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Review Article

Oral physiology

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ABSTRACT

Oral physiology is a broad term that includes the process of mastication, role of minerals namely calcium and phosphorus for normal growth and development & the importance of saliva in keeping the oral cavity moist. The present article presents a review of oral physiology characteristics and discusses each of the components mentioned previously.

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1. Introduction

The mouth is a window to the body's health. It can show signs of nutritional deficiencies or general infection. It is important to understand that the mouth is not a separate entity from the rest of the body. Oral health is an integral component of general health and well-being for all ages.

Oral physiology includes the physiological process of mastication and deglutition, role of saliva in maintaining oral health and facilitating digestion & actions of minerals on the oral cavity.

1.1. Mastication

The first and foremost step in the process of digestion is mastication or chewing. Mastication is the act of chewing food whereby the ingested food is crushed into small pieces, mixed with saliva and formed into a bolus.¹ Chewing is important for most fruits and raw vegetables because these have indigestible cellulose membrane around their nutrient portions which must be broken down before food can be acted upon by enzymes.² The process of mastication ensures

healthy growth and development of oral tissues.

The initiation of swallowing process depends on separate thresholds for food particle size and particle lubrication.³ It has also been suggested that swallowing is initiated when it is sensed that a batch of food particles is bound together under viscous forces for the purpose of forming a bolus. The oral cavity is of prime importance in the masticatory framework. Another important factor in mastication is the bite force. Coordination between the various chewing muscles is also an important factor and should not be ignored. The movement of the jaws and neuromuscular control of chewing plays an important role in the fragmentation of the food.

1.2. Forces of mastication

It has been noted that comparatively males are able to exert more masticatory force than females. The masticatory force exerted on anterior teeth is 55 pounds (10 – 15 kg) and on molars is 200 pounds (around 50 kg) approximately. Maximum biting force up to 150 kg has been recorded.¹

Food characteristics greatly influence the number of chewing cycles needed to prepare the food for swallowing.⁴ Dry and hard products require more chewing cycles.

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Evidently, more time is needed to break the food down and to add enough saliva to form a cohesive bolus that is suitable for swallowing.⁵

1.3. Neuromuscular control of chewing

Jaw movements and neuromuscular control of chewing play an important role in the comminution of food. More muscle activity is generated if the closing movement is counteracted by food resistance.⁶

2. Deglutition

Deglutition or swallowing refers to a series of coordinated muscular contractions that move the ingested food and pooled saliva from the oral cavity into the stomach, passing through the esophagus.¹ Swallowing is a reflex response controlled by the vagus nerve with its centre located in the medulla oblongata.² It can be divided into 3 stages:²

1. Oral Stage (voluntary).
2. Pharyngeal Stage (involuntary).
3. Esophageal Stage (involuntary).

2.1. Oral stage

1. Chewed food is softened by saliva and rolled into a bolus.
2. Bolus is pressed against the hard palate as a result of contraction of the front part of the tongue.
3. Swallowing commences by closure of the mouth and contraction of mylohyoid muscle.

2.2. Pharyngeal stage

1. Elevation of soft palate takes place thus preventing food from entering into the nasal cavity.
2. Larynx rises with elevation of hyoid bone which leads to approximation of the vocal cords.
3. Cricopharyngeal muscle relaxes and bolus enters the upper esophagus.
4. Vocal cords then eventually open to allow resumption of rhythmic breathing.

2.3. Esophageal stage:¹

1. Bolus moves down esophagus to reach the stomach.
2. The peristaltic movements (alternating contraction and relaxation of muscle fibers of GIT) help in the movement of food in esophagus.

3. Role of Saliva

Saliva is a dilute aqueous solution that contains both inorganic and organic constituents. It is secreted by three pairs of major salivary glands i.e. parotid, submandibular and sublingual. In addition, there are numerous minor

salivary glands that secrete saliva and are widely distributed in the oral mucosa. pH of saliva ranges from 6.2 – 7.6.¹ It becomes more alkaline during rapid secretions considering the high bicarbonate content. Saliva plays an essential role during mastication, swallowing and speech. Daily secretion of saliva constitutes to about 1500 mL/day.² Salivary biomarkers have also been introduced lately that aid in early detection of systemic disorders like dental caries, oral cancer and periodontitis thus validating saliva as a potential diagnostic tool.

3.1. Composition of saliva²

Saliva is composed of digestive enzymes such as ptyalin or salivary α – amylase, lysozymes (bactericidal in action), kallikrein (proteolytic enzyme) & lipase. It also consists of mucin which is a glycoprotein and IgA which provides defense against microorganisms. In addition it also has certain ions like sodium, potassium and chloride. Organic constituents include urea, uric acid and creatinine. The pH of saliva is slightly below 8 during active secretion.

3.2. Functions of saliva:

Saliva contains immunoglobulins mainly IgA, IgG and IgM may also be present. These immunoglobulins prevent the adhesion of microbes to oral tissues.¹ Salivary amylase is a digestive enzyme responsible for starch and glycogen breakdown, and salivary lipase may play a significant role in fat digestion.⁷ Saliva is effective in helping to maintain a relatively neutral pH in the oral cavity. Interaction of teeth with saliva increases surface hardness, decreases permeability and has been proven to increase resistance to caries thus maintaining tooth integrity.⁸ Certain viruses like viruses of rabies, mumps and poliomyelitis are also excreted through saliva.¹ Regulation of temperature by saliva is also a significant feature in animals.

3.3. Nervous control of salivary secretion

Secretory activity is mediated by cholinergic agents in parasympathetic system and by adrenergic agents in sympathetic system. The secretory motor nerve endings are seen in relation to secretory cells, cells of striated and intercalated ducts, myoepithelial cells, smooth muscles of arterioles, etc.

3.4. Clinical considerations

Sialorrhea : Sialorrhea (commonly known as drooling) is defined as excessive flow of saliva from the mouth. It is invariably caused by uncontrolled secretion of saliva, inability to retain saliva within the mouth or swallowing impairment.⁹ It is also termed as ptyalism or hypersalivation.

Xerostomia: Reduction in the quantity of saliva produced is called xerostomia. Xerostomia is the subjective complaint of dry mouth due to lack of saliva caused by multitude of factors.¹⁰ It can be caused due to psychological causes such as anxiety and depression. Other causes include dehydration due to diarrhoea, vomiting, use of antihistaminic drugs, diseases affecting salivary glands such as Sjogren's syndrome, tumors or salivary gland aplasia. Xerostomia can lead to difficulty in speech and eating. It can also predispose to halitosis (bad breath) and cause an increase in dental caries incidence.¹

4. Mineral Metabolism

Calcium and Phosphorus are considered as the two major elements that are required for normal growth and development.

4.1. Calcium metabolism

Adult human body contains approximately 1 – 1.5 kg calcium, of which 99% is in the bone.¹¹ Normal serum calcium level varies from 9 to 11 mg%. Good sources of calcium include milk, egg, fish and vegetables. Absorption of calcium takes place from the first and second part of duodenum. Factors increasing calcium absorption include vitamin D, high protein diet and low pH of the alimentary tract while those decreasing absorption are phytic acid and oxalic acid.¹ Calcium (in trace amounts) is necessary for the activation of clotting factors. It also plays an important role in the formation of bone and teeth and its maintenance. In addition calcium mediates secretion of parathyroid hormone and necessary for transmission of nerve impulses.^{1,9} Calcium is excreted both in urine and feces. Calcium levels less than 8.5 mg/dl may result in tetany characterized by spasms and convulsions. Osteoporosis is also associated with lower levels of calcium. Factors regulating blood calcium level are listed below:

4.1.1. Vitamin D

1. Active form is calcitriol (or dihydroxy – cholecalciferol).
2. Through the effect on intestine, kidney and bone, vitamin D increases the serum calcium level.¹

4.1.2. Parathyroid Hormone (PTH):

1. Causes decreased renal excretion of calcium and increased excretion of phosphates.⁹

4.1.3. Calcitonin

1. Decreases serum calcium level.
2. Inhibits resorption of bone by increasing activity of osteoblasts.
3. PTH and calcitonin together promote bone growth and remodeling.⁹

4.1.4. Phosphorus

1. Calcium and phosphorus share a reciprocal relationship.

4.2. Phosphorus metabolism

Normal phosphorus level varies from 2–4 mg/dl in adults. Absorption takes place in the small intestine in the form of soluble inorganic phosphate. Approximately 70% of dietary phosphate is absorbed in the form of orthophosphate. By the action of intestinal phosphatases food bound phosphorus is released during digestion. An excess of calcium, iron or aluminum may interfere with absorption. Excretion occurs primarily through urine.¹

4.3. Other minerals

4.3.1. Sodium

1. Normal level in plasma is 136 – 145 mEq/L.
2. Major cation of extracellular fluid.
3. Important in regulation of acid base balance.

4.3.2. Potassium

1. Major intracellular cation, maintains intracellular osmotic pressure.
2. Rich sources include banana, orange, apple, pineapple.
3. Excretion mainly through urine.

5. Age changes of oral tissues

These refer to all changes occurring from birth to death. Certain aging effects of oral tissues are discussed below¹:

5.1. Enamel

1. Attrition or physiological wearing of teeth resulting from masticatory movements.
2. Increased inorganic content with increase in fluoride and nitrogen levels has been reported.¹
3. Decreased permeability and water content.

5.2. Dentin

1. Color of dentin becomes darker with advancing age.¹
2. Gradual increase of dentin thickness occurs as age advances.
3. Formation of reparative dentin occurs.

5.3. Cementum

1. Fluoride content and thickness of cementum increases with age.
2. Irregular surface due to calcification of periodontal ligament fiber bundles.
3. Reduced permeability.

5.4. Pulp

1. Reduction in pulp size occurs.
2. Decreased vascular supply.
3. Sensitivity and healing capacity diminishes.

5.5. Periodontal ligament

1. Width of PDL becomes narrower.
2. Decreased vascularity.

5.6. Alveolar bone

1. Alveolar bone becomes irregular.
2. Decreased vascularity and healing capacity.
3. Cancellous bone becomes dense.

5.7. Oral mucosa

1. Gingiva may display decrease keratinization. • Gingiva may display decrease keratinization.
2. Sebaceous glands of lips and cheeks increase with age.
3. Loss of taste perception.

5.8. Salivary glands

1. Accumulation of lymphocytes is seen.
2. Reduced salivary secretion.
3. Number of oncocytes increases with advancing age.

6. Conclusion

Oral physiology is a broad term governed majorly by three principles. The masticatory process is aimed at the preparation of food for swallowing. Saliva is an important biological fluid that aids in maintaining mucosal integrity. Calcium (along with other minerals) is necessary for the formation of bones and teeth. All three components play an inevitable role to maintain ecological balance in the oral cavity and are equally important.

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8. Conflict of interest

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