

# Xerostomia - feeling tensed, don't worry TENS is there

## Abstract

Saliva is the physiological and critical fluid of the oral cavity. Xerostomia is a real or perceived decrease in the amount of saliva. The term xerostomia is restricted to refer to a subjective complaint or oral dryness, and use the term hyposalivation is used to describe an objective decrease in volume. There are multiple causes of salivary hypofunction, including oral disorders, systemic diseases, prescription and non-prescription medications, chemotherapy, and head and neck radiotherapy. Palliative treatments for xerostomia consists of topical agents; use of systemic sialogogues and acupuncture. Transcutaneous electrical nerve stimulation (TENS) is a well-known physical therapy used mainly for the relief of pain. In dentistry, it is used for managing TMJ Pains, muscular pains, neuralgias, but very less frequently used in dry mouth patients. This article highlights about the TENS unit, different types, its parts, the contraindications and precautions. We have tried to discuss about its mechanism of action on salivary glands and listed various generations of intraoral TENS and listed few studies done using TENS for stimulating saliva.

**Keywords:** tens, electro stimulation, xerostomia, saliva

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Anusha Rangare Lakshman,<sup>1</sup> Sham Kishor Kannepady,<sup>2</sup> Priya Sara Thomas,<sup>3</sup> Chaithra Kalkur,<sup>4</sup> Nilofer Halim<sup>4</sup>

<sup>1</sup>Department of Oral Medicine and Radiology, India

<sup>2</sup>Division of Oral Diagnostics and Surgical Sciences, International Medical University, Malaysia

<sup>3</sup>Senior Dental Review Officer, United Arab Emirates

<sup>4</sup>Department of Oral Medicine and Radiology, India

**Correspondence:** Dr. Anusha Rangare Lakshman, Reader, Department of Oral Medicine and Radiology, Century International Institute of Dental Science and Research Centre, Poinachi, Kasaragod – 671541, Kerala, India, Email dr.anusherl@gmail.com

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## Introduction

Saliva is a boon for oral cavity. It helps in maintenance of good oral health thereby it has a positive impact on general health as well. People will not miss water until the well runs dry. Similarly, we don't understand the importance of saliva, until it runs dry causing xerostomia. The subjective feeling of oral dryness is called xerostomia. It is a feeling of illness, but it's neither diagnosis nor a disease. It's a terminology including wide spectrum of patient's complaint about oral dryness.<sup>1</sup> It is a Latin word, in which xero-means dry and Greek - stomos, mouthed.<sup>2</sup> Salivary gland hypo function is the term used for qualitative decrease in the secretion of the saliva. Xerostomia and salivary gland hypo function are used interchangeably. Sjogren's syndrome, head and neck radiotherapy and various medications are the most common etiology of dry mouth.<sup>3</sup> Old population are more commonly affected secondary to compromised health due to underlying systemic diseases and medications for the same.<sup>4</sup>

## Epidemiology and the Etiology of xerostomia

Most commonly dry mouth is a common complaint. In the general population, it constitutes up to 10 percent of with persistent oral dryness.<sup>5,6</sup> More than 25% of elderly population's complains of dried mouth.<sup>7</sup> Various causes of etiology is described in the Table 1.<sup>8</sup> List of the drugs that may give rise to xerostomia are more than 400 in number.<sup>1</sup> At the dosages generally used, drugs do not damage the structure of the salivary glands. Their effects are reversible i.e. remove the drug and the oral dryness disappear. List of various medications causing xerostomia is enlisted in the Table 2.<sup>5</sup>

## TENS

Transcutaneous electric nerve stimulation (TENS) is most commonly used for the management of acute and chronic pain by medical and paramedical staffs.<sup>9,10</sup> It is one of the non-pharmacological methods. In dentistry, it is mainly used to manage

temporomandibular disorders and orofacial pain and neuralgias. Food and Drug Administration (FDA) in 1972 has classified it as class II device and has approved TENS for pain relief.<sup>11</sup> The basic mechanism of TENS uses pulsed low electric current which is generated either by alternating current or by using batteries and this current will be conducted to the skin surface through the electrodes.<sup>12</sup>

**Table I** Causes of xerostomia<sup>8</sup>

| Developmental            | Salivary gland aplasia                 |
|--------------------------|--|
|                          | Impaired fluid intake                  |
| Water or Metabolite loss | Hemorrhage                             |
|                          | Vomiting/ Diarrhea                     |
| Iatrogenic               | Medications                            |
|                          | Radiation therapy to the head and neck |
|                          | Sjogren's syndrome                     |
|                          | Diabetes mellitus                      |
|                          | Diabetes insipidus                     |
| Systemic diseases        | Sarcoidosis                            |
|                          | HIV infection                          |
|                          | Graft-versus-host disease              |
|                          | Psychogenic disorders                  |
|                          | Decreased mastication                  |
| Local factors            | Smoking                                |
|                          | Mouth breathing                        |

**Table 2** List of medications known to cause xerostomia<sup>8</sup>

| Class of drug     | Example  |
|-------------------|--|
| Antihistamines    | Diphenhydramine<br>Chlorpheniramine                                    |
| Decongestants     | Pseudoephedrine  |
| Antidepressants   | Amitriptyline  |
| Antipsychotics    | Phenothiazine derivatives<br>Haloperidol<br>Reserpine<br>Methyldopa    |
| Antihypertensives | Chlorothiazide<br>Furosemide<br>Metoprolol<br>Calcium channel blockers |
| Anticholinergics  | Atropine<br>Scopolamine  |

## Definition

According to American Physical Therapy Association, “TENS is defined as the application of electrical stimulation to the skin for pain control”.<sup>13</sup>

**Table 3** Different generations of intraoral TENS with its description<sup>15</sup>

| Generations of electro stimulation | Name of the equipment                         | Explanation   | Advantages and disadvantages   |
|------------------------------------|---|---|--|
| First generation <sup>29-31</sup>  | Salitron; Biosonics, Fort Washington, PA, USA | The probe was applied to the intra-oral mucosal surfaces by the user (between the dorsum of the tongue and palate) for a few minutes each day and delivered a stimulating signal to sensitive neurons of the mouth to induce salivation.  | <b>Disadvantages:</b><br>Clumsy apparatus large size, high price, and lack of user-riendliness.  |
| Second generation <sup>32</sup>    | GenNarino                                     | A removable intraoral appliance produced for individual patients by using their teeth pattern molds. It has a horseshoe-like shape and fits on the lower dentition.   | <b>Advantages:</b><br>Easy to insert and remove by the patient him- or herself.<br>The electronic components are embedded within the appliance to allow safe and contamination-free intra-oral application.<br>A remote control permits the patient to communicate with the device and modify its functions.   |
| Third generation <sup>33</sup>     | Saliwell Crown                                | A miniature neuro-electrostimulating device to be permanently implanted into the oral cavity. The components of the second-generation device were miniaturized and packaged into a device that has the dimensions and shape of a molar tooth. This device can be mounted on a commercially available osteo integrated implant. A wetness sensor has been embedded into the device to detect changes in wetness/dryness. | (1) To generate continuous or frequent stimuli.<br>(2) To be applied into the oral cavity without interfering with regular oral functions.<br>(3) To sense the wetness/dryness status of the oral cavity and automatically increase/decrease the stimulus within a preset range (autoregulatory mode).<br>(4) Also to be controlled by the patient via a remote control. |

## Types of TENS

Different types of TENS are there based on the frequency used, its clinical use. Based on the frequency of stimulation, it's of two types. High frequency TENS which uses >50Hz and its main action is based on gate control theory which helps to produce short term analgesia,

## Parts of tens equipment<sup>14</sup>

Different parts of TENS unit consists of a TENS unit, lead wires and the electrodes. Coming to the TENS unit, it's the main component of the equipment which generates electric pulse. It is of two models based on its use. The first one is called “Clinical” model which is most commonly used in a small clinical set up by the dentist or any practitioner and it runs through the current supply to the building.<sup>9</sup> The second one is called “Patient” model which is handy and portable carried in a pocket by the patient and it uses battery for the power supply. The Lead Wires are used to connect electrodes with the TENS unit and it helps in conduction of electric current. The last part is electrodes, which allows passing of the current from the unit to the underlying living tissue. Both extraoral and intraoral electrodes are available in the market. The extraoral electrodes are of two types:<sup>1</sup> Carbon- impregnated silicone rubber electrodes which are flexible and uses gel for surface conduction of electric current and it can be secured in place by placing surgical tape over the electrodes.<sup>2</sup> Tin plate or aluminum electrodes are coupled to the skin surface with tap water retained within cotton pad or sponge. Whereas the intraoral electrode types include cotton roll electrodes, clamp electrodes and adhesive electrodes. Among these types, the adhesive electrodes are most commonly used because of its advantage of its flexibility and adaptability to the oral mucosa. The recent developments of these intraoral devices can amplify the use of TENS in the management of xerostomia and various studies and researches are promising in the same field. The Table 3 summarizes the different generations of the TENS unit, its design, advantages and disadvantages.<sup>15</sup>

whereas the Low frequency TENS uses <10 Hz and its main action is by releasing the endogenous opioids and has more systemic and long term effect.<sup>13,16,17</sup> Clinical classification includes three types: Conventional TENS, Acupuncture type TENS [AL-TENS] and Intense type TENS and its action, effects and use is summarized in the Table 4.

**Table 4** Clinical types of Tens

| Clinical types        | Frequency  | Mechanism of action  | Effect produced   | Its use  |
|-----------------------|--|--|---|--|
| Conventional TENS     | Uses high frequency [between 10-200 pulses per second [pps]], low intensity [amplitude] pulsed currents  | Activate the large diameter A $\beta$ fibers without concurrently activating small diameter A $\beta$ and C [pain-related] fibres or muscle efferents. | Produces segmental analgesia which has a rapid onset [<30min after switch-on] and offset [<30min after switch-off].           | Administered regularly throughout the day, but intermittent breaks should be taken to reduce the skin irritation |
| Acupuncture-like TENS | Uses low frequency [less than 10pps, usually 2-4pps], high intensity pulsed currents                     | Activate the smaller diameter A $\delta$ fibers arising from muscles [ergoreceptors] by the induction of phasic muscle twitches.                       | produces extrasegmental analgesia which has a delayed onset [>30 min after switch-on] and offset [> h after switch-off]       | Can be used for about 30minutes at a time as fatigue may develop with ongoing muscle contractions.               |
| Intense TENS          | Uses high frequency [upto 200pps], high intensity pulsed currents which are just bearable to the patient | It activates small diameter A $\delta$ cutaneous afferents   | Produces extrasegmental analgesia which has a rapid onset [<30min after switch-on] and delayed offset [>1h after switch-off]. | -----  |

### Advantages of TENS therapy

The advantages of TENS therapy includes patient friendliness and easy acceptance as its safe<sup>18</sup> and non-invasive and it can be self-administered and monitored. And one more advantage includes the effect of anesthesia will be absent post operatively. It is also useful in needle-phobic patients.<sup>12</sup>

### Contraindications of TENS therapy:

It is contraindicated in apprehensive patients, mentally handicapped patients, patient's with cardiac pacemakers as TENS electric current interferes with the function of pacemaker,<sup>19</sup> Cerebrovascular patients like history of aneurysm, stroke and transient ischemia as it stimulates peripheral blood flow which can be fatal in such cases,<sup>20</sup> Epileptic patients as it can initiate an attack.<sup>20</sup> It should be cautiously used or should be avoided in pregnant patients and acute pain cases of unknown etiology.<sup>20</sup>

### Precautions while using TENS<sup>21,22</sup>

Certain precautions has to be taken before using TENS such as it should not be used over the carotid sinuses due to the risk of acute hypotension through a vasovagal reflex, over the anterior neck because of possible laryngospasm and last but not the least the electrodes should not be placed in an area of sensory impairment

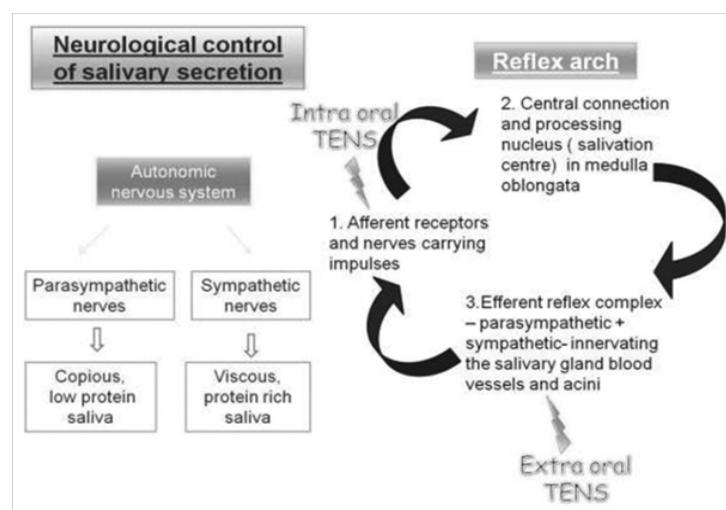
where possibility of burns exists.

### TENS/Electrostimulation on saliva

Electrostimulation has been used by medical professionals mainly managing the neuromuscular pain or other acute or chronic pain, its use in stimulating saliva is very limited. But recent studies has shown promising results and electrostimulation can stimulate the one or more components of salivary reflex arch thereby reducing the salivary hypofunction symptoms.<sup>23,24</sup>

### Mechanism of action of TENS on salivary glands

The postulated theory suggests that extraoral TENS placed over the parotid gland directly stimulates 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 (Figure 1).<sup>25,26</sup> Whereas the intraoral TENS stimulates the oral mucosa on afferent neuronal receptors and pathways thereby increasing salivary production.<sup>23,24</sup> To get copious watery saliva, higher frequencies and longer pulse duration is required which stimulate sympathetic salivation nerves, whereas lower frequency can stimulate the parasympathetic nerves which produces voluminous serous saliva.<sup>27,28</sup>



**Figure 1** Probable mechanism of action of TENS on salivary glands.<sup>33</sup>

## Various studies done on role of electro stimulation in xerostomia patients

The National Institutes of Health (NIH) recommends TENS therapy in managing xerostomia but definitive conclusions cannot be arrived because of lack of data. But the recent and upcoming studies are promising in this field and mandates further research. We have tried to list the various studies done using TENS unit to stimulate saliva in Table 5.

**Table 5** Various studies done using TENS to stimulate the salivary glands

| Sl no | Year | Authors                                  | Type of TENS unit used  | Studies  | Conclusions   |
|-------|------|--|---|--|---|
| 1     | 1985 | Nathalie SB,<br>William B. <sup>23</sup> | -----   | It included 10 patients undergoing radiotherapy for carcinoma of the head and neck and 13 patients in control group  | They concluded that all patients treated with electro stimulation had their symptoms reduced to minimal levels during and after the finish of their radiotherapy  |
| 2     | 1986 | Weiss WW<br>et al. <sup>31</sup>         | A study was done using an electronic stimulator for the treatment of dry mouth irrespective of their etiologies   | 24 xerostomic patients were included which was grouped into 3: sjogren's syndrome, patients who had undergone head and neck radiation therapy that ended at least one month prior to their entry into the study and miscellaneous category       | At the end of three-week study, 20% of the patients treated with active electrodes showed slight improvement, 50% showed moderate improvement and 30% showed substantial improvement. However, the placebo electrode caused no improvement in patient's dry mouth status                      |
| 3     | 1988 | Steller M et<br>al. <sup>29</sup>        | electrical stimulus applied to the tongue and hard palate by a battery operated device  | 29 patients with the salivary component of Sjogren's syndrome were randomly assigned active or placebo devices, which they used for three minutes, three times a day for four weeks  | The results indicated that some Sjogren's syndrome patients with residual salivary flow show a significant response to electrical stimulation, but others with low or absent whole saliva flow rates do not respond   |
| 4     | 2004 | Domingo DL                               | Hand held TENS unit with extraoral electrodes placed on parotid glands  | Electrostimulation on saliva production in 18 patients with Xerostomia after radiation therapy for head and neck cancer  | statistically significant improvement in saliva production during electrostimulation and no significant effects on unstimulated or stimulated saliva with the use of pilocarpine or intensity-modulated radiation therapy   |
| 5     | 2005 | Hargitai IA et<br>al. <sup>28</sup>      | TENS electrode pads were placed externally over the parotid glands  | To study the effects of TENS on salivary flow rate was assessed in 22 healthy subjects   | They observed significant increase in salivary flow following TENS and have concluded that TENS was effective in increasing parotid salivary gland flow in two-thirds of healthy adult subjects   |
| 6     | 2009 | Saraf KV et<br>al. <sup>34</sup>         | TENS electrode pads were placed externally on the skin overlying the parotid glands.  | To evaluate the effect of TENS on whole salivary flow rate in healthy adult subjects & One hundred healthy adult subjects were included  | They concluded that TENS unit was effective in increasing whole salivary flow in 85% of the healthy adult subjects  |
| 7     | 2010 | Ami S et al. <sup>35</sup>               | Saliwell Crown(Saliwell Ltd., Harutzim, Israel), an innovative saliva electrostimulation device fixed on an implant, placed in the lower third molar area | A Saliwell Crown was placed in the lower third molar area of an 81-year-old female patient with complaints of dry and burning mouth. The patient was monitored for a year, comparing her salivary secretion rates and the written questionnaires | They concluded that the saliva stimulation device Saliwell Crown, placed on an implant in an 81-year-old patient with dry and burning mouth complaints, presented promising results when both the salivary secretion tests and the self-assessment questionnaires were examined and compared. |

Table Continued....

| SI no | Year | Authors                                | Type of TENS unit used  | Studies   | Conclusions   |
|-------|------|--|---|---|---|
| 8     | 2013 | Sreenivasulu et al. <sup>36</sup>      | Hand held extraoral TENS unit with electrodes placed over parotid glands  | to evaluate the duration of stimulation over the parotid salivary flow following the use of transcutaneous electric nerve stimulation (TENS) in different age groups.                     | There was increase in salivary flow rate immediately after TENS in three age groups.  |
| 9     | 2015 | Hersheal Aggarwal et al. <sup>37</sup> | The TENS unit Anlaya MedIns – AMS-902. The surface electrode pads were placed externally on the skin, overlying the parotid glands,   | To assess and evaluate the effect of TENS on whole salivary flow rates in healthy adult subjects.   | Sixty-five of the 80 subjects demonstrated an increase in the salivary flow rate on application of TENS   |
| 10    | 2015 | AR Lakshman et al. <sup>26</sup>       | TENS model-NS Electro. It consists of two primary components the central control unit and electrode pads. The electrodes are placed externally on the skin overlying the parotid glands | study is to evaluate the effectiveness of a transcutaneous electrical nerve stimulation (TENS) unit in stimulating the whole salivary flow rate in radiation induced xerostomia patients. | The present study gave us an insight about the effectiveness of TENS therapy in stimulating salivary flow in healthy subjects and it is very effective when used in conjunction with radiation therapy by reducing the side-effects of radiation therapy. |

## Conclusion

Electro stimulation is more commonly used in Dentistry for the treatment of headaches, TMJ pains, Muscular pain and Neuralgias. But it never came as a main stream in the management of xerostomia. Very limited studies and researches are available on TENS therapy and xerostomia. But as the results are promising, TENS therapy can be used and mentioned as one of the treatment modality for managing patients with dry mouth.

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## Conflicts of interest

Author declares that there is no conflicts of interest.

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