ORIGINAL PAPER

Physiotherapy Quarterly (ISSN 2544-4395)
2023, 31(1), 23–27

Response of salivary flow rate to transcutaneous electrical nerve stimulation in haemodialysis patients

DOI: https://doi.org/10.5114/pq.2023.123524

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Abstract

Introduction. Hyposalivation is one of the common oral complications in end-stage renal disease. This study aimed to assess the immediate and 3-week effects of transcutaneous electrical nerve stimulation (TENS) on hyposalivation in end-stage renal disease patients on maintenance haemodialysis.

Methods. Overall, 80 haemodialysis patients with hyposalivation complaints (40 diabetics and 40 nondiabetics with a mean age of 59.35 ± 9.59 and 59.45 ± 9.66 years, respectively) were treated with 20-minute extraoral TENS (50 Hz and 250 μs pulse duration) applied bilaterally to parotid glands for 3 successive weeks (3 sessions per week). Besides the baseline measurement, the whole resting saliva was collected immediately after the first and last TENS sessions in a graduated test tube via the 5-minute low forced spitting method. The whole resting salivary flow rate (WRSFR) (ml/min) was calculated by dividing the collected salivary volume by the 5-minute collection period.

Results. When the baseline WRSFR mean was compared with its value after the first or last TENS session, WRSFR showed a highly significant increase in diabetic and nondiabetic haemodialysis patients.

Conclusions. Extraoral electrostimulation via TENS is an effective therapeutic modality for hyposalivation in end-stage renal disease patients on maintenance haemodialysis.

Key words: saliva, electrostimulation, transcutaneous electrical nerve stimulation, haemodialysis, diabetes mellitus, chronic renal failure

Introduction

The oral cavity is a mirror of the individual's general health status. Managing the oral manifestations of any systemic disease is a challenge to oral physicians. During the period of 2000–2015, the worldwide number of patients with chronic renal failure or end-stage renal disease (ESRD) induced by diabetes mellitus increased from 375.8 to 1016 per million. ESRD patients usually complain of complex oral manifestations caused not only by the disease itself but also by the therapy like haemodialysis (HD) [1].

HD is a blood passage through a dialysis venous catheter utilizing a dialysis fluid solution in an HD machine, with the blood returned to the patient after external filtration [2]. HD aim is to remove the waste products such as urea in addition to free water from the patient's blood when chronic renal failure occurs [3]. According to the Egyptian renal registry, in 2008, ESRD prevalence was 483 per million and the total recorded number of ESRD patients on dialysis were 40 000, using nearly 3000 HD machines in more than 600 dialysis units distributed in both governmental (25%) and private (75%) sectors [4].

Saliva is the most critical, valuable, slightly acidic, clear exocrine mucoserous secretion for the maintenance and preservation of oral health. The complex mixture of fluids from both major and minor salivary glands contributes to the whole resting unstimulated saliva (WRUS). The average daily WRUS volume is 1–1.5 l in healthy subjects. The different contribution of salivary glands to WRUS is 65% from submandibular, 20% from parotid, 7–8% from sublingual, and < 10% from numerous minor glands. Parotid contribution of > 50% of the total secreted saliva dramatically changes the percentage of contributions from the particular glands [5].

In 41% of 17 HD patients, a study showed markedly atrophied salivary glands but there has been no study to determine why this atrophy happens [6] and, consequently, the oral health status of HD patients is negatively affected as a result. Oral tissues are influenced by ESRD, which leads to xerostomia (a subjective sensation of dry mouth), altered salivary composition, hyposalivation (an objective sign of low saliva flow), oral infections, mucosal lesions, and oral malignancies [7].

Quality of life and oral health are negatively affected by a 33–76% dry mouth prevalence in HD patients [8]. Dry mouth is a depressive symptom for HD individuals owing to a low saliva flow, which is a risk factor of an increased intake of fluids – because of thirst secondary to xerostomia – resulting in excess interdialytic weight gain [3]. In addition to chewing, swallowing, taste, and speaking difficulties, low saliva flow is associated with increased oral complications such as fungal and bacterial infections (periodontal disease, dental caries, and candidiasis), lesions of oral tissues (tongue, gingiva, and mucosa) [9], halitosis, and difficulty in wearing dentures [10].

Owing to diabetes mellitus, diabetic autonomic neuropathy, and uraemia [11], functional and organic changes of salivary glands are very common in HD patients. Besides the accumulation of fibrillar components, fibrosis, mouth breathing, dehydration, and restricted fluid intake [12, 13], the HD-induced salivary changes may be related to the direct uraemic salivary glandular dysfunction, inflammation, glan-

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Received: 23.09.2020
Accepted: 28.12.2020

Citation: Ismail AMA, Abdelhay MI, Draz RS. Response of salivary flow rate to transcutaneous electrical nerve stimulation in haemodialysis patients. Physiother Quart. 2023;31(1):23–27; doi: https://doi.org/10.5114/pq.2023.123524.

dular atrophy, old age, psychological factors such as anxiety and depression, and the repeated use of xerostomia-related medications such as sympathomimetic anticholinergic, cytotoxic, and antihypertensive drugs, benzodiazepines, and opioids in addition to anti-migraine agents [9]. Salivary gland hypofunction in poorly controlled older diabetics may be caused by adverse microvascular, hormonal, and neuronal changes. Diabetic patients with oral dryness may complain of a poor salivary flow rate due to the disturbed glycaemic control and direct metabolic impact on salivary glands [14].

There are many techniques for salivary flow stimulation (including mechanical, taste, chemical, and electrical stimuli to salivary glands), with some limitations, side effects, and contraindications [15]. Unfortunately, no effective therapy exists for dry mouth in chronic HD patients [16]. Stimulating salivary glands by mechanical techniques (like chewing gum) among the elderly needs special attention to fitting with dentures, easily sticking to dentures, and problems with teeth and masticatory muscles [10].

Saliva substitutes (such as artificial saliva, disliked by HD patients owing to its flavour) [10], as well as pharmacological agents (such as angiotensin-converting-enzyme inhibitors alone or combined with angiotensin-receptor blockers and pilocarpine [16]) are all ineffective, with many side effects like profuse sweating, frequent urination, dyspepsia, rhinitis, etc. [17]. Further efforts should be taken to develop an economical, non-invasive, and effective therapy – with no side effects – for low saliva flow in HD patients [16]. Transcutaneous electrical nerve stimulation (TENS) is a strong tool in increasing the production of parotid saliva. TENS can be used with high comfort during the eating process in individuals who are not able to chew gum, e.g. those with temporomandibular joint disorders [17]. Since 1986, despite the evidence-based positive response of salivary flow to TENS, there has been a low evidence-based explanation in the literature to justify TENS use in the management of hyposalivation [18]. Because of the scarcity of research on electrostimulation effect on the salivary flow in ESRD patients on maintenance HD, this study aimed to find out the immediate and 3-week impact of extraoral TENS on hyposalivation in diabetic and nondiabetic HD patients.

Subjects and methods

Subjects

A total of 80 HD patients (40 diabetics and 40 nondiabetics) of both sexes aged 35–80 years were randomly selected from Meet Ghamr Urology and Kidney Hospital. The included patients had been receiving maintenance HD sessions – 3 times weekly – because of ESRD for at least 3 months. They complained of hyposalivation with a whole resting salivary flow rate (WRSFR) of ≤ 0.15 ml/min [19].

A physician excluded patients with a pathology of salivary glands (acute or chronic inflammation or tumours), oral cavity infection or inflammation, history of head and neck tumours, autoimmune disease, neurologic diseases, cardiac pacemaker, cardiac or psychogenic diseases. Besides, individuals undergoing pharmacological management of hyposalivation, alcoholics, smokers, and hypertensive patients were excluded.

Intervention

The electrodes (circular shaped, 50-mm adhesive Polar Trode, made in China) of 20-minute continuous TENS (50 Hz, 250 μs pulse duration, handheld Inter-Tens 668, modified version of TENS-Plus 2000, delivered by SAG International Company for physiotherapy devices in Egypt) were applied bilaterally in all patients on the skin overlying parotids, with an intensity reaching the maximal level of tolerability for each individual [17] (Figure 1). The sessions were applied 3 times weekly (day after day) for 3 successive weeks.

Figure 1. Application of transcutaneous electrical nerve stimulation electrodes on the parotid gland to stimulate saliva production

Assessment of salivary flow rate

The participants were instructed to prevent oral hygiene, drinking, eating, coffee intake, and chewing gum for at least 1 hour before the collection of the whole resting saliva. The saliva collection was performed between 9 and 11 a.m. via the 5-minute low forced spitting in a graduated test tube. The salivary flow rate was calculated by dividing the salivary volume – the liquid component of saliva, not the foam, in ml – by the 5-minute collection period. Each patient was ordered to sit facing the collection tube, with both arms resting on their knees. The collected saliva was accumulated in the anterior region of the floor of the mouth to be spitted for 5 minutes in the tube [17]. WRSFR was measured immediately before and after the first TENS session and immediately after the last TENS session in all patients [20].

Statistical analysis

After being subjected to the Kolmogorov-Smirnov test, all data showed a normal distribution. The unpaired test was used to assess the non-significance of baseline data among diabetic and nondiabetic HD patients. The repeated measure test of variance was utilized to evaluate the significance of WRSFR differences within and between the subjects. Data were analysed with the SPSS program, version 18 (IBM Corp., Chicago, USA), with the recommended significance level of $p < 0.05$.

Version 3.1.9.2 of the G*Power program was used to assess the *a priori* sized sample test via the *F*-test, MANOVA for repeated measures in HD patients. By conducting a pilot study among 10 HD patients, the gained size effect of WRSFR = 0.27 was acquired after setting the error rate – type I – at 5% and power for type II error at 80%; the minimal required size of the sample was 72 HD patients.

Ethical approval

The research related to human use has complied with all the relevant national regulations and institutional policies, has followed the tenets of the Declaration of Helsinki, and has been approved by the Institutional Review Board of Faculty of Physical Therapy, Cairo University (approval No.: P.T.REC/012/002679).

Informed consent

Informed consent has been obtained from all individuals included in this study.

Results

To determine the treatment and time effects between the studied groups, the Wilks' lambda test was extracted from the ANOVA repeated measure test. It revealed a significant effect of time ($p < 0.001$ and $F = 78.16$) and a non-significant effect of treatment between the 2 groups ($p = 0.742$ and $F = 78.16$).

As shown in Table 1, no significant difference was found between the baseline data of the diabetic and nondiabetic HD groups. As presented in Table 2, the pairwise WRSFR comparison revealed a non-significant pre-intervention difference between the 2 groups. Very highly significant within-group differences were detected when comparing the pre- and post-intervention WRSFR values either after the 1st or after the last TENS session in the 2 groups. Lastly, the between-group post-intervention WRSFR comparison exposed a non-significant difference ($p > 0.05$).

Table 1. Baseline data of the studied HD patients

Characteristics	Diabetic HD group	Nondiabetic HD group	*p*
Age (years)	59.35 ± 9.59	59.45 ± 9.66	0.963
Males/females (*n*)	20/20	20/20	–
HD (months)	45.92 ± 28.63	46.27 ± 28.52	0.956
IDWG (kg)	3.03 ± 1.08	3.28 ± 1.24	0.339
HbA1c (%)	7.38 ± 0.90	–	–

Data are expressed as mean ± standard deviation or number.
HD – haemodialysis, IDWG – interdialytic weight gain (defined as the fluid amount removed during the dialysis session, i.e. the pre-dialysis weight subtracted from the post-dialysis weight), HbA1c – glycated haemoglobin

Table 2. Pairwise WRSFR comparison within and between the diabetic and nondiabetic HD groups

WRSFR (ml/min)	Diabetic HD group (*n* = 40)	Nondiabetic HD group (*n* = 40)	Between-group *p*
Before intervention	0.09 ± 0.04	0.08 ± 0.05	0.757^B
Immediately after 1st session	0.13 ± 0.09	0.14 ± 0.09	0.922^B
Within-group *p*	0.006^A	0.002^A	
Immediately after last session	0.48 ± 0.27	0.50 ± 0.30	0.707^B
Within-group *p*	$< 0.001^A$	$< 0.001^A$	

Data are expressed as mean ± standard deviation.
HD – haemodialysis, WRSFR – whole resting salivary flow rate
^{A} significant *p*-value
^{B} non-significant *p*-value according to repeated measure ANOVA

Discussion

Dry mouth has a wide prevalence in HD patients and underestimation of this symptom by nephrologists is common, as reflected in the small number of studies published [21]. In addition to salivary gland dysfunction and low salivary flow, a fluid restricted diet – to avoid fluid overload – must be followed by HD individuals. Hence, many of them complain of hyposalivation and thirst that negatively affect their quality of life. Oral complications of long-standing dry mouth are caries and an increased risk of mucosal inflammation and soreness. Slight dry mouth can be treated by mechanical stimulation, salivary substitutes, or artificial saliva, but all these have limitations [8]. TENS is effective in increasing the saliva flow and production [22] but there are few studies that assessed the immediate and long-termed effect of TENS on hyposalivation in diabetic and nondiabetic ESRD patients undergoing HD. Therefore, our study seems to be of considerable importance. It revealed that both immediate and 3-week extraoral TENS applications were able to produce a highly significant improvement of abnormal low salivation in diabetic and nondiabetic ESRD subjects undergoing HD.

It is not yet obvious how electrostimulation affects the function of salivary glands but the auriculotemporal nerve may be involved in this process via a reflex mechanism between the afferent and efferent pathways. The increased impulses of electric current applied to the salivary nuclei (salivation centre) in the medulla oblongata may be the cause of intensified stimulation to the efferent pathway of salivation control [18].

Our results are in line with those obtained by Yang et al. [23], who found that 3-week 250-μs 50-Hz TENS – on ST 6 and TE 17 acupoints – was able to increase the salivary flow rate from 0.09 ± 0.08 to 0.30 ± 0.14 ml/min in chronic HD patients.

Another study – supporting the use of continuous extraoral TENS mode – revealed that after 1 session, the salivary flow rate (ml/10 min) increased from 1.34 ± 0.23 ml to 1.55 ± 0.31 ml/min in 15 complaints of hyposalivation among 40 diabetic patients aged 30–75 years [14]. Again, one 5-minute extraoral TENS session with the continuous mode applied bilaterally to parotids led to a saliva flow increase from 0.10 ± 0.10 to 0.15 ± 0.09 ml/min in 90 out of 100 diabetic patients with hyposalivation with a recommendation of adding TENS to the mainstream therapy of hyposalivation [17]. After 1 extraoral TENS session, 6 diabetics (4 females and 2 males) presented a saliva flow increase from 2.53 to 3.33 ml/min [24]. Also, after a 5-minute extraoral TENS session, 19 out of 25 subjects with hyposalivation complaints exhibited an increased parotid saliva flow [25]. Electrical stimulation of saliva via TENS showed a statistically significant improvement in the whole salivary flow rate among postmenopausal females with or without dry mouth [26].

Moreover, 20 minutes of TENS increased the salivary flow rate from 0.05 to 0.10 ml/min in 15 patients aged 56.8 ± 6.46 years with a complaint of hyposalivation that was induced by radiotherapy treatment of head and neck cancer [15]. Consistently, 30 individuals treated with radiotherapy for oral cancer with a resting saliva flow of 0.21 ± 0.13 ml/min showed an increase in their saliva flow (0.25 ± 0.13 ml/min) after a 5-minute extraoral TENS session [27]. Overall, 29 patients out of 30 presented an increase in the mean salivary flow rate from 0.056 to 0.12 ml/min. It is possible to add extraoral TENS as an effective adjunctive therapeutic application in the post-radiation management of hyposalivation in oropharyngeal/oral cancer patients [28]. Owing to the potentially increased blood supply to the parotids, 3 TENS sessions weekly for 30 minutes, alone or combined with mechanical salivary stimulation, improved the low saliva flow and prevented severe oral mucositis induced by chemotherapy [29].

In agreement with the results of this study, 37 patients with head and neck cancer with a complaint of radiotherapy-induced hyposalivation showed an increase of salivary flow rate from 0.16 to 0.58 ml/min after 8 extraoral TENS sessions (twice weekly, 20 minutes for each session) [18].

Against our results and perhaps owing to the complete damage of the salivary gland caused by a high dose of radiation therapy, continuous TENS did not improve the salivary flow after a radiotherapy course of 1 month because TENS is likely less effective with no baseline saliva flow [30].

Limitations

This study has several limitations, such as the lack of long-termed follow-up and no TENS comparison with other therapeutic pharmacological or non-pharmacological methods.

Conclusions

Within the limitations of this study, the results showed that the immediate and long-termed extraoral TENS bilateral application on the skin over the parotids is a strong alternative and/or main non-pharmacological modality that could be safely used in the treatment of hyposalivation to maintain the oral health in diabetic or nondiabetic ESRD patients undergoing HD. Future studies are needed to compare the response of hyposalivation to long-term TENS application versus other non-pharmacological methods, such as low-level laser, lip muscle trainer, and hyperbaric oxygen therapy.

Acknowledgements

The authors would like to thank the HD patients who participated in the conduction of this study.

Disclosure statement

No author has any financial interest or received any financial benefit from this research.

Conflict of interest

The authors state no conflict of interest.

References

1. Asha V, Latha S, Pai A, Srinivas K, Ganapathy KS. Oral manifestations in diabetic and nondiabetic chronic renal failure patients on hemodialysis. J Indian Acad Oral Med Radiol. 2012;24(4):274–279; doi: 10.5005/jp-journals-10011-1312.
2. Aboserea MM, El-Maghawry HA, Mohamed MSA. Effect of specific nutritional program on patients with chronic renal failure on hemodialysis on El-keman village Luxor Governorate. Egypt J Hosp Med. 2019;77(2):5060–5067; doi: 10.21608/EJHM.2019.49263.
3. Said H, Mohammed H. Effect of chewing gum on xerostomia, thirst and interdialytic weight gain in patients on hemodialysis. Life Sci J. 2013;10(2):1767–1777.
4. Abozead SE, Ahmed AM, Mahmoud MA. Nutritional status and malnutrition prevalence among maintenance hemodialysis patients. IOSR J Nurs Health Sci. 2015;4(4): 51–58; doi: 10.9790/1959-04465158.
5. 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(4):427–431; doi: 10.4103/0976-237X.123017.
6. Ponte Marques PL, Libório AB, de Lima Saintrain MV. Hemodialysis-specific factors associated with salivary flow rates. Artif Organs. 2015;39(2):181–186; doi: 10.1111/aor.12334.
7. Teratani G, Awano S, Soh I, Yoshida A, Kinoshita N, Hamasaki T, et al. Oral health in patients on haemodialysis for diabetic nephropathy and chronic glomerulonephritis. Clin Oral Investig. 2013;17(2):483–489; doi: 10.1007/s00784-012-0741-1.
8. Bots CP, Brand HS, Veerman ECI, Valentijn-Benz M, Van Amerongen BM, Amerongen AVN, et al. The management of xerostomia in patients on haemodialysis: comparison of artificial saliva and chewing gum. Palliat Med. 2005;19(3):202–207; doi: 10.1191/0269216305pm1009oa.
9. López-Pintor R-M, López-Pintor L, Casañas E, de Arriba L, Hernández G. Risk factors associated with xerostomia in haemodialysis patients. Medi Oral Patol Oral Cir Bucal. 2017;22(2):e185–e192; doi: 10.4317/medoral.21612.
10. Yu I-C, Tsai Y-F, Fang J-T, Yeh M-M, Fang J-Y, Liu C-Y. Effects of mouthwash interventions on xerostomia and unstimulated whole saliva flow rate among hemodialysis patients: a randomized controlled study. Int J Nurs Stud. 2016;63:9–17; doi: 10.1016/j.ijnurstu.2016.08.009.
11. Chuang S-F, Sung J-M, Kuo S-C, Huang J-J, Lee S-Y. Oral and dental manifestations in diabetic and nondiabetic uremic patients receiving hemodialysis. Oral Surg Oral Med Oral Pathol Oral Radiol Endod. 2005;99(6): 689–695; doi: 10.1016/j.tripleo.2004.06.078.
12. Sung J-M, Kuo S-C, Guo H-R, Chuang S-F, Lee S-Y, Huang J-J. Decreased salivary flow rate as a dipsogenic factor in hemodialysis patients: evidence from an observational study and a pilocarpine clinical trial. J Am Soc Nephrol. 2005;16(11):3418–3429; doi: 10.1681/ASN.2005040346.
13. Swapna LA, Reddy RS, Ramesh T, Reddy RL, Vijayalaxmi N, Karmakar P, et al. Oral health status in haemodialysis patients. J Clin Diagn Res. 2013;7(9):2047–2050; doi: 10.7860/JCDR/2013/5813.3402.
14. Dyasnoor S, Kamath S, Abdul Khader NF. Effectiveness of electrostimulation on whole salivary flow among patients with type 2 diabetes mellitus. Perm J. 2017;21(2): 15–164; doi: 10.7812/TPP/15-164.
15. Paim ÉD, Macagnan FE, Martins VB, Zanella VG, Guimarães B, Berbert MCB. Transcutaneous electrical nerve stimulation (TENS) on hyposalivation induced by radiotherapy in the head and neck region: a preliminary study. Codas. 2018;30(3):e20170143; doi: 10.1590/2317-1782/20182017143.
16. Bossola M, Tazza L. Xerostomia in patients on chronic hemodialysis. Nat Rev Nephrol. 2012;8(3):176–182; doi: 10.1038/nrneph.2011.218.
17. Ismail AMA, Ezz El-din HM, Abdel Aal MEM. Impact of transcutaneous electrical nerve stimulation (TENS) on hyposalivation in type 2 diabetics. Biosci Res. 2019;16(1): 690–694.
18. Paim ÉD, Berbert MCB, Zanella VG, Martins VB, Macagnan FE. Effects of transcutaneous electrical nerve stimulation on the salivary flow of patients with hyposalivation induced by radiotherapy in the head and neck region – a randomised clinical trial. J Oral Rehabil. 2019; 46(2):1142–1150; doi: 10.1111/joor.12851.

19. Navazesh M, Christensen C, Brightman V. Clinical criteria for the diagnosis of salivary gland hypofunction. J Dent Res. 1992;71(7):1363–1369; doi: 10.1177/00220345920710070301.
20. Nair P, Gangwal P, Gharote H, Bhambal A, Jain R, Gupta A. Evaluating the efficacy of the salivary pacemaker – TENS therapy in xerostomia patients – a pilot study. Int J Sci Res. 2016;5(4):202–205.
21. Al-yassiri AMH. Prevalence of xerostomia in patients with chronic hemodialysis in Babil city. Karbala J Med. 2014;7(1):1822–1828.
22. Pandey M, Reddy V, Wanjari PV. Comparative evaluation of citric acid and TENS as means for salivary stimulation in adults: an invivo study. J Indian Acad Oral Med Radiol. 2019;31(1):36–39; doi: 10.4103/jiaomr.jiaomr_210_18.
23. Yang L-Y, Chen H-M, Su Y-C, Chin C-C. The effect of transcutaneous electrical nerve stimulation on increasing salivary flow rate in hemodialysis patients. Oral Dis. 2019;25(1):133–141; doi: 10.1111/odi.12948.
24. Smriti BJ, Patni VM, Mukta M, Shweta G. To evaluate the effectiveness of transcutaneous electric nerve stimulation (TENS) in patients with hyposalivation: a pilot study. IOSR J Dent Med Sci. 2014;13(9):74–77; doi: 10.9790/0853-13917477.
25. Aparna PV, Sankari SL, Deivanayagi M, Priyadharshini A, Vishnupriya CK, Niveditha B. Effect of transcutaneous electrical nerve stimulation on parotid saliva flow in patients with hyposalivation. J Pharm Bioallied Sci. 2017; 9(Suppl. 1):142–146; doi: 10.4103/jpbs.JPBS_124_17.
26. Konidena A, Sharma D, Puri G, Dixit A, Jatti D, Gupta R. Effect of TENS on stimulation of saliva in postmenopausal women with or without oral dryness – an interventional study. J Oral Biol Craniofac Res. 2016;6(Suppl. 1):44–50; doi: 10.1016/j.jobcr.2016.01.004.
27. Ojha S, Bhovi TV, Jaju PP, Gupta M, Singh N, Shrivastava K. Effectiveness of transcutaneous electrical nerve stimulation on saliva production in post-radiated oral cancer patients. J Indian Acad Oral Med Radiol. 2016; 28(3):246–251; doi: 10.4103/0972-1363.195664.
28. Vijayan A, Asha ML, Babu S, Chakraborty S. Prospective phase II study of the efficacy of transcutaneous electrical nerve stimulation in post-radiation patients. Clin Oncol. 2014;26(12):743–747; doi: 10.1016/j.clon.2014.09.004.
29. Amaral TMP, Campos CC, dos Santos TPM, Leles CR, Teixeira AL, Teixeira MM, et al. Effect of salivary stimulation therapies on salivary flow and chemotherapy-induced mucositis: a preliminary study. Oral Surg Oral Med Oral Pathol Oral Radiol. 2012;113(5):628–637; doi: 10.1016/j.oooo.2011.10.012.
30. Lakshman AR, Babu GS, Rao S. Evaluation of effect of transcutaneous electrical nerve stimulation on salivary flow rate in radiation induced xerostomia patients: a pilot study. J Cancer Res Ther. 2015;11(1):229–233; doi: 10.4103/0973-1482.138008.