Effect of transcutaneous electrical nerve stimulation induced parotid stimulation on salivary flow

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Abstract

Aims and Objectives: The main objective of this study was to evaluate the duration of stimulation over the parotid salivary flow following the use of transcutaneous electric nerve stimulation (TENS) in different age groups. **Materials and Methods:** The study was carried out in three different age groups. Under group A individuals from 21 to 35 years of age, group B 36-50 years and group C above 51 years were considered. In each group 30 subjects were taken of whom 15 were males and 15 were females. The placement of pads was approximated bilaterally over the parotid glands. The working parameters of TENS unit were fixed at 50 Hz and the unit was in normal mode. **Results:** Subjects belonging to group B were showing statistically significant increases in the duration of stimulated parotid salivary flow following the use of TENS. **Conclusion:** TENS can be considered as a non-pharmacological alternative to improve salivation for longer period in xerostomia patients.

Keywords: Chroni cpain, electrostimulation, saliva, transcutaneous electric nerve stimulation

Introduction

Saliva is a clear, slightly acidic mucoserous exocrine secretion. Saliva is most valuable and critical for the preservation and maintenance of oral health. Whole saliva is a complex mixture of fluids from major and minor salivary glands and from gingival crevicular fluid, which contains oral bacteria and food debris.[1,2]

The average daily flow of whole salivav aries between 1 and 1.5 L in healthy individuals. Percentage contributions of the different salivary glands during unstimulated flow areas follow: 20% from parotid, 65% from submandibular, 7-8% from sub-lingualand less than10% from numerous minor glands. Stimulated salivary flow rates drastically change percent age contributions from each gland, with the parotid contributing more than 50% of total salivary secretions.[3]

Saliva is a very dilute fluid, composed of more than 99% water.[4] There is great variability in individual salivary flow rates. The accepted range of normal flow for unstimulated saliva is anything above 0.1 mL/min. For stimulated saliva, the minimum volume for the accepted norm increases to 0.2 mL/min.[5]

Salivary flow is, however, a very individualized measurement and ideally should be recorded as a base reference after the age of 15.[3] I find ividualized base rates havebeen established, then a 50% reduction in flow should be considered as hypofunction. Any unstimulated flow rate below 0.1 mL/min is considered as hypofunction.[6]

Transcutaneous electric nerve stimulation (TENS) and so, by definition, covers the complete range of transcutaneous applied currents used for nerve excitation. TENS or TENS is the popularized name for electrical stimulation produced by a portable stimulator commonly used to treat temporomandibular disorder muscular pain.

Various studies successfully evaluated the effect of TENS over the increased parotid salivary flow, but the duration of the extended stimulation following TENS was mentioned nowhere.[7] The present study is an attempt to evaluate the duration of stimulation over the parotid salivary flow following the use of TENS in different age groups.

Materials and Methods

The study was carriedout after approval by the Ethical Clearance Committee of our institution and the Ethical Committee of our Health University. Patients were drawn

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Access this article online	
Quick Response Code:	Website: www.contempclindent.org
	DOI: 10.4103/0976-237X.123017

from the out-patient department of our institution. Patients above 18 years of age who were not pregnan and with no previous history of salivary gland disorders or systemic diseases andsubjects no receiving any medications and willing to participate were included in the present study. Patients under18 years of age, those with cardiac pacemakers, autoimmune diseases, pregnancy and history of salivary gland pathology and presently using of any medications were excluded from this study.

Samplesize

The study group was considered into three different age groups. Under groupA age from 21 to 35 years, group B36-50 years and groupCwas above 51 years. In each group, 30 patients were included of whom15 were males and 15 were females.

Armamentarium consisted of: TENS unit, surgical gloves, graduated conical flask, graduated pipette, Betadine solution and Tweezer.

Subjects were asked to refrain from eating, drinking andsmoking andoralhygiene procedures for atleast 1 h prior to appointment. The placement of pads was approximated bilaterally over the parotid glands [Figure 1]. The working parameters of TENS unit were fixed at 50Hz andthe unit was in normal mode.

Sample collection

Whole saliva was collected immediately after electrostimulation and1hafter electrostimulation by asking the patient to spit into a graduated conical flask for quantification and measured with a graduated pipette [Figure 2].

Results

Data was tabulated and subjected to statistical analysis and analysis performed by using Chi-square test with the help of software statistical package for the social sciences 11.5 version for Windows [SPSS Inc. 233 South Wacker Drive, 11th Floor Chicago, IL 60606-6412]. Results were interpreted as the only group B was considered to be significant, i.e., $P < 0.05$ [Tables 1-5 and Figures 3-5].

Discussion

The present study was carried out in three different age groups; group A from 21 to 35 years, group B 36-50 years and group C 51-65 years. There was a slight variation in salivary flow rates between A and B group, between B and C group and moderate variation in salivary flow rates between A and C groups in both conditions i.e., immediately after TENS and 1 h after TENS. Dawidson *etal*.[7] reported that the stimulated salivary flow was not affected by manual acupuncture while the electrically stimulated acupuncture led to a significant decrease of the chewing stimulated salivary flow. There was no effect on the unstimulated salivary flow with electro-acupuncture Hargitai *etal*.[8] in their study reported that salivary flow did not diminish with age but they found gender differences in salivary flow rates with males producing more saliva than females. Percival *et al*.[9] reported that there was diminished salivary flow rate as age advances and females had significantly lower mean salivary flow rates than males. In the present study, we found that there was a diminished stimulated salivary flow rate with advancing age. There was a considerable variation in salivary flow rate between males and females. Males had significantly higher mean salivary flow rate than females.

Figure 1: Placement of electrode pad

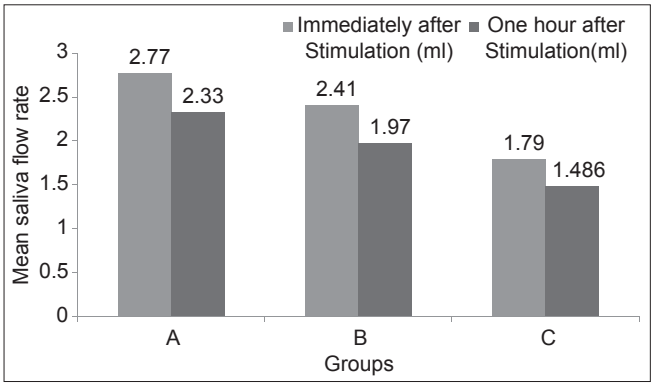

Figure 2: Group wise mean saliva flow rate

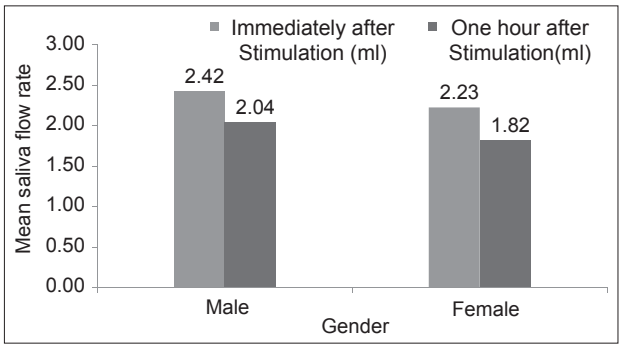

Figure 3: Group wise mean saliva flow rate

Table 1: Mean saliva flow rates in group A

Saliva collection time	Number of patients	Mean	Standard deviation	Chi-square	*P* value
Immediately after stimulation	30	2.77	0.26	10.67	0.30
1 h after stimulation	30	2.33	0.27	14	0.23

Table 2: Mean saliva flow rates in group B

Saliva collection time	Number of patients	Mean	Standard deviation	Chi-square	*P* value
Immediately after stimulation	30	2.41	0.25	21.33	0.02
1 h after stimulation	30	1.97	0.18	26	0.00

Table 3: Mean saliva flow rates in group C

Saliva collection time	Number of patients	Mean	Standard deviation	Chi-square	*P* value
Immediately after stimulation	30	1.79	0.160495	11.06667	0.086338
1 h after stimulation	30	1.486667	0.187052	11.06667	0.135737

Table 4: Mean saliva flow rates of males in three groups

Saliva collection time	Number of patients	Mean	Standard deviation	Chi-square	*P* value
Immediately after stimulation	45	2.42444	0.516173	15.8222	0.465436
1 h after stimulation	45	2.04444	0.439812	23.14	0.136676

Table 5: Mean saliva flow rates of females in three groups

	Number of patients	Mean	Standard deviation	Chi-square	*P* value
Immediately after stimulation	45	2.22666	0.39219	14.3777	0.49709
1 h after stimulation	45	1.81777	0.34594	18.1555	0.15170

Table 6: Drugs that may give rise to xerostomia

Drugs with anticholinergic effects	Drugs with sympathomimetic actions	Other drugs
Atropine and analogs (antimuscarinics)	Decongestants	Lithium
Tricyclic antidepressants	Bronchodilators	Omeprazole
Serotonin reuptake inhibitors	Appetite suppressants	Disopyramide
Antihistamines	Amphetamines	Didanosine
Antiemetics		Diuretics
Antipsychotics		Protease inhibitors

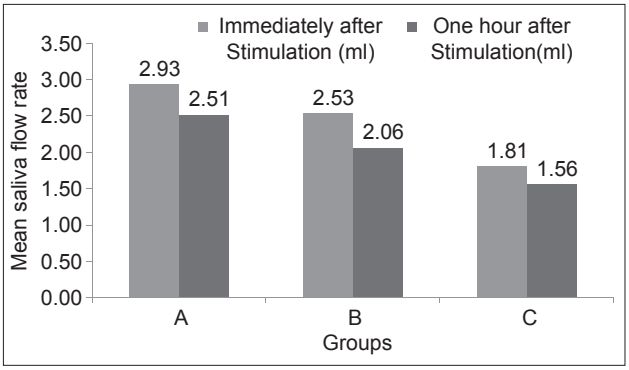

Figure 4: Group wise mean saliva flow rate

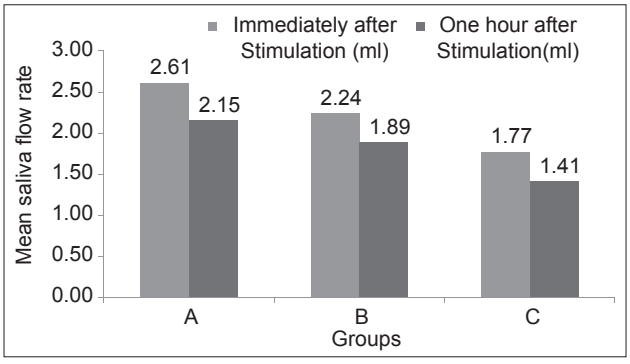

Figure 5: Females mean saliva flow rates in three groups

Having distinguished between unstimulated and stimulated flow rates, it probably is more meaningful and easier to measure whole salivary flow volume. Circadian (daily) low flow occurs during sleep, where as peaks occur during high stimulation periods. Circannual (yearly) low flow occurs during the summer, where as peak flow is during the winter. Circadian flow variations affect not only the flow but also the concentration level of salivary components such as salivary electrolytes and proteins.[5] To prevent the effect of seasonal variation over the saliva, the present study was carriedout in one season itself i.e. summer. The secretion of saliva is

controlled by a salivary centre composed of nuclei in the medulla, but the rear specific triggers forth is secretion. Three types of triggers, or stimuli, for this production are mechanical (the act of chewing), gustatory (with acid the most stimulating trigger and sweet the least stimulating) and olfactory (a surprisingly poor stimulus). Other factors affecting secretion include psychic factors such as pain, certain types of medication and various local or systemic diseases affecting the glands themselves.

Sialorrhea is excessive secretion of saliva. Hypersalivation can be caused by medications (pilocarpine, cevimeline, lithium, bethanechol, physostigmine, clozapine risperidone and nitrazepam), hyperhydration, infant teething, the secretory phase of menstruation, idiopathic paroxysmal hypersalivation, heavy metal poisoning (iron, lead, arsenic, mercury and thallium), organophoshorous poisoning, nausea, gastro esophageal reflex disease, obstructive esophagitis, neurologic changes in cerebralvascular accident, neuromuscular diseases, neurologic diseases (parkinson's disease, wilson's disease, down syndrome, autism and cerebral palsy) and central neurologic infections. Minor hypersalivation may result from local irritations, such as aphthous ulcers or ill-fitting oral prosthesis.[10]

Xerostomia is the subjective symptom of oral dryness resulting from decreased salivary flow.[11] The most common causes of xerostomia including; iatrogenic (drugs, local radiation, chemotherapy, chronic graftvs.host disease), salivary gland diseases (Sjögren's syndrome, sarcoidosis, human immunodeficiency virusinfection, hepatitis C virus infection, primary biliary cirrhosis and diabetes mellitus) and rare causes (amyloidosis, hemochromatosis, Wegener's disease, salivary gland agenesis).[12]

Treatment modalities available for xerostomia broadly classified into following categories:[10]

- Preventive therapy
- Symptomatic treatment
- Local or topical salivary stimulation
- Systemic salivary stimulation
- Therapy directed at an underlying systemic disorder.

From these symptomatic, topical and systemic stimulatory methods are widely used. In the symptomatic treatment, patient should be encouraged to sip water throughout the day. The use of systemic secretogogues for salivary stimulation has been tried before. Variety of drugs is tried for systemic stimulation. After successful clinical trials, only pilocarpine hydrochloride and cevimeline hydrochloride got approved by Food and Drug Administration for stimulation of salivary glands. Coming to topical stimulation several approaches are available for stimulating salivary flow. Chewing gum will stimulate salivary flow effectively, as well sour and sweet tastes. The combination of chewing gum and taste canbe very effective in relieving symptoms for patients who have remaining salivary function. Acupuncture, with application of needles in the perioral and other regions, has been proposed as a therapy for salivary gland hypofunction and xerostomia, but it is under clinical trails only.[10]

Electrostimulation is another useful method of salivary stimulation. It has been proved that it increase the salivary flow rate in healthy individuals as well as in xerostomia patients.[8,12] Steller *et al*. used electrical stimulation to stimulate salivary flow. They used TENS in Sjögren's syndrome, patients were residual salivary flow showed a significant response to electricalstimulation, but others with low or absent whole salivary flow rates did not respond.[13] Hargitai *et al*. Did electrical stimulation in healthy adults by placing TENS electrode pads externally on the skin overlying the parotid glands, 75% of participated individuals showed increased parotid salivary flow when stimulated via the TENS unit. Some side-effects noted including twitching of facial musculature and anesthesia of the facial skin.[8] Strietzel *et al*. Reported that electrostimulation may significantly decrease the sensor dryness, leading to beneficial effect to patient swith subjective condition. No significant side-effects were observed.[14] In the present study, the only side-effect noticed was the transient twitching of facial musculature in 80% of participated individuals.

There was increase in salivary flow rate immediately after TENS in three age groups, but group B individuals showed a significant effect on salivary flow rate even after 1 h of TENS. The exact mechanism of how salivary flow rate increased after TENS was not yet clear.

Conclusion

In present study, we found that only group B (36-50 years) individuals had significant effect on salivary flow rate even after1hof TENS. To conclude in this study, there was an increased salivary flow rate with basic settings of TENS (50 Hz frequency and 250 μs pulse rate). Based on this finding TENS can be used as an adjuvant to conventional treatment modalities or can be used as main treatment modality when conventional modalities failed, with modification of frequency and pulse rate of TENS.

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How to cite this article: Pattipati S, Patil R, Kannan N, Kumar BP, Shirisharani G, Mohammed RB. Effect of transcutaneous electrical nerve stimulation induced parotid stimulation on salivary flow. Contemp Clin Dent 2013;4:427-31.

Source of Support: Nil. **Conflict of Interest:** None declared.