EFFICACY OF TRANSCUTANEOUS ELECTRICAL NERVE STIMULATION ON WHOLE SALIVARY FLOW RATE- A CLINICAL STUDY

ABSTRACT

Aim: To evaluate the efficacy of Transcutaneous Electrical Nerve Stimulation (TENS) over the whole salivary flow rate in normal healthy adults. **Materials and methods:** Twenty healthy adults were included in this study with no salivary gland pathology. Saliva before TENS therapy was collected for each patient in a plastic container on each minute one spit basis for about 5 minutes. The tens electrode pads were placed on the skin over the parotid gland on both sides. Post therapy salivary collection was done by the above mentioned procedure. **Statistics:** Paired 't' test used to compare unstimulated and stimulated whole salivary flow rate. P value is 0.03 and hence results are statistically significant. **Results:** Out of 20 patients, 19 patients have been observed with increased salivary flow post TENS therapy. **Conclusion:** TENS acts as a valuable device in increasing salivary flow rate and can be used in all cases of xerostomia and hyposalivation to increase the salivary flow.

Key words: TENS, saliva, salivary flow

INTRODUCTION

Saliva is an important fluid required to maintain normal oral health. There are three major salivary glands (parotid, sub-mandibular and sub-lingual gland) and many minor salivary glands that secretes 1.2 to 1.5 litre of saliva into the oral cavity.[1] The functions of saliva in oral cavity are for digestion, speech, mastication, caries prevention, immune function, defensive function and nutrition. Xerostomia is a clinical condition characterized by decrease in the amount of saliva in oral cavity. Some doctors restrict the use of the term xerostomia to refer to a subjective complaint or oral dryness, and use the term hyposalivation to describe an objective decrease in volume [10]. There are various causes of salivary hypofunction. Some are systemic diseases, prescription/non-prescription medications, chemotherapy and head-neck radiotherapy. It includes topical agents such as saliva substitutes, increased water intake, application of lip balm, chewing sugar-free gums, sucking sour lemon drops,

paraffin containing lozenges and rinses.[2] Patients need to be advised to avoid mouth breathing, smoking, carbonated beverages, alcohol-based drinks and mouthwashes, and to change or discontinue drugs causing dry mouth.

Transcutaneous Electrical Nerve Stimulation (TENS) is a well-known physiotherapy unit, which is useful in various orofacial pain control. Electro-stimulation to produce saliva has been studied in the past and the results were encouraging.[3] Transcutaneous Electrical Nerve Stimulation (TENS) consists of application of low frequency, pulsed electrical currents [10]. These electrical currents are transmitted via surface electrode pads placed on the skin surface. They potentially initiate the peripheral nerves to produce various physiological effects. The first TENS units were developed in the year 1965 by Melzack and Wall.[4] Since 1965, TENS is considered to be one of the most common therapeutic resources used in clinical practice for the relief of chronic and acute pain. In recent times, many researchers have observed that in addition to the analgesic effects of TENS, it may also be used to increase salivary flow by stimulating the peripheral nerves that reaches the salivary glands. By having this idea, the present study was undertaken to evaluate the efficacy of TENS on whole salivary flow rate in healthy adult subjects and to compare the whole salivary flow rate between unstimulated saliva before TENS and stimulated saliva after TENS.[5]

MATERIALS AND METHOD

Twenty healthy adults who visited the Department of Oral Medicine and Radiology in the period of July - September 2019 with no history of salivary gland pathology were included in this clinical study. Written informed consent was obtained before the start of study from all the participants. Inclusion criteria were normal patients without any underlying systemic diseases and local diseases of salivary gland that may affect the normal salivary outflow. Age group will be within 20 - 40 irrespective of gender.

Exclusion criteria were patients with history of salivary gland pathology, patients wearing active pacemakers, hearing aids, cochlear implants, patients suffering from systemic diseases or conditions, patients currently taking medications for any conditions, those with a history of radiation to the head and neck region,

patients with a history of psychiatric disorders and pregnant women, patients having tobacco and pan chewing habits. All the patients were explained the details of the procedure and were informed to refrain from eating, drinking alcohol, chewing gum, smoking, and oral hygiene procedures for at least 1 hour prior to the appointment [10].

The subjects were made to sit in an upright position, with the head inclined slightly forward. They were asked to swallow saliva first and then instructed to stay motionless, so that the saliva would collect passively in the anterior region of the floor of the mouth. Patients were then asked to spit the whole saliva into the ependorf vial for each minute for about five minutes (5 spits). After 5 minutes, the whole unstimulated saliva level in the vial is noted. Then, the surface electrode pads were placed e xternally on the skin, overlying the parotid glands, with the TENS unit in the 'off' position [10]. The unit was preset at a frequency of 100 Hz and a pulse width of 100-150μs. After a gap of about two minutes the TENS unit was activated and the amplitude was gradually increased to a maximum tolerable level of patient. Once the maximum tolerable amplitude is achieved the flow of current is maintained for about 30 minutes. After 30 minutes, the device is switched off and the pads were removed. Patient was instructed to sit in the same upright position with head slightly inclined forward. The stimulated saliva gets pooled in anterior part of floor of the mouth. Patient was again asked to spit the saliva into the vial for each minute for about five minutes (5 spits).

RESULTS

Among 20 patients, 7 were male and 13 were female. Among 7 male cases, 6 patients had increased salivary flow after TENS therapy, and 1 patient had decreased salivary flow. Among 13 female cases, all patients had increased salivary flow after TENS therapy. Student's t-test (paired) was used for comparisons. Correlation Analysis was performed to assess the relationship between measurements. For all the tests, P value of 0.05 or less was considered statistically significant.

Statistical analysis of flow rates for inter-group analysis demonstrated that the difference between unstimulated and stimulated salivary flow was given in [Table 1 and Figure 1]. The mean difference in salivary flow rate

between males and females was given in [Table 3]. The difference in salivary flow rate between different age groups was given in [Table 3].

Type of saliva	N	Mean	Std. Deviation	Std. error of mean
Unstimulated saliva	20	1.28	0.469	0.105
Stimulated saliva	20	1.63	0.621	0.139

Table 1: Comparison between stimulated and unstimulated salivary flow rate (ml/min)

	Age	N	Mean	Std. Deviation	Std. Error Mean
Post-value(ml)	20-29	16	1.5875	.69174	.17293
	30-39	4	1.6750	.22174	.11087

Table 2: Statistics between two age groups in post TENS values

	Gender	N	Mean	Std. Deviation	Std. Error Mean
Post-value(ml)	male	7	1.8429	.70441	.26624
	female	13	1.4769	.55999	.15531

Table 3: Statistics between two gender group in post TENS values

Age	Post value (ml)	P value
20-29 years 30-39 years	1.58 ± 0.69 1.6 7± 0.22	0.89

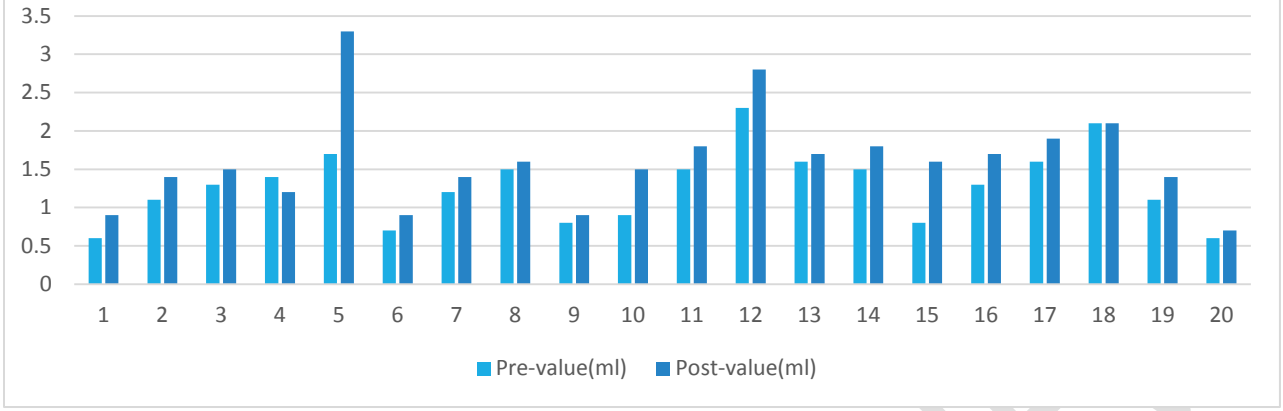
Table 4: P value for different age groups

Gender	Post value (ml)	P value
Male Female	1.84 ± 0.70 1.47 ±0.55	0.218

Table 5: P value for both gender groups

Both the parameters are not statistically significant.

Figure 1- Comparison of pre and post TENS salivary flow rate



DISCUSSION

The application of electric current through the oral mucosa to the afferent neuronal pathway causes electrical stimulation of the salivary glands and this has been reported to increase the production of saliva and to reduce the symptoms of xerostomia.[6] The effect of transcutaneous electrical nerve stimulation (TENS) has been observed in stimulating salivary flow and it was found to be more effective even in patients with xerostomia secondary to radiation therapy for head and neck cancer.

Salivary flow is classified as unstimulated, resting, and stimulated. Both the parasympathetic and sympathetic nerve supply innervate the salivary glands. Parasympathetic stimulation induces more watery secretions, whereas the sympathetic system produces more viscous salivary flow.[7] Therefore, sensation of dryness may occur, during episodes of acute anxiety or stress, which produce alteration in salivary composition owing to predominant sympathetic stimulation during such periods.

The mechanism by which the TENS unit worked on the parotid gland may be that it directly stimulates the salivary secretion arc. Salivary secretion is performed by a neuronal mechanism composed of a reflex arch. This neuronal mechanism has three basic components; (1) afferent receptors and nerves which carry impulses generated by both masticatory and gustatory actions; (2) a central connecting and processing center which is the salivatory nucleus; and (3) an efferent neuronal pathway consisting of both parasympathetic and sympathetic nerve bundles that separately but in a coordinated manner innervate the blood vessels and acini of

their target glands leading to regulation of salivary secretion. It is believed that afferent nerves carry impulses from the periphery to the salivary nuclei which is the salivation center in the medulla oblongata, which in turn directs the signals to the efferent part of the reflex arch leading to initiation of salivation.

Manu Dhilon *et al* stated that TENS unit was effective in increasing parotid gland salivary flow in healthy subjects. There was no gender-related variability of salivary flow rate of parotid gland. In another study conducted by Pattipati *et al* in 2013, showed an increase in salivary flow rate on application of TENS, and more so, this increase in salivary flow was pertinent even one hour after the application of TENS in a select group of individuals.

In one patient, the salivary flow was decreased with the application of TENS. The reasons for the decreased salivary flow will depend upon the frequency and intensity settings of the TENS unit.[8] The stimulus perceived by the brain may be painful and the salivary reflex is enhanced when nociceptive inputs reaching the brain via trigeminal sensory nuclei. Not all pre-ganglionic parasympathetic fibers are necessarily facilitated; some may be inhibited thus leading to the decrease in salivary flow rate.

Dipti Singh *et al* conducted a similar study in which forty-three out of 50 subjects showed increase in salivary flow when stimulated via TENS. The mean of unstimulated salivary flow rate found out was 0.354 ml/min (range 0.1-0.6 ml/min). There was 37% significant increase in the salivary flow, i.e. 0.494 ml/min (range 0.1-1.3 ml/min), during TENS application and the difference was highly significant.

The main advantages offered by TENS over other non-pharmacologic measures are as follows. TENS unit is an extraoral device. Thus, the potential for salivary production while eating would be beneficial. TENS is a non-pharmacologic measure. One of the side effect of noted in TENS therapy is the twitching of the facial musculature. This effect was minimal and transient. These effects could be minimized by adjusting the electrode placement and ceased once the TENS unit was turned off. Perhaps modifications can be made in future in TENS units, such as smaller electrodes, to minimize the side effects and make electro-stimulation more effective.[9]

CONCLUSION

TENS therapy was highly productive in significantly increasing the whole salivary flow in healthy adult subjects with minimal side effects. Tens is an effective adjunct to sialologues and also cost effective with user friendly features. However it provides only momentary relief. Further modifications can be made on TENS in the future to reduce side effects and to improve more electro stimulation for longer lasting effects.

CONSENT

Informed consent obtained from the patient prior to the study.

ETHICAL APPROVAL

Ethical approval obtained from the institutional review board members prior to the study

REFERENCES

1. Hargitai IA, Sherman RG, Strother JM. The effects of electrostimulation on parotid saliva flow: A pilot study. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2005;99:316-20.

2. Vilas SK, Shashikanth MC, Ali IM. Evaluation of the effect of transcutaneous electrical nerve stimulation on whole saliva flow: A clinical study. J Indian Acad Oral Med Radiol 2009;21:7-11.

3. Chiappin S, Antonelli G, Gai R, De Palo EF. Saliva specimen: A new laboratory tool for diagnostic and basic investigation. Clinica Chimica Acta 2007;383:30-40.

4. Guggenheimer J, Moore PA. Xerostomia: Etiology, recognition and treatment. J Am Dent Assoc 2003;134:61-9; quiz 118-9.

5. Steller M, Chou L, Daniels TE. Electrical stimulation of salivary flow in patients with Sjogren's syndrome. J Dent Res 1988;67:1334-7.

6. Domingo DL. The effects of electro-stimulation on saliva production in post radiation head and neck cancer patients. Oral Surg Oral Med Oral Pathol Oral Radiol 2004;95:464.

7. Ghezzi EM, Large LA, Ship JA. Determination of variation of stimulated salivary flow rates. J Dent Res 2000;79:1847-8.

8. Ikebe K, Sajiima H, Kobayashi S, Hata K, Morii K, Nokubi T, *et al*. Association of salivary flow rate with oral function in a sample of community-dwelling older in Japan. Oral Surg Oral Med Oral Pathol Oral Radiol Endod 2002;94:184-90.

9. Singh D, Agrawal S, Shashikanth MC, Misra N. The effects of transcutaneous electric nerve stimulation (TENS) on salivary flow: A study. J Indian Acad Oral Med Radiol 2015;27:16-9.

10. Aggarwal, H., Pal-Singh, M., Mathur, H., Astekar, S., Gulati, P., & Lakhani, S. (2015). Evaluation of the effect of transcutaneous electrical nerve stimulation (TENS) on whole salivary flow rate. *Journal of clinical and experimental dentistry*, *7*(1), e13.