Measuring salivary flow
Challenges and opportunities

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P
romoting health by preventing disease is a goal of health care providers, and risk assessment and disease prevention are common themes in the surgeon general’s report on oral health in America. Clinicians commonly use health questionnaires and clinical evaluations to identify patients at risk of developing diseases. Hematologic, serologic and imaging diagnostic modalities are used to assess these patients further. In recent years, saliva-based diagnostic tests have been increasing in popularity because of their noninvasive nature.

Technologies are available that use saliva to diagnose, follow and assess the risk and severity of diseases, high-risk behaviors or both. Salivary biomarkers have been used to assess the risk of developing oral, ovarian and breast cancers; HIV infection; Sjögren syndrome; and dental caries and periodontal diseases, as well as to detect exposure to alcohol and illegal drugs. Nicotine and cotinine levels also can be measured in saliva and be used by the life insurance industry to verify the smoking status of applicants. Hormone levels detected in saliva

ABSTRACT

Background. Saliva is being studied extensively and is being used for risk assessment, diagnosis and monitoring high-risk behavior and disease progression. A variety of medical conditions and medications are associated with salivary gland hypofunction. The major disadvantage in the use of saliva for health-related purposes is the lack of standardization in saliva collection methods.

Methods. The authors provide a brief overview of different methods of saliva collection and the advantages and disadvantages associated with each method, as well as of how to assess the salivary flow rate.

Results. The authors present the complete set up and step-by-step guidelines for the collection of unstimulated and stimulated whole saliva.

Conclusions. The life expectancy of people will continue to increase with advances in medicine and therapeutic modalities, and the prevalence of salivary gland hypofunction in the elderly population will increase owing to their longevity. The assessment of salivary gland hypofunction will need to be incorporated into everyday clinical practice.

Clinical Implications. The saliva collection methods outlined in this article can be used by dentists to assess patients at risk of developing diseases and by scientists for scholarly activities.

Key Words. Saliva; saliva collection; salivary flow rate; salivary glands; salivary gland hypofunction; xerostomia.

JADA 2008;139(5 suppl):35S-40S.

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A. COLLECTION OF UNSTIMULATED WHOLE SALIVA

The patient is advised to refrain from intake of any food or beverage (water exempted) one hour before the test session. Smoking, chewing gum and intake of coffee also are prohibited during this hour. The subject is advised to rinse his or her mouth several times with deionized (distilled) water and then to relax for five minutes. The patient is then told the following: “I will first obtain measures of saliva flow while you are at rest. This means that before and during the collection you should make every effort to minimize movement, particularly movements of your mouth. To begin a collection trial, I will ask you to swallow to void the mouth of saliva. Then you should lean your head forward over the test tube and funnel” (demonstrate), “Keep your mouth slightly open and allow saliva to drain into the tube. Keep your eyes open. At the end of the collection period, I will ask you to collect any remaining saliva in your mouth and spit it into the test tube. This movement should be done very quickly and should be done in the same manner from trial to trial. This is very important. Do you understand the procedures?”

When you start a trial, tell the subject:
1. Swallow to begin a trial (begin timing).
2. Make as little movement as possible. Do not swallow, and keep your eyes open during collection periods.
3. At the conclusion of the trial, collect the remaining saliva and spit it out. For each subject, collect saliva for one minute of practice trial and discard it. A plastic or paper cup may be used for this trial. The actual trial should last for five minutes, and the sample should be saved for further analysis if indicated.

B. COLLECTION OF STIMULATED WHOLE SALIVA—GUM

1. Instruct the subject to sit motionless.
2. Instruct the subject to lean the head forward over the funnel.
3. Instruct the subject to swallow to void the mouth of saliva (starting time).
4. Instruct the subject to chew the inert gum base according to the pace of the metronome (approximately 70 strokes per minute).
5. Every one minute, ask subject to spit saliva into the tube without swallowing. Tell subject, “Spit out, keep chewing” (after first minute), “Spit out, keep chewing” (after second minute), etc. Discard the first two-minute collection. A plastic or paper cup may be used for this collection. Proceed with another three-minute collection. Save this sample for further analysis if indicated.
6. Ask the patient to spit everything (that is, both saliva and gum base) into the tube.
7. Remove the gum base from the funnel before weighing the tube and funnel with saliva.
8. If the patient is too dry (that is, has dry mouth), it is possible to add the weight of the gum base to the preweight measure with the gum base in the funnel of the test tube of saliva.

C. COLLECTION OF STIMULATED WHOLE SALIVA—CANDY

Repeat steps one through eight as in B. Substitute chewing gum base with sucking on sugar-free, lemon-flavored candy.

Remember, unstimulated whole saliva collection always should precede stimulated whole saliva collection.

Although the minor salivary glands are not major contributors to the whole-saliva volume, they play a significant role in the lubrication and protection of the oral mucosa because of their mucous secretions. Parotid gland secretion is purely serous, and submandibular and sublingual gland secretions are mixed (mucous and serous). The primary saliva, formed by the acinar cells,
Figure 2. Three tubes with measurements, funnels, inert gum base and sugar-free candy used for the collection of unstimulated and stimulated whole saliva.

has an ionic composition similar to that of plasma. It is modified by the ductal cells to a hypotonic solution by reabsorption of sodium and chloride without water.

Saliva secretion can be enhanced by a variety of stimulants. The salivary flow depends on the nature of the stimulus and its duration and intensity. Strong acidic stimulus, high-frequency chewing and high bite force result in increased saliva output. Parasympathetic stimulation results in increased watery (less viscous) saliva, whereas sympathetic stimulation results in mucoid (more viscous) saliva secretions.7

**SALIVARY GLAND HYPOFUNCTION AND XEROSTOMIA**

Lack of salivary flow affects a person’s quality of life by causing difficulties in speaking, eating, swallowing and tasting.8 Xerostomia—the subjective feeling or complaint of dryness in the mouth—can be caused by several medications without actual reduction in salivary flow. The major cause of xerostomia, however, is objectively assessed salivary gland hypofunction,8-11 which could be attributed to several systemic diseases such as Sjögren syndrome, rheumatoid arthritis and systemic lupus erythematosus.8 Salivary flow rate measurement becomes essential in diagnosing salivary gland hypofunction as the cause of xerostomia.8 Accurate measurement of salivary flow rate also is essential for various other clinical and research purposes.

**ASSESSMENT OF SALIVARY FLOW RATES**

Salivary flow rates are assessed differently for different purposes. Clinicians commonly use a patient’s response to a health questionnaire and the outcome of clinical evaluation as the basis for identification and assessment of dry mouth. For example, “yes” responses to the following four questions have been significantly associated with salivary gland hypofunction:
- Does the amount of saliva in your mouth seem too little?
- Does your mouth feel dry when eating a meal?
- Do you have difficulty swallowing any food?
- Do you sip liquids to aid in swallowing dry food?12

Some clinicians and scientists use a visual analog

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**Table 1:**

<table>
<thead>
<tr>
<th>Collection Period (Minutes)</th>
<th>Saliva Type</th>
<th>Tube No.</th>
<th>Postweight (Grams)</th>
<th>Preweight (Grams)</th>
<th>Flow Rate/Minute</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>UWS</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>SWS-Gum</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>SWS-Candy</td>
<td>3</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Salivary Flow Rate* = postweight measure — preweight measure =  \( g/minute \)

* Salivary gland hypofunction is considered as whole unstimulated saliva < 0.1 g/minute (that is, mL/minute), whole chewing stimulated saliva < 0.7 g/minute or both.

Figure 1. University of Southern California School of Dentistry Salivary Flow Rate Measurement Sheet. UWS: Unstimulated whole saliva. SWS-Gum: Stimulated whole saliva—gum. SWS-Candy: Stimulated whole saliva—candy. mL: Milliliters. Adapted with permission of Mahvash Navazesh, DMD.
powered toothbrushes have been used to stimulate salivary flow.¹⁵

**UNSTIMULATED AND STIMULATED WHOLE SALIVA COLLECTION**

Several methods for collecting saliva have been reported and tested for validity and reproducibility.¹³,¹⁶ In this article, we provide in detail the guidelines for collecting unstimulated and stimulated whole saliva (Box, page 36S) and measuring salivary flow rate (Figure 1) as followed at the University of Southern California School of Dentistry (Figures 2-5).

**COLLECTION OF SALIVA FROM INDIVIDUAL GLANDS**

Saliva collection from individual glands should not be contaminated with food debris and microorganisms, so it is prudent to acquire saliva from
individual major glands. The techniques, however, are tedious and require custom-made collection devices.17

Parotid gland. The parotid gland secretion is voided in the oral cavity via the Stensen duct at the vicinity of the parotid papilla opposite the maxillary second molar. A modified Lashley cup or Carlson-Crittenden collector often is used for collecting saliva from the parotid glands (Figure 6).

Submandibular and sublingual glands. The submandibular and sublingual gland secretions are voided in the oral cavity via the Wharton duct, which opens into the floor of the mouth. Many custom-made collectors such as the Wolff collector are used (Figure 7).17,18

Minor salivary glands. Minor salivary gland secretions do not have much clinical application, owing to the labor-intensive nature of collecting them. Specific methods are used to measure minor salivary gland secretions.19

CONCLUSION

With advances in medicine and therapeutic modalities, human life expectancy is increasing steadily. One can expect an increase in salivary gland hypofunction, along with other more prevalent medical conditions, in the elderly population. In this article, we presented saliva collection methods that can be used by dentists in their practices to assess patients at risk and by scientists for scholarly activities.
