

Evaluation of the Effect of Transcutaneous Electrical Nerve Stimulation on Postoperative Pain in Surgical Extraction of Impacted Mandibular Third Molars: A Double Blind Randomized Clinical Trial

Hamidreza Arabion^a, Hamid Kazemi^b, Yaser Dehghanian^c, Reyhaneh Ebrahimi^d, Reza Tabrizi^{e*}

^aDepartment of OMFS, Shiraz University of Medical Sciences, Shiraz, Iran; ^bDental School, Shiraz University of Medical Sciences, Shiraz, Iran; ^cDentist, Private Practice, Shiraz, Iran; ^dDepartment of Periodontology, Shiraz University of Medical Sciences, Shiraz, Iran; ^eDepartment of Oral and Maxillofacial Surgery, Dental School, Shahid Beheshti University of Medical Sciences, Tehran, Iran

*Corresponding author: Reza Tabrizi, Department of Oral and Maxillofacial Surgery, Shahid Beheshti University of Medical Sciences, Daneshjou Blvd., Evin Ave., Chamran Expressway, Tehran, Iran. *E-mail:* Tabmed@gmail.com; *Tel:* +98-912 5850829

Submitted: 2016-10-12; Accepted: 2016-12-5

Introduction: Transcutaneous electrical nerve stimulation (TENS) has been used to reduce post-operative pain. The aim of this study was to assess the efficacy of TENS as an adjunctive pain relief measure after impacted third molar surgery. **Materials and Methods:** In this double-blind randomized clinical trial, patients requiring surgical extraction of third molars (Class 2 and B of Pell and Gregory) were randomly divided into two groups. Group I subjects received TENS immediately after surgery along with analgesics (400 mg Gelofen). In group II, patients received 400 mg Gelofen immediately post-operation (control group). The pain intensity was evaluated using a visual analog scale (VAS) eight hours after surgery. The independent t-test was applied to compare pain intensity between the two groups. **Results:** Three-hundred subjects were studied in two groups (each group had 150 participants). The mean pain intensity score was 3.7 ± 1.43 in group I and 4.36 ± 1.66 in group II. A significant difference was noted for pain intensity between the two groups ($P=0.001$). **Conclusion:** Use of TENS may decrease pain intensity during the first eight hours after impacted third molar surgery and may obviate the need for additional doses of non-steroidal anti-inflammatory drugs (NSAIDs).

Keywords: Tooth extraction; Pain; Transcutaneous electric nerve stimulation

Introduction

Transcutaneous electrical nerve stimulation (TENS) is a form of noninvasive, non-pharmacological electrotherapy commonly used in clinical practice (1). It has been confirmed that after an operation can reduce pain and acute anxiety (2). This modality has shown to be effective for arthritis pain, cancer pain, labor pain, back pain, and acute traumatic pain relief (2-4).

The clinical use of TENS involves the delivery of an electrical current typically from a small battery-operated device to the skin via surface electrodes. Each session typically lasts for 5 to 15 minutes and treatment may be repeated as often as needed depending on the severity of pain (5).

The electroanalgesia (pain relief by electrical methods) was first described in 1965 by Melzack and Wall's pain gate theory (5, 6). According to this theory, a gate exists in the dorsal horn of the spinal cord, which controls the incoming nociceptive traffic through the small-diameter afferent nerve fibers (fibers conducting impulses towards the brain). This gate can be blocked by a variety of other types of stimuli such as touch, pressure and electrical currents which stimulate the large-diameter afferent fibers (5); TENS also encourages the body to

release endorphins which are produced in response to pain or stress (7).

Transcutaneous electrical nerve stimulation has been successfully used for control of post-operative pain (8). Few studies used TENS for post-operative pain control in dental surgery (9, 10). However, a small number of cases and poor control of confounders were among the limitations of these studies.

The purpose of this study was to address a question; whether TENS can effectively decrease pain after surgical extraction of mandibular third molars. We hypothesized that TENS could reduce postoperative pain after surgical extraction of impacted third molars. Therefore, the aim of this study was to compare postoperative pain severity after impacted mandibular third molar surgery between patients who received TENS compared with a control group.

Materials and Methods

The authors designed a randomized clinical trial. The sample was derived from the population of patients referred to the Oral and Maxillofacial Surgery Department of Shiraz University of Medical Sciences between September 1, 2012 and May 31, 2015. The

Table 1. Comparison of variables between the two groups

Variables	Group I	Group II	P-value
Age (years)	23.26±3.19	23.69±3.75	P=0.29*
Sex	63 males, 87 females	73 males, 77 females	P=0.28**

*Independent t-test **Chi-square test

Table 2. Comparison of pain intensity between males and females.

Outcome	Males	Females	Independent t-test
Pain intensity	4.33±1.57	3.72±1.48	P=0.001

Table 3. Comparison of pain intensity between groups I and II

Outcome	Group I	Group II	Independent t-test
Pain intensity	3.7±1.43	4.36±1.66	P=0.001

research was approved by the Committee of the Medical Ethics Group of Shiraz University of Medical Sciences. Subjects eligible for study inclusion had an impacted mandibular third molar scheduled for surgical extraction. Subjects were excluded from the study if they had a pathological lesion around the teeth, jaw movement limitation, were taking psychiatric medication, or had a history of jaw fracture in the angle of the mandible. Written informed consent was obtained from all patients.

All impact teeth were mesioangular (Class 2 and B of Pell and Gregory). All patients received a single dose of Gelofen (400 mg, Daana Pharma Co, Iran) one hour before the operation.

Transcutaneous electrical nerve stimulation (Nihon Kohden Corporation, Japan) was applied using a Nihon Kohden unit (10 Hz frequency, 500µs pulse width, 30s stimulation duration). The patients received two intensity levels: a low intensity (sensory) level and a high intensity (motor) level. The TENS electrodes were placed on the skin of the angle and body of the mandible over the surgical site.

The patients were randomly divided into two postoperative analgesic treatment groups by a computer-generated randomization sequence (n = 150). In group I, subjects received TENS immediately after the surgery along with analgesics (400 mg Gelofen). In group II, patients received 400 mg Gelofen immediately after the operation (control group).

Patients complaining of severe pain were instructed to take additional doses of Gelofen. Number of patients who took additional doses of Gelofen was documented in each group. All surgeries were performed by an oral and maxillofacial surgeon (the first author). The surgeon and the patients were blinded to the groups. The pain intensity was evaluated using a VAS eight hours after surgery. Scores 0-3 indicated mild pain, 4-7 indicated moderate pain and 8-10 indicated severe pain (patients needed to use analgesics). An examiner documented the pain intensity of all patients.

Statistical Analysis:

The statistical analyses were performed using the statistical package SPSS for PCs, version 19 (IBM, USA). The independent t-test was applied to compare age and pain intensity between the two groups. We considered p values < 0.05 to be statistically significant. The chi-square test was used to compare gender between the study groups. The Pearson's correlation test was applied to find any correlation between age and pain.

Results

Sixty-seven males and 83 females were studied in group I and 73 males and 77 females were studied in group II. Analysis of the data did not indicate any difference for sex between the two groups (P=0.28). The mean age of patients was 23.26±3.19 years in group I and 23.69±3.75 years in group II (Table 1). There was no difference between the two groups for age (P=0.28). The mean pain intensity score was 4.33±1.57 in males and 3.72±1.48 in females. There was a significant difference between males and females for postoperative pain severity (P=0.001). The results did not demonstrate any correlation between pain and age (P=0.23) (Table 2).

The mean pain intensity score was 3.7±1.43 in group I and 4.36±1.66 in group II. Analysis of the data demonstrated a significant difference in pain intensity between the two groups (P=0.001) (Table 3).

Discussion

TENS has been used for pain relief, according to several interrelated theories in the mechanisms of pain transmission and blocking. The first of these theories was the gate control theory advanced by Melzack and Wall (11). According to the



theory, stimulation of large, peripheral A-delta nerve fibers closes a spinal gate and inhibits painful stimuli transmitted by small C-fibers to access the ascending signaling pathway. Another theory suggested that the favorable pain control efficacy of TENS was due to the release of endorphins, which attach to opioid receptors and block the transmission of noxious stimuli (5).

Low-intensity TENS decreases the nociceptor cell activity and sensitization of the central nervous system when used in somatic receptive fields and after spinal cord transection. TENS-induced A-delta activity can depress central nociceptor cell activity for up to two hours (12). TENS affects small-diameter afferents (A-delta) which can activate of the midbrain periaqueductal grey and rostral ventromedial medulla and inhibit descending pain-facilitatory pathways (12). Also, TENS can block peripheral afferent impulses from a peripheral structure (13) and can produce nerve impulses, which collide and extinguish afferent impulses arising from the peripheral structures. Peripheral blockade of nociceptive impulses happens when TENS affects A-delta fibers. Moreover, TENS blocks afferent activity in large-diameter fibers that may contribute to pain (12).

It should be noted that TENS is inexpensive, non-invasive and safe with no major side effects. It can be easily used by patients following a simple training and since there is no risk of toxicity, patients can adjust the dosage on an as-needed basis (14). In this clinical trial, TENS was successfully used in conjunction with Gelofen to decrease post-operative pain after impacted third molar surgery. One major advantage of using TENS in conjunction with NSAIDs for pain relief is to decrease the need for additional doses of NSAIDs, which leads to decreased dose-dependent adverse effects of such drugs. Ibuprofen is traditionally administrated by oral and maxillofacial surgeons for pain relief following third molar surgery. Gelofen used in our study in the form of soft gelatin capsules, which can be easily attached to plasma proteins and absorbed by the gastric mucosa by approximately 80% with four- to six-hour half-life (15). We measured pain intensity eight hours after prescription of Gelofen because the effect of Gelofen on pain would decrease after this time (15).

Johnson *et al.* evaluated TENS as a non-pharmacological modality based on delivering low-voltage electrical currents to the skin. They concluded that TENS reduced pain intensity significantly more than the placebo (16). In another review by Walsh *et al.*, they could not make any definitive conclusion about the effectiveness of TENS as an isolated treatment for acute pain in adults due to insufficient extractable data in the studies included in their review (17).

Electro-acupuncture has also been used for postoperative pain control after mandibular third molar surgery. Electro-acupuncture was efficient in pain relief after third molar surgery

(18). TENS was used for resolution of post inter maxillary fixation trismus and pain (19). Schäfer *et al.* studied the effect of TENS on pain perception threshold of human teeth and concluded that as an alternative to local anesthetics, TENS was not useful for painful dental interventions, since it had only a few advantages over a placebo (20). In another study, TENS was successfully used to decrease pain associated with orthodontic tooth movement (21).

There are no reports on the adverse effects of TENS, but its use is contraindicated in patients with cardiac pacemakers and epilepsy (12). Its effects on pregnancy are unknown, although several reports have described the successful use of TENS in labor and delivery (22, 23).

Electrode placement is an important factor in the successful use of TENS. They must be applied in such a way to address the referred pain taking into account the anatomical and physiological factors. Identical placement patterns are not always effective for different patients with similar pain patterns (5).

Conclusion

Use of TENS may decrease pain intensity during the first eight hours after impacted third molar surgery and also, the need for additional doses of NSAIDs.

Conflict of Interest: 'None declared'.

References

1. Facci LM, Nowotny JP, Tormem F, Trevisani VFM. Effects of transcutaneous electrical nerve stimulation (TENS) and interferential currents (IFC) in patients with nonspecific chronic low back pain: randomized clinical trial. *Sao Paulo Med J.* 2011;129(4):206-16.
2. Simpson PM, Fouche PF, Thomas RE, Bendall JC. Transcutaneous electrical nerve stimulation for relieving acute pain in the prehospital setting: a systematic review and meta-analysis of randomized-controlled trials. *Eur J Emerg Med.* 2014;21(1):10-7.
3. Johnson MI, Mulvey MR, Bagnall AM. Transcutaneous electrical nerve stimulation (TENS) for phantom pain and stump pain following amputation in adults. *Cochrane Database Syst Rev.* 2015(8).
4. Hurlow A, Bennett MI, Robb KA, Johnson MI, Simpson KH, Oxberry SG. Transcutaneous electric nerve stimulation (TENS) for cancer pain in adults. *Cochrane Database Syst Rev.* 2012.
5. Walsh DM, Howe TE, Johnson MI, Moran F, Sluka KA. Transcutaneous electrical nerve stimulation for acute pain. *The Cochrane Library.* 2009.



6. Melzack R, Casey KL. Sensory, motivational, and central control determinants of pain. *The skin senses* 1968. p. 423-39.
7. Vera-Portocarrero LP, Cordero T, Billstrom T, Swearingen K, Wacnik PW, Johanek LM. Differential effects of subcutaneous electrical stimulation (SQS) and transcutaneous electrical nerve stimulation (TENS) in rodent models of chronic neuropathic or inflammatory pain. *Neuromodulation*. 2013;16(4):328-35.
8. Tyler E, Caldwell C, Ghia JN. Transcutaneous electrical nerve stimulation: an alternative approach to the management of postoperative pain. *Anesth Analg*. 1982;61(5):449-56.
9. Olaogun MO, Parkins G, Addo E, Avogo D, Appiah-Kubi K. Comparative Effects of Transcutaneous Electrical Nerve Stimulation, Cryotherapy and Placebo on Pain, Swelling and Trismus Following Third Molar Tooth Extraction. *Nigerian J Med Rehabilitation*. 2012;15(1 and 2):38-43.
10. Olaogun M, Fagade O, Akinloye A, Omojowolo O. Effects of Transcutaneous Electrical Nerve Stimulation on pain, swelling and trismus following third molar tooth extraction. *Nigerian J Health Sci*. 2001;1(1):18-22.
11. Melzack R, Wall PD. Pain mechanisms: a new theory. *Survey of Anesthesiology*. 1967;11(2):89-90.
12. Johnson M. Transcutaneous electrical nerve stimulation: mechanisms, clinical application and evidence. 2007.
13. Sluka KA, Walsh D. Transcutaneous electrical nerve stimulation: basic science mechanisms and clinical effectiveness. *J Pain*. 2003;4(3):109-21.
14. Tashani O, Johnson M. Transcutaneous Electrical Nerve Stimulation (TENS). A Possible Aid for Pain Relief in Developing Countries? *Libyan J Med*. 2009;4(2).
15. Wynn R. Update on nonprescription pain relievers for dental pain. *General Dent*. 2004;52(2):94.
16. Johnson MI, Paley CA, Howe TE, Sluka KA. Transcutaneous electrical nerve stimulation for acute pain. *Cochrane Database Syst Rev*. 2015;6:Cd006142.
17. Walsh DM, Howe TE, Johnson MI, Sluka KA. Transcutaneous electrical nerve stimulation for acute pain. *Cochrane Database Syst Rev*. 2009(2):Cd006142.
18. Tavares MG, Machado AP, Motta BG, Borsatto MC, Rosa AL, Xavier SP. Electro-acupuncture efficacy on pain control after mandibular third molar surgery. *Braz Dent J*. 2007;18(2):158-62.
19. Fagade O, Obilade T. Therapeutic effect of TENS on post-IMF trismus and pain. *Afr J Med Med Sci*. 2003;32(4):391-4.
20. Schafer E, Finkensiep H, Kaup M. Effect of transcutaneous electrical nerve stimulation on pain perception threshold of human teeth: a double-blind, placebo-controlled study. *Clin Oral Investig*. 2000;4(2):81-6.
21. Roth PM, Thrash WJ. Effect of transcutaneous electrical nerve stimulation for controlling pain associated with orthodontic tooth movement. *Am J Orthod Dentofacial Orthop*. 1986;90(2):132-8.
22. Santana LS, Gallo RB, Ferreira CH, Duarte G, Quintana SM, Marcolin AC. Transcutaneous electrical nerve stimulation (TENS) reduces pain and postpones the need for pharmacological analgesia during labour: a randomised trial. *J Physiother*. 2015.
23. Peng T, Li XT, Zhou SF, Xiong Y, Kang Y, Cheng HD. Transcutaneous electrical nerve stimulation on acupoints relieves labor pain: a non-randomized controlled study. *Chin J Integr Med*. 2010;16(3):234-8.

Please cite this paper as: Arabion H, Kazemi H, Dehghanian Y, Ebrahimi R, Tabrizi R. Evaluation of the Effect of Transcutaneous Electrical Nerve Stimulation on Postoperative Pain in Surgical Extraction of Impacted Mandibular Third Molars: A Double Blind Randomized Clinical Trial. *Regen Reconstr Restor*. 2017;2(1):40-43.