

ROLE OF SALIVA IN PERIODONTAL HEALTH & DISEASE – A REVIEW

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ABSTRACT: Saliva is essential for maintaining the protection and normal functioning of the masticatory system. A 'dry mouth' or xerostomia resulting from a perceived reduction in salivary flow may lead to numerous signs and symptoms of oral dysfunction. The quality of life for affected people may be poor. Many of these persons are taking multiple medications that cause a reduced salivary flow, and the number of people taking such drugs can be expected to increase. The ingestion of softer cariogenic foods, and acidic foods and beverages in attempts to stimulate an increased saliva flow, is disastrous for the teeth.

KEYWORDS: Acquired Dental Pellicle, Plaque Biofilm, Oropharyngeal, Sjogren's Syndrome

INTRODUCTION

The production of adequate amounts of unstimulated and stimulated normal salivary secretions is critical for the prevention of tooth erosion, dental caries and other adverse oral, pharyngeal and esophageal conditions. Unfortunately, however, the importance of saliva for maintaining oral health does not appear to be fully appreciated by dental practitioners.¹ Hyposalivation, from salivary gland hypofunction, can result in the subjective sensation of 'dry mouth' or xerostomia, which generally occurs when the unstimulated salivary flow rate is reduced to approximately half of normal for that individual. However, the rate might still be within the range of 'normal', suggesting that the quality of the saliva could also be an important factor in determining the perceived degree of dryness. Xerostomia appears to be due not to a complete absence of oral fluid, but to localized areas of mucosal dryness, notably on the palate, which contains few minor salivary glands anteriorly, and is susceptible to drying when mouth breathing.²

Composition and Functions

Mixed salivary secretions contain over 99 percent water with less than 1 percent of other variable components, which include many electrolytes, urea, statherin, mucins and proline-rich proteins, α -amylase and other enzymes such as antimicrobial lysozyme, and immunoglobulins.³ These complex interacting components are responsible for the protection and normal functioning of the masticatory system. Whole saliva also contains gingival crevicular fluid, desquamated epithelial cells and bacteria, and other solids from the mouth.

Saliva forms a thin protective diffusion barrier over all upper alimentary tract surfaces. Saliva provides moisture to form a bolus with dry foods, initiates digestion of starch and fat, acts as a solvent to allow taste, and dilutes and

clears the mouth of food detritus, microorganisms and harmful dietary acids and gastric reflux acid⁴. The oral clearance rate is much faster from the lingual of the mandibular incisors than from the facial of the maxillary incisors and mandibular molars⁵, which probably accounts for the less frequent involvement of the mandibular anterior teeth in dental caries and erosion. The normal flow pattern of saliva can be disrupted by incompetent lips and mouth breathing, tooth extractions, facial paralysis and unilateral damage to the major glands. *There* is little mixing of saliva from the parotid glands and the other major glands, or from one side of the mouth to the other.

Importantly, the electrolytes in saliva provide an ion reservoir and buffering system, which normally prevent tooth demineralization, and promote the remineralization repair of damaged teeth.

Acquired Dental Pellicle and Plaque Biofilm

A thin strongly-bound organic biofilm of selectively adsorbed salivary mucins and other proteins very rapidly coats all exposed tooth (and restoration) surfaces⁴. Within a few hours the film can be 100 to 200 μ m thick⁶. The formation of pellicle is initiated by selectively adsorbed salivary proteins containing micelle-like globules,⁷ which have a high affinity for tooth mineral, and comprise a major proportion of the newly-formed pellicle before it slowly matures.

Pellicle-bound enzymes such as amylase, lysozyme, carbonic anhydrases and glucosyltransferases, and proline-rich proteins and statherin facilitate bacterial colonization of the tooth surfaces to form dental plaque.^{8,9} Bacterial metabolism within the developing plaque leads to the release of extracellular polysaccharides, which make up the structured matrix of this biofilm.

The biofilm acts as a physical diffusion barrier to acids of non-bacterial origin, protecting the tooth surface from demineralization. However, any acids diffusing through this physical barrier, together with acids produced by acidogenic bacteria which make up the plaque, have the potential to cause demineralization of the adjacent tooth surface. Where excessive non-bacterial acids are present, the biofilms are chemically eliminated, to leave tooth surfaces unprotected. Without biofilm protection, the tooth surfaces will be demineralized when acid displaces the saliva. This 'open system' allows the building blocks of hydroxyapatite, the ions resulting from demineralization, to be permanently lost. The removal of dental pellicle and the displacement of saliva by acids results in the loss of tooth mineral. There appears to be an inverse relationship between pellicle site and thickness with the initial occurrence of erosion.^{10,11} The presence of calculus may also decrease the susceptibility of teeth to erosion. The formation, ultrastructure, composition and functions of dental and mucosal pellicles have been reviewed.^{12,13}

Production

The secretion of hypotonic saliva is regulated by 'unconditioned' primarily unilateral reflex pathways involving the autonomic nervous system. Afferent nerves carry sensory impulses principally from chemoreceptors located in the taste buds of the tongue and oropharynx, and from mechanical receptors located mainly in the periodontal ligament and also in the muscle spindles of the masticatory muscles.⁴ The afferent impulses are carried to the salivary nuclei in the pons and medulla oblongata of the brain. From here, parasympathetic and sympathetic secretory impulses travel to the salivary glands along separate pathways, to cause the release of acetylcholine and norepinephrine (noradrenaline) neurotransmitters, respectively. Approximately 90 percent of the saliva is produced by three pairs of major salivary glands. The parotid glands produce watery amylase-rich serous secretions, which are increased greatly on stimulation. The submandibular and sublingual glands produce mainly mucin-rich mucous secretions. These bind water, to produce a less-viscous salivary secretion able to coat the surfaces of the teeth and oral mucosa with a thin protective lubricating film. The minor salivary glands, found on the tongue (except the dorsum), palate (except the anterior part of the hard palate), buccal and labial mucosa and other intraoral sites, also produce mainly mucous secretions³.

Although there are wide variations, the normal daily production of whole saliva is approximately 0.6 liters. Unstimulated flow rates are from 0.3-0.5 ml/minute and stimulated flow rates are from 1.0-2.0 ml/minute³. Salivary flow rates are usually highest during mid-afternoon. There are very low flow rates during sleep, which has practical implications for the management of tooth surface loss from

erosion and tooth grinding. The dilution and oral clearance of harmful substances from the mouth is severely impaired at flow rates of <0.2 ml/minute¹⁴. Approximately half of all people who say that they have a dry mouth when asked will have an abnormally low saliva flow rate. However, the ability to predict salivary hypofunction increases with positive answers to further questions.¹⁵ The accurate measurement of unstimulated saliva is affected by many factors, such as *the degree* of hydration, body position, light exposure and circadian rhythms, smoking and drugs. Salivary flow rates increase in response to the stimulus from acidic tastes, forceful chewing, nausea and certain drugs.¹⁶

Hyposalivation is defined as

- Unstimulated saliva flow < 0.1 ml/minute
- Stimulated saliva flow < 0.7 ml/minute

In clinical practice, it is simpler and much faster to assess the unstimulated saliva production by everting the lower lip and gently blotting the labial mucosa¹⁷. If the time taken for the small seromucous droplets or saliva to reappear from the orifices of the labial glands is greater than 60 seconds, then hyposalivation is present.¹⁸

Hyposalivation and Xerostomia

Reduced salivary production or hyposalivation may result in the subjective sensation of dry mouth or xerostomia to varying degrees. Systemic causes of hyposalivation affect the serous secretions from the parotid glands, in particular. Xerostomia can be self-assessed by patients by using either a visual analogue scale (0-10 cm long) or an ordinal scale (with four questions), ranked from having no dryness to severe dryness.

Oropharyngeal and non-oral associated effects of tissue dryness

Oropharyngeal

- Frequent thirst, awakening frequently at night to sip water
- Dry mouth with viscous, sticky, foamy saliva, and halitosis
- Impaired taste, chewing, swallowing and speech
- Difficulties wearing removable dentures, candidiasis
- Burning tongue and mucosal ulcers, sore throat, dry cough
- Cracked and sore lips, angular cheilitis/cheilosis
- Tooth sensitivity, incisal/cusp tip and cervical caries, and erosion
- Enlarged major salivary glands, sialoliths and infections

Non-oral

- Heartburn, esophagitis, aggravated gastric acid reflux.,_
- Dry nasal passages, impaired sense of smell, nose bleeds
- Dry eyes with itching, blurred vision, photophobia, corneal abrasion
- Dry skin and 'butterfly rash' on face, shortness of breath
- Vaginal and vulval dryness, itching, burning and candidiasis

The reported prevalence of xerostomia varies widely, increasing with age and the taking of medications. When questioned about having a dry mouth, perhaps approximately 15 to 30 percent of people in Western countries are affected either 'frequently' or 'always', particularly at night, and females more often than males^{19, 20}. The effects of hyposalivation extend to affect normal gastroesophageal functioning, because of reduced bicarbonate, mucins and other salivary components, which are required to neutralize gastric acid reflux and to protect the esophageal mucosa from the gastric contents.⁴ The increase of opportunistic microorganisms in the mouth can lead to aspiration pneumonia, a significant cause of death in the medically compromised, frail and elderly. The numbers of potentially pathogenic oral microorganisms may be reduced with the use of therapeutic mouthrinses. Many systemic diseases may be associated with xerostomia, and several may give rise to other signs and symptoms of exocrine gland hypofunction. There are many local and systemic causes for a reduced salivary flow, which may be accompanied by altered salivary composition. Local causes include surgical gland removal, damage from trauma and radiotherapy, and diseases of the major glands and ducts. Systemic causes include dehydration, numerous medications/drugs, depression, and hereditary, hormonal, and autoimmune diseases.^{21,22}

Aging in itself is not a cause of hyposalivation following functional stimulation, although the salivary composition may alter with a reduced production of mucins. However, many older "people take multiple drugs (polypharmacy) such as antihypertensives, antidepressants and antipsychotics, anticholinergics and antispasmodics, antihistamines and decongestants, antiarrhythmics, anti-Parkinsonian drugs, statins, diuretics and analgesics, which can cause variable reductions in salivary secretions²³

Causes of reduced salivary flow and xerostomia**Local causes of gland and duct damage**

- Radiotherapy, surgical gland removal, trauma
- Infections, tumors, sialoliths

Systemic causes of gland damage

- Autoimmune diseases - Sjogren's syndrome, rheumatoid arthritis, systemic lupus erythematosus, sarcoidosis, scleroderma, graft-versus-host disease
- Infections - HIV/AIDS, hepatitis C (HCV)
- Hereditary conditions - cystic fibrosis, ectodermal dysplasia

Systemic factors affecting normal gland functioning

- Dehydration - vomiting, diarrhea, diabetes, renal failure, fevers, hot and dry environments, excessive physical activities, alcohol, caffeine, diuretics
- Vasoconstriction - tobacco and other nicotine-containing products
- Neural transmission - medications/chemotherapy, drugs, depression/anxiety, Bell's palsy, Parkinson's and Alzheimer's diseases, hormone imbalances. (Individuals with Alzheimer's and stroke cannot feel the presence of saliva)

The diagnosis of several of the systemic causes may require e.g. eye, urine and blood tests, sialometry and minor gland biopsy, sialography and chest radiographs. In some instances a cause cannot be determined.

Sjogren's Syndrome

Sjogren's syndrome is one of the most prevalent autoimmune diseases and a significant cause of xerostomia. Although occurring predominately in postmenopausal women, the syndrome can affect all age groups in both women (80-90%) and men (10-20%).

The primary form of Sjogren's syndrome is a chronic inflammatory autoimmune disease where the moisture-producing exocrine glands are attacked by the individual's own antibodies. Although the syndrome may be a familial condition, the cause is not known and there is no cure. Lymphocytic infiltration of the salivary and lacrimal glands leads to xerostomia and xerophthalmia, respectively. This classical combination is called the sicca syndrome, regardless of its cause. It is associated with ocular grittiness, blurred vision, eye infections, corneal abrasion, dried nasal passages, nosebleeds, altered smell sensations and the numerous oral and other consequences from the lack of saliva. Enlarged major salivary glands occur in approximately one-third of affected individuals. However, Sjogren's syndrome is a systemic disease which affects the entire body to varying extents, resulting in many other symptoms and signs of exocrine gland hypofunction, often associated with dry skin and a 'butterfly rash' on the face, pulmonary inflammation, vaginitis, extreme fatigue and joint pain. The lymphocytic infiltration is associated with a higher risk of lymphoma.

Approximately half of the time, Sjogren's syndrome is associated with connective tissue diseases such as rheumatoid arthritis, systemic lupus erythematosus, scleroderma, Hashimoto's thyroiditis and polymyositis/dermatomyositis. Here, the condition is referred to as the secondary form of Sjogren's syndrome.

Buffering Capacity

Apart from the amount of unstimulated saliva produced, the capacity of saliva to maintain an optimal pH of approximately 6.7 to 7.4 when exposed to acids is also very important for the prevention of erosion and dental caries. The buffering capacity is provided largely by bicarbonate, dihydrogen and hydrogen phosphates, and proteins in the unstimulated saliva. The pH of unstimulated saliva can be checked using a pH test strip, with highly acidic saliva having a pH < 6. .¹⁸

The production of saliva is greatly increased, principally as serous secretions from the parotid glands, by a pronounced acidic taste and strong chewing forces.

Increased flow rates lead to increased concentrations of urea and electrolytes such as Na⁺, Cl⁻, Ca²⁺, PO₄³⁻, OH⁻ and particularly HCO₃⁻. The bicarbonate ions cause a rise in the pH and also become the principal buffer system in the saliva. HCO₃⁻ and H⁺ react to form carbonic acid, which then breaks down into water and carbon dioxide. However, although PO₄⁴⁻ also increases, the total concentration of the phosphate species decreases. The approximate buffering capacity of stimulated saliva can be checked using a buffer test strip (Saliva-Check BUFFER), with normal saliva having a score of > 9¹⁸.

.Increased saliva production results in an increased

- Flow rate and oral clearance
- Buffering capacity and pH
- Concentration of hard tissue minerals.
- The health of the oral environment can be assessed by evaluating the saliva.
- Assess the appearance - it should not be thick, stringy and foamy, or fail to coat all tooth and mucosal surfaces
- Assess the unstimulated flow rate of seromucous saliva from the labial glands after drying the lower lip - droplets should reappear in < 60 seconds
- Assess the pH of the unstimulated saliva - it should not be < 6.0 to 6.8
- Assess the buffering capacity of the stimulated saliva- it should not have a score of 6 to 9.

CONCLUSION

The importance of the many functions of saliva for maintaining oral health is often not appreciated until the flow of saliva is severely reduced. The lack of saliva results in a loss of oral clearance and buffering capacity, protective pellicle and enzymes. The soft tissues of the upper digestive tract become inflamed and painful, causing difficulties in wearing removable dentures, chewing, swallowing, speaking and digestion. Choosing softer cariogenic and acidic foodstuffs leads to severe tooth damage. Low acid buffering capacity and low saliva and plaque fluid concentrations of calcium and phosphate raise the critical pH at which tooth mineral dissolves, increasing the potential for erosion. Treatment management of the effects of xerostomia may be largely palliative, and the quality of life for affected persons may be poor.

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