Evaluation of the Effect of Transcutaneous Electrical Nerve Stimulation (TENS) On Salivary Flow in Patients with Xerostomia

Mittal Kumud¹, Keluskar Vaishali², Kapoor Shekhar³

Abstract

Objectives: Xerostomia & salivary gland hypofunction are associated with advancing age, autoimmune diseases such as Sjögren’s syndrome, head & neck radiation, smoking and recreational drug usage. This study was undertaken to evaluate the effect of transcutaneous electrical nerve stimulation (TENS) on whole salivary flow rate in patients with xerostomia. Methods: 50 patients with history of xerostomia enrolled in this study. The TENS electrode pads were placed externally on the skin overlying the parotid glands. Unstimulated whole saliva was collected for 5 minutes into graduated tube using low forced spitting method. The TENS unit was then activated and stimulated saliva was collected for additional 5 minutes. Results and conclusion: The mean unstimulated salivary flow rate was 0.0792 ± 0.035ml/min and there was 70.28%±47.28% increase in salivary flow following TENS application. Statistical analysis of flow rates utilizing the paired t-test showed the difference to be statistically significant (p < 0.001). The TENS unit was effective in increasing whole salivary flow in most of patients with xerostomia.

Keywords: Stimulated saliva; TENS; whole salivary flow; xerostomia


Introduction

The oral cavity is a moist environment; where in a film of fluid called saliva constantly coats its inner surfaces and occupies the space between lining oral mucosa and the teeth. Saliva is a complex fluid, the important role of which is to maintain the well being of oral cavity.\(^1\)

Saliva has many important functions. It maintains neutral pH and is essential for maintaining enamel mineralization. The fluid not only lubricates the mouth and upper pharynx but also modulates oral flora, aids in digestion of food and facilitates speech and swallowing. It also plays a role in oral immunology and possesses a number of antibacterial enzymes such as lysozyme, peroxidase, histatins and lactoferrin.\(^2\)

Xerostomia, a decreased production or total lack of saliva secretion, is a common clinical phenomenon and is present in about 40% of adults over the age of 50 years.\(^3\) Xerostomia & salivary gland hypofunction are associated with local & systemic conditions, advancing age, selected medical disorders, head & neck radiation, smoking and recreational drug usage.\(^4\) Systemic agents like pilocarpine and cevimeline stimulate salivary flow but often have unfavourable side effects such as profuse sweating, rhinitis, dyspepsia etc.

Transcutaneous electrical nerve stimulation (TENS) is a well-known physical therapy, which is useful for the relief of pain. With TENS, electrical stimulation is directed to chronic pain areas via surface electrodes, and current passed through these areas reduces or eliminates pain.\(^5\) It is noninvasive, safe, easy to master and generally well accepted by the patients.\(^6\)

Electro stimulation to produce saliva was studied in the past and showed moderate promise but never became part of mainstream therapy. Results of recent preliminary investigations of noninvasive electronic stimulation of reflex salivation in xerostomic patients have been encouraging.\(^7\)

Research in this area is sparse and hence this study was undertaken to evaluate the effect of TENS on whole salivary flow rate in patients with xerostomia.

Materials and methods

50 clinically confirmed cases of xerostomia were included in the study. Before starting the study, clearance was obtained from the institutional ethical committe. Informed consent was obtained from all the patients. Patients who gave history of xerostomia were checked for ‘mirror stick’ test. For patients with positive mirror stick test unstimulated saliva was collected with ‘low forced spitting’ method in a graduated test tube for 5 minutes. Patients with unstimulated saliva equal to or less than 0.5 ml in 5 min were included in the study.

The electrode of TENS unit were placed externally on skin overlying the parotid gland with TENS unit in off position. The TENS unit was then activated and intensity control switch was gradually increased to tolerable level of patient for 15 min. At this optimal intensity, stimulated saliva was collected for 5 min with same method in a separate graduated test tube and flow rate was compared with unstimulated...
salivary flow rate. The salivary flow rate was calculated by dividing the amount of collected saliva (volume in mL) by the duration of collection period (five minutes).

Student’s t-test (unpaired and paired) was done for group wise comparisons.

**Results**

The experimental group comprised of 50 subjects (29 males and 21 females) with an age range of 30-54 years and was divided into five age groups.

**COMPARISON OF UNSTIMULATED AND STIMULATED SALIVARY FLOW RATE (TABLE I)**

The mean unstimulated salivary flow rate was 0.0792± 0.035 mL/min. There was 70.28%±47.28% increase in salivary flow i.e. 0.1248±0.036 mL/min during the TENS application and the difference was highly significant (p< 0.001 HS).

**COMPARISON OF SALIVARY FLOW RATE IN DIFFERENT AGE GROUPS (TABLE II)**

In age group between 30 to 34 years the mean unstimulated salivary flow rate was 0.06 ± 0.2 mL/min and there was 95.83%±53.36% increase in salivary flow (i.e.0.12± 0.02mL/min) with the application of TENS and the difference was statistically significant (p<0.05).

In between 35 to 39 years age group the mean unstimulated salivary flow rate was 0.08 ± 0.03 mL/min and there was 70.60%±52.38% increase in salivary flow (i.e.0.12 ± 0.03 mL/min) with the application of TENS and the difference was statistically significant (p < 0.001).

In between 40 to 44 years age group the mean unstimulated salivary flow rate was 0.07 ± 0.02 mL/min and there was 78.70%±41.36% increase in salivary flow (i.e. 0.12 ± 0.03 mL/min) with the TENS application and the difference was statistically significant (p<0.001).

In between 45 to 49 years group the unstimulated salivary flow rate was 0.08 ± 0.04 mL/min and there was 64.55%±51.84% increase in salivary flow (i.e. 0.12 ± 0.04 mL/min) with the TENS application and the difference was statistically significant (p < 0.001).

In between 50 to 54 years age group the mean unstimulated salivary flow rate was 0.09 ± 0.04 mL/min and there was 61.28%±40.24% increase (i.e. 0.14± 0.04 mL/min) with TENS therapy and the difference was statistically significant (p < 0.001).

**COMPARISON OF SALIVARY FLOW RATE BETWEEN MALES AND FEMALES (TABLE III)**

The mean unstimulated salivary flow rate in males was 0.08 ± 0.03 mL/min. There was 59.82%±36.11% increase in salivary flow (i.e. 0.12± 0.04 mL/min) with the TENS application and the difference was statistically significant (p < 0.001).

In females unstimulated salivary flow rate was 0.08 ± 0.03 ml/min. There was 84.51%±57.28% increase in salivary flow (i.e. 0.13 ± 0.03 mL/min) with the application of TENS and the difference was statistically significant (p< 0.001).

Statistical analysis of flow rates utilizing the unpaired‘t’ test for inter-group analysis demonstrated the difference between unstimulated, stimulated and mean difference in salivary flow rate between males and females was statistically not significant.

**Discussion**

Nerves supplying salivary glands are known to control the secretion of saliva. This became evident with Ludwig’s momentous
discovery in 1850 that electrical stimulation of chorda tympani nerve in the dog caused a copious secretion of submandibular saliva.  

Xerostomia is the subjective sensation of dry mouth, while hyposalivation is the objective finding of reduced salivary flow rate. Palliative management tried in xerostomia are topical agents such as ice chips and saliva substitutes, increase in water intake, applying lip balm, chewing sugarfree gum or sucking sour sugarfree lemon drops. Systemic sialogogues were also tried but has many side effects. All have met with limited success.  

Neural electrostimulation of salivary gland function by application of electric current through the oral mucosa, on afferent nerve pathway receptors has been reported to increase production of saliva and to reduce the symptoms of xerostomia. Proponents of electrostimulation as a method to increase salivary production suggest that this procedure enhances the patient’s ability to generate saliva by augmenting normal physiologic salivary reflexes. Transcutaneous electrical nerve stimulation (TENS) has been evaluated in stimulating salivary flow and found effective even in patients with xerostomia secondary to radiation therapy for head and neck cancer. Therefore, the present study was conducted to evaluate the efficacy of TENS therapy in patients with xerostomia.

The unstimulated saliva was collected before the TENS therapy for 5 minutes and stimulated saliva was collected during the TENS therapy for 5 minutes with 'low forced spitting' method in a graduated tube. The method of saliva collection was based on Aagaard et al except a graduated tube was used instead of preweighed cylinder.

The adjustment of the pulse rate at 50 HZ and placement of electropads on the skin overlying the parotid glands was similar to the method of Hargitai et al. The saliva was collected at optimal intensity of TENS (the maximum intensity that the subject was comfortable).

In our study, there was 70.28% increase in salivary flow which was statistically significant. Forty seven out of fifty patients responded positively to TENS therapy. This result was in agreement with the study by Hargitai et al in which 15 (out of 22) healthy subjects demonstrated significant increase in parotid salivary flow and the maximum increase was 8.75 fold greater than the baseline. Also in a study by Damingo, 6 of the 18 postradiation head and neck cancer patients demonstrated significant increase in salivary flow after the TENS application.

In the present study, it was found that in all the age groups there was statistically significant increase in TENS stimulated saliva compared to unstimulated saliva. The unstimulated and stimulated salivary flow rates in different age groups was not statistically significant. In our study, the stimulated salivary flow rate was higher in females than males but the difference between males and females was not stastically significant. This can also be attributed to less number of female subjects in our study. In a study by Ghezzi et al had showed there was no significant age and gender differences in salivary flow rates

The mechanism by which the TENS unit acted on the parotid gland can be attributed to direct stimulation of the auriculotemporal nerve that supplies secretomotor
drive to the parotid gland. It is believed that afferent nerves carry such impulses to the salivary nuclei (salivation center) in the medulla oblongata which in turn directs signals to the efferent part of the reflex leading to initiation of salivation.\textsuperscript{2}

The main advantage offered by TENS over other non-pharmacologic measures such as chewing gum or citric lozenges is that, it is an extraoral device with minimal side effects. It can be used while eating food and will not affect normal mastication process. Chewing gum bases may need to be avoided in those with temporomandibular disorders and have had favorable but mixed results in various studies\textsuperscript{2}. Artificial saliva preparations can be used but have some limitations. The majority of commercial products available are based upon carboxymethylcellulose (CMC). However, these products do not contain specific antibacterial components, enzymes and other components of saliva.

**Conclusion**

The present study substantiated that TENS can be an effective therapy in increasing whole salivary flow rates in patients with xerostomia. TENS may be used synergistically with other sialogogues for the management of xerostomia.

**Acknowledgment**

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Table 1: Comparison of unstimulated and electro-stimulated salivary flow rate

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Unstimulated saliva (ml/min)</th>
<th>Stimulated saliva (ml/min)</th>
<th>Mean difference (ml/min)</th>
<th>% difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean± SD</td>
<td>0.099±0.035</td>
<td>0.124±0.036</td>
<td>0.045±0.02</td>
<td>7.28±4.78</td>
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</table>

Table 2: Comparison of salivary flow rate in different age groups

<table>
<thead>
<tr>
<th>Age (year)</th>
<th>No. Of cases</th>
<th>Unstimulated saliva (ml/min)</th>
<th>Stimulated saliva (ml/min)</th>
<th>Mean difference (ml/min)</th>
<th>% difference</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>30-34</td>
<td>4</td>
<td>0.06±0.2</td>
<td>0.12±0.02</td>
<td>0.06±0.02</td>
<td>95.83±53.36</td>
<td>&lt;0.05 S</td>
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<tr>
<td>35-39</td>
<td>11</td>
<td>0.08±0.03</td>
<td>0.12±0.03</td>
<td>0.04±0.02</td>
<td>70.60±52.38</td>
<td>&lt;0.001 HS</td>
</tr>
<tr>
<td>40-44</td>
<td>9</td>
<td>0.07±0.02</td>
<td>0.12±0.03</td>
<td>0.05±0.02</td>
<td>78.70±41.36</td>
<td>&lt;0.001 HS</td>
</tr>
<tr>
<td>45-49</td>
<td>16</td>
<td>0.08±0.04</td>
<td>0.12±0.04</td>
<td>0.04±0.02</td>
<td>64.55±51.84</td>
<td>&lt;0.001 HS</td>
</tr>
<tr>
<td>50-54</td>
<td>10</td>
<td>0.09±0.04</td>
<td>0.14±0.04</td>
<td>0.05±0.02</td>
<td>61.28±40.24</td>
<td>&lt;0.001 HS</td>
</tr>
</tbody>
</table>

Table 3: Comparison of salivary flow rate between males and females

<table>
<thead>
<tr>
<th>Gender</th>
<th>No. Of cases</th>
<th>Unstimulated saliva (ml/min)</th>
<th>Stimulated saliva (ml/min)</th>
<th>Mean difference (ml/min)</th>
<th>% difference</th>
<th>P</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>29</td>
<td>0.08±0.03</td>
<td>0.12±0.04</td>
<td>0.04±0.02</td>
<td>59.82±36.11</td>
<td>&lt;0.001 HS</td>
</tr>
<tr>
<td>Female</td>
<td>21</td>
<td>0.08±0.03</td>
<td>0.13±0.03</td>
<td>0.05±0.02</td>
<td>84.51±57.78</td>
<td>&lt;0.001 HS</td>
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References

