Does transcutaneous electrical nerve stimulation (TENS) have a clinically relevant analgesic effect on different pain conditions? A literature review

Asami Naka (1), Mohammed Keilani (2), Stefan Loefler (1), Richard Crevenna (2)

(1) Ludwig Boltzmann Institute of Electrical Stimulation and Physical Rehabilitation, Wilhelminenspital, Vienna; (2) Department of Physical Medicine and Rehabilitation, Wilhelminenspital, Vienna; (3) Department of Physical Medicine and Rehabilitation, Medical University of Vienna, Austria

Abstract

Transcutaneous electric nerve stimulation (TENS) is a standard therapy used in different painful conditions such as low back pain, diabetic polyneuropathy or arthrosis. However, literature reviews focusing on the effects and the clinical implication of this method in various painful conditions are yet scarce. The purpose of this literature research was to determine, whether TENS provides an analgesic effect on common painful conditions in clinical practice. Literature research was performed using three data bases (Pubmed, Embase, Cochrane Database), focusing on papers published in the space of time from 2007 to 2012. Papers were evaluated from two reviewers independently concerning the clinical outcome, taking account for the level of external evidence according to the German Cochrane levels of evidence (Ia – IV). 133 papers of varying methodological quality dealing with different painful conditions were selected in total. A clinically relevant analgesic effect was described in 90 painful conditions (67%). In 30 painful states (22%), the outcome was inconclusive due to the study design. No significant analgesic effect of TENS was observed in 15 painful conditions (11%). The vast majority of the papers were classified as Cochrane evidence level Ib (n = 64; 48%), followed by level Ia (n = 23; 17%), level III (n = 18; 14%), level IV (n = 15; 11%), level IIb (n = 10; 8%) and level IIa (n = 3; 2%). Most of the studies revealed an analgesic effect in various painful conditions, confirming the usefulness of TENS in clinical practice.

Key Words: Review, TENS, transcutaneous electric nerve stimulation, low frequency electrical stimulation, pain, analgesia, clinic

European Journal Translational Myology - Basic Applied Myology 2013; 23 (3): 95-103

Transcutaneous electric nerve stimulation (TENS) is a common therapeutic device used in different painful situations in the everyday clinical practice. It is non-invasive, inexpensive and reveals hardly any major side effects. TENS can be easily self-administered by the patients following a short training, and the intensity of electrical stimulation can be adjusted by the patients themselves according to need. Previous meta-analysis and reviews have reported about the effect of TENS in various painful conditions [1,3-6]. However, papers analyzed in meta-analysis or reviews revealed study designs of higher quality such as randomized controlled trials. Controlled studies without randomization, quasi-experimental studies or experts' opinion based on clinical observations were generally elided due to the poor study quality. Because of the limited or contradictory data, the effect of TENS was often evaluated as inconclusive. As stated by Sackett et al., the use of the best available scientific evidence from literature research solely is not sufficient, but requires the integration of individual clinical expertise [7]. Indeed in the daily clinics, the choice for the appropriate therapeutic modality is not based on the level of scientific evidence solely, but rather has to be customized according to the patients' need. The statement for inconclusiveness because of limited data or poor study design could distort the effectiveness of TENS in various painful conditions, and thus unethically deprive patients of effective treatment.

Therefore, the aim of this descriptive literature research was to provide an overview of papers including all kinds of study design dealing with the use of TENS in different painful situations. Clinical

Table 1. Levels of external scientific evidence according to the German Cochrane Center.

Ia	Systematic review based on randomized controlled trials with methodologically high quality
Ib	Methodologically well designed randomized controlled trial
IIa	Controlled study with high quality without randomization
IIb	Study with a quasi-experimental design
III	Non experimental study of high quality
IV	Experts' options, descriptive studies such as case reports

effectiveness of TENS taking into account the levels of external scientific evidence according to Cochrane was evaluated.

Materials and Methods

For a structured literature search, three different electronic data bases (Pubmed, Embase, Cochrane Central Register of Controlled Trials) were used to screen for papers published from January 2007 to May 2012. "TENS", "transcutaneous electrical nerve stimulation" and "pain" were used as key words. Only articles in English or German were selected. AN and MK acted as reviewers and evaluated the clinical outcome (positive/negative/inconclusive), while RC supervised the work. Since the aim of the current literature research was focused on the analgesic effect of TENS in patients, studies from basic research, such as papers dealing with non-human models, were excluded. The remaining studies were further classified according to the scientific levels of evidence of the German Cochrane Center ([6]; see Table 1). Control group was defined as a group obtaining either sham-TENS, where no electrical stimulation was given, or low threshold stimulation below the patients' detection threshold.

Results and Discussion

More than 800 hits were found in total, including painful conditions such as acute or chronic low back pain, osteoarthritis of the knee, rotator cuff tendinitis, cancer-related pain, postoperative pain, pain during child birth, painful diabetic neuropathy tension headache, trigeminal neuropathia or myofascial pain syndrome. Thereof, 133 papers were useful for further analysis. In two papers (Crawford-Faucher 2010, Dubinsky and Miyasaki 2010), two different painful conditions were described (positive outcome in painful diabetic neuropathy, negative outcome in chronic low back pain, respectively), hence resulting in a total of 135 outcomes. (see Table 2). The number of treated patients per study varied from eight to1466 (mean value = 141, standard error of the mean = 27).

An analgesic effect of TENS was reported in 90 out of 135 painful conditions in total ("positive"; 67%). In 15 painful states (11%), no alleviation of pain was observed ("negative"). The rest of the studies (n = 30; 22%) was inclusive, e. g. due to poor statistical quality, limited and/or contradictory data in studies with level Ia, because of the missing statement about the outcome in case of reviews or experts' opinions, the use of other therapeutic interventions as control, or due to the study design (study protocol, methodological papers).

The vast majority of the papers were classified as evidence level Ib (randomized controlled trial), showing mostly a statistically significant analgesic effect of TENS. Second most common were level Ia studies (systematic review based on randomized controlled trials), consisting of mostly inconclusive studies, followed by papers from level III (non-experimental studies, such descriptive case series) and level IV (experts' opinion based on the clinical experience, descriptive studies). Only few studies were graded as level IIa (experimental studies without randomization) or level IIb (studies of quasi-experimental design, such as case-control studies or cohort studies). See summary in Fig. 1.

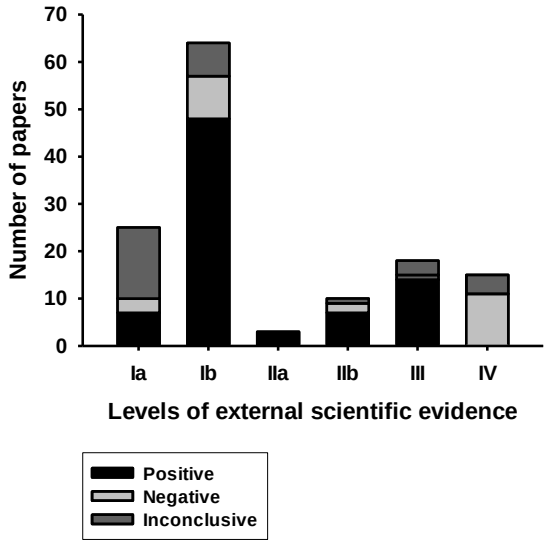

Fig 1. *Studies dealing with the use of TENS in different painful conditions were classified according to the outcome and to the levels of evidence. Scientific levels of evidence according to the German Cochrane Center are plotted against the number of the papers. Studies were categorized according to the analgesic effect of TENS described in different gray scales*

Many of the papers published between January 2007 and May 2012 were graded in higher levels of evidence. The majority of the studies showed an analgesic effect of TENS in various painful conditions, encouraging the continuing use of TENS in the everyday clinical practice. Nevertheless, taking into account the large amount of inconclusive studies graded in Cochrane level Ia, further randomized, double-blind, placebo-controlled studies revealing a statistically adequate number of patients are required to provide a better statement.

As mentioned above, good clinical practice requires the use of both best available scientic evidence and individual clinical expertise. Hence, low grading according to the Cochrane levels of scientific evidence does not automatically mean that these papers contain less clinically useful information. For example, the literature review from Pieber et al. (2010) contains much clinical details about the use of electrotherapy in painful diabetic peripheral neuropathy, considering the stimulation mode, stimulation intensity and frequency, time span of application, as well as the outcome, providing a good clinical overview. However, since it contains not only randomized controlled trials but also non-randomized controlled studies, uncontrolled studies or pilot studies, and because no statistical analysis was performed, it is graded as level IV, showing the difficulty of achieving both high scientific evidence and clinical relevance.

External scientific evidence allone can not replace the individual clinical expertise and vice versa. Although grading of papers in aspect of both scientific reliability and clinical usefulness is a challenging task, it is essential for the patients' sake and still remains to be optimized.

Table 2. Papers are graded according to the Cochrane levels of scientific evidence.

Author	Reference
Level Ia – positive outcome	
Bjordal JM, Johnson MI, Lopes-Martins RA, Bogen B, Chow R, Ljunggren AE.	Short-term efficacy of physical interventions in osteoarthritic knee pain. A systematic review and meta-analysis of randomised placebo-controlled trials. BMC Musculoskelet Disord 2007; 8:51.
Claydon LS, Chesterton LS, Barlas P, Sim J.	Dose-specific effects of transcutaneous electrical nerve stimulation (TENS) on experimental pain: a systematic review. Clin J Pain 2011; 7:635-47.
Crawford-Faucher A.	TENS helpful for management of diabetic neuropathy pain. Am Fam Physician 2010; 82(8):991-2. Positive outcome for painful diabetic neuropathy.
Dowswell T, Bedwell C, Lavender T, Neilson JP.	Transcutaneous electrical nerve stimulation (TENS) for pain relief in labour. Cochrane Database Syst Rev 2009; 2:CD007214.
Dubinsky RM, Miyasaki J.	Assessment: efficacy of transcutaneous electric nerve stimulation in the treatment of pain in neurologic disorders (an evidence-based review): report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology. Neurology 2010; 74(2):173-6. Positive outcome for painful diabetic neuropathy.
Jin DM., Xu Y, Geng D-F., Yan T-B.	Effect of transcutaneous electrical nerve stimulation on symptomatic diabetic peripheral neuropathy: A meta-analysis of randomized controlled trials. Diabetes Res Clin Pr 2010; 89(1):10-5.
Johnson M., Martinson M.	Efficacy of electrical nerve stimulation for chronic musculoskeletal pain: A meta-analysis of randomized controlled trials. Pain 2007; 130(1-2):157-165.
Level Ia – negative outcome	
Crawford-Faucher A.	TENS helpful for management of diabetic neuropathy pain. Am Fam Physician 2010; 82(8):9912. Negative outcome for chronic low back pain.
Dubinsky RM, Miyasaki J.	Assessment: efficacy of transcutaneous electric nerve stimulation in the treatment of pain in neurologic disorders (an evidence-based review): report of the Therapeutics and Technology Assessment Subcommittee of the American Academy of Neurology. Neurology 2010; 74(2):173-6. Negative outcome for chronic low back pain.
Mello LF, Nóbrega LF, Lemos A.	Transcutaneous electrical stimulation for pain relief during labor: a systematic review and meta-analysis. Rev Bras Fisioter 2011; 15(3):175-84.
Level Ia – inconclusive outcome	
Bedwell C, Dowswell T, Neilson JP, Lavender T.	The use of transcutaneous electrical nerve stimulation (TENS) for pain relief in labour: a review of the evidence. Midwifery 2011; 27(5):e141-8.

Bennett MI, Hughes N, Johnson MI.	Methodological quality in randomised controlled trials of transcutaneous electric nerve stimulation for pain: low fidelity may explain negative findings. Pain 2011; 152(6):1226-32.
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; 3:CD006276.
Johnson MI, Bjordal JM.	Transcutaneous electrical nerve stimulation for the management of painful conditions: focus on neuropathic pain. Expert Rev Neurother 2011; 11(5):735-53.
Khadilkar A, Odebiyi DO, Brosseau L, Wells GA.	Transcutaneous electrical nerve stimulation (TENS) versus placebo for chronic low-back pain. Cochrane Database Syst Rev 2008; 4:CD003008.
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Kroeling P, Gross A, Goldsmith CH, Burnie SJ, Haines T, Graham N, Brant A.	Electrotherapy for neck pain. Cochrane Database Syst Rev 2009; 4:CD004251.
Mello LF, Nóbrega LF, Lemos A.	Transcutaneous electrical stimulation for pain relief during labor: a systematic review and meta-analysis. Rev Bras Fisioter 2011; 15(3):175-84.
Mulvey MR, Bagnall AM, Johnson MI, Marchant PR.	Transcutaneous electrical nerve stimulation (TENS) for phantom pain and stump pain following amputation in adults. Cochrane Database Syst Rev 2010; 5:CD007264.
Nnoaham KE, Kumbang J.	Transcutaneous electrical nerve stimulation (TENS) for chronic pain. Cochrane Database Syst Rev 2008; 3:CD003222.
Robb KA, Bennett MI, Johnson MI, Simpson KJ, Oxberry SG.	Transcutaneous electric nerve stimulation (TENS) for cancer pain in adults. Cochrane Database Syst Rev 2008; 3:CD006276.
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Walsh DM, Howe TE, Johnson MI, Sluka KA.	Transcutaneous electrical nerve stimulation for acute pain. Cochrane Database Syst Rev 2009; 2:CD006142.
Level Ib – positive outcome	
Aghamohammadi A, Behmanesh F, Zafari M., Tofighi M.	Effect of using transcutaneous electrical nerve stimulation (TENS) in acupuncture points [Hegu (Li4) and Sanyinjiao (Sp6)] on duration of the first stage of labor. Journal of Babol University of Medical Sciences 2011; 13(2):19-24.
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Level Ib – negative outcome	
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Corresponding Author

Univ.-Prof. Dr. Richard Crevenna, Medical University of Vienna, Waehringer Guertel 18-20, AT-1090 Vienna, Austria
Phone +43 40400 4330; Fax +43 40400 5281
e-mail: richard.crevenna@meduniwien.ac.at

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