

HUMAN ANATOMY & PHYSIOLOGY-II- BP201T**UNIT: 2 (DIGESTIVE SYSTEM)****CLASS: 05****TOPIC: Movements of Gastrointestinal Tract****MASTICATION**

Mastication or chewing is the first mechanical process in the gastrointestinal (GI) tract, by which the food substances are torn or cut into small particles and crushed or ground into a soft bolus. Significances of mastication 1. Breakdown of foodstuffs into smaller particles 2. Mixing of saliva with food substances thoroughly 3. Lubrication and moistening of dry food by saliva, so that the bolus can be easily swallowed 4. Appreciation of taste of the food.

DEGLUTITION

Definition Deglutition or swallowing is the process by which food moves from mouth into stomach.

Stages of Deglutition Deglutition occurs in three stages: I. Oral stage, when food moves from mouth to pharynx II. Pharyngeal stage, when food moves from pharynx to esophagus Esophageal stage, when food moves from esophagus to stomach.

ORAL STAGE OR FIRST STAGE Oral stage of deglutition is a voluntary stage. In this stage, the bolus from mouth passes into pharynx by means of series of actions.

Sequence of Events during Oral Stage 1. Bolus is placed over postero-dorsal surface of the tongue. It is called the preparatory position 2. Anterior part of tongue is retracted and depressed. 3. Posterior part of tongue is elevated and retracted against the hard palate. This pushes the bolus backwards into the pharynx 4. Forceful contraction of tongue against the palate produces a positive pressure in the posterior part of oral cavity. This also pushes the food into pharynx

PHARYNGEAL STAGE OR SECOND STAGE

Pharyngeal stage is an involuntary stage. In this stage, the bolus is pushed from pharynx into the esophagus. Pharynx is a common passage for food and air. It divides into larynx and esophagus. Larynx lies anteriorly and continues as respiratory passage. Esophagus lies behind the larynx and continues as GI tract. Since pharynx communicates with mouth, nose, larynx and esophagus, during this stage of deglutition, bolus from the pharynx can enter into four paths: 1. Back into mouth 2. Upward into nasopharynx 3. Forward into larynx 4. Downward into esophagus. However, due to various coordinated movements, bolus is made to enter only the esophagus. Entrance of bolus through other paths is prevented as follows: 1. Back into Mouth Return of bolus back into the mouth is prevented by: i. Position of tongue against the soft palate (roof of the mouth) ii. High intraoral pressure, developed by the movement of tongue. 2. Upward into Nasopharynx Movement of bolus into the nasopharynx from pharynx is prevented by elevation of soft palate along with its extension called uvula. 3. Forward into Larynx Movement of bolus into the larynx is prevented by the following actions: i. Approximation of the vocal cords ii. Forward and upward movement of larynx iii. Backward movement of epiglottis to seal the opening of the larynx (glottis) i v. All these movements arrest respiration for a few seconds. It is called deglutition apnea. Deglutition apnea Apnea refers to temporary arrest of breathing. Deglutition apnea or swallowing apnea is the arrest of breathing during pharyngeal stage of deglutition. 4. Entrance of Bolus into Esophagus As the other three paths are closed, the bolus has to pass only through the esophagus. This occurs by the combined effects of various factors: i. Upward movement of larynx stretches the opening of esophagus ii. iii. Simultaneously, upper 3 to 4 cm of esophagus relaxes. This part of esophagus is formed by the cricopharyngeal muscle and it is called upper esophageal sphincter or pharyngoesophageal sphincter At the same time, peristaltic contractions start in the pharynx due to the contraction of pharyngeal muscles i v. Elevation of larynx also lifts the glottis away from the food passage. All the factors mentioned above act together so that, bolus moves easily into the esophagus. The whole process takes place within 1 to 2 seconds and this process is purely involuntary.

ESOPHAGEAL STAGE OR THIRD STAGE

Esophageal stage is also an involuntary stage. In this stage, food from esophagus enters the stomach. Esophagus forms the passage for movement of bolus from pharynx to the stomach.

Movements of esophagus are specifically organized for this function and the movements are called peristaltic waves. Peristalsis means a wave of contraction, followed by the wave of relaxation of muscle fibers of GI tract, which travel in aboral direction (away from mouth). By this type of movement, the contents are propelled down along the GI tract. When bolus reaches the esophagus, the peristaltic waves are initiated. Usually, two types of peristaltic contractions are produced in esophagus. 1. Primary peristaltic contractions 2. Secondary peristaltic contractions. 1. Primary Peristaltic Contractions When bolus reaches the upper part of esophagus, the peristalsis starts. This is known as primary peristalsis.

MOVEMENTS OF STOMACH

Activities of smooth muscles of stomach increase during gastric digestion (when stomach is filled with food) and when the stomach is empty.

Types of movements in stomach 1. Hunger contractions 2. Receptive relaxation 3. Peristalsis.

1. HUNGER CONTRACTIONS

Hunger contractions are the movements of empty stomach. These contractions are related to the sensations of hunger. Hunger contractions are the peristaltic waves superimposed over the contractions of gastric smooth muscle as a whole. This type of peristaltic waves is different from the digestive peristaltic contractions. The digestive peristaltic contractions usually occur in body and pyloric parts of the stomach. But, peristaltic contractions of empty stomach involve the entire stomach. Hunger contractions are of three types: Type I Hunger Contractions Type I hunger contractions are the first contractions to appear in the empty stomach, when the tone of the gastric muscles is low. Each contraction lasts for about 20 seconds. The interval between contractions is about 3 to 4 seconds. Tone of the muscles does not increase between contractions. Pressure produced by these contractions is about 5 cm of H₂O. Type II Hunger Contractions Type II hunger contractions appear when the tone of stomach is stronger. Tone increases in stomach if food intake is postponed, even after the appearance of the type I contractions. Each of the type II contractions lasts for 20 seconds like type I contractions. But the pause between the contractions is decreased. Pressure produced by these contractions is 10 to 15 cm of H₂O. Type III Hunger Contractions Type III hunger contractions are like incomplete tetanus. These contractions appear when the

hunger becomes severe and the tone increases to a great extent. Type III hunger contractions are rare in man as the food is taken usually before the appearance of these contractions. These contractions last for 1 to 5 minutes. The pressure produced by these contractions increases to 10 to 20 cm of H₂O. When the stomach is empty, the type I contractions occur first, followed by type II contractions. If food intake is still postponed, then type III contractions appear and as soon as food is consumed, hunger contractions disappear.

2. RECEPTIVE RELAXATION

Receptive relaxation is the relaxation of the upper portion of the stomach when bolus enters the stomach from esophagus. It involves the fundus and upper part of the body of stomach. Its significance is to accommodate the food easily, without much increase in pressure inside the stomach. This process is called accommodation of stomach.

3. PERISTALSIS When food enters the stomach, the peristaltic contraction or peristaltic wave appears with a frequency of 3 per minute. It starts from the lower part of the body of stomach, passes through the pylorus till the pyloric sphincter. Initially, the contraction appears as a slight indentation on the greater and lesser curvatures and travels towards pylorus. The contraction becomes deeper while traveling. Finally, it ends with the constriction of pyloric sphincter. Some of the waves disappear before reaching the sphincter. Each peristaltic wave takes about one minute to travel from the point of origin to the point of ending. This type of peristaltic contraction is called digestive peristalsis because it is responsible for the grinding of food particles and mixing them with gastric juice for digestive activities.

MOVEMENTS OF SMALL INTESTINE

Movements of small intestine are essential for mixing the chyme with digestive juices, propulsion of food and absorption. Types of Movements of Small Intestine Movements of small intestine are of four types: 1. Mixing movements: i. Segmentation movements ii. Pendular movements. 2. Propulsive movements: i. Peristaltic movements ii. Peristaltic rush. 3. Peristalsis in fasting – migrating motor complex 4. Movements of villi.

1. MIXING MOVEMENTS Mixing movements of small intestine are responsible for proper mixing of chyme with digestive juices such as pancreatic juice, bile and intestinal juice. The mixing movements of small intestine are segmentation contractions and pendular movements. i. **Segmentation Contractions** Segmentation contractions are the common type of movements of small intestine, which occur regularly or irregularly, but in a rhythmic fashion. So, these movements are also called rhythmic segmentation contractions. The contractions occur at regularly spaced intervals along a section of intestine. The segment of the intestine involved in each contraction is about 1 to 5 cm long. The segments of intestine in between the contracted segments are relaxed. The length of the relaxed segments is same as that of the contracted segments. These alternate segments of contraction and relaxation give appearance of rings, resembling the chain of sausages. After sometime, the contracted segments are relaxed and the relaxed segments are contracted. Therefore, the segmentation contractions chop the chyme many times. This helps in mixing of chyme with digestive juices. ii. **Pendular Movement** Pendular movement is the sweeping movement of small intestine, resembling the movements of pendulum of clock. Small portions of intestine (loops) sweep forward and backward or upward and downward. It is a type of mixing movement, noticed only by close observation. It helps in mixing of chyme with digestive juices.

2. PROPULSIVE MOVEMENTS Propulsive movements are the movements of small intestine which push the chyme in the aboral direction through intestine. The propulsive movements are peristaltic movements and peristaltic rush. i. **Peristaltic Movements** Peristalsis is defined as the wave of contraction followed by wave of relaxation of muscle fibers. In GI tract, it always travels in aboral direction. Stimulation of smooth muscles of intestine initiates the peristalsis. It travels from point of stimulation in both directions. But under normal conditions, the progress of contraction in an oral direction is inhibited quickly and the contractions disappear. Only the contraction that travels in an aboral direction persists. Starling's law of intestine Depending upon the direction of the peristalsis, 'Law of intestine' was put forth by Starling. According to the law of intestine, the response of the intestine for a local stimulus consists of a contraction of smooth muscle above and relaxation below the stimulated area. Peristaltic contractions start at any part of the intestine and travel towards anal end, at a velocity of 1 to 2 cm/sec. The contractions are always weak and usually disappear after traveling for few centimeter. Because of this, the average movement of chyme through small intestine is very slow and the average velocity of movement of

the chyme is less than 1 cm/ sec. So, the chyme requires several hours to travel from duodenum to the end of small intestine. Peristaltic waves in small intestine increase to a great extent immediately after a meal. This is because of gastroenteric reflex, which is initiated by the distention of stomach. Impulses for this reflex are transmitted from stomach along the wall of the intestine via myenteric plexus. ii. Peristaltic Rush Sometimes, the small intestine shows a powerful peristaltic contraction. It is caused by excessive irritation of intestinal mucosa or extreme distention of the intestine. This type of powerful contraction begins in duodenum and passes through entire length of small intestine and reaches the ileocecal valve within few minutes. This is called peristaltic rush or rush waves. Peristaltic rush sweeps the contents of intestine into the colon. Thus, it relieves the small intestine off either irritants or excessive distention.

3. PERISTALSIS IN FASTING – MIGRATING MOTOR COMPLEX Migrating motor complex is a type of peristaltic contraction, which occurs in stomach and small intestine during the periods of fasting for several hours. It is also called migrating myoelectric complex. It is different from the regular peristalsis because, a large portion of stomach or intestine is involved in the contraction. The contraction extends to about 20 to 30 cm of stomach or intestine. This type of movement occurs once in every 1½ to 2 hours. It starts as a moderately active peristalsis in the body of stomach and runs through the entire length of small intestine. It travels at a velocity of 6 to 12 cm/min. Thus, it takes about 10 minutes to reach the colon after taking origin from the stomach. Significance of Peristalsis in Fasting Migrating motor complex sweeps the excess digestive secretions into the colon and prevents the accumulation of the secretions in stomach and intestine. It also sweeps the residual indigested materials into colon.

4. MOVEMENTS OF VILLI Intestinal villi also show movements simultaneously along with intestinal movements. It is because of the extension of smooth muscle fibers of the intestinal wall into the villi. Movements of villi are shortening and elongation, which occur alternatively and help in emptying lymph from the central lacteal into the lymphatic system. The surface area of villi is increased during elongation. This helps absorption of digested food particles from the lumen of intestine. Movements of villi are caused by local nervous reflexes, which are initiated by the presence of chyme in small intestine. Hormone secreted from the small intestinal mucosa called villikin is also believed to play an important role in increasing the movements of villi.

MOVEMENTS OF LARGE INTESTINE Usually, the large intestine shows sluggish movements. Still, these movements are important for mixing, propulsive and absorptive functions. Types of Movements of Large Intestine Movements of large intestine are of two types: 1. Mixing movements: Segmentation contractions 2. Propulsive movements: Mass peristalsis. 1. **MIXING MOVEMENTS – SEGMENTATION CONTRACTIONS** Large circular constrictions, which appear in the colon, are called mixing segmentation contractions. These contractions occur at regular distance in colon. Length of the portion of colon involved in each contraction is nearly about 2.5 cm. 2. **PROPULSIVE MOVEMENTS – MASS PERISTALSIS** Mass peristalsis or mass movement propels the feces from colon towards anus. Usually, this movement occurs only a few times every day. Duration of mass movement is about 10 minutes in the morning before or after breakfast. This is because of the neurogenic factors like gastrocolic reflex (see below) and parasympathetic stimulation. **DEFECATION** Voiding of feces is known as defecation. Feces is formed in the large intestine and stored in sigmoid colon.