Mastication & Deglutition

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• By the end of lecture, students should be able to know:
• Define mastication and deglutition
• Outline the phases deglutition and their regulation
• Summarize the nervous regulation of mastication and deglutition
• Outline the reflex arc of mastication and deglutition
Mastication (Chewing)

• Hunger: Intrinsic desire for food.

• Appetite: Preference for the type of food.

• Purpose: To aid digestion (Grinding food into small particles)
  • To mix with salivary secretions
  • To make bolus for deglutition
  • To perceive taste

• Role of Teeth:
  • Help in cutting & grinding action.
  • Incisors (Ant. Teeth) for cutting = 55 lbs
  • Molars (Post. Teeth) for grinding = 200 lbs
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.
Mastication

• **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.

• **Muscles of Mastication**
  1. Masseter muscle
  2. Temporal muscle
  3. Pterygoid muscles

• **Movements of Mastication**
  1. Opening and closure of mouth
  2. Rotational movements of jaw
  3. Protraction and retraction of jaw
Chewing Reflex

• Stimulus : Presence of food in mouth
• Afferent : Through trigeminal nerve,
• Centre : Nuclei in brain stem (N.T.S, reticular formation) and cerebral cortex
• Efferent : Motor part (Mandible division) of trigeminal nerve
• Effectors : Muscles of mastication (Masseter, temporalis, pterygoids, buccinators)
• Movements: Closure & opening of mouth, rotational movement, protraction and retraction of jaw
CONTROL OF MASTICATION

• Action of mastication is mostly a reflex process.
• It is carried out voluntarily also.
• The center for mastication is situated in medulla and cerebral cortex.
• Muscles of mastication are supplied by mandibular division of 5th cranial (trigeminal) nerve.
Swallowing

- Deglutition or swallowing is the process by which food moves from mouth into stomach.
- Coordinated with respiration.
- Three stages/phases:
  - Oral stage—Voluntary
  - Pharyngeal stage—Involuntary
  - Esophageal stage—Involuntary
Deglutition--Oral stage

• Bolus is voluntarily squeezed or rolled posteriorly into the pharynx by the pressure of the tongue upward & backwards against the palate
• Bolus is placed over postero-dorsal surface of the tongue. It is called the preparatory position
• Is initiated voluntarily when the tongue forces a bolus of food (upward and backward against the palate) toward the pharynx
• Contains high density of somatosensory receptors
• Activation of these receptors initiates the involuntary swallowing reflex in the medulla
Swallowing—Pharyngeal Stage

• Involuntary, reflex action

• At the pharynx, the bolus of food stimulates epithelial swallowing receptor, send impulses from this area pass to the brain stem (swallowing center) and accordingly initiate a series of autonomic pharyngeal muscle contractions

• Begins when food enters esophagus from pharynx.
Swallowing—Pharyngeal Stage

• Never initiated by direct stimuli to the swallowing center (Always initiated by voluntary movement of food into back of mouth).
• Peristaltic contractions (of pharyngeal muscles) begin in the pharynx.
• Upward movement of larynx stretches the opening of esophagus + Relaxation of upper 3-4 cm of esophagus (upper esophageal sphincter).
• Elevation of larynx lifts the glottis away from food passage.
Swallowing

1. Bolus of food
   - Upper esophageal sphincter (UES) closed
2. Tongue blocks the oral cavity
   - Soft palate blocks the nasal cavity
   - UES opens
   - Esophagus
   - Epiglottis blocks the larynx
3. UES re-closes
Pharyngeal stage

• Steps
  1. Soft palate is pulled upward
  2. The epiglottis moves to cover opening of larynx
  3. Palatopharyngeal folds approximate and slit is formed allows the food to move into pharynx
  4. Upper esophageal sphincter relaxes allowing food to move from pharynx to esophagus
  5. Peristalsis wave of contraction initiated in the pharynx moves food from pharynx through the upper esophageal sphincter.

• Breathing is inhibited during the pharyngeal stage of swallowing.
Swallowing—Pharyngeal Stage

• Entry of bolus into esophagus due to :-
  i. Closure of larynx by;
    • Approximation of vocal cords
    • Forward & upward movement of larynx (glottis)
    • Backward movement of epiglottis to seal glottis
  ii. Arrest of breathing (deglutition apnea)
  iii. Closure of Nasopharynx (elevation of soft palate)
  iv. Closure of Oropharynx (position of tongue against soft palate + high intraoral pressure)
    • This phase takes 1-2 sec to complete
MECHANISM OF SWALLOWING

• The soft palate is pulled upward to close the posterior nares which prevents the food from entering the nasal cavities.

• The palatopharyngeal folds on each side of the pharynx are pulled medially to approximate each other.

• These folds form a sagittal slit through which food must pass into the posterior pharynx.

• The vocal cords of the larynx are strongly approximated and the larynx is pulled upward and anteriorly by the neck muscles. These actions and the ligaments that prevent the epiglottis from moving upward, cause the epiglottis to swing backward over the opening of the larynx. All these effects prevent food from going into the nose and trachea.
MECHANISM OF SWALLOWING

• The upward movement of the larynx pulls up and enlarges the opening to the esophagus.

• The upper esophageal sphincter (or the pharyngoesophageal sphincter) relaxes and allows food to move freely from the posterior pharynx into the upper esophagus.

• Once the larynx is raised and the pharyngoesophageal sphincter relaxes, the entire muscular wall of the pharynx contracts (superior, middle, then inferior parts) propelling the food by peristalsis into the esophagus.
Swallowing—Esophageal Stage

• Involuntary
• Conduction of food from pharynx to stomach.
• By two types of Peristaltic Movements:
  i. Primary Peristalsis:
  • Continuation of peristaltic wave of pharynx that spreads into esophagus during pharyngeal stage
Esophageal stage:

• The esophagus is a conduit to move food rapidly from the pharynx to the stomach.
• The esophageal stage is controlled partly by the swallowing reflex and partly by the enteric nervous system (ENS).
• When bolus of food passes through the upper esophageal sphincter, the swallowing reflex closes the sphincter so food cannot reflux into the pharynx.
• Musculature of the pharyngeal wall and upper 1/3 of esophagus (striated muscles) are innervated by vagus (10th cranial) & glossopharyngeal nerves (9th cranial),
• Musculature of the lower two thirds of the esophagus is smooth muscle (controlled by the vagus through connections with the esophageal myenteric nervous system)
Swallowing—Esophageal Stage

ii. Secondary Peristalsis:

- Appear if primary peristalsis fail to move the food that enters esophagus into the stomach.
- It results from the distention of esophagus by retained food.
- Initiated by Myenteric plexus & vagal afferents to the medulla and back through vagal efferents.
- Relaxation of lower esophageal sphincter
- Receptive relaxation of stomach through Myenteric inhibitory Neurons
Relaxed muscles

Circular muscles contract, constricting passageway and pushing bolus down

Bolus of food

Longitudinal muscles contract, shortening passageway ahead of bolus

Gastroesophageal sphincter closed

Stomach

Relaxed muscles

Gastroesophageal sphincter open
Swallowing Reflex

• Stimulus: Bolus in the posterior mouth or pharynx.
• Receptors: Swallowing (tactile) receptors around the opening of pharynx *i.e* tonsillar pillars.
• Afferents: Sensory portion of trigeminal & glossopharyngeal & Vagus nerves.
• Swallowing Centre: Nucleus tractus solitarius in medulla oblongata + reticular formation in medulla & lower pons.
Swallowing Reflex

• Efferent Nerves: 5th, 9th, 10th & 12th cranial & a few superior cervical nerves
• Effectors:
  • Soft palate
  • Palatopharyngeal muscles
  • Posterior Nares
  • Vocal cords of Larynx
  • Pharyngoesophageal sphincter
Peripheral stimuli of the oropharynx, larynx and esophagus

Sensory neurons (V, VII, IX, X)

Cortical and subcortical structures

Brainstem swallowing centre

Dorsal swallowing group

Ventral swallowing group

Motor nuclei

Oropharyngeal
Trigeminal, facial, ambiguus, hypoglossal, C1-C2

Esophagus
Dorsal motor nucleus

Motor neurons

V, VII, IX, XI, XII, ansa cervicalls

X

Oropharyngeal swallow response

Primary peristalsis
Receptive Relaxation of Stomach

• When the esophageal peristaltic waves reaches the stomach through the food which reach the lower esophageal sphincter it causes an inhabitation to the peristaltic movement of the stomach via inhibition to the my enteric plexus “Which is responsible for GI motility”.

Lower esophageal sphincter

• Basically this sphincter is formed by circular muscles and its locate above the gastroesophageal junction 3 cm.

• Sphincter is TONICALLY contract and when the bolus reaches the sphincter it causes a “receptive relaxation” which finally end into a relaxation to this sphincter.

• If the process failed this will lead to accumulation of the food on the sphincter and this process called ACALASIA.

• Protective role of Lower esophageal sphincter—GERD (gastroesophageal reflux)

• short portion of esophagus that extends slightly into the stomach and that caves the esophagus inward in response to increased intra-abdominal pressure.
Gastroesophageal reflux disease

Healthy

GERD

Sphincter open, allowing reflux
Achlasia

• condition due to high resting pressure at the LES that fails to relax during swallowing. As a result, food transmission from the esophagus into the stomach is prevented.

• Physiological basis—absence of the myenteric plexus containing VIP & NO in the lower third of esophagus.

• The musculature of the lower esophagus instead remains contracted and the myenteric plexus has lost the ability to transmit a signal to cause relaxation of the LES.
Dysphagia

• Difficulty in swallowing.

• Characteristic manifestation of dysphagia is the sensation of food “sticking” somewhere in its passage to the stomach.

• Causes:
  1. Mechanical obstruction of esophagus e.g. tumor, stricture, diverticular hernia etc.
  2. Decreased movement of esophagus due to neurological disorder e.g. parkinsonism
  3. Muscular disorders e.g. of mouth or esophagus
Dysphagia—Causes

• Oropharyngeal:
  • Pharyngitis
  • Stomatitis, Glossitis
  • Retro pharyngeal abscess
  • Gingivitis, ulcers.
  • Herpetic lesions.
  • Poliomyelitis
  • Myasthenia Gravis
  • Diphtheria
  • Tumors

• Esophageal:
  • Carcinoma esophagus
  • Esophagitis
  • Achalasia cardia
  • Mediastinal tumors
  • Diaphragmatic hernia
Thank You