

Effect of TENS on whole saliva in healthy adult Indians: evaluation of influence of protocol on quantity of saliva measured

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ABSTRACT

Objective: The objective of this study was to evaluate the effects of Transcutaneous Electric Nerve stimulation (TENS) on whole salivary flow rate in healthy adult subjects and to find out whether the protocol utilized for collection of saliva influence the quantity of saliva stimulated.

Materials and Methods: Using an extraoral TENS applied over parotid glands stimulated whole saliva flow rate in fifty healthy adult subjects was measured. Collection of TENS stimulated saliva was performed on day 1 after collection of unstimulated saliva, on day 2 only TENS stimulated saliva was measured. The data obtained was subjected to statistical analysis using paired 't' test.

Results: Thirty nine patients on day one and thirty six patients on day two out of 50 (75 % of the subjects tested) responded to TENS therapy with an increase of stimulated whole saliva flow rate. There was a reduction in quantity of TENS stimulated saliva on day one and two with a difference of 4% which statistically significant with p value 0.009.

Conclusions: Transcutaneous electric nerve stimulation (TENS) as an extra-oral device can be considered as a safe, non-pharmacological measure in order to achieve an increase of the rate of unstimulated saliva. Further studies should be conducted to evaluate the possibility of using TENS in relieving the symptoms of xerostomia.

Keywords: Stimulated saliva, transcutaneous electric nerve stimulation, whole saliva flow rate.

INTRODUCTION

Saliva is a highly complex secretory product of major and minor salivary glands dispersed throughout the oral cavity producing about 1.5 l of whole saliva daily.

¹ These glands are located in every region of the mouth except for the gums and the anterior part of the hard palate,² and they are essential in functioning and protection of oral cavity and contiguous gastrointestinal epithelium.³ At rest, saliva secretion ranges from 0.25 to 0.35 ml/min majorly contributed by the submandibular and sublingual glands. Sensory, electrical or mechanical stimuli can raise the secretion rate to 1.5 ml/min.² Saliva has many important functions by virtue of its constituents, which includes:

a) Protective functions: lubrication, antimicrobial activity, growth factors, maintaining mucosal integrity, buffering

and remineralization capacity etc.

b) Food- and speech- related functions: food preparation, digestion, taste perception and speech.⁴

On account of reduced saliva flow there is dryness of mouth, viscous sticky saliva, altered taste, a deviant sense of smell, failed speech, lackluster singing, trouble with chewing, increased disfiguring dental caries, erosion of teeth, bad breath, esophagitis, aggravated acid reflux, burning tongue, cracked lips and pestering yeast infections.⁵

The presence of saliva is usually taken for granted, and considered as if it is not required for any life-sustaining functions. Nevertheless, its diminution or absence can cause significant morbidity and a reduction in a patient's perceptions of quality of life.⁶

Xerostomia or dry mouth is, in fact one of the oldest recorded symptom by man in ancient times.⁵ Xerostomia is subjective feeling of dry mouth, a symptom that may

or may not be accompanied by hyposalivation, an objective decrease in salivary flow.³ Salivary gland hypofunction are associated with various local and systemic conditions, various modalities ranging from palliative, systemic medications, psychological counseling and acupuncture have been utilized for its management but often associated with unfavorable side effects and patient discomfort.⁷

Usage of TENS in production of saliva has been studied in the past which showed moderate promising results. However, it never became a part of the mainstream therapy.⁷ Results of preliminary investigations of noninvasive electronic stimulation of reflex salivation in xerostomic patients have been encouraging.^{8,9} Very few studies are conducted so far to find out the effects of TENS in patients with xerostomia. Research in this area has been sparse thus requiring further study in this regard.

The purpose of the present study was to evaluate the effects of TENS on whole salivary flow rate in healthy adult subjects and to find out whether the protocol utilized for collection of saliva influences the quantity of saliva stimulated. If this modality is found effective, it could be used as one of the treatment modality or an additional measure for management of xerostomia.

MATERIALS AND METHODS

An experimental study was performed with approval from college ethical committee and patients' written consent. Using an extraoral Transcutaneous electrical nerve stimulation (TENS) [TX-3T model] applied over parotid glands stimulated whole saliva flow rate in fifty healthy adults between 18 to 60 years subjects was measured. The pulse rate was fixed at 50 Hz and amplitude was gradually increased to a maximum tolerable level of patient. Collection of stimulated saliva was done in two different occasions In order to find out effects on the

quantity of stimulated saliva in relation to the collection method, so TENS stimulated saliva was collected after measuring unstimulated saliva (SSF1) on day 1, while on day 2 only collection of TENS stimulated saliva was performed (Figures 1, 2 and 3).



Figure 1. Patient positioning for collection of unstimulated saliva on day one.



Figure 2. Patient positioning for collection of TENS stimulated saliva on day one.

Inclusion Criteria

Healthy patients with no history of systemic diseases or medications and no history of salivary gland disorders were included.



Figure 3. Patient positioning for collection of TENS stimulated saliva on day two.

Exclusion Criteria

Patients wearing active pacemakers, defibrillator, hearing aids, cochlear implants, and pregnant female patients were excluded and patients taking medications to increase salivary secretion in the past 6 months were also excluded from the study.

All the participants were explained about the need and design of the study and a written consent form was signed. Saliva was collected between 9.30 to 12 pm and the following instructions were provided to patient to be followed before and according to the guidelines for saliva collection:

All participants were asked to refrain from eating, drinking, chewing gum, smoking and oral hygiene practices for at least one hour prior to the investigation.

➤ On the first visit the subjects were made to sit in an upright position, with the head inclined forward and with minimal body and oro-facial movements. Patients are then asked to swallow saliva first and stay motionless, with 'low forced spitting' un-stimulated saliva was collected every minute for five minutes in a test tube fitted

with funnel. Collected saliva is measured using the micropipette and recorded. Then electrode pads of the TENS unit were applied on parotid region and amplitude adjusted so that the patient did not refer discomfort, stimulated saliva collected every minute for 5 minutes and measured .

➤ During second visit the only stimulated whole saliva was collected and measured using the same procedure of stimulation. Data obtained was analyzed using paired t test.

RESULTS

Thirty nine patients on day one and thirty six patients on day two out of 50(75 % of the subjects), responded to TENS therapy with an increase of the stimulated whole saliva flow rate. The observed un-stimulated and stimulated whole saliva on day 1 in male and female patients Showed a statistically significant ($p < 0.000$) increase in saliva flow rate, 0.23 ± 0.04 ml/5min and 0.26 ± 0.11 ml/5min respectively in males and females. Females showed 12.9% increase in saliva when compared to males who had 11.4% increase in saliva flow rate (table 1). The amount of un-stimulated and stimulated whole saliva on day 2 Showed a statistically significant increase in the salivary flow rate after TENS: 0.15 ± 0.02 ml/5min (p value 0.004) in males and 0.17 ± 0.10 ml/5min (p value 0.013) in females. Thus females showed 8.5% of increase in saliva whereas males had 7.4% of increase in saliva on stimulation using TENS (Table 2). Comparing stimulated whole saliva on day one and stimulated whole saliva on day two it was evident That the quantity resulted higher on the day 1 with a statistically significant difference (p value 0.0009) of 0.09ml/5min (4%) (Table 3). With a difference of -0.09 ± 0.0 ml/ 5 minutes than that of the stimulated saliva flow on day 2 which is statistically significant with p value 0.009.

Table 1. Comparison of un-stimulated whole saliva flow rate (USF) and stimulated whole saliva flow rate on day one (SSF1) in males and females.

Particulars	No. of Cases	USF (ml/5min)	SSF1 (ml/5min)	Mean difference (ml/5min)	% of difference	Significance	
						t*-value	p value
Male	25	2.02±0.65	2.25±0.69	0.23±0.04	11.4%	-5.074	0.000 HS
Female	25	2.01±0.59	2.27±0.70	0.26±0.11	12.9%	-4.885	0.000 HS
Male vs Female	t**	0.046	-0.102	-	-	-	-
	p value	0.964 NS	0.919 NS	-	-	-	-

t*: paired t test; t**: independent sample t- test; statistically significant if p<0.05; if p<0.001 Highly significant (HS); NS: not significant.

Table 2. Comparison of un-stimulated whole saliva flow rate (USF) and stimulated whole saliva flow rate on day two (SSF2) in males and females.

Particulars	No. of Cases	USF (ml/5min)	SSF2 (ml/5min)	Mean difference (ml/5min)	% of difference	Significance	
						t*-value	p value
Male	25	2.02±0.65	2.17±0.67	0.15±0.02	7.4%	-3.238	0.004 S
Female	25	2.01±0.59	2.18±0.69	0.17±0.10	8.5%	-2.671	0.013 S
Male vs Female	t**	0.046	-0.041	-	-	-	-
	p value	0.964 NS	0.967 NS	-	-	-	-

t*: paired t test; t**: independent sample t- test; statistically significant if p<0.05; if p<0.001: Highly significant (HS); S:significant ; NS: not significant

Table 3. Comparison of stimulated whole saliva flow rate on day one (SSF1) and stimulated whole saliva flow rate on day two (SSF2).

Particulars	No. of Cases (M&F)	SSF1 (ml/5min)	SSF2 (ml/5min)	Mean difference (ml/5min)	% of difference	Significance	
						t*-value	p value
Mean ± SD	50	2.26±0.68	2.17±0.68	-0.09±0.0	-4%	2.714	0.009 S
Range (Min-Max)	-	0.8-4.20	0.90-4.20	-	-	-	-

t*: paired t test; statistically significant if p<0.05; if p<0.001: Highly significant (HS)

DISCUSSION

Saliva plays a significant role in oral homeostasis¹¹ and has many important functions by virtue of its constituents.¹² Salivary secretion fluctuates between minimal and maximal rates, with the basal secretion of saliva, which is a result of spontaneous activity of salivary nuclei, displaying the circadian rhythm.¹³ The range of normal flow rates in unstimulated condition is from 0.2 to 0.5 ml/min, and that of the stimulated flow rate is from 0.9 to 2.6 ml/min.¹³ The secretion of saliva is regulated by autonomic nervous system, with minor role played by hormones and autoids. While both autonomic divisions act synergistically to produce salivation by the salivary glands, the parasympathetic system is mostly responsible for water and electrolyte secretion, and the sympathetic system mainly regulates the protein secretion.¹⁴ The mechanism by which TENS unit worked on parotid gland is not clear. It is possible that it directly stimulated the auriculotemporal nerve that supplies secretomotor drive to the parotid gland.¹⁵ It is less clear if peripheral stimulation of gland results in a reflex facilitation of central output from the salivatory nucleus of the medulla.¹⁵ The early investigators of electro stimulation postulated that normal physiologic salivary reflexes are augmented on electro stimulation.¹⁵

Therefore this study was conducted to evaluate the efficacy of TENS therapy in whole saliva stimulation in healthy adult subjects and also to evaluate if the protocol of collection of saliva could influence the quantity recorded. Protocol of saliva collection influencing the quantity of saliva stimulated. Whole saliva measurements are simple to perform and are useful as an indicator of general salivary performance, Providing also meaningful information concerning the quantitative aspects of gland function and can be obtained easily in a dental office.⁷ In previous studies authors collected un-stimulated saliva followed by TENS stimulated saliva in a

continuity for 5 minutes each,⁷ in our study we Aimed to evaluate the effects on the quantity of TENS stimulated saliva collecting saliva immediately after a period of collection of un-stimulated saliva and on the other hand with no period of un-stimulated saliva collection.

Thirty nine patients on day one and thirty six patients on day 2 out of 50(75% of the subjects) responded to TENS therapy with an increase in stimulated whole saliva flow rate. This result is in agreement with previous studies which showed similar response in healthy individuals to TENS therapy for saliva stimulation.^{7,15} A wide range of un-stimulated and stimulated salivary flow rates were observed in our study, these variations of salivary flow rates were similar to observations made in previous studies.^{5,7,16} TENS was unable to stimulate saliva in six subjects on day one and ten subjects on day two, in previous studies it was observed that TENS was unable to stimulate the parotid saliva and it was interpreted that TENS may act more efficiently as an accelerator of salivary flow rather an initiator and further suggested that it is likely to be more effective in cases of decreased in salivary function than the absolute absence of function.^{7,15} In five patients on day one and four patients on day two there was decrease in the quantity of TENS stimulated saliva, this finding can be observed in previous studies where the cause for this reduction in saliva was attributed to the frequency and intensity settings of TENS. The stimulus perceived by brain may be painful and salivary reflex is enhanced when nociceptive input reaches the brain via trigeminal sensory nuclei.^{7,15}

Our results in healthy subjects warrant further studies on the aspects of how long the increase in saliva flow lasts after turning off the TENS unit moreover on the ability of TENS to stimulate parotid salivary flow in presence of xerostomia, on the patient's acceptance and on usefulness

of TENS alone versus in combination with other sialogogues in the patients with xerostomia. Thus in near future TENS may be included as an additional modality in the ever-growing approaches to manage xerostomia.

CONCLUSION

Transcutaneous electric nerve stimulation of parotid gland resulted in a statistically significant increase in the quantity of whole saliva flow rate in healthy adult subjects. Thus TENS as an extraoral device, can be considered as a safe, non-pharmacological measure in order to achieve an increase of the rate of unstimulated saliva. Further studies should be conducted to evaluate the possibility of using TENS in relieving the symptoms of xerostomia.

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