Salivary flow patterns and the health of hard and soft oral tissues

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ABSTRACT

Background. This nonsystematic review summarizes the effects of saliva on some of the diseases affecting the hard and soft oral tissues.

Results. Saliva enters the mouth at several locations, and the different secretions are not well-mixed. Saliva in the mouth forms a thin film, the velocity of which varies greatly at different sites. This variation appears to account for the site specificity of smooth-surface caries and supragingival calculus deposition. Saliva protects against dental caries, erosion, attrition, abrasion, candidiasis and the abrasive mucosal lesions seen commonly in patients with hyposalivation. These effects are the result of saliva's being a source of the acquired enamel pellicle; promoting the clearance of sugar and acid from the mouth; being supersaturated with respect to tooth mineral; containing buffers, urea for plaque base formation, and antibacterial and antifungal factors; and lubricating the oral mucosa, making it less susceptible to abrasive lesions.

Clinical Implications. For optimal oral health, people should keep food and liquids in the mouth as briefly as possible. The most important time for toothbrushing is just before bedtime, because salivary flow is negligible during sleep and the protective effects of saliva are lost. Chewing sugar-free gum or sucking on sugar-free candies stimulates salivary flow, which benefits hard and soft oral tissues in many ways.

Key Words. Pellicle; caries; calcium; phosphate; flow rate; supersaturation; attrition; abrasion; erosion; salivary film; clearance; lubrication; antibacterial factors; calculus; gastroesophageal reflux disease.

JADA 2008;139(5 suppl):18S-24S.

The three paired major salivary glands are the parotid, submandibular and sublingual. Their ducts open opposite the second maxillary molar, at the side of the lingual frenum and in the lingual sulcus. In addition, there are many minor salivary glands, whose ducts open onto most areas of the oral mucosa except the area covering the dorsum of the tongue, the anterior part of the hard palate and the gingivae. The combined secretions from these various glands are termed "whole saliva." When flow is unstimulated, the parotid, submandibular, sublingual and minor mucous glands (MMGs) contribute about 25 percent, 60 percent, 7 to 8 percent and 7 to 8 percent, respectively, to whole saliva, but when flow is stimulated, the parotid glands' contribution increases by at least 10 percent.[1-4]

Because saliva from the various glands enters the mouth at several locations, it is not well-mixed. The enzyme amylase is secreted primarily by the parotid glands, and, by using amylase as a marker for parotid saliva, Sas and Dawes[5] found that they could calculate the percentage contribution of parotid saliva to whole saliva sampled at several sites. The table shows the mean results when salivary flow

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was unstimulated and when it was stimulated by gum chewing. Even during gum chewing, which might have been expected to mix the different secretions well, little parotid saliva reached the anterior parts of the mouth. Thus, different sites in the mouth are exposed to different fluid environments.

Whole saliva contains components in addition to salivary secretions, including gingival crevicular fluid, leukocytes, epithelial cells and microorganisms, as well as, possibly, food debris, blood and viruses. These sources of enzymes initiate the breakdown of several proteins secreted by the salivary glands.[6]

SALIVARY FLOW RATE

The salivary flow rate is influenced by a large number of factors, including the degree of hydration, body position, exposure to light, previous stimulation, circadian and circannual rhythms, gland size and drug use.[7] The unstimulated flow rate averages 0.3 to 0.4 milliliter per minute, but the range is wide. Unfortunately, dentists do not routinely measure the salivary flow rate of their patients, so when a patient complains of experiencing a dry mouth, there are no baseline data for comparison. During sleep, the salivary flow rate is negligible.[8]

Unstimulated flow rates of less than 0.1 mL/minute are considered evidence of hyposalivation. The main factors responsible for a decreased flow rate are therapeutic drugs, particularly when multiple drugs are used[9]; Sjögren syndrome; and radiation treatment for head and neck cancer.[10] The latter two conditions are not common, and therapeutic drug use is the typical cause of dry mouth. Several hundred such drugs cause the condition as an adverse effect,[11] although 20 percent of the population experience dry mouth on occasion[9] as do 30 percent of people older than 65 years.[10]

Several studies have been conducted to determine the effects of various stimuli on the salivary flow rate and many have reported flow rates of less than 2 mL/minute.[7] However, Watanabe and Dawes[12] found that when subjects ate several foods, the mean flow rates during chewing varied between 3.15 and 4.94 mL/minute, while infusion of 5 percent citric acid into the mouth elicited a flow rate of 7.07 mL/minute. Taste stimulation is a much more effective salivary stimulus than is chewing alone.[13] The same authors estimated that the total volume of saliva secreted each day is about 600 mL.[13]

TABLE

Percentage contribution of parotid saliva to unstimulated and stimulated whole saliva at different sites.*

ORAL SITE	PERCENTAGE CONTRIBUTION	
	Unstimulated Saliva	Stimulated Saliva
Whole Saliva (Entire Mouth)	30.1	35.6
Buccal Maxillary Molars	56.1	61.3
Palatal Maxillary Molars	24.7	31.9
Lingual Mandibular Molars	20.4	28.9
Palatal Maxillary Incisors	8.5	17.2
Lingual Mandibular Incisors	5.0	9.4
Buccal Maxillary Incisors	2.8	6.7

* Adapted with permission of Elsevier from Sas and Dawes.[5]

For patients with severe dry mouth, pilocarpine and cevimeline may enhance salivary secretion, provided some residual secretory tissue remains.[10] More commonly, however, patients can chew sugar-free gum or those with temporomandibular joint disorders can suck on sugar-free candy to stimulate salivary flow sufficiently to help relieve the dryness. With gum chewing, the flow rate peaks at about 6 mL/minute in the first minute. Across the next 15 minutes, it decreases to a plateau of about 1 mL/minute, well above the normal unstimulated flow rate, and this rate can be maintained for two hours or more.[14]

SALIVARY COMPONENTS

Proteins. Recent developments in proteomics have resulted in the identification of a large number of different proteins, both in whole saliva and in secretions from individual glands. The technique uses an initial separation of proteins by means of electrophoresis or chromatography, isolation of small groups of proteins or their constituent peptides and, after further separation by means of chromatography, identification of the peptides via mass spectrometry. From a database of the peptides in known proteins, researchers

ABBREVIATION KEY. Ca: Calcium. **Cl:** Chloride. **HCO_3:** Bicarbonate. **IgA:** Immunoglobulin A. **IgG:** Immunoglobulin G. **K:** Potassium. **MMG:** Minor mucous gland. **Na:** Sodium. **P_i:** Inorganic phosphate. **Resid:** Minimum saliva volume. **sIgA:** Secretory immunoglobulin A. **Vmax:** Maximum saliva volume.