Saliva and its Importance in Complete Denture Prosthodontics

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Abstract: Saliva is a complex fluid composed of secretions from salivary glands and gingival crevicular fluid. The oral cavity is a moist environment; a film of fluid called saliva constantly coats its inner surface and occupies its space between the lining oral mucosa and teeth, whose important role is maintaining the well being of the mouth. Saliva plays a critical role in the maintenance of oral and dental health. Saliva is most valuable oral fluid that is taken for granted. Knowledge of the salivary system and saliva is essential for evaluating prosthodontic problems and for educating patients in what to expect in this phase of denture use.

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Introduction: From the end of 17th century to the early 19th century, salivary glands were thought to be excretory organs which filtered the noxious substances from blood. Neglected by the dentists and ignored by the physicians saliva is the least known and least appreciated of all body fluids. Yet, this lowly secretion plays a vital role in the integrity of the oral tissues, in the selection, ingestion and preparation of food for digestion and in our ability to communicate with one another. It was even used as a lie detector, the accused was given a handful of dry rice to chew, if feared of guilt the salivary secretion is inhibited so that he could not form bolus, and he was summarily executed.

Dentist and dental researchers have been keenly interested in saliva and have made important contributions to the knowledge of the subject. Investigation has progressed on the possible effect of various properties of saliva such as amount, solubility, buffering capacity and viscosity in dental caries, periodontal disease, dental restoration and dental prosthesis. A wealth of evidence suggests that saliva plays a profound role in the maintenance of oral health in the denture wearing patient. Indeed the presence of a thin salivary film layer is essential to the comfort of the mucosa beneath a denture base and for denture retention.[1]

Definition: "Saliva is a clear, tasteless, odourless slightly acidic viscous fluid, consisting of secretions from the parotid, sublingual, submandibular salivary glands and mucous glands of oral cavity".[2]

Composition of saliva: Salivary fluid is an exocrine secretion consisting of approximately 99.6% of water and 0.5% of solids. *Cellular components* constitute yeast cells, bacteria, protozoa, polymorphonuclear leucocytes, desquamated epithelial cells etc.

Inorganic salts constitute: about 0.2% of solids and consists of sodium chloride, potassium chloride, acid and alkaline phosphatase, calcium carbonate, calcium phosphate, potassium thiocyanate (smokers' saliva is rich in thiocyanate).

Organic components: constitute 0.3% of solids and contain enzymes like ptyalin (salivary amylase), lipase, carbonic anhydrase, bacteriolytic enzyme and lysozome. It also contains immunoglobulins and other antimicrobial factors, mucosal glycoprotein's, traces of albumin and some polypeptides and oligopeptides of importance to oral health. Mucin, urea, amino acids, cholesterol and vitamins, soluble specific blood group substances A, B, O ranging from 10 to 20 mg/L., gases - 1 ml of oxygen, 2.5 ml nitrogen and 50 ml of CO_2 per 100 ml. of saliva.[3,4,5,6]

A healthy person's mean daily saliva production ranges from 1 to 1.5 L, a large proportion of this volume is secreted at meal time when the secretory rate is highest. The salivary flow (SF) index is a parameter allowing stimulated and unstimulated saliva flow to be classified as normal, low, or very low (hyposalivation). It is slightly cloudy because of the presence of cells and mucin. It is usually acidic

in pH (6.02 - 7.05), on standing or boiling it loses CO_2 and becomes alkaline, this alkaline reaction causes precipitation of salivary constituents, as tartar on the teeth and calculus in salivary ducts. Its specific gravity is 1.002 to 1.02 and freezing point is 0.07 to 0.34°C.[4,5,6]

Some of the major salivary proteins in context of their function and possible clinical impact:

Digestive Enzymes: Human salvia contains ∝-amylase, an enzyme that hydrolyses the ∝ -1,4 glycosidic linkage of starch molecules hence the breakdown of ingested starch to simple hexose's occurs in two phases, starting in the oral cavity with salivary amylase and continuing in the intestine with pancreatic ∝ -amylase.[7] The concentration of ∝ -amylase in saliva is high and may constitute as much as 30-40% of the total protein in whole saliva.

Growth Factors in Saliva: Since ancient times saliva from various animals has been applied to wounds to accelerate the healing process. It is now known that the wound healing effect of saliva arises from it's intrinsic growth factors. These growth factors are secreted from duct cell in the salivary gland.

Some like *EPIDERMAL GROWTH FACTOR (EGF)* have a local effect. When secreted in saliva, *EGF* enhances healing of ulcers and plays a protective role in oesophageal mucosal protection. Salivary *EGF* interacts with the innate salivary protein defense mechanism to from a mucosal defense barrier.[6,8]

NERVE GROWTH FACTOR (NGF) that has stimulating effect on ganglionic function is also released from salivary gland.[8]

FIBROBLAST GROWTH FACTOR (FGF), a potent regulator of wound healing, has also been found in saliva.[8]

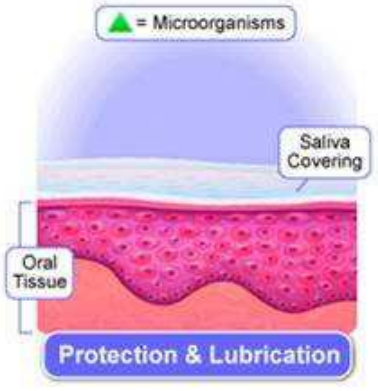
Other organic components in saliva: In addition to the proteins, there are numerous other organic components in saliva, including the circulating adrenal glucocorticoid cortisol. The concentration of cortisol in saliva reflects its concentration in plasma, although its concentration is 10-30 times lower in saliva.

Since a collection of saliva is non-stressful compared with blood sampling, *saliva has become widely used in measurements of cortisol for monitoring stress.* Saliva also contains many of the sex hormones present in blood for e.g.: *the salivary concentration of estriol in pregnant women also correlates well with its plasma concentration and can therefore be used to monitor foetal well being.*
Glucose is normally present in saliva only in very low concentration less than 0.1 mM. *Patients with high plasma glucose from untreated diabetes have elevated salivary glucose concentrations that can search nearly 1.0 mM of glucose.* Since glucose serve as a bacterial substrate such patients are likely to develop dental caries at high rates.[7,8,9]

FUNCTIONS OF SALIVA

Functions of saliva are mainly non-digestive in nature and it plays a relatively insignificant role in food digestion.[8,9]

Mechanical Function: Saliva forms a seromucosal covering that lubricates and protects the oral tissues against irritating agents. This occurs due to mucins (proteins with high carbohydrate content) responsible for lubrication, protection against dehydration, and maintenance of salivary visco-elasticity. They also selectively modulate the adhesion of microorganisms to the oral tissue surfaces, which contributes to the control of bacterial and fungal colonization. In addition, they protect these tissues against proteolytic attacks by microorganisms. Mastication, speech, and deglutition are aided by the lubricant effects of these proteins.[6,9]



(FIGURE 1) Mechanical function

Digestive Function: Saliva is responsible for the initial digestion of starch, favouring the formation of the food bolus. This action occurs mainly by the presence of the digestive enzyme α-amylase (ptyalin) in the- -- composition of the saliva. Its biological function is to divide the starch into maltose, maltotriose, and dextrin's. This enzyme is considered to be a good indicator of properly functioning salivary glands, contributing 40% to 50% of the total salivary protein produced by the glands.[6,8,9]

Excretory Functions: Saliva excretes urea, heavy metals thiocyanates, certain drug like iodide etc, alkaloids such as morphine, and antibiotics such as penicillin etc.[8]

Sensation of taste: The salivary flow initially formed inside the acini is isotonic with respect to plasma. However, as it runs through the network of ducts, it becomes hypotonic. The hypo tonicity of saliva (low levels of glucose, sodium, chloride, and urea) and its capacity to provide the dissolution of substances allows the gustatory buds to perceive different flavours. Gustin, a salivary protein appears to be necessary for the growth and maturation of these buds.[6,8,9]

Water Balance: Saliva keeps the mouth moist. When moisture is reduced in the mouth, certain nerve endings at the back of the tongue are stimulated and the sensation of thirst arises. The degree of individual hydration is the most important factor that interferes in salivary secretion. When the body water content is reduced by 8%, salivary flow virtually diminishes to zero, whereas hyper hydration causes an increase in salivary flow. During dehydration, the salivary glands cease secretion to conserve water.[6,8,9]

Heat Loss: This is found mainly in animals. When they become hot and excited more saliva is secreted causing greater heat loss.[6]

Buffering Action: Saliva behaves as a buffer system to protect the mouth as follows:

1) It prevents colonization by potentially pathogenic microorganisms by denying them optimization of environmental conditions.
2) Saliva buffers (neutralizes) and cleans the acids produced by acidogenic microorganisms, thus, preventing enamel demineralization.

Ammonia, a product of urea and amino acid metabolism, is potentially cytotoxic to gingival tissues. It is an important factor in the initiation of gingivitis because it may increase the permeability of the sulcular epithelium to other toxic or antigenic substances in addition to the formation of dental calculus.[10]

The carbonic acid-bicarbonate system is the most important buffer in stimulated saliva, while in unstimulated saliva it serves as the phosphate buffer system.[9,11]

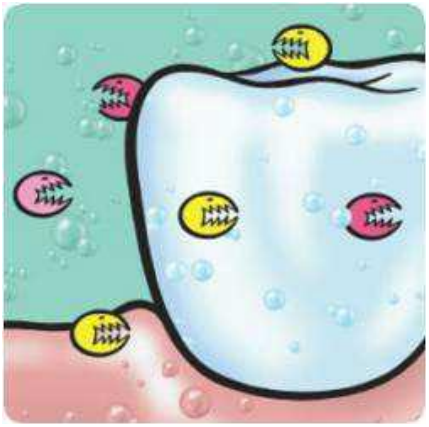
Maintenance of Tooth Integrity: When tooth erupts it is crystallographically incomplete. Interaction with saliva provides a post eruptive maturation via diffusion of ions of calcium, phosphate magnesium, and fluoride thereby results in surface hardness, decreased permeability and caries resistance. Saliva plays a fundamental role in maintaining the physical-chemical integrity of tooth enamel by modulating re-mineralization and demineralization. The main factors controlling the stability of enamel hydroxyapatite are the active concentrations of calcium, phosphate, and fluoride in solution and the salivary pH.[12]

The high concentrations of calcium and phosphate in saliva guarantee ionic exchanges directed towards the tooth surfaces that begin with tooth eruption resulting in post-eruptive maturation. Re-mineralization of a carious tooth before cavitation occurs is possible, mainly due to the availability of calcium and phosphate ions in saliva.[8,12]

Anti-Bacterial Action: Saliva contains a spectrum of immunologic and non-immunologic proteins with antibacterial properties. In addition, some proteins are necessary for inhibiting the spontaneous precipitation of calcium and phosphate ions in the salivary glands and in their secretions.

Secretory immunoglobulin A (IgA) is the largest immunologic component of saliva. It can neutralize viruses, bacterial, and enzyme toxins. It serves as an antibody for bacterial antigens and is able to

aggregate bacteria, inhibiting their adherence to oral tissues. Other immunologic components, such as IgG and IgM, occur in less quantity and probably originate from gingival fluid.



(FIGURE 2) Anti-bacterial action

Among the non-immunologic salivary protein components, there are enzymes (lysozyme, lactoferrin, and peroxidase), mucin glycoprotein's, agglutinins, histatins, proline-rich proteins, statherins, and cystatins.[5,9]

Lysozyme can hydrolyze the cellular wall of some bacteria, and because it is strongly cationic, it can activate the bacterial "auto-lysine's" which are able to destroy bacterial cell wall components.[9,11]

Lactoferrin links to free iron in the saliva causing bactericidal or bacteriostatic effects on various microorganisms requiring iron for their survival such as the *Streptococcus mutans* group. Lactoferrin also provides fungicidal, antiviral, anti-inflammatory, and immunomodulatory functions.[9,11]

The *Cystatins* are also related to acquired film formation and to hydroxyapatite crystal equilibrium. Due to its proteinase inhibiting properties, it is surmised they act in controlling proteolytic activity.[5,9,11]

Salivary Agglutinin, a highly glycosylated protein frequently associated with other salivary proteins and with secretory IgA, is responsible for bacteria agglutination.[9,11,12]

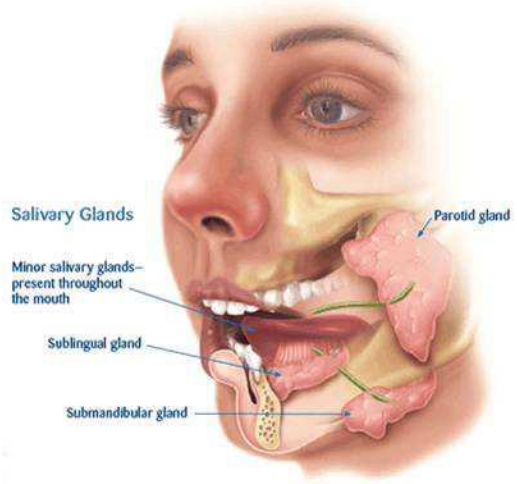
Soft tissue Repair: Presence of nerve growth factor and epidermal growth factor in saliva may accelerate wound healing. It speeds blood coagulation both by affecting anticoagulants directly in blood and by diluting the anti-thrombin.[13]

Maintenance of Ecological Balance: Colonization on tissue surface and adherence are the critical events for survival of many bacteria. Bacterial clearance by mechanical, and immunological means is one of the major function of the salivary defense system.[14]

CONTRIBUTIONS OF DIFFERENT SALIVARY GLANDS

Other factors that influence total salivary composition are the relative contribution of the different salivary glands and the type of secretion. The percentage of contribution by the glands during unstimulated SF is as follows:

- 20% by the parotid glands
- 65%-70% submandibular glands
- 7% to 8% sublingual glands
- <10% by the minor salivary glands



(FIGURE 3) Major and Minor Salivary Glands

The salivary secretions may be serous, mucous, or mixed. *Serous* secretions, produced mainly by the parotids, are rich in ions and enzymes. *Mucous* secretions are rich in mucins (glycoproteins) and present little or no enzymatic activity. They are produced mainly by the smaller glands. In the *mixed glands*, such as the submandibular and sublingual glands, the salivary content depends on the proportion between the serous and mucous cells.[6,13,15]

SALIVARY GLAND DYSFUNCTION

Salivary gland dysfunction is defined as any quantitative and / or qualitative change in the output of saliva.

Thus salivary gland dysfunction includes either an increase in salivary output (hyperfunction) or a decrease (hypofunction).[4,6]

Hyposalivation: Refers to a measurable decrease in function of one or more salivary glands as reflected in the flow rate.[4,6,8]

CAUSES:

1) *Iatrogenic* - Medications (Antidepressant, Diuretics, Antihypertensives, Antipsychotics), Chemotherapy, Radiotherapy to head and neck region, Surgical trauma
2) *Autoimmune disease* - Rheumatoid arthritis, Sjogrens syndrome
3) *Neurological disorders* - Mental depression, Cerebral palsy
4) *Harmonal disorders* - Diabetes mellitus, Hyper & hypothyroidism
5) *Hereditary disorders* - Cystic fibrosis, Ectodermal dysplasia
6) *Metabolic disturbance* – Malnutrition, Dehydration, Vitamin deficiency
7) *Local salivary diseases* - Sialoliths, Sialadenitis, Carcinoma

Management of Oral Sequalae of Salivary Hypofunction

First, the patient must be informed about the relationship between salivary hypofunction and the increased predisposition for oral disorders.

The key concepts of preventive dental management includes careful instruction of patient in oral hygiene and regular (at least every 3 month) follow up at a dental clinic including dental plaque control, dietary instructions and a application of topical fluoride in order to reduce the carries activity.

Sugar free chewing gums containing fluoride may be useful in these patients the beneficial effect of fluoride on tooth substance is prolonged due to low saliva flow rate and subsequently, reduced oral clearance.[16]

During meals, the patients should be advised to sip water when eating and swallowing. The mouth of *denture-wearers* should be examined frequently to detect and treat possible mucosal ulcerations and denture stomatitis. If present, oral candidiasis should be treated with:

- Topical application of miconazole (2%) ointment or gel.
- Nystatin ointment or oral suspension
- Systemic treatment with fluconazole, ketaconazole or itraconazole should be reserved for refractory cases and Immuno-compromised patients.

Pharmacological sialogogues (e.g.: pilocarpine and cevimeline) may also stimulate an increase in salivary secretion. These drugs are cholinergic agonists that stimulate muscrainic receptors. Symptoms of oral dryness may be alleviated by the use of mouth gels, oral sprays or artificial saliva.[16,17]

"ARTIFICIAL SALIVA" product contains[18]

Carboxymethyl cellulose	- 10 gm/L
Sorbitol	- 30.0 gm/L
Potassium chloride	- 1.200gm/L
Sodium chloride	- 0.843gm/L
Magnesium chloride	- 0.051gm/L
Calcium chloride	- 0.146gm/L
Dipotassium hydrogen phosphate	- 0.342gm/L

The present saliva substitutes are intended to act as a replacement of the mucoadhesive, lubricative and protective function of the natural saliva. They are not used as substitutes for the digestive and enzymatic actions. The saliva substitutes must be as close as possible to the natural saliva in terms of composition as well as in biophysical properties.

Hypersalivation (Ptyalism or Sialorrhea): Refers to a measurable increase in function of one or more salivary glands as reflected in the flow rate.[4,6,8]

CAUSES:

1) Morning sickness of pregnancy
2) Bulbar paralysis
3) Insanity
4) Severe oral injuries

Treatment: Treating the underlying cause and also using astringent.

ROLE OF SALIVA IN COMPLETE DENTURE PROSTHODONTICS

The practical application of the knowledge of salivary glands and saliva in complete denture prosthodontics are many.[16,17,19] These may be enumerated as:

1) When it is determined that saliva is a problem, the cause should be investigated and appropriate therapy should be given to correct the problem.

2) When the cause is undetermined or there is no favourable response to therapy, the problem should be discussed with the patient prior to treatment. When the patient understands the problem his co-operation is assured. For example, in a patient whose mucosa will not tolerate dentures because of xerostomia it may be necessary to limit the denture use to short periods and to restrict the diet to moist foods that are soft or liquid.

3) Excessive salivation, particularly by the submaxillary and sublingual glands presents a problem in impression making. Suitable antisialogogues can be administered prior to impression making.

4) Excessive secretion of mucous from the palatal glands may distort the impression material in the posterior two thirds of the palate. To counteract this problem:

a) The palate may be massaged to encourage the glands to empty.
b) The mouth may be irrigated with an astringent mouth wash prior to inserting the impression material.
c) The palate may be wiped with a gauge.

THE ROLE OF SALIVA IN RETENTION OF COMPLETE DENTURES

Adequate retention is a basic requirement for the acceptance of complete dentures and the physical mechanisms of complete dentures and the physical mechanisms of denture retention are of great importance.

Retention for a denture is its resistance to removal in a direction opposite that of its insertion. It is the quality inherent in a denture that resists the force of gravity, the adhesiveness of foods and forces associated with opening of jaws.

Among the factors of importance for retention of complete dentures mention might be made of.[17,20,21]

1) Reduced atmospheric pressure between denture plate and mucosa covered by the denture.
2) Good border seal and intimate tissue contact.
3) Neuromuscular control and function.
4) Gravity on dentures in case of the mandibular.
5) Saliva and its physical properties.

Saliva is considered a major factor in evaluating the physical influences that contributes to denture retention.

The physical forces of retention in which saliva s involved are:

1) Adhesion
2) Cohesion
3) Interfacial surface tension
4) Capillarity
5) Atmospheric pressure.

ADHESION: It is the physical force involved in the attraction between unlike molecules. A drop of water introduced on the surface of a solid glass plate will resist movement away from the glass in proportion to the adhesion between the unlike molecules. A layer of saliva between the denture base and the mucosa of the basal seat acts in the same way. The effectiveness of adhesion depends on close adaptation of the denture base to the supporting tissue and is also directly proportional to the area covered by the denture.

Serous or watery saliva is quite efficient provided the denture base can be wetted. Some denture base materials allow saliva to stick to them and spread out in a thin layer. These materials have greater potential for being retained by adhesion than materials that cause drops to form over their surface.[19,21]

COHESION: Cohesion is the physical factor of electromagnetic force acting between molecules of the same material or otherwise called like molecules. Cohesion occurs in the layer of saliva between the denture base and the mucosa and is

effective in direct proportion to the area covered by the denture.[19]

INTERFACIAL SURFACE TENSION: The phenomenon of surface tension is the force that maintains the surface continuity of a fluid. This results from an imbalance in cohesive forces present at the surface of the layer or column of the fluid. All denture base materials have higher surface tension than oral mucosa, but once coated by salivary pellicle, their surface tension is reduced, which promotes maximizing the surface area between saliva and base.

The thin fluid film between the denture base and the mucosa of the basal seat therefore furnishes a retentive force by virtue of the tendency of the saliva to maximize its contact with both surfaces. [17,20]

(Figure 4) Interfacial surface tension

CAPILLARITY: Capillary attraction or capillarity is a force developed because of surface tension that causes the surface of a liquid to become elevated or depressed when it is in contact with a solid.[17,21]

When the adaptation of the denture base to the mucosa is sufficiently close the space between the denture base and mucosa usually about 0.1mm or less – filled with a thin film of saliva acts as a capillary tube and helps to retain the dentures.

ATMOSPHERIC PRESSURE: The atmospheric pressure acts as a retentive force when dislodging forces are applied to the denture. Atmospheric pressure itself is supplied by the weight of the atmosphere and amounts to 14.7 lb/inch^2. This means that the retentive force supplied by the atmospheric pressure is directly proportional to the area covered by the denture base. A perfect border seal is essential all around the denture base for this force to be effective.

Atmospheric pressure is an emergency retentive force which comes into play when the denture is being pulled away from the basal seat and the negative pressure created between the denture and the basal seat helps in retention. Even if the other retentive forces are being over powered the atmospheric pressure may be able to keep the denture in position.[17,20,21]

Conclusion: Human saliva is a complex fluid secreted by the major and minor salivary glands and the secretion is under the control of the autonomic nervous system. Saliva performs various distinct functions namely cleansing, lubrication, mucosal integrity, buffering, remineralisation, digestion and antimicrobial action.

Research in salivary physiology and chemistry is just beginning with the recognition of the significance of saliva to oral and dental health. With a more complete knowledge of the profile of normal saliva in health and with ageing, comparison can be made with disease states or prosthetic intervention to determine which aspects of salivary composition are affected.

A wealth of evidence suggests that saliva plays a profound role in the maintenance of oral health in the denture wearing patient. Indeed the presence of a thin salivary film layer is essential to the comfort of the mucosa beneath a denture base and for denture retention.

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