Innovations

Transcutaneous Electrical Nerve Stimulation (TENS) in the Management of Orofacial Pain Disorders- An Updated Review

1. Dr. Gajapriya, preethedoc@gmail.com

2. **Dr. M. Preethy**, Senior lecturer preethedoc@gmail.com

3. **Dr. Deivanayagi .M**, drdeivanayagi@apdch.edu.in

4. **Dr. Mukundh Chaitanya**, drmukundh@apdch.edu.in

Department of oral medicine and radiology, Adhiparasakthi dental college and hospital, melmaruvathur, Tamilnadu

Corresponding Author: **Dr. M. Preethy,**

Abstract

Objective: The aim of this review is to provide the current status of TENS applications in dentistry. Data: Transcutaneous electrical nerve stimulation (TENS) is a non-pharmacological method of pain alleviation. It can be used for pain management while performing dental procedures and also in various conditions affecting Orofacial region. It focuses on the history of therapeutic dentistry, mechanism of action, components of TENS, types, techniques, advantages, contraindications and precautions, applications and effectiveness of TENS in the management of orofacial pain. Sources: PubMed, Google scholar are the main sources in providing various articles with adequate information. Study selection: The article is a review collected from various review articles related to TENS and it's application in dentistry. Conclusion: TENS therapy can be used as an adjuvant therapy for pain management and to perform various procedures in dentistry. It is safe, non-invasive, can be self-administered and has less side effects than compared to others. Clinical significance: TENS being a non invasive technique with almost no side effects can be used in majority patients as means of pain reduction rather than prescribing analgesic medications for a long period of time.

Keywords: *Transcutaneous electrical nerve stimulation, Pain, Orofacial pain.*

Introduction

Orofacial pain disorder is a more prevalent and debilitating condition arising from head and neck region (1). Okeson classified orofacial pain into physical and psychological conditions (2). Physical conditions include temporomandibular disorders (TMD), neuropathic pain and neurovascular disorders. Psychological conditions include mood and anxiety disorders.

Orofacial pain requires early diagnosis and an appropriate multidisciplinary approachof management. If pain untreated or mistreated lasts for more than 6 months it's considered aschronic(3).Biopsychosocialapproach of pain management are physical exercise/relaxation, pharmacotherapy and clinical psychology (4).

Transcutaneous electrical nerve stimulation (TENS) is a techniqueemployed forpain alleviation by peripheral nerve stimulation (5). It is a form of physical therapy, safe, non-invasive and effectively used for acute and chronic pain management. This review focuses on theTENS therapy and it's management of orofacial pain.

History

The concept of employingelectricity for pain reduction is avery old technique. In the era of ancientEgyptians, Greeks and Romans in 2500 B.Cused alive Torpedo marmorata,kind of electricalfishto reduce pain (5).
In19thcentury, a physician named Francis was the first to describehow the electricity is used to treatdental pain andin 20thcentury electricity producing dental handpiece via bur to the toothwere introduced to alleviate pain while preparing cavity for restoration(6).After many researches,TENS was established itself as one of the anaesthetic agents, also called as Electronic dental anesthesia.

Mechanism of action

Anaelgesiaeffect of TENSmainly dependsupon two theories: Gate control theory of pain and Endogenous opioid theory.

Gate control theory of pain

Melzack and Wall proposed this theory in 1965.The process is termed as gate which permits signals to pass through or not. Gate mechanism of pain is situated in spinal cord's dorsal horn, particularly in substantia gelatinosa,it modifies the sensory information sent by the primary afferent neurons (6).
Primary neurons occurs as 3 different types; 1.A-ß fibres are large diameter fibres have a quick transmission of impulses due to their myelination. 2. A-δ fibres are smaller diameter fibres with thin myelination. 3. C fibres are similar to A-δ fibres, as they lack myelinationthe impulsetransmission is slow.The activation of the large diameter A-ß fibres, helps to control pain by closing the gate and also reducesor inhibits the communication of small diameter A-δand C fibres (7).

Endogenous opioid theory

Reynoldsdemonstrated that the analgesia produced by electro-stimulationof periaqueductal gray region of the midbrain is similarto that of morphine-induced. This led to the evolutionof severalmorphine-like substances like beta endorphins, existing at various stages of pain control pathway. The main principleof mechanismof TENS is it provokes the endogenous opioids release in central nervous system through the local circuit activationin the spinal cord itselforfrom descending pathway of pain-inhibition (8).

TENS Procedure:

TENS can beadministeredat varying frequencies, intensity, and pulse durations of stimulation (5). Based on stimulation of frequency, it can be classified into two types: 1. High frequency TENS (>50 Hz). 2. Low frequency TENS (<10 Hz). High frequency TENS works on the principle of gates theoryproduces short term anaelgesia, whilelow frequency TENS depends on endogenous opioids which causes adequate systemicresponse that last longer (6).

Figure 1 : TENS unit (IMS NOVA T.TENS – A 01) 4 - Channel

Components of TENS

- TENS unit.
- Lead wires.
- Electrodes.

TENS unit

It has a powered-batterydevicewhich produces electricalimpulsevia electrodes. It has two variations 1. "Clinical" models- The dentist uses it in the office and these are connected it to a building's electrical socket to provide power. It uses AC 60-cycle current sources. 2. "Patient" models- small and easy to carry even in pocket by the patient. It uses alkaline or nickel-cadmium energy source.

Energy sources may provide stimulation through single-channel or dual-channel system based on pain relief. If pain relief is adequate within two electrodes (single channel),If pain exists at several locations, the dual channel is better (9).

Lead wires

It establishes an electrical connection by connecting electrodes to the TENS unit. Available as different wire systems that vary in thickness, tensile strength, length and degree of flexibility.

Electrodes

One of the important factors in the successful use of TENS is accurate placement of electrodes. Electrodes should be placed on intact healthy sensate skin (10). In a live tissue, the electrical flow from aTENS unit is converted to anionic current flow.

There are extraoral and intraoral electrodes based on placement (5).The two of extraoral electrodesare 1.Carbon-impregnated silicone rubber electrodes- These are versatile, with a use of electrically conductive gel it's coupled to the skin surface. They are held in a position with the help of a surgical tape(9). 2.Tin or aluminium electrodes- Itdoesn't contour to the body and they are attached to the surface of skinusing tap water kept within the cotton pad or sponge. Intraoral electrodes consist of cotton roll, clamp and adhesive electrodes. These are delicate and versatile electrodeswhich easily adapts to the oral mucosa (6).

TENS Techniques

The 3 main techniques are

- Conventional TENS
- Acupuncture-like TENS
- Intense TENS

Selective activation of various afferent nerve fibres is achieved with various TENS procedures.

Conventional TENS

Most frequentlyemployed method for disseminating current in clinical practise. The InternationalAssociation for the Study of Pain (IASP) defines conventional TENS as "High-frequency (50-100 Hz), low-intensity (paraesthesia, not painful), small pulse width (50-200μs)"(11). The objective of this TENS is to inducelarge diameter, low threshold non-noxious afferents (A-ß fibres) without activating small diameter Aδ and C (pain-related)fibres. This prohibittheactivity of second order nociceptive transmissionneurons in the central nervous system and it's accomplished by raising TENS pulse amplitude to produce a strong, comfortable, non-painful paraesthesia under the electrodes.It can be used continuously throughout the day, but it's important to take periodicbreaks to prevent skin irritation (12).

Acupuncture-like TENS [AL-TENS]

In 1970s sjolund and hiscolleagues described AL-TENS is a form of hyperstimulation. IASP defines AL-TENS as "Low-frequency (2-4Hz), higher intensity (to tolerance threshold), longer pulse width (100-400μs)"(11). Low-frequency trains or bursts (2-4Hz) of high-frequency pulses (100-200pps) are often employed in clinical practice. The objective of AL-TENS is to inducesmall diameter, high threshold peripheral afferents (A-δ fibres)that arise from muscles (ergoreceptors) by causing phasic muscle twitches in order to produce extrasegmental analgesia (5). Electrodes are positioned over myotomes, trigger points and acupuncturelocations for pain relief. AL-TENS is used for about 20 minutes, 3times a day or it may develop fatigue with ongoing muscle contraction. It is useful for patients resistance to conventional techniques and with radiating neurogenic pain, pain arising from deep structures and pain associated with altered skin sensitivity(13).

Intense TENS

The objective of this TENS is to inducesmall diameter, high threshold cutaneous afferents (A-δ fibres) forblockingnociceptive information in peripheral nerves and to initiate extrasegmental analgesic mechanism. It uses high-frequency (till200pps) and high-intensity pulsed current that are tolerable to the patient. Intense TENS given for short duration, it acts as a counter irritant and beneficial for minor procedures such as suture removal, wound dressing and venepuncture.

TENS Techniques	Physiological Intention	Intensity/Frequency	Uses
Conventional TENS	To stimulate large diameter non-noxious afferents (A-ß) to produce segmental analgesia	Low intensity/High frequency It can be used whenever for pain relief.	Acute/chronic pain Acute superficial pain.
AL-TENS	To stimulate small diameter motor afferents (A-δ) to provideextrasegmental analgesia	High intensity/Low frequency Used for approximately 15-30 minutes thrice daily.	Acute/chronic pain Used for radiating neurogenic pain and pain arising from deep structures.
Intense TENS	To stimulate small	High intensity/High	Acute/chronic pain.

	diameter noxious afferents to produce peripheral blockade and extrasegmental analgesia	frequency Used for short duration.	Used for minor procedures such as wound dressing, suture removal.

Table 1 : The characteristics of different TENS techniques.

Advantages

- Non-invasive, safe and easy to handle (14).
- It can be used at home with portable machine (15).
- Pain is controlled by gate control mechanism (15).
- Reduction in pain and sensitivity is betterwith TENS (16).
- Improved joint function is seen (16).
- No prostaglandins inhibition (15).
- Used in tryphanophobic patients to achieve anaesthesia (16).
- Comparing to local anaesthesia post-operative anaesthesia is absent once you turn off the TENS unit (16).
- It can be self administered by the patient, learn how to appropriately titrate dosage to manage their excruciating condition (16).
- It has a positive effects in musculoskeletal pain conditions and in neurogenic pain (17).
- It has anti-ischemic and antianginal effects with refractory angina therapy (17).
- In pregnant women TENS wasemployed to treat musculoskeletal pain and no fetal abnormalities have been reported in the literature (Walsh 1997) or placental insufficiency (Enzelsberger et al. 1991; Say et al. 1996; Resnik2002) with increased placental blood flow (18).

Contraindications and Precautions

- Severe adverse effects are rarely seen (10).
- TENS contraindicated in patients with cardiac pacemakers, pregnancy, epilepsy and bleeding disorders (19-24).
- Cardiac pacemakers –The synchronous type of cardiac pacemakers can interfere with TENS but it can be given to the patient with asynchronous type(fixed rate)pacemakers without risk. The patient may not be aware exactly which type they have (19)(20).
- Pregnancy – Though there are no particular adverse effects, it isn't approved by FDA(18)(21).
- Epilepsy –Pulsing light or sounds of TENS have atendency to provokea seizure (20)(22).
- Cerebrovascular problems –Stimulates peripheral blood flow leading to death in some cases (stroke, aneurysm, transient ischaemia) (20).
- Pain of unknown aetiology – It might suppress the warning signs and leads to misdiagnose thecondition (20).
- Avoid placing of electrodes for patient with metal implant,stents and ventricular assist device (artificial hearts) (12)(23).
- It is not recommended for patients with Implantable cardioverter defibrillator (ICD) (17).
- Avoid using electrodes while operating motor vehicles (10).
- It is not used in apprehensive or mentally disabled patients (9).
- TENS shouldn't be administered close to transdermal drug delivery system (24).
- Electrodes are not administeredover the anterior and posterior portionof the chest, due to excess activationof the intercostal muscles it may compromise pulmonary ventilation (24).
- Electrodes are not placed over theeye, open wounds, recent hemorrhage, thrombosis, ischemic tissue and malignancy (except in palliative care)(9)(12)(24).

- Children as young as 4 years can bear TENS but those with cognitive impairmentcannot understand the instructions (10).
- Placing electrodes over the anterior neck may lead to hypotension or laryngospasm (20).
- Electrodes must be placed over the normal skin with protective sensation (23).

Disadvantages

- Skin irritation and allergic contact dermatitis are seen below the electrodes (25) and electrical burns are seen in some cases (23).
- Skin irritation are also produced by the adhesive tape or electrode gel used (25).
- In some cases it can cause nausea, dizziness and even syncope (12).

Applications of TENS in Dentistry

Dental treatment in pediatric patients

TENSin children has been successfully employed to alleviate pain while performing numerous procedures such asplacing pit and fissure sealants, preparing cavity, restoration, simple extraction and endodontic surgeries. Commonly noticed negative behaviour inchildren is anxiety towards syringes.Application of TENS improves patient behaviour, which in turn reduces anxiety by removing their dread of syringes. According to studies, TENS is preferred by 53 – 78% of children over local anaesthesia (26 – 31).

TENS and Tooth pulp

A handpiece that delivered brief electric impulse to the teeth during cavity preparation was described among the earliest accounts of TENS application in dentistry. Effective pain reduction was achieved by the subliminal current. According to Andersson et al., if a strong TENS is administered in the cheek (infraorbital nerve) it allows pain-free tooth preparation (32). It was necessary to increase the pain threshold three or four times.

TENS has been used to produce electro analgesia during tooth extraction and minor surgical procedures. 98% of patients experienced adequate pain relief when one electrode placed at the mandible and another at the main trigeminal trunk (33).

Ihalainen and Perkki used TENS to relieve pain and discomfort after mandibular third molar extraction. In the immediate post-operative phase, a 100 Hz current was delivered ipsilateral to the extraction site for 30 minutes.Best results can be achieved by the stimulation of mental foramen and angle of the mandible (34).

In 1989 Quarnstrom and Milgrom determined the effectiveness of pain reduction during restoration without employing local anesthesia, 309 patients received TENS along with nitrous oxide-oxygen, while 62 of them received TENS alone. They observed successful results in 84% of cases with combination of TENS and 55% of cases with TENS only(35).

TENS and diazepam together used for nine years, from 1980 to 1989, to accomplish various dental treatments. The researchers discovered that adequate analgesia could be achieved to perform treatments like extraction, devitalization, prosthetic replacement, 3rd molar surgery and enucleation of tooth bud (36).

Trigeminal Neuralgia

Trigeminal neuralgia, a severe paroxysmal facial pain syndrome, can be treated by causing the afferent trigeminal fibres in the mandibular region to become refractory (37).

Singla et al., used a portable TENS unit to provide continuous bursts of current along the affected nerve path,20 to 40 days for 20 minutes daily. Patient were then assessed for pain at 1 and 3 month intervals, which revealed a substantial reduction in pain (15).

Yameen applied TENS to treat 31 patients with Trigeminal neuralgia whose pain was resistant to or only partially responding to medication. Prior to treatment and 15 days later, the severity of pain was measured

using visual analogue scale (VAS). 83.7% of patients had a significant improvement with TENS, constant mode produced better therapeutic outcome than the burst mode (38).
According to case study by Thorsen and Lumsden, a 36 years old man's trigeminal neuralgia symptoms immediately and permanently disappeared when a powerful TENS discharge was provided mistakenly. Therefore they believed that TENS at a high intensity could have long-lasting effects (39).

Temporom and ibular Disorders

Shanavas et al., carried out a study to know the efficacy of TENS as an adjuvant in Temporomandibular disorders (TMD). Two groups were selected, one group was treated with medication alone and other with adjuvant TENS. They found that TENS provided a significant pain reduction and discomfort (40).
TENS has been used for pain control in a 10 year old girl with TMD for 20 minutes along with cold compression. 50-75% of pain relief was achieved (41).
A study that was done to evaluate the efficacy of TENS using ultrasonography in patients with myositis and myofascial pain, observed significant pain reduction and improvement in mouth opening. TENS therapy is considered as an effective treatment modality in the management of myositis and myofascial pain (42).
A cross-sectional study was done to determine and compare the effectiveness of active TENS and physiotherapy in the management of pain in TMD patients. This study includes 122 patients, where 61 patients received active TENS and 61 patients received physiotherapy. A significant pain reduction was seen in both active TENS and routine physiotherapy. On comparative analysis, TENS therapy was effective in the management of pain in TMD patients (43).

Orthodontic pain

A recent study evaluated the effectiveness of the new portable TENS unit to track orthodontic pain and duration of pain alleviation after application of TENS. Patient who immediately felt discomfort after orthodontic adjustment or wire activation were involved in this study, and it was found that the introduction of a small electric current significantly reduced pain (44).
In 1986 Roth and Thrash observed the effects of TENS therapy on periodontal pain with orthodontic separators placed onmesial and distal aspect of upper 1st molarsin 45 patients. Patient utilising TENS reported a considerable pain reduction at the 24, 36, 48 hour assessment periods, but they didn't feel any pain immediately or within the first 12 hours (45).

Myofascial Pain Dysfunction Syndrome

Psychic tension and occlusal disharmonies are hypothesised to be the cause of the Myofascial Pain Dysfunction Syndrome (MPDS). One theory is that masticatory muscle spasmcauses pain in this syndrome. It can be treated by reducing the occlusal disharmony and alleviatingmuscle spasm.Studies stated that the use of TENS reduces muscle spasm (46). TENS has been used in different ways to treat MPDS. Electrodes were placed either on the patients skin or in the mouth, and an current delivered for 3 to 15 minutes. According to studies, TENS provided a significant pain reduction for the patient (47).

Post-herpetic Neuralgia

Majority of largemyelinated afferent nerve fibres weredamagedin Post-herpetic Neuralgia and this results in loss of normal presynaptic inhibition of input C fibres which causes pain and hyperalgesia.The idea for TENS utilisation is that it will restore normal inhibition by stimulating the large fibres activity (48).
In 1974 TENS were used in 30 patients with severe post-herpetic Neuralgia by Nathan and Wall to alleviate pain, when all other treatment had failed. TENS was self-administered by the patient using a portable machine (frequency 15-180 Hz) for more than or equal to 12 hours.Best results were observed in 11 cases. They observed that patientwith uncontrolled pain doesn'tget any relief from TENS due tolack of larger myelinated fibers to provideinhibition (48).

In 1998 Mittal applied TENS for 10 patients those who suffer from pain due to Post-herpetic Neuralgia. TENS is delivered 20 minutes daily (frequency 70 Hz) for 10 days. TENS was successful by achieving 50% or more pain reduction in 60% of cases. They found that patient with shorter duration had good response to TENS treatment (49).
Based on study, TENS therapy was found to be associated with pain reduction in patients with recalcitrant Post-herpetic Neuralgia (50).
Kolsek stated that the use of TENS as an adjunct or as a replacement of antiviral drugs in management of acute herpes zoster. It seems to be more effective in preventing Post-herpetic Neuralgia (51).

Xerostomia

Application of TENS in healthy adults over parotid region increases the salivary flow rate. It improved salivary flow rate in 2/3rd of healthy adults and also in xerostomia patients. Their study suggested that if TENS therapy to be successful and effective, presence of baseline saliva flow is indicated (52,53).
A randomized, double-blind study was conducted by Weiss in 1986. It is a placebo-controlled trial in xerostomia patients to determine the effects of electrical stimulation on salivary flow. The study usedintraoral device, the hand-held probesget in touch on the dorsum of the tongue, then with thetongue pressure it were made to contact the palate. They observed substantial improvement, but the performed assessment method was very subjective (54).
In 1988 Stellar et al., organised a double-blind study for 29 patients with Sjogren's syndrome to evaluate whether an application of electrical impulses over the tongue and palate by a battery-operated device to provokesalivary flow. It was administered 3 times daily for 3 minutes each for 4 weeks. It showed a significant response with few residual salivary flow, but no response in low or absent of saliva flow rates (55).
Talal et al., organiseda multi-centre double-blind study in 1992 for patients with Sjogren's syndrome to determine the effectivenessof TENSin increasingsaliva production. In 77 patients, 40 usedactive TENS devices, 37used placebo devices, this continued for 4 weeks. The results showed a significant improvement in saliva productionfor patients with active device than compared to placebo device (56).
In 2003 Wong et al., performed a study to determine the effectiveness of AL-TENS device (codetron) in 46 patients with radiation-induced xerostomia for relief of dry mouth.Presence of salivary function in all patients. Codetron acupuncture points of treatment were preselect based on old Chinese principle of medicine, delivered for 12 weeks and after 6 weeks of therapy 2 weeks break was provided. They found improvement in saliva production a whole, the effects were retained for minimum 6 months even after the completion of treatment (57).
Similarly Wong et al., conducted a study in 2012 to determinethe feasibility of AL-TENS in multi-centre set up and it's efficiency in decreasing radiation-inducedxerostomia in 48 cases. AL-TENS was delivered 20 minutes weekly twice for 12 weeks. They noted a positive response in 80% of patients (58).

Conclusion

TENS therapy can be used as an adjuvant therapy for pain management and to perform various procedures in dentistry. It is safe, non-invasive, can be self-administered and has less side effects than compared to others. Many researchers has to done to increase the use of TENS in various conditions.
Conflict of interest : None declared.

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