Thug's

Physiology of Saliva and Swallowing

**INTRODUCTION**
The digestive system consists of:
A-The alimentary canal or the gastrointestinal tract (GIT).
-It is a muscular tube about 4.5 meters long extending from the mouth to the anus.
-It includes the buccal cavity, pharynx, esophagus, stomach, small intestine, and large intestine.

B-Various digestive glands associated with it e.g. the salivary glands, liver, and pancreas.

**GENERAL FUNCTIONS OF THE DIGESTIVE SYSTEM**
1-Motility
2-Secretion of digestive juices
3-Gisegtion of food
4-Absorption

**MOUTH AND ESOPHAGUS**
1. In the oral cavity, the process of food mastication occurs which cuts down the large food particles into small pieces and mix them with saliva forming what is called a bolus.
2. The bolus is propelled backwards into the pharynx and downwards through the esophagus to the stomach by the process of swallowing.

**PRODUCTION OF SALIVA**

**I. SALIVARY SECRETION**
- Saliva is secreted by 3 pairs of salivary glands: the parotid, submandibular and sublingual glands as well as by several small glands scattered in the mucous membrane of the buccal cavity.
- Each gland is formed of a group of secretory acini, the secretion of which is carried by a system of ducts, that unite to form one large duct which opens into the buccal cavity.

**II. THE SALIVARY GLANDS**

The salivary acini (salivons)

There are two types of acini:

<table>
<thead>
<tr>
<th>SEROUS CELLS</th>
<th>MUCOUS CELLS</th>
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<tbody>
<tr>
<td>secrete thin saliva</td>
<td>viscid saliva</td>
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<tr>
<td>rich in the enzyme ptyalin</td>
<td>rich in mucin</td>
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</table>

1. Parotid glands - serous cells
2. Sublingual gland - mucous cells
3. Submandibular glands - both secretory cells and secrete 70% of the total secretion

- An active secretory process.
- The initial salivary secretion from the acini is nearly isotonic
- In the duct:
  - Some Na$^+$ and small amount of Cl$^-$ and HCO$_3^-$ are actively reabsorbed
  - K$^+$ ions are secreted.
  - This process is potentiated by the aldosterone hormone.

**III. COMPOSITION OF SALIVA**
- The amount secreted daily is about 1.5 liters
- The pH of saliva is about 7.
- It is hypotonic relative to saliva
- Its composition is:
  1-Water 99.5%
  2-Solids 0.5%
    a-Inorganic ions
    b-organic ions

**IV. INNERVATIONS OF SALIVARY GLANDS**

<table>
<thead>
<tr>
<th>Sympathetic</th>
<th>Parasympathetic</th>
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<tbody>
<tr>
<td>- A little secretion of viscous saliva rich in organic constituents</td>
<td>- Secretion of large amount of watery saliva.</td>
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<tr>
<td>e.g. mucin and ptyalin.</td>
<td>- Marked vasodilatation in the salivary glands</td>
</tr>
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</table>
- Salivary secretion is a rapid process which is under nervous control only.
- It passes in 3 phases:
  1. Cephalic phase (Conditioned reflexes)
  2. Buccal phase (Unconditioned reflexes)
  3. Gastrointestinal phase

<table>
<thead>
<tr>
<th>Cephalic Phase</th>
<th>Buccal Phase</th>
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<tbody>
<tr>
<td>Salivary secretion occurs before food enters the mouth.</td>
<td>Salivary secretion occurs when food enters the mouth.</td>
</tr>
<tr>
<td>It is caused by conditioned (psychic) reflex</td>
<td>It is caused by unconditioned reflex</td>
</tr>
<tr>
<td>Is acquired not inherent reflex.</td>
<td>Is inherent and not acquired reflex.</td>
</tr>
<tr>
<td>Needs training and intact cerebral cortex.</td>
<td>Does not need training nor intact cerebral cortex.</td>
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</table>

**GIT Phase**

- It is caused by:
  - Esophageo-salivary reflex.
  - Gastro-salivary reflex.
    - These are inherent unconditioned reflexes

**Mechanism:**

**1. Stimulus:**
- Irritation of the lower end of the esophagus by food or pathological lesion (e.g. ulcer or cancer)
- Also irritation of the stomach or upper intestine.

**2. Receptors:** mechano and chemoreceptors in the wall of the irritated viscera.

**3. Afferents:** vagus nerve.

**4. Center:** Salivary nuclei in the medulla oblongata

**5. Efferents:**
Salivary nuclei send sympathetic and parasympathetic fibers to the salivary glands.

**6. Effect:** Increased salivary secretion.
Swallowing (Deglutition)

- It is the act of transferring the food from the buccal cavity to the stomach.
- It can be studied from successive X-ray films taken while swallowing a barium meal which is opaque to the X-ray.

Phases of Swallowing

The process of swallowing is divided into:
1. Buccal stage
2. Pharyngeal phase
3. Esophageal phase

1. Buccal Stage

- This stage is voluntary
- After mastication, and the formation of the bolus of food, the tongue is voluntarily elevated against the hard palate mainly by contraction of the mylohyoid muscles.
- The bolus is rolled backwards then is forced into the pharynx.
- The mouth must be closed.

2. Pharyngeal Stage

- This stage is involuntary
- It occurs as a result of a reflex called the swallowing reflex
- As the bolus is pushed backwards it stimulates certain receptors around the opening of the pharynx
- Impulses which arise are transmitted via 5, 9, 10th cranial to the deglutition center in the medulla
- From the deglutition center, impulses are discharged via efferent fibers in the 5, 7, 9, 10, 12th cranial nerves leading to:
  - Elevation of the soft palate.
  - Elevation of the larynx against the epiglottis.
  - Approximation of the vocal cords.
  - Approximation of palato-pharyngeal folds at the fauses.
  - Continued contraction of the mylohyoid muscles.
  - The superior constrictor muscle of the pharynx contracts initiating a rapid peristaltic movement that passes downwards through the pharyngeal muscles.
  - This raises the intra-pharyngeal pressure from atmospheric to about 100 cm water which pushes the bolus into the esophagus.
  - The entire process occurs only in 1-2 seconds.

3. Esophageal Stage

- The esophagus is a muscular tube about 20cm long which is lined by a mucous membrane containing many simple mucus glands.
- The esophagus can be divided into 3 parts according to the nature of muscle in its wall.
  1. Upper 1/3 consists of striated muscles only
  2. Lower 1/3 consists of smooth muscles only
  3. Middle 1/3 consists of both striated and smooth muscles
- Its upper esophageal end is guarded by the upper esophageal sphincter while lower end is guarded by lower esophageal sphincter
- During rest, these 2 sphincters are normally closed while the pressure inside the esophageal lumen is negative like the intra-thoracic pressure.
- The esophageal stage of deglutition is also an involuntary stage in which peristaltic movement occurs in the esophageal wall propelling the bolus to the stomach.
- Two types of peristaltic movements normally occur in the esophagus:
  1. Primary peristalsis
  2. Secondary peristalsis

<table>
<thead>
<tr>
<th>Protective Reactions</th>
<th>Propulsive Mechanisms</th>
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<td>This prevents food entrance into the nose, trachea or back into the buccal cavity.</td>
<td></td>
</tr>
<tr>
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1) Primary peristalsis

Initiation
This is a continuation of the contraction of the superior constrictor muscles of the pharynx.

Control
by vagal fibers.

Vagotomy
Prevents initiation of the primary peristalsis.

Function
Transport food from pharynx to stomach

2) Secondary peristalsis

It is generated if the primary wave fails to move all food to the stomach.

Control
ENS and vagal fibers.

Vagotomy
Not prevent initiation of the secondary peristalsis.

Function
These waves continue until all the food has emptied into the stomach

<table>
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<th>NEURAL CONTROL OF SWALLOWING</th>
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<tbody>
<tr>
<td><strong>Swallowing Center</strong></td>
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<tr>
<td><strong>Respiratory Center</strong></td>
</tr>
<tr>
<td><strong>Extra Vagal</strong></td>
</tr>
<tr>
<td><strong>Vagal</strong></td>
</tr>
<tr>
<td><strong>Pharyngeal muscles</strong></td>
</tr>
<tr>
<td><strong>Esophageal skeletal muscle</strong></td>
</tr>
<tr>
<td><strong>Esophageal smooth muscle</strong></td>
</tr>
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<td><strong>Myenteric plexus</strong></td>
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<th>STAGES OF SWALLOWING</th>
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A list of things that can be done to make swallowing easier
1. Chew all food well
2. Slow the rate of eating
3. Alternate food with liquids to "wash" food down
4. Take smaller bites
5. Swallow everything before the next bite
6. Swallow several times per bite
7. Eat when less fatigued
8. Eat in a relaxed atmosphere
9. Eat the most difficult food first (when swallowing muscles are less fatigued)
10. Avoid problematic food or prepare it in a way that is easier to swallow (e.g., peel apple, blend carrots, etc.)

**SWALLOWING DISORDERS**

Dysphagia: difficulty or discomfort in swallowing.

Achalasia: a condition in which the muscles of the lower part of the esophagus fail to relax, preventing food from passing into the stomach.

Aerophagia: the swallowing of air, whether deliberately to stimulate belching, accidentally, or as an involuntary habit.

**CLINICAL SIGNIFICANCE**
- Swallowing becomes a great concern for the elderly since strokes and Alzheimer's disease can interfere with the ANS.
- **Speech therapy** is commonly used to correct this condition since the speech process uses the same neuromuscular structures as swallowing.

Esophageal sphincter due to cancer