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The Effectiveness of Transcutaneous Electrical Nerve Stimulation in Knee Osteoarthritis with Neuropathic Pain Component: A Randomized Controlled Study

Nöropatik Ağrı Komponenti Olan Diz Osteoartritinde Transkutanöz Elektrik Sinir Stimülasyonu Etkinliği: Randomize Kontrollü Çalışma

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Abstract

Objective: The aim of our study was to assess the efficacy of transcutaneous electrical nerve stimulation (TENS) in knee osteoarthritis with neuropathic pain component.
Materials and Methods: The patients were assessed by visual analogue scale (VAS) for pain severity, Western Ontario and McMaster osteoarthritis index (WOMAC) for physical function and the Kellgren-Lawrence system for severity of osteoarthritis, painDETECT questionnaire for presence of neuropathic pain. Patients were divided into two groups according to painDETECT questionnaire scores. Group 1 consisted of 20 patients (39.2%) with likely and possible neuropathic pain, group 2 consisted of 31 patients (60.8%) with unlikely neuropathic pain. All patients received hot pack, TENS and home exercise program was given. Physical therapy agents were given for 3 weeks, 5 days a week. Assessments were evaluated in all patients before and after the treatment.
Results: There was no statistically significant difference in demographic features and radiographic evaluations between the groups. The VAS, WOMAC pain and physical function scores were significantly lower after treatment in knee patients with neuropathic pain component, but there was no significant difference between the two groups.
Conclusion: TENS is a neuropathic pain component in knee osteoarthritis patients, which is effective in reducing pain and improving physical function. The benefit of TENS therapy is that it can be used in conjunction with drug therapy, thereby reducing the drug dose and drug side effects.
Keywords: Neuropathic pain, knee osteoarthritis, transcutaneous electrical nerve stimulation

Öz

Amaç: Çalışmamızın amacı nöropatik ağrı komponenti olan diz osteoartritinde transkütanöz elektriksel sinir stimülasyonunun (TENS) etkinliğini araştırmaktır.
Gereç ve Yöntem: Hastalar ağrı şiddeti açısından görsel analog skala (VAS), fiziksel fonksiyon için Western Ontario ve McMaster osteoartriti indeks (WOMAC), osteoartrit şiddeti açısından Kellgren-Lawrence derecelendirme, nöropatik ağrı varlığı açısından painDETECT ağrı anketi ile değerlendirildi. Hastalar painDETECT puanlarına göre 2 gruba ayrıldı. Grup 1 nöropatik ağrısı pozitif ve muhtemel olan 20 (%39,2) hastadan, grup 2 nöropatik ağrısı olmayan 31 (%60,8) hastadan oluşmaktadır. Bütün hastalar hot pack ve TENS tedavisi aldı, ev egzersiz programı verildi. Fiziksel tedavi ajanları haftada 5 gün olmak üzere 3 hafta verildi. Değerlendirmeler bütün hastalarda tedavi öncesi ve sonrası yapıldı.
Bulgular: Demografik özellikler ve radyografik değerlendirme açısından gruplar arasında istatiksel olarak fark yoktu. VAS, WOMAC ağrı ve fiziksel fonksiyon skorları nöropatik ağrı komponenti olan diz hastalarında tedaviden sonra anlamlı derecede azaldı fakat her iki grup arasında anlamlı farklılık yoktu.
Sonuç: TENS nöropatik ağrı komponenti olan diz osteoartriti hastalarında ağrıyı azaltmada ve fiziksel fonksiyonu geliştirmede etkilidir. TENS tedavisinin avantajı ilaç tedavisi ile birlikte kullanılabilmesi böylelikle ilaç dozunun ve ilaç yan etkilerinin azaltılmasını sağlamasıdır.
Anahtar kelimeler: Nöropatik ağrı, diz osteoartriti, transkütanöz elektriksel sinir stimülasyonu

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Introduction

Historically, the pain of osteoarthriti (OA) knee has been considered to be nociceptive pain but cumulative data suggest that both nociceptive and neuropathic mechanisms can play role in the pain of OA (1,2). Transcutaneous electrical nerve stimulation (TENS) is commonly used physical therapy modality for the treatment of pain caused by OA (3,4). TENS strengthens local inhibitory control and is indicated in focal neuropathic pain (NP) (5). The analgesic effect of TENS is similar to that achieved with opioid agonists in the treatment of NP (6).

There are only a limited number of studies that use TENS for treatment of different NP conditions (7-9). These studies suggest that TENS is a reasonable treatment to manage NP (10). Due to the presence of NP component in some knee OA patients we considered to investigate the effects of TENS in this patient population. To our knowledge the effect of TENS has not been investigated for the treatment of NP in knee OAs. The purpose of this study was to investigate whether TENS could reduce the severity of NP in knee OAs and to compare the effects of TENS in knee OA with and without NP component.

Materials and Methods

Fifty one women patients who treated in Ankara Physical Medicine and Rehabilitation Training and Research Hospital were randomly enrolled in this study. The Local Ethics Committee of Ankara Physical Medicine and Rehabilitation Training and Research Hospital approved the study and written consent was taken from each patient. Knee OA was diagnosed according to the American College of Rheumatology criteria. Each patient's knee X-rays were taken while the patient was standing, knee extended in anteroposterior position. Each knee was staged according to the Kellgren and Lawrence (11) radiological stage. All patients (>45 years) had knee pain for more than 3 months. Patients with any previous history of knee surgery (arthroscopy and total knee replacement), infection, rheumatoid arthritis and other pain/neurological conditions such as radiculopathies, coxarthrosis, stroke, traumatic brain injury and were already receiving medical treatment for NP were excluded from the study.

Demographic characteristics (age, work status, educational level, body mass index, comorbidities) and pain duration of the patients were recorded. All patients completed the painDETECT questionnaire (PDQ) for presence of NP. The patients were divided into two groups according to the PDQ scores. Group 1 consisted of patients with likely and possible NP and group 2 consisted of patients with unlikely NP. Assessment of pain [visual analog scale (VAS); Western Ontario McMaster Osteoarthritis Index (WOMAC pain score)], disability and stiffness (WOMAC physical function and stiffness score) were done in all patients before and after the treatment. All patients received TENS (20 min/day) and hot pack (20 min/day). They were applied 5 days a week for 3 weeks in total. Everyway (EV-603M) branded device was used for the TENS treatment. The TENS was applied at a frequency of 80 hertz with 10 to 30 mA intensity. Four electrodes were placed on the anterior medial and lateral portions of the knee. All the patients completed 15 treatment sessions. Physiotherapists who applied physical therapy agents were blinded, they didn't know about the study and patients' different groups. All patients were given a home exercise program at the beginning of the treatment. Patients were directed to perform the exercise program, including quadriceps isometric and strengthening exercises, for 10 repetitions of the set, 2 times a day for three weeks.

Scales

The painDETECT questionnaire: It is used to evaluate the features of pain experienced by participants in the preceding four weeks. It contains a body drawing for patients to show the sites of pain and any radiation present, evaluation of pain quality with a marker of severity from hardly noticed to very strongly, pattern of pain and measures of current, worst and average pain severity. The PDQ score ranges from 0 to 38; a score ≥19 indicates likely NP, ≥13 to ≤18 indicates possible NP, and ≤12 indicates unlikely NP (12). The Turkish version of the PDQ was developed and validity and reliability studies were conducted (13).

Visual analog scale: The VAS consists of a 10 cm line, with the left extreme indicating "no pain or zero" and the right extreme indicating "unbearable pain or 10" (14).

Western Ontario McMaster osteoarthritis index: This scale consists of subsections for pain (5 questions), stiffness (2 questions) and physical functionality (17 questions). In 5-point Likert form, 0 is none while 4 is extreme pain, with 0 as the best and 96 as the worst. The Turkish reliability and validity studies were conducted by Tüzün et al. (15).

Statistical Analysis

Data was analyzed by using SPSS 20.0 (SPSS Inc., Chicago, IL, USA). Distribution of continuous variables was evaluated by Shapiro-Wilk test. Descriptive statistics were expressed as mean ± standard deviation (SD) for continuous variables and as median (minimum-maximum) for discrete variables. Number and percentage (%) were expressed for categorical variables. Comparisons between the groups in terms of sociodemographic and clinical characteristics were measured by Kruskal-Wallis test for mean values, Mann-Whithey U test for median values and chi-square test (or Fisher's exact test) for categorical variables. The Wilcoxon Signed-Ranks test was used to determine statically significant changes in VAS and WOMAC scores between before and after the treatment. $P<0.05$ was considered statistically significant.

Results

The comparison of socio-demographic characteristics, clinical properties and radiographic evaluation of the groups was shown in Table 1. There was no statistically significant difference in these parameters between the groups except baseline pain

Table 1. The comparison of baseline characteristics and clinical parameters of the groups

	Group 1 (n=20)	Group 2 (n=31)	p
Age (years)	65.4±8.41	62.77±9.10	0.30
BMI (kg/m^2)	32.46±5.08	33.21±5.03	0.60
Educational level n (%)			
Illiterate	3 (15)	6 (19.35)	0.92
Primary school High school	13 (65) 4 (20)	9 (61.3) 6 (19.35)	
Work status n (%)			0.66
Working	1 (5)	2 (6.5)	
Housewife/retired	19 (95)	29 (93.5)	
VAS median(min-max)			
Rest	5 (2-8)	3 (0-8)	0.01
Activity	8 (7-10)	7 (5-8)	0.01
Kellgren-Lawrence scale			
Grade 1	0 (0)	1 (3.2)	0.14
Grade 2	3 (15)	12 (38.7)	
Grade 3	11 (55)	14 (45.2)	
Grade 4	6 (30)	4 (12.9)	
WOMAC scores			
Pain	13.5 (7-20)	10 (5-18)	0.01
Stiffness	2.5 (0-6)	2 (0-6)	0.38
Physical function	43 (20-40)	34 (18-52)	0.11

n: Number of patients per group, %: Percantage of patients per group, (p<0.05) is considered as statistically significant, BMI: Body mass index, VAS: Visuel analog scale, WOMAC: Western Ontario McMaster Osteoarthritis Index

at rest and activity (p<0.05). The comparison of treatment changes (Δ) of the clinical parameters according to baseline values (mean ± SD) was demonstrated in Table 2. According to, within each group, significant improvements were observed in all clinical variables (p<0.05). The comparison of treatment changes of the clinical parameters according to baseline values was shown in Table 3. According to baseline values, there was no significant differences in the changes in outcome scores (Δ) between the groups (p>0.05).

Table 2. Pre- and post-treatment visuel analog scale and Western Ontario McMaster osteoarthritis index values of both groups

	Pre-treatment Median (min-max)	Post-treatment Median (min-max)	p
VAS at rest			
Group	5 (2-8)	3 (0-6)	<0.001
Group 2	3 (0-8)	2 (0-5)	<0.001
VAS activit			
Group 1 Group 2	8 (7-10) 7 (5-8)	5 (4-6) 5 (0-8)	0.001 <0.001
WOMAC Pain			
Group 1 Group 2	13.5 (7-20) 10 (5-18)	7.5 (3-15) 5 (0-13)	<0.001 <0.001
WOMAC Stiffness			
Group 1 Group 2	2.5 (0-6) 2 (0-6)	0.5 (0-4) 1 (0-4)	0.001 <0.001
WOMAC Physical function			
Group 1 Group 2	43 (20-50) 34 (18-52)	25 (12-39) 19 (4-49)	<0.001 <0.001

VAS: Visuel analog scale, WOMAC: Western Ontario McMaster Osteoarthritis index

Table 3. The comparison of treatment changes (Δ) of the clinical parameters according to baseline values

	Group 1 (n=20) Median (min-max)	Group 2 (n=31) Median (min-max)	p
ΔVAS			
Rest	3 (0-5)	3 (0-6)	0.32
Activity	3 (0-5)	3 (0-6)	0.32
ΔWOMAC			
Pain	5 (2-10)	5(0-11)	0.33
Stiffness	2 (0-4)	1 (0-5)	0.34
Physical function	14.5 (7-27)	14 (0-33)	0.99

n: Number of patients per group, Δ: The changes of parameters
VAS: Visuel analog scale, WOMAC: Western Ontario McMaster osteoarthritis index Min: Minimum, Max: Maximum

Discussion

TENS is a recommended treatment for relief of pain in recent guidelines for the management of knee OA. The use of TENS is important due to considerable gastrointestinal and cardiac side effects of pharmacological agents commonly used in the treatment of OA (16). There have been a number of systematic review/meta-analyses that have explored efficacy of TENS in knee OA. As a whole, these reviews are conflicting with some showing efficacy and some showing no efficacy for the use of TENS (17,18). The recommendation level of TENS in the guidelines (2014) developed by Osteoarthritis Research Society International was uncertain for knee OA (19). Chen et al. (20) evaluated the efficacy of TENS for the management of knee OA in their systematic review and meta-analysis. They found that TENS significantly decreased pain compared with control group but there was no significant difference in the WOMAC index between the TENS and control groups (20). The present study showed that both knee pain and physical function assessment parameters were improved significantly in

knee OA with NP. Atamaz et al. (21) investigated the efficacy of electrical stimulation forms for the management of knee OA in their double-blind, randomized, controlled, multicenter trial and they showed that both knee pain and function assessment parameters were improved with TENS therapy. Cherian JJ et al. (22,23) found that TENS has a significant effect on the reduction of pain in OA of the knee in their studies (22,23). The results of this study are consistent with the results of the before mentioned studies in confirming the effectiveness of TENS in osteoarthritic knees but there was not a placebo TENS group in this study so we could not show the superiority of TENS treatment over placebo group.

Neuropathic mechanisms can play role in the pain of OA (1,2). NP due to arthritis can lead to a marked impairment in patients' quality of life (24). In the past years, there have been a number of studies that have investigate defficacy of TENS for pain reduction in people with several pain conditions, but to our knowledge there are only a limited number of studies that use TENS for treatment of NP (7-9). TENS strengthens local inhibitory controls and is indicated in focal NP (5). The advantage of TENS therapy is that it can be used in combination with drug therapy, thus decreasing drug dosage and adverse effects. There are too few randomized controlled trials on TENS for NP to judge effectiveness (10). Kılınç et al. (25) investigated the effects of TENS therapy on pain intensity and functional capacity in patients with NP and they found that TENS therapy was effective in the NP patients. Allodynia and hyperalgesia are the two common sensation disorders in patients with NP (26). Previous studies have demonstrated that TENS is effective for decreasing mechanic hyperalgesia. Ainsworth et al. (27) found that TENS relieves primary mechanic hyperalgesia caused by joint inflammation. In this study knee patients with NP reported allodynia and hyperalgesia in their pain complaints. Pain VAS at rest, pain VAS with activity and WOMAC pain scores of the knee OA patients with NP were significantly higher than the other group. The decrease in VAS and WOMAC pain scores at the end of the treatment was statistically significant. The results of this study showed that TENS was effective in reducing pain and improving physical function in knee OA patients with NP. The European Federation of Neurological Societies determined that TENS is superior to placebo. This is based on 9 controlled trials with data obtained from 200 NP patients. Trial reports suggest that TENS is more useful than placebo for chronic pain that includes neuropathic elements (10). However, this information does not prove the lack of control group in our study. This study has several limitations. An important limitation of this study is the absence of a third group with no-treatment or sham TENS. Second we can't conclude whether hot pack and TENS without exercise have similar effects on improvement for knee pain, because there was no group consisting of use of physical therapy agents alone. Third, our follow-up period was short, we did not assess the long-term follow-up effects of TENS. Future work should purpose to evaluate patients with longer follow-up. In addition, our sample size is small that our results need to be verified by further controlled studies on a wider population.

Conclusion

This study showed that the pain intensity decreased and physical function improved significantly following TENS therapy in knee OA patients with and without NP. TENS therapy can be used in clinical practice as part of the treatment of NP in knee OAs. The advantage of TENS therapy is that it can be used in combination with drug therapy, thus decreasing drug dosage and adverse effects.

Ethics

The Local Ethics Committee of Ankara Physical Medicine and Rehabilitation Training and Research Hospital approved the study and written consent was taken from each patient.

Informed Consent: It was taken.

Peer-review: Internally peer-reviewed.

Authorship Contributions

Surgical and Medical Practices: C.S.P., Concept: C.S.P., A.D., B.F.K., Design: C.S.P., Ş.Ş.O., Data Collection or Processing: C.S.P., S.K.A., Analysis or Interpretation: C.S.P., D.S.Ö., Literature Search: C.S.P., Writing: C.S.P.

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