Effects of Transcutaneous Electrical Nerve Stimulation on Pain Control in Patients with Knee Osteoarthritis a Systematic Review

Lee H*, Clark A and Draper DO

Brigham Young University, Provo, UT 84602.


Keywords
Knee osteoarthritis, Joint pains, TENS.

Introduction
Knee osteoarthritis (OA), which causes knee joint pain, stiffness, and functional disability [1], is common among elderly individuals [2]. A literature search suggested that 27.8% of individuals aged over 45 years old had a prevalence of radiographic knee OA grade of at least 2 in at least 1 knee and 43.3% had symptomatic knee pain, aching, or stiffness in at least 1 knee [3]. There is no perfect treatment or measures for knee OA patients up to date. Therefore, pain therapy is considered as a main treatment for those with knee OA.

Transcutaneous electrical nerve stimulation (TENS) is a commonly used conservative treatment method that is effective in reducing knee pain in patients with knee OA [4-6]. However, it is still controversial in effectiveness of TENS based on randomized controlled trials (RCTs) and systematic reviews compared with healthy control groups [7-9]. Therefore, it is effective in decreasing knee pain. In addition, the main outcome of the literature on TENS is level of knee pain, which was measured using instruments such as the visual analog scale (VAS) or Western Ontario and McMaster Universities Arthritis Index scale (WOMAC). Decrease in pain can lead improved normal physical function; however, limited studies have reported the effect of decrease in pain on physical function through factors such as muscle strength, speed, endurance, and balance. Further, it has been limited to confirm if TENS intervention is effective in reducing pain and developing physical tests [10,11].

In the previous studies, they have suggested that discrepancy between physical symptom and radiographic evaluation. The K/L grade is a common radiographic evaluation system for knee OA; it involves classification of knee OA according to the severity of bone deformity [12]. However, there was no statistically significant relationship between K/L grade and knee pain [13], leg extensor and flexor muscle strengths, and WOMAC [14,15]. In addition, people with K/L score 0 may have cartilage damage or bone marrow lesions, as demonstrated using magnetic resonance imaging [16]. There is possibility that even people with K/L grade 0 or 1 (preradiographic OA) have inadequate function and/or knee pain. Additionally, those with preradiographic OA, particularly with K/L grade 1, have been expected to develop to at least grade 2,17,18]. Moreover, another previous study reported that people with early-stage knee OA have higher possibility of having better response to treatment than those with late-stage knee OA [19].

Therefore, the purpose of this systematic review with meta-analysis was to determine whether TENS can alleviate joint pain in patients with knee OA. On the basis of the existing literature, we hypothesize that TENS treatment is effective in reducing joint pain for knee OA patients.

Methods
We searched PubMed, CINAHL, SPORT Discus, and Scopus databases from their earliest available date to March 2016 using the combination of key words, including 1) joint pain OR knee osteoarthritis OR TENS OR pain control OR 2) ACLR OR ACL injury; and 3) items 1 AND 2.

Inclusion and exclusion criteria
After the initial electronic search, duplicated articles were eliminated by comparing the results from each database. On the basis of title and abstracts, articles returned that were not relevant and English language, full text, or original articles were rejected [1-19].

The authors independently made the initial selection based on the
<table>
<thead>
<tr>
<th>Study</th>
<th>Study design</th>
<th>Inclusion/Exclusion criteria</th>
<th>Participants / Groups</th>
<th>Main Outcome measures for pain</th>
<th>Manufacturer TENS Unit</th>
<th>Treatment Duration (# of session)</th>
<th>Parameters</th>
<th>Progressive Y/N</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atamaz (2012)</td>
<td>RCT</td>
<td>Inclusion: (1) aged 50-80, (2) ACR criteria, (3) radiologically confirmed with a Kellgren-Lawrence grade of 2 or 3, (4) VAS for pain &gt; 4 for at least 6 months. Exclusion: (1) a history of any contraindication for electrotherapy, (2) corticosteroid therapy, (3) chondroprotective agents during the 30 days prior to the study, (4) viscosupplementation treatment within 6 months prior to the study, or (4) had undergone previous major surgery, such as joint replacement or arthroscopy, within 6 months prior to the study.</td>
<td>203 participants; Groups: TENS sham (33), TENS (29), IFCs sham (34), IFCs (27), SWD (27)</td>
<td>VAS</td>
<td>Bio-stim SD-980a, Endomed CV-405b and Sonopuls 492b</td>
<td>Electrodes: 4 surface electrodes (5 x 5 cm)</td>
<td>5 times a week for 3 weeks (15 sessions)</td>
<td>Frequency (Hz): 80 Intensity (mA): 10-30 Duration (min): 20</td>
</tr>
<tr>
<td>Chen (2013)</td>
<td>RCT</td>
<td>Inclusion: (1) aged 50-80, (2) ACR criteria, (3) radiologically confirmed with a Kellgren-Lawrence grade of 2 or 3, and (4) VAS for pain &gt; 4 for at least 6 months. Exclusion: (1) a pacemaker, (2) previous knee operation (including replacement surgery), (3) rheumatoid arthritis, (4) severe medical or neurologic conditions, or (4) who had received intra-articular corticosteroid/HA injections over the previous 6 months.</td>
<td>50 participants; HA injection (27) TENS (23)</td>
<td>VAS</td>
<td>Electrodes: SSR; 4 surface electrodes (5 x 3.5 cm)</td>
<td>3 times a week for 4 weeks (12 sessions)</td>
<td>Frequency (Hz): mixed-frequency constant mode of 3 - 20 Pulse width (µs): 200 Intensity (mA): vary Duration (min): 20</td>
<td>Y: VAS, Lequesne</td>
</tr>
<tr>
<td>Cherian (2016)</td>
<td>RCT</td>
<td>Inclusion: (1) aged 50-80, (2) ACR criteria, (3) radiologically confirmed with a Kellgren-Lawrence grade of 2 or 3, and (4) VAS for pain &gt; 4 for at least 6 months. Exclusion: (1) a pacemaker, (2) previous knee operation (including replacement surgery), (3) rheumatoid arthritis, (4) severe medical or neurologic conditions, or (4) who had received intra-articular corticosteroid/HA injections over the previous 6 months.</td>
<td>70 participants; TENS Standard conservative therapy</td>
<td>VAS</td>
<td>N/A</td>
<td>Y: VAS</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Govil (2020)</td>
<td>RCT</td>
<td>Inclusion: (1) aged 18-60, (2) ACR criteria, (3) able to ambulate to the mailbox and back (4) stable medication schedule over the prior 3 weeks, and (5) VAS for pain &gt; 3. Exclusion: (1) knee surgery within the last 6 months, (2) knee injection within the last four weeks, (3) presence of any serious medical condition, and (4) uncontrolled diabetes mellitus or hypertension, dementia or cognitive impairment, (5) permanent lower extremity sensory loss and (6) prior TENS use.</td>
<td>74 participants; Groups: High-frequency Low-frequency Sham</td>
<td>VAS</td>
<td>Rehabilicare Maxima, Empi, Inc</td>
<td>Electrodes: 4 (2 x 2 inch)</td>
<td>Frequency (Hz): 100 OR 4 Pulse width (µs): 100 Intensity (mA): vary Duration (min):</td>
<td>Y: VAS</td>
</tr>
<tr>
<td>Isik (2017)</td>
<td>RCT</td>
<td>Inclusion: (1) aged 18-60, (2) ACR criteria, (3) radiologically confirmed with a Kellgren-Lawrence grade of 2 or 3. Exclusion: (1) Diagnosis of rheumatoid arthritis and other systemic joint diseases, (2) Secondary osteoarthritis, (3) Arthroscopy or surgery of the knee, (4) Intra-articular injection in the past 3 months, (5) Physical therapy in the past 3 months, (6) Skin disorders with or without exfoliation, scar or open wound on the knee, (7) Comorbidities, such as blood disorders, anemia, uncontrolled diabetes, severe depression or other psychological diseases, (8) Anticoagulation treatment, (9) Advanced joint deformity, (10) Pregnancy, (11) Intercurrent disease(s) that might interfere with the free use and evaluation of the affected knee.</td>
<td>105 participants; Groups: TENS; 53 Leech therapy: 52</td>
<td>VAS</td>
<td>N/A</td>
<td>5 times a week for 3 weeks (15 sessions)</td>
<td>Frequency (Hz): 40 - 150 Intensity (mA): vary Duration (min): 20</td>
<td>Y: VAS and Leech</td>
</tr>
</tbody>
</table>
### Discussion

The systematic review is the first to pool data from individual studies on the effects of TENS on pain control in patients with knee OA. The results provide evidence that TENS treatments are effective in reducing self-reported pain level. More specifically, the TENS treatments, 12-15 sessions over 4-6 weeks, reduce VAS in pain right after the treatments and it lasts about 2 weeks. However, it did not show how long the effect lasted after 2 weeks. Different physical therapy approaches have been used to develop the clinical course of knee OA, but the evidence of effectiveness has not been sufficient based on randomized controlled studies and analyzed by a systematic review.

TENS is effective for nociceptive pain mechanisms based on the gait control theory of pain [20] and activation of endogenous opioids, and it may improve exercise tolerance in individuals who experience movement-evoked pain. Shimoura et al. [21] reported that TENS intervention was considered to reduce knee movement-evoked pain and increase walking distance without pain. Thus, participants in the TENS group may be able to walk longer distances in the post-assessment period. According to Isik’s [22] study, they compared a three-session leech therapy applied on ambulatory patients with a routinely applied full term TENS therapy which involved 15 sessions of TENS therapy application on hospitalized patients in 3 weeks. In the evaluation of the main outcome scores on day 21st, pain score in VAS significantly decreased in both groups which were consistent with previous studies. In addition, Pietrosimone et al. [23] stated that although significant differences were not found between groups, moderate TENS effect sizes were found 4-weeks following the initiation of the intervention. In the most recent article in this systematic review, significant analgesic effect and functional improvement were observed in patients who received TENS.

Based on the RCTs in our systematic review, TENS decreases pain in patients with knee OA. Previous authors have concluded that the neural drive is immediately increased during the active administration of sensory TENS current, and that TENS immediately diminished the excitatory effect upon removal. Current theories suggest that TENS provides increased afferent stimuli interpreted by the CNS as excitatory resulting in the facilitation of inhibited motor neuron pools.

In conclusion, this systematic review indicated that: (1) patients who received TENS had significantly decreased pain compared with the control group; (2) there was no significant difference between the TENS and control groups in terms of the WOMAC index and all-cause discontinuation; (3) there was no significant difference between the TENS and control groups in the pain-index and all-cause discontinuation; (4) TENS might significantly improved the maximum knee ROM on day 10 and during follow-up compared with the control group.

### Reference


