antrum, when the peristaltic constrictive wave reaches the pylorus, it causes constriction of the pyloric sphincter which impedes emptying of chyme into the duodenum.

2) "the gastric peristaltic movement :Which occurs as the wave approaches the larger mass of wall muscle

it's a more powerful contraction. which both mixes the luminal contents and closes the pyloric sphincter. (a ring of smooth muscle and connective tissue between the antrum and the duodenum). The pyloric sphincter muscle contract upon arrival of a peristaltic wave.

As a consequence of sphincter closing, only a small amount of chyme is expelled into the duodenum with each wave, and most of the antral contents are forced backward toward the body of the stomach (squeezing action) ,the moving peristaltic constrictive ring, combined with this upstream squeezing action, is called "retropulsion," which is an important mixing mechanism in the stomach.

Stomach secretes large amount of secretions (2000ml/day). This secretion when mixed with the ingested food in the stomach is forming chyme

This secretion when mixed with the ingested food in the stomach is forming chyme. • The motor functions of the stomach are threefold: 1) storage of large quantities of food until the food can be processed in the stomach, duodenum, and lower intestinal tract. 2) mixing of this food with gastric secretions until it forms chyme. 3) slow emptying of the chyme from the stomach into the small intestine at a rate suitable for proper digestion and absorption by the small intestine.

Note : pylorus are in tonic contraction control

hunger contraction: is another type of contraction in which its mechanism isn't not well understood. It seems that these contractions are in relation with glucose concentration in the blood (They are increased by decreasing glucose level in blood).

### **Neural and hormonal control of gastric emptying:**

Stimulation of gastric emptying:

- Filling of the stomach: initiates myenteric reflexes that causes an increase in the activity of pyloric pump and inhibits the tone of pyloric sphincter.
- Gastrin: secreted by the antral mucosa. This hormone has mild stimulatory effect on the peristaltic activities of the stomach, which result in enhanced pyloric pump.

Inhibition of gastric emptying:

- Enterogastric reflex: The passage of chyme to the duodenum causes decrease pH (in duodenum). This initiates intrinsic and extrinsic reflexes to decrease gastric emptying.

3 levels of inhibition induced by enterogastric reflexes:

- Through ENS.
- Through prevertebral ganglia.
- Through signals via the vagus nerve to inhibit the excitatory signals of vagus nerve to the stomach.

The effects of these reflexes decrease the antral propulsive contractions and increase the tone of the pyloric sphincter.

- Hormonal feedback from the duodenum:
  - CCK cholecystokinin: (secreted by jejunum) the release is stimulated by fat in chyme.
  - GIP: Gastric Inhibitory Peptide: released from upper small intestinal specialized cells and stimulated by fat and carbohydrates in chyme.
  - Secretin: stimulated by acid in duodenum.

Movement of small intestines:

- Motility patterns in the small intestine differ within different regions and with time since the last meal. **Mixing and propulsion** of chyme are the primary mechanical events that occur in the small intestine: **propulsive** movements ensure the movement of chyme analward at an appropriate rate.

all movements of the small intestine cause at least some degree of both mixing and propulsion.

- After a meal, four types of contraction occur. They are: 1) segmentation contractions (related to the mixing movement), peristaltic contraction, migrating contractions. Also, we can have some movement of mucosa

Mixing movement in the small intestines:

- is provided by the activity of circular smooth muscle cells. The type of contraction that appears during this movement is the segmentation contraction Which are brief, localized events in circular muscles. They appear, disappear, and reappear regularly (contraction after relaxation...)

Propulsive movements: (peristalsis in the small intestines)

Chyme is propelled through the small intestine by peristaltic waves.

By peristaltic movement we mean contraction up, relaxation down. this is the first component ,the second component is the lengthening and shortening of the longitudinal layer .this component is taking place all the time , those contractions can take place even if the organ is empty .this is because they have an electrical control which is not related to the presence of bolus. an effective peristaltic activity to cause a propulsive movement of chyme requires an intact and active ENS

note that segmentation contraction characterizes the fed state while the peristaltic contraction is a basic contraction existed continuously! This indicates that when having a section of the intestines and hanging it only the longitudinal shortening and lengthening will be seen!

Control of intestinal movements: 1. Neural control by ENS and 2.

Parasympathetic nervous system: this system can modulate the peristaltic activities by changing the activity of neural network or by changing the activity of smooth muscle cells. 3. Hormonal control: Gastrin, CCK, serotonin enhance intestinal motility. Secretin and glucagon inhibit intestinal motility.

4. Electrical activity of muscle

- Importantly, before having a surgical operation patient must be fast at least 6 hours before the operation to avoid some of the complications caused by anesthesia. Like Ileus which is disruption caused by the failure of peristalsis, so if you have food or fluid in your stomach during your surgery, you could vomit while under anesthesia. and intubation makes it possible for you to inhale the vomit into your lungs.

- Other Pathological conditions cause increasing or decreasing movement along intestines, or even the pumping of content occurs toward the stomach instead of anal ward!! .

another type of contraction called the, • Migrating Motor Complex (MMC) begins in the stomach in the interdigestive periods. The activity begins in the distal part of the stomach and continues along the entire small intestine. The function of these contractions is to sweep the intestinal content in the time between meals.

The contractions that forming MMC appear in 3 phases:

In the first phase: slow waves (as electrical activity) without contraction are present.

In the second phase: not all slow waves are followed by contractions (one slow wave is followed by contraction and 1-5 slow waves are not followed).

In the third phase lasts for 5-15 minutes all slow waves are followed by contractions.

These movements are controlled by hormonal (Motilin is believed to be involved) and neural mechanisms