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Review Article

Assessment of correlation between the Modified Schirmer Test and unstimulated salivary flow testing

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Abstract: Purpose: To evaluate the efficacy and subjects' perception of the Modified Schirmer Test (MST) to the traditional Unstimulated Salivary Flow Test (USFT) when measuring salivary flow rate for screening and monitoring patients' dry mouth. **Methods:** A total of 100 subjects were enrolled including subjects with and without dry mouth. All subjects answered a brief self-reported survey about dry mouth before and after the two types of saliva tests and their preference for the type of test administered. The order of performing MST and USFT were randomized. MST was conducted by the clinician holding a Schirmer strip paper at the bottom of the subject's mouth for 1 minute. USFT was measured by having the subject spit any accumulating saliva into a medicine cup for 5 minutes. Correlation analyses were conducted to test the relationship between MST and USFT using the Pearson correlation coefficient. All analyses were performed at a $P< 0.05$. **Results:** A significant positive correlation existed between the two salivary flow tests ($r= 0.556$, $P< 0.001$). Most of the subjects (79%) preferred the MST while 6% preferred USFT; 15% reported no preference. A negative association between MST and USFT with age indicated that as age increased, subjects' salivary flow rate results for both types of tests decreased ($r= - 0.287$, $P= 0.004$). (*Am J Dent* 2024;37:313-316).

Clinical significance: MST provides dental care providers with an effective, economical, easy-to-perform, and patient-preferred method to screen and monitor salivary flow rate.

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Introduction

Saliva plays an important role in the oral cavity as it provides lubrication, protects oral structures, buffers oral pH, aids in taste and digestion, and assists with speech.[1] Therefore, the lack of saliva that is perceived as dry mouth or known as hyposalivation or xerostomia, can significantly affect a person's physical, emotional, and social well-being. According to a systematic review, the overall prevalence of xerostomia was 22% of the general population, highlighting that one out of five are impacted by this condition.[2] It is well known that medications,[3] auto-immune diseases,[4] and radiation therapy[5] are among the main contributors of dry mouth. To effectively manage dry mouth, dental care providers must first determine its cause. It is also essential to regularly monitor the progress of different management strategies through quantitative measurements and detailed record-keeping.

There are several ways to screen and monitor patients' dry mouth conditions. The Challacombe scale is widely used by visually identifying ten dry mouth features subjectively by the clinician. This index measures the severity related to the dry mouth on a 10-point scale. Scores range from 0 to 10, where 0 is no burden and 10 is an excruciating burden.[6,7] For quantitative methods, the traditional stimulated and unstimulated saliva spitting tests have been used throughout the years. The normal stimulated salivary flow rate ranges from 1.5 to 2 mL/minute, while the normal unstimulated salivary flow rate ranges from 0.3 to 0.4 mL/minute.[8] The biggest challenge of both spitting tests is the time and effort of both the dental care provider and patient to finish the 5-15-minute spitting test. Additionally, during the COVID-19 pandemic, dental care providers were hesitant to have patients spit saliva into the collecting cup. The Modified Schirmer test, which uses a color-coded strip, was originally designed to measure the rate of lacrimal tear production. It was then introduced as a simple and reproducible method to determine unstimulated salivary flow rates.[9,10] In a preliminary study,[11] the efficacy of the modified Schirmer test has been demonstrated to be beneficial to both dentists and patients as it is low cost, easy to perform, and well-tolerated by the patient.

Saliva spitting tests are widely used and considered reliable, yet it has been suggested that there is currently no consistent and reliable screening test for assessing salivary flow rate.[12] Despite studies showing that the Modified Schirmer test is a simple and reproducible method for measuring unstimulated salivary flow rates, its use in dentistry remains limited. Therefore, the objective of this study was to evaluate the efficacy and comparability of the modified Schirmer test to the traditional unstimulated saliva spitting test for monitoring salivary flow rate and determine the patient's preference in testing salivary flow rate. It is hypothesized that there would be no correlation in the test results of patients' salivary flow rate between the modified Schirmer test and the unstimulated salivary flow test. It was also hypothesized that there would be no difference in the patient's preference between the two types of test methods.

Materials and Methods

Study design/inclusion and exclusion criteria - The Institutional Review Board of Loma Linda University approved the clinical study (IRB #5230467, October 25, 2023) to compare dry mouth assessment methods. A total of 100 subjects with and without dry mouth were enrolled. The study had four inclusion criteria: subjects who were 18 years or older, who complied with the study protocol, who read and understood the consent form, and who were available during the study period. There were two exclusion criteria: subjects under the age of 18 and subjects with fever, chills, or a positive COVID-19 test.

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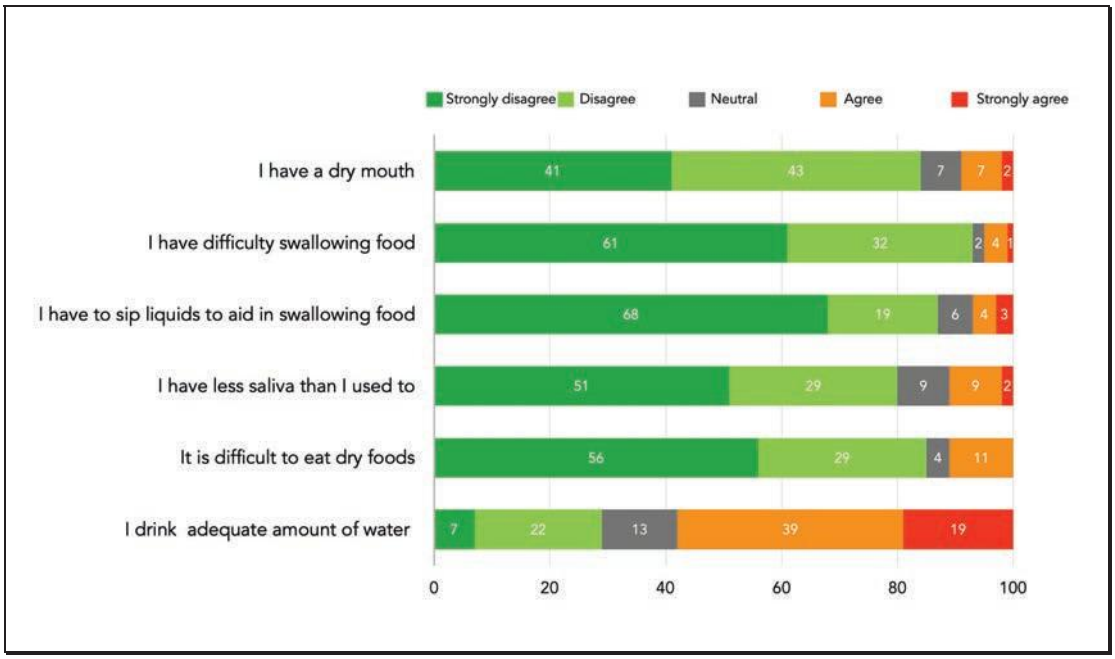

Fig. 1. Summary of responses to pre-screening questions.

Fig. 2. a. Administering the Modified Schirmer Test (MST) and b. the Unstimulated Salivary Flow Test (USFT).

Study procedures/pre-screening questionnaire - All subjects signed a consent form and completed a pre-screening questionnaire to assess dry mouth. The questions were adopted from Shruthi et al[13] and evaluated various aspects such as mouth dryness, difficulty swallowing food, the need for sipping liquid to aid swallowing, the feeling of having less saliva than before, difficulty eating dry foods, and the adequacy of their water intake (Fig. 1). Responses were recorded on a 5-point Likert scale, ranging from strongly disagree to strongly agree.

On completion of the questionnaire, two types of saliva tests (MST vs USFT) were administered in a clinic cubicle setting. The sequence of the two tests was determined by using a randomization sheet generated by Excel, where half of the subjects performed the MST first while the other half performed the USFT first. The results from the two tests were compared to determine if MST can be an alternative clinical test for the assessment of dry mouth.

The Modified Schirmer Test (MST) - The test was conducted by using a Color Bar Schirmer Tear Test strip that is available commercially.[a] The strips are preprinted on 5×35 mm standardized filter paper with a blue color bar that travels with the fluid, at a millimeter scale delineating the amount of saliva flow. The subjects were instructed to swallow their residual saliva and position their tongue on the palate to avoid tongue contact with the MST strip. The strip was then held and positioned touching the floor of the mouth using a cotton plier for 1 minute. The strip turned from white to blue upon contact with saliva, and the distance of the blue color change was recorded (Fig. 2a).

Unstimulated Salivary Flow Test (USFT) - Before the test, the subjects were asked to swallow all the saliva. The test was then performed by having the subject spit any saliva that accumulated within the oral cavity into a 30 mL medicine cup for 5 minutes (Fig. 2b). The amount of saliva collected was recorded.

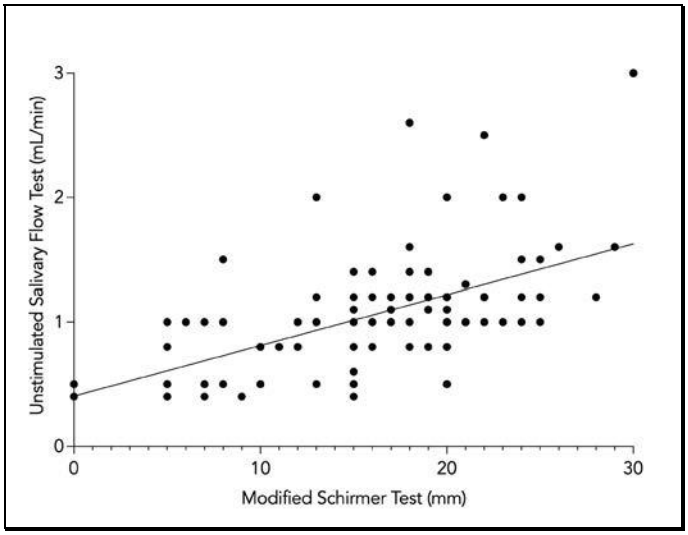

Fig. 3. Correlation of Modified Schirmer Test (MST) and Unstimulated Salivary Flow Test (USFT).

Post-testing questionnaire - After completing the two types of saliva tests, subjects were asked to take a two-item post-testing questionnaire to evaluate the subjects' preference for the testing method and why they preferred one over the other.

Statistical analysis - The sample size was determined by referencing Shruthi's study[13] comparing MST to USFT. Descriptive analysis of relevant variables including age, gender, MST and USFT results, and pre-screening question responses were compiled. Correlation analyses were conducted to test the relationship between MST and USFT, demographics and responses to pre-screening questions using Pearson correlation coefficient. All analyses were performed at a 0.05 significance level with R software[b] (version 4.1.2).

Results

Descriptive analysis - A total of 100 volunteers participated in the study, with 47% being female and 53% male. The age ranged from 18 to 86 years, with a mean age of 41.3 years (SD 20.7).

The assessment of the participant's perception of dry mouth is shown in Fig. 1. Approximately 10% of participants reported to have dry mouth, characterized by having less saliva than they used to, and difficulty in eating dry foods. Furthermore, 30% of participants indicated inadequate water consumption throughout the day.

Correlation analysis - The test results of MST ranged from 0 to 30 mm, with the mean strip wetness of 16.24 mm. The test results of USFT ranged from 0.4 to 3 mL/minute, with a mean of 1.07 mL/minute. The correlation between MST and USFT is illustrated in Fig. 3. A significant positive correlation existed ($r= 0.556$, $P< 0.001$), suggesting a strong association between MST and USFT. Additional correlation analysis showed a negative association between MST and age ($r= -0.287$, $P= 0.004$) as well as USFT and age ($r= -0.284$, $P= 0.004$), suggesting that as age increases, both MST and USFT outcomes tend to decrease. Correlation analysis of pre-screening questions to MST and USFT showed a significant negative correlation between both tests and feeling of dry mouth, difficulty in swallowing food, having to sip liquid to aid in swallowing, and having less saliva than they had in the past ($P< 0.05$, in all instances).

Preference analysis - The findings regarding the test method preference on completing MST and USFT showed that most subjects (79%) favored the MST while 6% indicated a preference for USFT and 15% reported no preference. Among the study participants, approximately 50% indicated a preference for MST due to its shorter duration requirement of 1 minute, contrasted to the 5-minute time commitment needed for the USFT. Concurrently, a significant other proportion, 40% of the respondents, showed a preference for MST based on the overall testing experience. Participants who favored USFT reported the importance of autonomy, and that keeping the mouth open for 1 minute caused more dryness.

Discussion

Effective screening and monitoring of dry mouth can help early identification to reduce unfavorable effects and enhance patients' daily functioning and well-being. Additionally, reliable screening enables dental care providers to provide timely interventions for maintaining oral health. The findings of the study are significant as they implicate the comparability of MST to USFT in testing patients' salivary flow in a clinical setting. There was a significant positive correlation which led us to reject our null hypothesis. Our results are similar to other studies[11,13,14] comparing the two methods, showing that the MST is a useful screening tool for hyposalivation and measuring salivary flow rate while being objective, inexpensive, easy to perform, and well-tolerated.

The implementation of evidence-based dentistry (EBD) in our daily practice is vital. EBD combines scientific evidence, clinician experience, and patient preference.[15,16] A significant novel aspect of the study was the assessment of patients' preferences concerning the use of MST and USFT. The present findings demonstrated an overwhelming preference for MST over USFT. Subjects preferred the MST due to the overall experience and the shorter time. This preference supports the implementation of MST in clinical practice. Notably, those who preferred the USFT valued the sense of autonomy it provided.

This study presents several important clinical implications. From the patients' perspective, the MST requires less chair time, allowing patients to be relaxed, unlike the USFT where they need to perform the test themselves. The MST also provided subjects with a clear, visual view of their salivary flow rate, displayed as a line of blue dye on the strip paper. For providers, the MST offers several advantages. It is an economic alternative to the USFT, taking about 20 cents of materials cost per test. Additionally, since the MST is administered directly by the provider, it ensures consistent test administration. However, it is noteworthy that the perception of providers on the usage of MST has not been assessed yet. One of the major limitations of the study was that it could not specify MST reading cut-off values to determine patients with mild, moderate, and severe dry mouth.

Future research with a larger sample size is warranted to establish these critical ranges that would determine and guide clinical recommendations for patients suffering from dry mouth. Based on a systematic review, there is yet no treatment strategy that has consistently proven to be effective for long-

term symptom control. However, for elderly patients experiencing low saliva flow, pilocarpine, a parasympathomimetic drug, showed the most effective results, particularly for those with residual gland function after radiation therapy. In cases of drug-induced xerostomia, malic acid combined with fluoride and xylitol resulted in moderate success. Mouthwashes generally soothe symptoms, and alternative therapies like oral electrostimulation and acupuncture offer potential with minimal side effects.[17]

Within the study's limitations, it is concluded that the MST provides dental care providers with an effective, economical, easy-to-perform, and patient-preferred method to screen and monitor salivary flow rate.

a. Eagle Vision, Memphis, TN, USA.
b. The R Foundation, Vienna, Austria.

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