Original Investigation / Orijinal Araştırma

DOI: 10.4274/tod.galenos.2025.53765
Turk J Osteoporos

Comparison of the Effectiveness of Short-wave Diathermy and Extracorporeal Shock Wave Therapy in Knee Osteoarthritis: A Quasi-experimental Clinical Study

Diz Osteoartritinde Kısa Dalga Diatermi ve Ekstrakorporeal Şok Dalga Tedavisinin Etkinliğinin Karşılaştırılması: Yarı Deneysel Klinik Çalışma

Ayla Çağlıyan Türk[1], Sevil Okan[2]

[1]Hitit University Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Çorum, Türkiye
[2]Gaziosmanpaşa University Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Tokat, Türkiye

Abstract

Objective: Physical therapy agents are widely used in knee osteoarthritis (OA) to relieve symptoms and improve function. This study aimed to compare the effectiveness of combined physical therapy protocols including short-wave diathermy (SWD) or extracorporeal shock wave therapy (ESWT) on pain and functional status in patients with knee OA.

Materials and Methods: A prospective, quasi-experimental trial was conducted with 49 patients with stage 2-3 knee OA. Group 1 received hot pack (HP) + transcutaneous electrical nerve stimulation (TENS) + SWD, while Group 2 received HP + TENS + ESWT. ESWT was administered once weekly for four sessions. Patients were evaluated at baseline, post-treatment, and at 3 and 6 months using the visual analog scale (VAS), the Western Ontario and McMaster Universities osteoarthritis index (WOMAC), and the Lequesne OA severity index.

Results: Mean ages were 58.3±5.2 years (Group 1) and 54.9±6.5 years (Group 2) ($p>0.05$). Both groups showed significant improvements at all follow-ups compared to baseline ($p<0.05$). Group 1 demonstrated greater short-term improvements, particularly in rest VAS, Lequesne index scores and WOMAC scores ($p<0.05$). By 6 months, no significant differences were found between the groups ($p>0.05$).

Conclusion: Both combined protocols were effective in knee OA. SWD showed superior short-term effects, while mid-term outcomes were comparable.

Keywords: Knee osteoarthritis, short-wave diathermy, extracorporeal shock wave therapy

Öz

Amaç: Fizik tedavi ajanları, diz osteoartritinde (OA) semptomların hafifletilmesi ve fonksiyonların iyileştirilmesi amacıyla yaygın olarak kullanılmaktadır. Bu çalışmanın amacı, kısa dalga diatermi (KDD) veya ekstrakorporeal şok dalga tedavisini (ESWT) içeren kombine fizik tedavi protokollerinin diz OA'lı hastalarda ağrı ve fonksiyonel durum üzerine etkinliğini karşılaştırmaktır.

Gereç ve Yöntem: Evre 2-3 diz OA'sı olan 49 hasta ile prospektif, yarı deneysel bir çalışma yürütüldü. Grup 1'e sıcak paket (HP) + transkutanöz elektriksel sinir stimülasyonu (TENS) + KDD, Grup 2'ye ise HP + TENS + ESWT uygulandı. ESWT haftada bir olmak üzere toplam dört seans yapıldı. Hastalar başlangıçta, tedavi bitiminde, 3. ve 6. aylarda görsel analog skala (VAS), Western Ontario and McMaster Universities osteoartrit indeksi (WOMAC) ve Lequesne OA şiddet indeksi ile değerlendirildi.

Bulgular: Ortalama yaş Grup 1'de 58,3±5,2, Grup 2'de 54,9±6,5 yıl idi ($p>0,05$). Her iki grupta da tüm takiplerde başlangıca göre anlamlı iyileşme görüldü ($p<0,05$). Grup 1, kısa dönemde özellikle istirahat VAS, Lequesne indeksi skorları ve WOMAC skorlarında daha belirgin düzelme gösterdi ($p<0,05$). Altıncı ayda ise gruplar arasında anlamlı fark bulunmadı ($p>0,05$).

Sonuç: Her iki kombine protokol de diz OA tedavisinde etkilidir. KDD kısa dönemde daha üstün görünse de orta vadede sonuçlar benzerdir.

Anahtar kelimeler: Diz osteoartriti, kısa dalga diatermi, ekstrakorporeal şok dalga tedavisi

Corresponding Author/Sorumlu Yazar: Assoc. Prof. Sevil Okan, Gaziosmanpaşa University Faculty of Medicine, Department of Physical Medicine and Rehabilitation, Tokat, Türkiye
E-mail: doctorsevil@yahoo.com **ORCID ID:** orcid.org/0000-0002-0446-6866
Received/Geliş Tarihi: 03.09.2025 **Accepted/Kabul Tarihi:** 08.10.2025 **Epub:** 27.10.2025

Cite this article as/Atıf: Çağlıyan Türk A, Okan S. Comparison of the effectiveness of short-wave diathermy and extracorporeal shock wave therapy in knee osteoarthritis: a quasi-experimental clinical study. Turk J Osteoporos. [Epub Ahead of Print]

Introduction

Osteoarthritis (OA) is the most prevalent chronic rheumatic disease and is one of the leading causes of pain and disability worldwide. Its prevalence is strongly associated with aging and is more common in women than in men (1). Although OA can affect many joints, weight-bearing joints such as the knee are particularly at risk, with the knee joint being the most commonly affected site. Radiographic signs of knee OA (KOA) are observed in approximately 30% of individuals over the age of 45, and about half of these individuals experience clinical symptoms (2). The etiology and progression mechanisms of OA are not yet fully understood, and therefore, current treatments cannot provide complete recovery (3). The primary aims of treatment are to alleviate pain, reduce functional limitations, and improve quality of life (4). Treatment options for KOA are diverse and include biomechanical interventions, intra-articular corticosteroids, exercise, self-management and education, weight management, paracetamol, balneotherapy, capsaicin, mobility aids, duloxetine, oral and topical non-steroidal anti-inflammatory drugs (NSAIDs), and physical therapy modalities (5).

Physical therapy agents are modalities that use physical modalities to achieve therapeutic effects. Heat, cold, and electricity have been used since ancient times to relieve and manage pain (3). Shortwave diathermy (SWD) is an electrotherapy modality used in the treatment of KOA. The application of continuous electromagnetic radiation in SWD increases tissue temperature, which leads to vasodilation, reduction in muscle spasms, acceleration of cellular activity, and elevation of the pain threshold (6).

In recent years, extracorporeal shock wave therapy (ESWT) has been widely used in the treatment of musculoskeletal disorders such as epicondylitis, plantar fasciitis, and calcific tendinitis (5). ESWT is increasingly being utilized in patients with KOA (7,8). Its advantages include being non-invasive, having a low complication rate, not requiring hospitalization, and being relatively cost-effective compared to other modalities (8). While most studies have reported superior analgesic effects of ESWT compared to placebo (5,8), some have reported comparable efficacy between ESWT and placebo in pain control (9).

When we reviewed the literature, we found no studies directly comparing SWD and ESWT within combined physical therapy applications for KOA. SWD has been used for decades as a conventional physical therapy modality, whereas ESWT has emerged more recently and gained popularity due to its non-invasive nature and promising results in musculoskeletal disorders. Since both methods are commonly applied in clinical practice but differ in mechanisms of action and application, it is important to investigate whether one offers superior clinical outcomes. Therefore, the aim of the present study was to compare the effectiveness of combined physical therapy protocols including SWD or ESWT in patients with KOA.

Materials and Methods

The study was conducted between November 2020 and June 2021 at the Physical Medicine and Rehabilitation Outpatient Clinics of Hitit University Faculty of Medicine and Tokat Gaziosmanpaşa University Faculty of Medicine, involving patients who presented with complaints of knee pain. The study was approved by the Institutional Ethics Committee (337/2020). The study was conducted in accordance with the principles set forth in the Declaration of Helsinki. Written informed consent was obtained from all patients before the study.

Inclusion criteria were; age between 40 and 65 years, diagnosis of KOA according to the American College of Rheumatology criteria (10), presence of unilateral knee joint pain persisting for at least 6 months and unresponsive to medical treatments, Kellgren-Lawrence (KL) radiographic stage II or III (11), agree to participate in the study. Exclusion criteria included; bilateral knee symptoms, history of surgery or intra-articular injection/ physical therapy within the past 6 months in the affected knee, secondary OA of the knee joint (inflammatory or metabolic origin), contraindications to ESWT or SWD (e.g., metallic implants, infection or tumor near the treatment site, coagulation disorders, or pregnancy).

Outcome measures for assessing treatment efficacy included; pain scores using the visual analog scale (VAS) at rest and during activity, Western Ontario and McMaster Universities osteoarthritis index (WOMAC, Turkish version), Lequesne OA severity index.

VAS: Developed by Price et al. (12), the VAS is used to evaluate pain severity. It consists of a 10-cm horizontal or vertical line with two anchors (0= no pain, 1= worst imaginable pain). Patients are instructed to mark the point that corresponds to the intensity of pain they feel. The distance (in cm) from the "no pain" anchor to the marked point is recorded as the pain score (12).

The Turkish version of the WOMAC scale was validated by Tüzün et al. (13). The WOMAC OA scale consists of three sections and 24 questions that assess pain, stiffness, and physical function. Higher WOMAC scores indicate increased pain and stiffness and greater impairment in physical function (13,14).

The Lequesne OA severity index was used to assess OA severity. This disease-specific tool evaluates pain, maximum walking distance, and daily living activities. The total score ranges from 0 to 24: 1-4: Mild, 5-7: Moderate, 8-10: Severe, 11-13: Very severe, ≥14: Extremely severe functional impairment (15).

Patients were quasi-experimental into two groups according to the order of their arrival at the outpatient clinic.

Group 1: Hot pack (HP) + TENS + SWD

Group 2: HP + TENS + ESWT.

The physical therapy modalities were applied five days per week for four weeks. In the ESWT group, ESWT was administered once weekly for a total of four sessions.

The full physical therapy program consisted of 20 sessions (1 session/day, 5 sessions/week) for both groups, with 4 additional sessions of ESWT. HPs were applied around the knee for 20

minutes. TENS was applied bilaterally for analgesic purposes using a Danmeter device in burst mode, with 20-minute sessions per knee.

Shortwave Diathermy: SWD was applied with the patient seated on a wooden chair, knees in 90° flexion. Electrodes (12 cm in diameter) were placed parallel to the knees, and treatment was administered in continuous mode (frequency =27.12 MHz), thermal dose, for 20 minutes per session across 10 sessions. The device used was Curapulse 970 (Enraf-Nonius, Rotterdam, Netherlands).

Both the ultrasound and SWD machines were calibrated annually in accordance with the IEC 60601-1 international standard.

Extracorporeal Shock Wave Therapy: ESWT was administered once weekly for a total of four sessions on the same day of the week. The ESWT was applied by a physiotherapist who had received specific training in this area. During each session, patients lay in the supine position with the target knee flexed at 90°. The physiotherapist identified the pain points of the target knee via palpation and marked the painful areas along with the patellofemoral and tibiofemoral borders. Ultrasound gel was applied to the skin surface in contact with the ESWT probe. Therapy parameters included 2000 shocks delivered at a frequency of 8 Hz and pneumatic pressure of 2.5 bar (5). The first 1000 shocks were distributed equally across the identified pain points (maximum of four points). The remaining shocks were applied by moving the probe back and forth along the patellofemoral and tibiofemoral borders. No local anesthesia or other injections were used.

Both groups were given the same home exercise program, which consisted of isometric strengthening exercises for the quadriceps muscle. The exercise was planned as three sets of ten repetitions.

Evaluations were performed both before and after treatment. The researchers performing the evaluations were blinded to treatment allocation.

Sample size: To determine the number of participants in the intervention and control groups, a power analysis was performed using the G*Power (version 3.1.9.4; Düsseldorf University) software package, referencing the study by Lizis at al. (16). The analysis resulted in a sample size of 22 participants per group, based on an effect size of 0.7, 80% power, and α=0.05 type I error.

Statistical Analysis

Continuous quantitative variables were expressed as mean ± standard deviation, while categorical variables were expressed as counts, median (Q2), 25th (Q1), and 75th (Q3) percentiles. Normality of distribution was assessed using the Kolmogorov-Smirnov and Shapiro-Wilk tests. For normally distributed independent variables, the Independent Samples t-test was used. For non-normally distributed independent variables, the Mann-Whitney U test was used. For dependent variables from repeated measures, the Friedman Repeated Measures Analysis of Variance on Ranks test was applied. Categorical variables were analyzed using chi-square tests. A p-value of <0.05 was considered statistically significant. All data analyses were performed using IBM SPSS Statistics version 21.

Results

The mean age was 58.3±5.2 years in the SWD group and 54.9±6.4 years in the ESWT group, with no statistically significant difference between them (p>0.05). The mean BMI was 31.4±5.0 kg/m² in Group 1 and 33.3±8.0 kg/m² in Group 2, also with no significant difference (p>0.05). Groups were similar in terms of sex and occupation distribution (p>0.05), with the majority being housewives in both groups. The most common comorbidities were diabetes and hypertension. The demographic data of the groups are presented in Table 1.

In the comparison between Group 1 and Group 2, all baseline parameters were similar (p>0.05). At the 1st month post-treatment, Group 1 (SWD) had significantly lower scores in resting VAS, WOMAC pain, stiffness, physical function, and total scores, as well as Lequesne index scores for pain, quality of life, and total (p<0.05). At the 3rd month post-treatment, WOMAC pain, stiffness, physical function, and total scores remained significantly lower in Group 1 (p<0.05). By the 6th month post-treatment, there were no significant differences between the two groups for any of the parameters (p>0.05) (Tables 2-4).

In the SWD group, resting and activity VAS, WOMAC pain, stiffness, physical function, and total scores, as well as Lequesne index scores for pain, walking distance, quality of life, and total, significantly improved at the 1st, 3rd, and 6th months compared to baseline (p<0.05). However, no statistically significant

Table 1. Demographic data

Variables	Group	n	Mean	SD	Median	Q1	Q3	p
Age	SWD	25	57.5	5.7	58.0	55.0	62.5	0.137
	ESWT	24	54.9	6.4	55.5	50.0	60.0	
BMI	SWD	25	31.4	5.0	31.9	27.3	34.2	0.154
	ESWT	24	33.3	4.0	33.9	30.1	36.1	
Kellgren-Lawrence	SWD	25	2.4	0.50	2.0	2.0	3.0	0.064
	ESWT	24	2.6	0.48	3.0	2.0	3.0	

SD: Standard deviation, BMI: Body mass index, SWD: Short-wave diathermy, ESWT: Extracorporeal shock wave therapy

Table 2. Comparison of pain by groups

Variables	Group	n	Mean	SD	Median	Q1	Q3	p
Rest VAS pretreatment	SWD	25	4.6	1.6	5.0	3.5	6.0	0.082
	ESWT	24	5.6	1.8	5.5	4.0	7.7	
Rest VAS 1st month	SWD	25	1.2	1.8	0.0	0.0	2.5	**0.033**
	ESWT	24	2.0	1.6	2.0	1.0	3.0	
Rest VAS 3rd month	SWD	25	1.4	2.4	0.0	0.0	2.5	0.258
	ESWT	24	1.7	2.3	1.0	0.0	2.7	
Rest VAS 6th month	SWD	25	1.7	2.2	0.0	0.0	3.0	0.213
	ESWT	24	0.8	1.6	0.0	0.0	1.0	
Activity VAS pretreatment	SWD	25	7.7	1.3	8.0	6.5	9.0	0.196
	ESWT	24	8.2	0.7	8.0	8.0	9.0	
Activity VAS 1st month	SWD	25	3.0	2.5	3.0	0.5	5.0	0.051
	ESWT	24	4.1	1.5	4.0	3.0	5.0	
Activity VAS 3rd month	SWD	25	2.7	3.0	2.0	0.0	4.5	0.516
	ESWT	24	2.8	2.4	2.0	1.0	4.7	
Activity VAS 6th month	SWD	25	3.1	3.4	2.0	0.0	6.5	0.597
	ESWT	24	1.6	2.0	1.0	0.0	2.0	

Mann-Whitney Rank-Sum test, Median (Q1-Q3), SD: Standard deviation, SWD: Short-wave diathermy, ESWT: Extracorporeal shock wave therapy, VAS: Visual analog scale

differences were observed between the 1st, 3rd, and 6th month measurements for all parameters (p>0.05).

In the ESWT group, resting and activity VAS, WOMAC pain, stiffness, physical function, and total scores, along with Lequesne index scores for pain, walking distance, quality of life, and total, also showed significant improvement at the 1st, 3rd, and 6th months compared to baseline (p<0.05). When comparing the 1st and 6th months, significant improvements were observed in activity VAS, WOMAC stiffness, WOMAC physical function, WOMAC total, and Lequesne index for pain, quality of life, and total scores (p<0.05). In the comparison between month 3 and month 6, only the Lequesne quality of life and total scores showed further improvement (p<0.05).

Discussion

In our study comparing the effect of the treatment package including SWD and ESWT in the treatment of KOA, we found that both modalities were effective. However, treatment package including SWD demonstrated a superior effect compared to treatment package including ESWT in terms of pain, physical function, and disability in patients with chronic KOA.

There are various opinions regarding the effectiveness of physical therapy agents in the treatment of KOA (9,17). Most studies conducted with ESWT are placebo-controlled, and no prior studies comparing SWD and ESWT were found in the literature (1,5). The exact mechanism of action of ESWT is not fully understood. However, it is believed that ESWT induces neovascularization by disrupting microvascular structures in the treated area, followed by the release of local growth factors that promote tissue regeneration from stem cells, thereby accelerating healing and reducing pain (18). ESWT has been shown to inhibit nitric oxide production in knee synovium, reduce chondrocyte apoptosis, and cause selective dysfunction of sensory unmyelinated nerve fibers (5).

In studies evaluating the use of ESWT in the treatment of KOA, the results have been variable while some have reported its effectiveness, others have found its outcomes to be comparable to placebo (5,9,18). These discrepancies may be attributed to differences in total energy flux density and variations in patient positioning during treatment (5). In a study by Zhao et al. (1), 4000 shock waves at 0.25 mJ/mm² and 6 Hz were applied to the intervention group, and assessments at 1 and 3 months using pain, WOMAC, and Lequesne indices revealed significant pain reduction and improved function. Zhong et al. (4) applied 2000 shocks at 2.5 bar pneumatic pressure and 8 Hz in patients with KL grade II or III KOA and concluded that a 4-week low-dose ESWT course was superior to placebo in pain relief, with effects lasting up to 12 weeks in most patients (5). Another study divided 60 patients with KOA into low- and medium-energy ESWT groups and applied weekly sessions for 3 weeks. Significant improvements were observed in VAS, WOMAC, and Lequesne index scores at weeks 1, 4, and 12 in both groups, with greater improvement in the medium-energy group (5). In a study involving patients with mild KOA, ESWT was compared with sham therapy. Both groups showed improvements in VAS, WOMAC, and Lequesne scores, but ultrasonographic evaluation revealed a reduction in suprapatellar effusion only in the ESWT group, which persisted through the 1-month follow-up (19). In our study, ESWT led to significant improvements

Table 3. Western Ontario and McMaster Universities osteoarthritis index (WOMAC) comparison by groups

Variables	Group	n	Mean	SD	Median	Q1	Q3	p
WOMAC pain pretreatment	SWD	25	5.0	1.2	5.0	4.0	5.7	0.057
	ESWT	24	5.7	1.6	5.7	5.0	7.0	
WOMAC pain 1st month	SWD	25	1.1	1.6	0.0	0.0	2.0	**0.009**
	ESWT	24	1.8	1.2	1.7	0.6	2.5	
WOMAC pain 3rd month	SWD	25	1.0	1.8	0.5	0.0	1.2	**0.047**
	ESWT	24	1.5	1.7	1.0	0.5	2.3	
WOMAC pain 6th month	SWD	25	1.4	2.1	0.0	0.0	3.2	0.672
	ESWT	24	1.1	1.4	0.7	0.0	1.3	
WOMAC Stiffness pretreatment	SWD	25	5.3	1.4	6.0	5.0	6.2	0.064
	ESWT	24	5.9	2.3	6.2	5.0	7.5	
WOMAC Stiffness 1st month	SWD	25	0.7	1.8	0.0	0.0	0.0	**0.001**
	ESWT	24	2.3	1.7	2.5	1.2	3.7	
WOMAC Stiffness 3rd month	SWD	25	0.5	1.2	0.0	0.0	0.0	**0.002**
	ESWT	24	1.7	1.8	1.2	0.0	3.4	
WOMAC Stiffness 6th month	SWD	25	0.7	1.3	0.0	0.0	1.8	0.796
	ESWT	24	0.8	1.5	0.0	0.0	1.2	
WOMAC physical function pretreatment	SWD	25	5.2	1.5	5.0	4.0	6.6	0.052
	ESWT	24	6.0	1.9	6.4	4.9	7.3	
WOMAC physical function 1st month	SWD	25	1.1	1.6	0.5	0.0	1.6	**0.001**
	ESWT	24	2.5	1.4	2.6	1.5	3.6	
WOMAC physical function 3rd month	SWD	25	1.1	1.7	0.2	0.0	1.6	**0.037**
	ESWT	24	1.7	1.5	1.6	0.5	2.5	
WOMAC physical function 6th month	SWD	25	1.6	2.0	0.4	0.0	3.9	0.910
	ESWT	24	1.0	1.1	0.5	0.1	1.3	
WOMAC total pretreatment	SWD	25	17.0	1.3	17.4	16.2	18.0	0.063
	ESWT	24	17.9	4.5	18.6	14.7	21.5	
WOMAC total 1st month	SWD	25	2.7	4.5	0.5	0.0	3.4	**0.001**
	ESWT	24	7.0	3.4	6.5	4.3	9.4	
WOMAC total 3rd month	SWD	25	2.8	4.7	0.6	0.0	3.3	**0.010**
	ESWT	24	4.9	4.8	3.0	1.2	7.4	
WOMAC total 6th month	SWD	25	3.7	5.1	0.5	0.0	8.1	0.521
	ESWT	24	2.9	3.6	1.5	0.4	5.1	

Mann-Whitney Rank-Sum test, Median (Q1-Q3), SD: Standard deviation, SWD: Short-wave diathermy, ESWT: Extracorporeal shock wave therapy

in pain, functional outcomes, and quality of life at follow-up, demonstrating sustained benefits over time. Compared with other treatment options, ESWT offers several advantages, including its non-invasive nature, low complication rate, avoidance of hospitalization, and cost-effectiveness (19).

In another study, Mostafa et al. (20) compared the effectiveness of ESWT and high-intensity laser therapy (HILT) in 40 patients with KL grade II KOA. The ESWT group received 0.05 mJ/mm² once weekly for 4 weeks, while the HILT group received three weekly sessions over the same period. Both groups received standard physiotherapy programs. Statistically significant improvements were reported in both groups, with HILT demonstrating superior effects in pain and physical function (20). In a study by Zhao et al. (21), one group received ESWT, the second group electroacupuncture, and the third topical NSAIDs (control). Comparisons were made at weeks 0, 2, and 4 in terms of pain, WOMAC, and quality of life. The authors reported that electroacupuncture and the combination of ESWT with pharmacotherapy were more effective than conventional drug therapy, and that ESWT and electroacupuncture had comparable efficacy (21). Our results indicate that SWD may provide superior pain relief and functional improvement compared to ESWT in

Table 4. Lequesne OA severity index comparison by groups

Variables	Group	n	Mean	SD	Median	Q1	Q3	p
Lequesne pain pretreatment	SWD	25	5.3	1.3	5.0	4.0	7.0	0.073
	ESWT	24	6.0	1.3	6.0	6.0	7.0	
Lequesne pain 1st month	SWD	25	1.2	1.8	1.0	0.0	2.0	**0.001**
	ESWT	24	2.6	1.5	2.0	2.0	4.0	
Lequesne pain 3rd month	SWD	25	1.1	1.9	0.0	0.0	2.0	0.056
	ESWT	24	1.6	1.5	1.0	0.2	3.0	
Lequesne pain 6th month	SWD	25	1.3	1.7	0.0	0.0	3.0	0.744
	ESWT	24	0.9	1.1	0.5	0.0	1.7	
Lequesne distance pretreatment	SWD	25	2.2	1.3	2.0	1.0	3.0	0.296
	ESWT	24	2.7	1.8	2.0	1.2	4.0	
Lequesne distance 1st month	SWD	25	0.8	0.6	1.0	0.0	1.0	0.383
	ESWT	24	1.0	0.8	1.0	0.2	1.7	
Lequesne distance 3rd month	SWD	25	0.8	0.8	1.0	0.0	1.5	0.395
	ESWT	24	0.7	1.0	0.0	0.0	1.0	
Lequesne distance 6th month	SWD	25	0.8	0.9	1.0	0.0	2.0	0.117
	ESWT	24	0.4	0.7	0.0	0.0	1.0	
Lequesne daily living activities pretreatment	SWD	25	4.4	1.0	4.0	4.0	5.0	0.229
	ESWT	24	4.7	1.2	4.5	4.0	5.7	
Lequesne daily living activities 1st month	SWD	25	1.4	1.7	1.0	0.0	3.0	**0.001**
	ESWT	24	3.0	1.1	3.0	2.0	4.0	
Lequesne daily living activities 3rd month	SWD	25	1.5	1.7	1.0	0.0	3.0	0.058
	ESWT	24	2.2	1.5	2.0	1.0	4.0	
Lequesne daily living activities 6th month	SWD	25	1.6	1.8	1.0	0.0	4.0	0.967
	ESWT	24	1.2	1.1	1.0	0.2	2.0	
Lequesne total pretreatment	SWD	25	12.2	2.1	13.0	11.0	14.0	0.054
	ESWT	24	13.5	3.1	14.0	12.0	15.7	
Lequesne total 1st month	SWD	25	3.5	3.8	3.0	0.0	5.5	**0.001**
	ESWT	24	6.7	2.5	7.0	5.0	8.0	
Lequesne total 3rd month	SWD	25	3.4	4.1	2.0	0.0	6.5	0.130
	ESWT	24	4.5	3.5	4.0	2.0	6.7	
Lequesne total 6th month	SWD	25	3.8	4.4	2.0	0.0	8.5	1.000
	ESWT	24	2.7	2.9	2.0	1.0	4.0	

Mann-Whitney Rank-Sum test, Median (Q1-Q3), SD: Standard deviation, SWD: Short-wave diathermy, ESWT: Extracorporeal shock wave therapy, OA: Osteoarthritis

patients with grade 2-3 KOA, emphasizing the need to consider clinical effectiveness when choosing adjunctive therapies.

The efficacy of SWD, a common physiotherapy modality in KOA, remains a topic of debate (6,17,22-26). In the study by Berktaş et al. (23), the effectiveness of pulsed SWD and therapeutic ultrasound was compared. Both modalities were found to be effective for pain, ROM, and functional parameters, with no superiority over one another (23). Similarly, Sarıfakıoğlu et al. (17) evaluated 132 patients with KOA, dividing them into ultrasound and SWD groups. Significant improvements in VAS and WOMAC scores were observed in both groups after 15 sessions, but no superiority between treatment agents was reported (17). Another study demonstrated that SWD reduced synovial tissue thickness on ultrasound, suggesting reduced synovitis, which was accompanied by a significant decrease in pain scores (24). In contrast, Akyol et al. (25) compared a group receiving SWD and exercise with an exercise-only group in 40 patients and found no significant difference between the groups. Likewise, Rattanachaiyanont and Kuptniratsaikul (26) evaluated 113 patients and concluded that SWD had no significant effect on

pain and function. Cetin et al. (27) reported that SWD improved adherence to exercise therapy in women with KOA. In our study, SWD appeared to provide notable improvements in both pain and functional outcomes, supporting its potential clinical benefit in patients with KOA.

Ultrasound, pulsed SWD combined with TENS and superficial heating agents have been shown to be effective treatment options for pain, physical function and quality of life in knee (23). Başar and Erhan (6) evaluated the efficacy of continuous SWD, US, and TENS in patients with KL stage 2-3 KOA, and reported that TENS was more effective than the other agents in terms of pain relief both immediately after treatment and at the 1-month follow-up, whereas SWD was found to be more effective in improving physical functions based on the repeated sit-to-stand and 20-meter walking tests. In our study, both groups received HP and TENS treatments. Both HP and TENS are modalities known to be effective in the treatment of KOA (17). However, since they were applied to both groups with identical protocols and durations, they were assumed to have no influence on between-group comparisons.

Study Limitations

Our study has several limitations. Patients were included consecutively based on their attendance at the outpatient clinic, and the study was not randomized, which may introduce selection bias and limit the generalizability of the findings. Additionally, no sham treatment was administered to create a control group, which restricts the ability to fully account for placebo effects. Future studies with larger sample sizes, randomization, and control groups are needed to confirm and strengthen the validity of these results. Despite these limitations, our study's strengths include being the first to compare SWD and ESWT within a combined treatment regimen and incorporating a 6-month mid-term follow-up, providing valuable insight into the sustained effects of these therapies.

Conclusion

This study demonstrated that both SWD and ESWT are effective modalities in the treatment of KOA. These agents are significant due to their ease of application, low cost, non-invasive nature, positive impact on quality of life, and rapid therapeutic response. In patients with appropriate indications, factors such as the clinical condition's impact on the choice of physical agent, patient compliance, available technical infrastructure, and physician preferences play crucial roles in treatment selection.

Ethics

Ethics Committee Approval: The study was conducted between November 2020 and June 2021 at the Physical Medicine and Rehabilitation Outpatient Clinics of Tokat Gaziosmanpaşa University and Hitit University Faculty of Medicine, involving patients who presented with complaints of knee pain. The study was approved by the Institutional Ethics Committee (337/2020).

Informed Consent: Written informed consent was obtained from all patients before the study.

Footnotes

It was uploaded for presentation as an oral presentation at the OSTEOAKADEMI 2025 symposium organized by the Turkish Osteoporosis Association.

Authorship Contributions

Concept: A.Ç.T., S.O., Design: A.Ç.T., S.O., Data Collection or Processing: A.Ç.T., S.O., Analysis or Interpretation: A.Ç.T., S.O., Literature Search: A.Ç.T., S.O., Writing: A.Ç.T., S.O.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

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