Immunopathologia Persa
http immunopathol.com
DOI:10.34172/ipp.2026.43885

Study and comparison of the effect of TECAR therapy in the symptoms and functions of the patients with knee osteoarthritis; a non-blind, controlled clinical trial

Shila Haghighat[1], Pooria Yeganehfard[2*], Hamed Zare Dehnavi[1], Mahdi Dastanpour Hoseinabadi[1]

[1]Department of Physical Medicine and Rehabilitation, Faculty of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran
[2]Faculty of Medicine, Isfahan University of Medical Sciences, Isfahan, Iran

***Correspondence to**
Pooria Yeganehfard, Email: Pooriayeganehfard@gmail.com

Received 24 Apr. 2025
Revised: 29 Jul. 2025
Accepted 10 Feb. 2026
ePublished 15 Apr. 2026

Keywords: Knee osteoarthritis, TECAR therapy, Capacitive and resistive electric transfer

Abstract

Introduction: Knee osteoarthritis is a prevalent condition contributing to disability worldwide, primarily treated with non-surgical approaches to alleviate pain and improve function. Transfer energy capacitive and resistive (TECAR) therapy is a non-invasive method gaining attention for managing musculoskeletal conditions, though its efficacy for knee osteoarthritis remains underexplored.

Objectives: To compare the effects of TECAR therapy and physiotherapy on symptoms and function in patients with knee osteoarthritis.

Patients and Methods: This single blind, randomized clinical trial compared the efficacy of TECAR therapy to standard physiotherapy in treating knee osteoarthritis at Amin hospital's physical therapy clinic (Isfahan university of medical sciences) during 2023-2024. Forty patients with mild to moderate knee osteoarthritis were divided into two groups: one received standard physiotherapy for 10 sessions, and the other underwent six sessions of TECAR therapy. Pain and functional outcomes were assessed using the Visual Analogue Scale (VAS) and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) at baseline and during follow-ups immediately after the treatment and at one and three months.

Results: Both groups showed significant improvements from baseline in VAS and WOMAC scores ($P<0.001$). However, TECAR therapy yielded greater reductions in pain and improvements in function, particularly at the three-month follow-up ($P<0.001$). The TECAR group also showed significant enhancements in WOMAC pain and stiffness sub-scores, attributed to TECAR's deep tissue heating effect, which facilitates improved circulation and cellular repair ($P<0.001$ and $P<0.005$, respectively).

Conclusion: TECAR therapy was effective for managing knee osteoarthritis, with greater improvements in pain and function than standard physiotherapy. Although limited by sample size and lack of placebo control, these findings support TECAR therapy as a promising non-surgical treatment for knee osteoarthritis.

Trial Registration: This trial protocol was approved by the Iranian Registry of Clinical Trial website (identifier: IRCT20190618043931N5; https://irct.behdasht.gov.ir/trial/75626, ethical code; IR.MUI.MED.REC.1402.444).

Citation: Haghighat Sh, Yeganehfard P, Zare Dehnavi H, Dastanpour Hoseinabadi M. Study and comparison of the effect of TECAR therapy in the symptoms and functions of the patients with knee osteoarthritis; a non-blind, controlled clinical trial. Immunopathol Persa. 2026;12(2):e43885. DOI:10.34172/ipp.2026.43885.

Introduction

Osteoarthritis is a chronic, progressive musculoskeletal disorder characterized by the degeneration of articular cartilage, subchondral bone remodeling, and synovial inflammation (1). With rising incidence and prevalence, osteoarthritis presents a significant public health concern, imposing a significant health burden on both patients and the healthcare system (2). The 2010 global burden of disease report highlights the high disability impact of hip and knee osteoarthritis, compared to other conditions (3). The report identified hip and knee osteoarthritis as one of the top contributors to global disability, using measures such as years lived with disabilities (YLDs) and disability-adjusted life years (DALYs). Worldwide, based on YLDs, hip and knee osteoarthritis ranked 11th as a contributor to disability (3). Between 1990 and 2010, YLDs related to hip and knee osteoarthritis increased from 10.5 million to 17.1 million. Among all age groups, the DALYs for hip and knee osteoarthritis rose from 0.42% in 1990 to 0.69% in 2010 (3). The osteoarthritis multifactorial nature, along with frequent comorbidities, makes early prevention and treatment challenging (4). Research into the epidemiology and pathogenesis of hip and knee osteoarthritis has advanced more than that for other joints, with significant interest in understanding the molecular pathways leading to cartilage degeneration, a key factor in the progression

Key point

- This randomized trial compared the effectiveness of transfer energy capacitive and resistive (TECAR) therapy and physiotherapy in patients with knee osteoarthritis.
- TECAR therapy showed superior improvement in symptoms and function compared to physiotherapy.
- The findings suggest that TECAR therapy may be a viable option for managing knee osteoarthritis.

of osteoarthritis. Aging, genetic factors, and obesity are among the primary risk factors for knee osteoarthritis.

Non-operative management remains the mainstay of treatment in early to moderate stages of osteoarthritis (Kellgren-Lawrence [KL] grade 1–3), while advanced osteoarthritis (KL grade 4) often requires surgical intervention as a definitive solution (5). Conventional non-operative therapeutic modalities aim to alleviate pain and include physical therapy, pharmacological interventions such as oral anti-inflammatory medications, and intra-articular injections (e.g., corticosteroids, hyaluronic acid, platelet-rich plasma) (6,7).

Transfer energy capacitive and resistive (TECAR) therapy is an emerging non-invasive physiotherapeutic intervention (8). The TECAR protocols utilize radiant energy to generate internal heat and are employed in musculoskeletal conditions to reduce pain, relax muscles, and improve flexibility (9). The resistive and capacitive modes of TECAR are both known for their therapeutic benefits (10). The two modes are delivered through different electrodes based on tissue resistance. The Capacitive mode, delivered via an insulating ceramic layer on the electrode targets, superficial and selectively low impedance tissues, while the Resistive mode, utilizing a non-insulated electrode, generates heat in deeper and more resistant tissue layers (11). Additionally, TECAR therapy has demonstrated promising outcomes in improving pain, reducing disability, and increasing range of motion when used for chronic low back pain, while also enhancing the benefits of exercise (10,12,13). Modern TECAR devices enable concurrent use with manual therapy or therapeutic exercise through special electrodes that effectively turn the therapist's hand into an electrode for a dynamic treatment approach. However, the efficacy of TECAR therapy in the context of knee osteoarthritis remains under-investigated.

Objectives

This randomized controlled trial was designed to compare the clinical efficacy of TECAR therapy with conventional physiotherapy in patients diagnosed with knee osteoarthritis.

Patients and Methods

Study design and participants

This randomized, single-center, single-blind, controlled clinical trial evaluates the effectiveness of TECAR therapy compared to standard physiotherapy. Conducted at the Department of Physical Medicine and Rehabilitation, Amin Hospital, affiliated with Isfahan University of Medical Sciences, the study spanned from August 2023 to October 2024. The study included patients referred to the Amin physical therapy clinic who met the following eligibility criteria:

Inclusion criteria

- Diagnosis of mild to moderate knee osteoarthritis based on the KL radiological grading system (14).
- Ages between 40 and 80 years old.
- A pain duration of at least one month.
- A VAS score >3 at baseline (15).
- Signed informed written consent to participate.
- Absence of contraindications for TECAR therapy (e.g., pregnancy, implantable cardioverter-defibrillators, cancer, open wounds or skin lesions, skin irritation, or heat sensitivity issues)
- No recent intra-articular interventions (hyaluronic acid within six months or corticosteroids within six weeks)

Exclusion criteria

- Non-compliance with study protocol or follow-up assessments.
- Patients who underwent knee surgery during follow-up or experienced osteoarthritis exacerbation due to factors such as intense exercise.
- Unwillingness to continue cooperation.
- Undergoing a similar intervention that could potentially interfere with or confound the effects of the study interventions.

Intervention

At baseline, patients underwent a comprehensive physical exam and demographic, pain, and osteoarthritis assessments. Pain was measured via the Visual Analogue Scale (VAS) and the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) (16). Accordingly, VAS is a patient-reported measure ranging from zero to 10, where higher scores indicate greater pain severity. The Persian version of the WOMAC questionnaire was conducted to assess functional status. It includes 24 items covering pain, function, and stiffness, each scored from 0 to 4, with a total score ranging from 0 to 96; higher scores reflect greater severity of osteoarthritis. The validity and reliability of the Persian version of the questionnaire have been established in a previous study (17). Participants were randomized into two intervention arms:

- Conventional physiotherapy group (n=20); patients received 10 sessions of standard physiotherapy, including infrared radiation, transcutaneous electrical nerve stimulation (TENS), and superficial thermotherapy via hot packs. Each session lasted 60 minutes and was administered on alternate days.
- TECAR therapy group (n=20); patients underwent

six sessions of TECAR therapy (WINBACK, France), administered twice weekly. Each session comprised a 5-minute capacitive phase followed by a 10-minute resistive phase. The treatment was individualized based on patient-reported thermal feedback. Patients were positioned in prone alignment, with knees flexed at 30 degrees. Two electrodes were attached, one at the abdominal level and the other on the posterior knee.

All patients in both groups also received adjunctive pharmacologic management (meloxicam 15 mg daily for two weeks) and were instructed to perform quadriceps-strengthening exercises twice daily throughout the intervention period.

Randomization

Randomization was conducted using Microsoft Excel, generating 46 unique random integers for allocation into the two treatment arms (n=23 each).

Blinding

Blinding of patients was not possible due to the use of distinct devices for TECAR therapy and physiotherapy, which were easily recognizable by the participants.

Sample size

Sample size was determined based on a 95% confidence level, 90% statistical power, a 5% margin of error, and the variance in NAS scores between TECAR and standard therapy groups reported in a prior study (18). A minimum of 20 patients per group was required.

Outcome measures

The primary outcome was defined as the change in VAS score at baseline, immediately post-treatment, and at 1- and 3-month follow-up intervals. Secondary outcome measures included changes in total and subdomain WOMAC scores (pain, stiffness, and physical function), which were assessed using the validated Persian version of the WOMAC questionnaire (17).

Statistical analysis

Statistical analysis data were assessed using SPSS version 26. Continuous variables were presented as means and standard deviations, while categorical variables were reported as frequencies and percentages. The Kolmogorov-Smirnov test assessed the normality of continuous variables. Treatment efficacy over time was evaluated using the Friedman test and repeated measures ANOVA. Between-group comparisons of continuous variables were performed using the independent sample T-test for the normally distributed data, and the Mann-Whitney U test for non-normally distributed data. The chi-square test was used to compare categorical variables between groups. Besides, for each statistical test, if the *P* value was less than 0.05, it was considered significant.

Results

A total of 69 patients were assessed for eligibility. Of those, 23 were excluded (21 did not meet the inclusion criteria and 2 declined to participate). The remaining 46 patients were randomized, with 23 allocated to the TECAR therapy group and 23 to the physiotherapy group. All patients received their assigned interventions. During follow-up, three participants in each group were lost due to non-compliance with questionnaire completion. Ultimately, 20 patients in each group completed the study and were included in the final analysis. The detailed flow of participants through the study is illustrated in the CONSORT diagram (Figure 1).

There were no significant differences between groups in terms of baseline characteristics, such as age and gender, as well as clinical measures including VAS and WOMAC scores and WOMAC sub-scores (pain, function, and stiffness), as shown in Table 1.

Both interventions produced statistically significant improvements in pain and functional indices over time, with no significant difference until the third month. The Friedman test indicated significant improvement in both groups. Additionally, WOMAC subdomain analysis revealed significantly greater reductions in stiffness and pain scores in the TECAR group across all follow-up points, whereas differences in functional improvement were more evident in the earlier follow-ups but not significant by the third month. Repeated measures ANOVA confirmed that TECAR therapy yielded greater overall improvement in WOMAC total and subdomain scores compared to physiotherapy alone. Results are explained in Table 2.

Table 3 presents the mean differences in scores for the VAS, WOMAC at different time intervals for both the Physiotherapy and TECAR therapy groups. The p-value indicates the statistical significance of the difference in these mean changes between the two groups.

Discussion

This trial demonstrates that TECAR therapy offers superior clinical benefits over conventional physiotherapy in the non-operative management of knee osteoarthritis. TECAR therapy is a non-ablative and noninvasive form of the combined contact diathermy and electrotherapy that improves therapeutic effects in the body, using high frequency (300 kHz to 1 MHz) long radiofrequency waves without external energy emission. The clinical efficacy of TECAR therapy has been evaluated for various musculoskeletal conditions, including pain in the lower back, shoulders, and legs (16). However, its effectiveness in treating knee osteoarthritis remains unclear. Previous investigations, including a trial by Coccetta et al (18) reported significant reductions in pain and disability following TECAR intervention in knee osteoarthritis, compared to a control group receiving sham treatment, corroborating our findings. The study included two groups of 31 and 22 patients in the intervention and study groups,

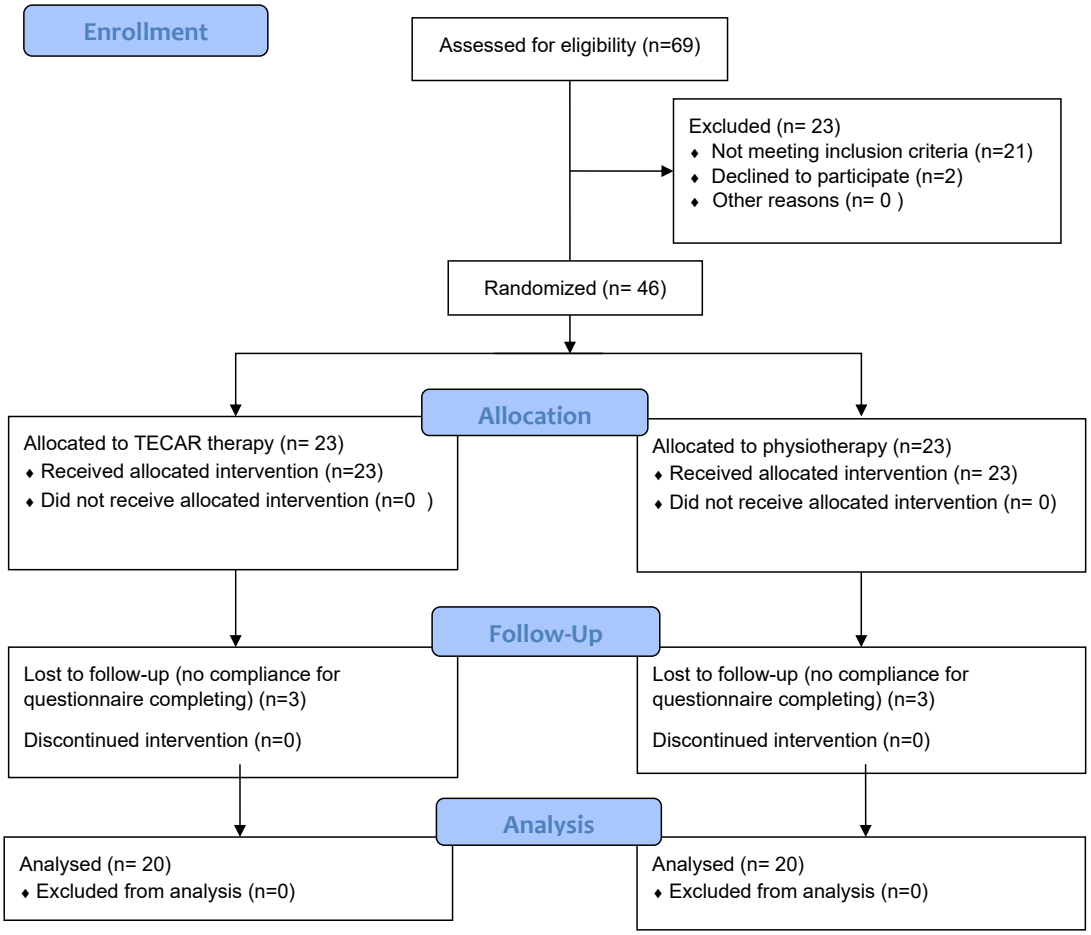

Figure 1. CONSORT flow diagram illustrating the progress of participants through each stage of the randomized clinical trial comparing TECAR therapy and conventional physiotherapy, including enrollment, allocation, follow-up and analysis

respectively. Patients received 2 weeks of treatment and were followed up at the end of the therapeutic sessions, one and three months after the final session. The results revealed a significant improvement in pain, as measured by WOMAC and VAS, with no significant improvement in the control group. The delayed peak efficacy observed at three months post-treatment aligns with evidence suggesting that TECAR-induced biological effects. Previous studies indicate that CRET acts by warming up deep tissues, which enhances cellular metabolism and increases oxygen delivery to tissues through improved vascular circulation, facilitating catabolite elimination (13) and stimulating stem cell proliferation to aid in tissue repair (19). In addition, other studies suggest that the

Table 1. Demographic characteristics (age and sex) and baseline scores (WOMAC and VAS) of patients before intervention with physiotherapy and TECAR therapy

Variable	Physiotherapy (n=20) Mean ± SD	TECAR therapy (n=20) Mean ± SD	*P* value	MD	SE
Age	66.2 ± 7.05	64.55 ± 5.95	0.429*	-1.65	2.06
Sex					
Male	5 (25%)	5(25%)	>0.999**		
Female	15 (75%)	15(75%)			
VAS	8.7 ± 0.47	9 ± 0.56	0.174***	0.30	0.16
WOMAC (total)	61.75 ± 2.45	62.75 ± 2.94	0.051*	1.00	0.86
WOMAC (pain)	16.65 ± 0.67	16.6 ± 0.99	0.947***	-0.05	0.27
WOMAC (function)	38 ± 1.45	39.1 ± 1.37	0.06***	1.10	0.45
WOMAC (stiffness)	7.1 ± 0.85	7.05 ± 0.83	0.862***	-0.05	0.27

SD: Standard deviation, TECAR: Transfer of energy capacitive and resistive. MD: Mean difference. SE: Standard error; VAS: Visual Analogue Scale, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index.

*The analysis was conducted by an independent sample T-test. **The analysis was conducted by chi-square. ***The analysis conducted by Mann-Whitney U test.

Table 2. VAS and WOMAC scores (total and subgroup scores) across three follow-ups in patients treated with physiotherapy and TECAR therapy, with statistical analysis of changes over time

Variable	Physiotherapy (n=20)	TECAR therapy (n=20)	P value	MD	SE
VAS					
Baseline	8.7 ± 0.47	9 ± 0.56	0.086*	0.30	0.16
After intervention conducting	4.55 ± 1.19	4.45 ± 0.51	0.786*	-0.10	0.29
1-month follow-up	4.25 ± 1.07	4.1 ± 0.64	0.918*	-0.15	0.28
3-month follow-up	4.8 ± 1.06	4.1 ± 0.55	0.014*	-0.70	0.27
P value	<0.001***	<0.001***			
Stiffness					
Baseline	7.1 ± 0.85	7.05 ± 0.83	0.841*	-0.05	0.27
After intervention conducting	3.1 ± 0.85	2.15 ± 0.99	0.004*	-0.95	0.29
1-month follow-up	2.95 ± 0.76	1.85 ± 0.81	<0.001*	-1.10	0.25
3-month follow-up	3.15 ± 0.75	2.25 ± 1.02	0.005*	-0.90	1.28
P value	<0.001***	<0.001***			
Pain					
Baseline	16.65 ± 0.67	16.6 ± 0.99	0.943*	-0.05	0.27
After intervention conducting	12.8 ± 0.77	11.55 ± 0.83	<0.001*	-1.25	0.25
1-month follow-up	11.25 ± 0.55	10.05 ± 0.94	<0.001*	-1.20	0.24
3-month follow-up	11.5 ± 0.51	10.6 ± 0.50	<0.001*	-0.90	0.16
P value	<0.001***	<0.001***			
Function					
Baseline	38 ± 1.45	39.1 ± 1.37	0.057*	1.10	1.45
After intervention conducting	40.65 ± 0.67	39.45 ± 0.69	<0.001*	-1.20	0.22
1-month follow-up	38.7 ± 0.47	37.5 ± 0.69	<0.001*	-1.20	0.19
3-month follow-up	37.3 ± 0.66	37.1 ± 0.97	0.485*	-0.2	0.26
P value	<0.001***	<0.001***			
WOMAC (total)					
Baseline	61.75 ± 2.45	62.75 ± 2.94	0.249**	1	2.86
After intervention conducting	56.55 ± 1.05	53.15 ± 1.23	<0.001**	-3.4	1.36
1-month follow-up	51.5 ± 0.95	49 ± 0.92	<0.001**	-2.5	0.30
3-month follow-up	53.35 ± 1.04	50.35 ± 0.93	<0.001**	-3	0.31
P value	<0.001****	<0.001****			

SD: Standard deviation, TECAR: Transfer of energy capacitive and resistive. MD: Mean difference. SE: Standard error; VAS: Visual Analogue Scale, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index.

*The analysis conducted by Mann-Whitney U test. **The analysis was conducted by an independent sample T-test. ***The analysis conducted using by Friedman test. ****The analysis conducted by repeated measure ANOVA test.

diathermy effect of TECAR therapy may also contribute to its clinical efficacy (20). TECAR therapy generates heat in both the superficial and deep layers. This heating effect is crucial as it enhances microcirculation and promotes vasodilation, which in turn improves oxygenation and nutrient delivery to the affected tissues (21).

Furthermore, a recent study confirmed TECAR's greater efficacy in treating musculoskeletal disorders, particularly patellofemoral pain syndrome. This study reported statistically significant improvements, highlighting TECAR's potential to accelerate the body's healing process. This therapeutic effect is attributed to TECAR's ability to stimulate tissue metabolism and promote cellular repair, resulting in reduced pain and faster recovery (22).

The findings of this study showed no statistically significant difference in VAS score at the first and second follow-up; however, a significant reduction in VAS score was observed at the third follow-up. In addition, the comparison of the WOMAC total score and its subscales demonstrated treatment efficacy even immediately post-intervention; this discordance between VAS and WOMAC trends in early follow-up could be attributed to the WOMAC's broader scope in evaluating joint-specific symptoms beyond nociception alone. The consistent improvement in WOMAC subdomains throughout follow-up reinforces the therapeutic impact of TECAR on both structural and functional joint parameters.

Conclusion

TECAR therapy is a safe, effective, and well-tolerated adjunct to the conservative management of mild to moderate knee OA. It offers sustained pain relief and improved joint function, outperforming conventional physiotherapy in both subjective and functional domains. These findings support the incorporation of TECAR therapy into rehabilitative protocols for knee osteoarthritis, particularly in geriatric populations. Additionally, it is a valuable resource for physical therapists, enhancing their effectiveness and job satisfaction when working with the elderly population.

Table 3. Comparison of mean changes in clinical outcomes between treatment groups

Outcome measure	Time comparison	Physiotherapy MD (SD)	TECAR therapy MD (SD)	MD	SE	*P* value
VAS	Immediately post-Intervention vs. baseline	-3.75 (1.16)	-3.90 (0.97)	-0.15	0.34	0.693*
	1-Month post-Intervention vs. baseline	-4.50 (1.15)	-4.95 (0.95)	-0.45	0.33	0.232*
	3-Month post-intervention vs. baseline	-4.05 (1.19)	-5.00 (0.92)	-0.95	0.34	0.030*
	1-Month post-intervention vs. immediately post-intervention	-0.75 (0.79)	-1.05 (0.69)	-0.30	0.23	0.240*
	3-Month post-intervention vs. immediately post-intervention	-0.30 (0.80)	-1.10 (0.72)	-0.80	0.24	0.013*
	3-Month post-intervention vs. 1-month post-intervention	0.45 (0.69)	-0.05 (0.69)	0.40	0.22	0.048*
Stiffness	Immediately post-Intervention vs. baseline	-3.85 (0.94)	-5.15 (1.14)	-1.30	1.33	<0.001*
	1-Month post-Intervention vs. baseline	-4.10 (0.97)	-5.60 (1.10)	-1.50	1.33	<0.001*
	3-Month post-intervention vs. baseline	-4.00 (0.92)	-5.60 (1.05)	-1.60	1.31	<0.001*
	1-Month post-intervention vs. immediately post-intervention	-0.25 (0.64)	-0.45 (0.60)	-0.20	0.20	0.352*
	3-Month post-intervention vs. immediately post-intervention	-0.15 (0.50)	-0.45 (0.60)	-0.30	0.17	0.136*
	3-Month post-intervention vs. 1-month post-intervention	0.10 (0.45)	0.00 (0.32)	0.10	0.12	0.312*
Pain	Immediately post-Intervention vs. baseline	-4.00 (0.87)	-5.85 (1.14)	-1.85	1.32	<0.001*
	1-Month post-Intervention vs. baseline	-5.65 (0.99)	-6.95 (1.10)	-1.30	1.33	<0.001*
	3-Month post-intervention vs. baseline	-5.45 (0.94)	-6.85 (1.09)	-1.40	1.32	<0.001*
	1-Month post-intervention vs. immediately post-intervention	-1.65 (0.75)	-1.10 (0.63)	0.55	0.22	0.034*
	3-Month post-intervention vs. immediately post-intervention	-1.45 (0.76)	-1.00 (0.65)	0.45	0.22	0.078*
	3-Month post-intervention vs. 1-month post-intervention	0.20 (0.62)	0.10 (0.45)	0.10	0.17	0.529*
Function	Immediately post-Intervention vs. baseline	2.05 (1.36)	1.15 (1.09)	0.90	1.39	0.077*
	1-Month post-Intervention vs. baseline	-0.30 (1.13)	-1.80 (1.15)	-1.50	1.36	<0.001*
	3-Month post-intervention vs. baseline	0.05 (1.15)	-1.40 (1.23)	-1.35	1.38	<0.001*
	1-Month post-intervention vs. immediately post-intervention	-2.35 (0.93)	-2.95 (0.83)	-0.60	0.28	0.079*
	3-Month post-intervention vs. immediately post-intervention	-2.00 (0.92)	-2.55 (0.94)	-0.55	0.29	0.090*
	3-Month post-intervention vs. 1-month post-intervention	0.35 (0.67)	0.40 (0.75)	-0.05	0.22	0.817*
WOMAC	Immediately post-Intervention vs. baseline	-3.20 (2.19)	-5.65 (1.98)	-2.45	1.66	<0.001**
	1-Month post-Intervention vs. baseline	-6.70 (2.25)	-8.80 (2.14)	-2.10	2.69	0.014**
	3-Month post-intervention vs. baseline	-5.40 (2.23)	-8.00 (2.13)	-2.60	2.69	<0.001**
	1-Month post-intervention vs. immediately post-intervention	-3.50 (1.43)	-3.15 (1.14)	0.35	1.41	0.440**
	3-Month post-intervention vs. immediately post-intervention	-2.20 (1.44)	-2.35 (1.09)	-0.15	1.40	0.744**
	3-Month post-intervention vs. 1-month post-intervention	1.30 (1.08)	0.80 (0.95)	0.50	0.32	0.186**

SD: Standard deviation, TECAR: Transfer of energy capacitive and resistive. MD: Mean difference. SE: Standard error; VAS: Visual Analogue Scale, WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index.
*The analysis conducted by Mann-Whitney U test. **The analysis was conducted by an independent sample T-test.

Limitations of the study

Despite the positive outcomes, this study is limited by its relatively small sample size, single-center design, and lack of a placebo-controlled arm. Further multicenter trials with larger cohorts and mechanistic assessments (e.g., imaging, biomarkers) are warranted.

Authors' contribution

Conceptualization: Shila Haghighat.
Data curation: Hamed Zare Dehnavi, Mahdi Dastanpour Hoseinabadi.
Formal analysis: Pooria Yeganehfard.
Funding acquisition: Shila Haghighat.
Investigation: Hamed Zare Dehnavi, Mahdi Dastanpour Hoseinabadi.
Methodology: Shila Haghighat.
Project administration: Shila Haghighat.
Resources: Shila Haghighat.
Software: Pooria Yeganehfard.
Supervision: Shila Haghighat.
Validation: Shila Haghighat.
Visualization: Pooria Yeganehfard.
Writing–original draft: Pooria Yeganehfard.
Writing–review & editing: Shila Haghighat, Pooria Yeganehfard.

Conflicts of interest

The authors declare that they have no competing interests.

Ethical issues

The research was conducted in accordance with the principles outlined in the Declaration of Helsinki. The Ethics Committee of Isfahan University of Medical Sciences approved this study (Ethical code#IR.MUI.MED.REC.1402.444). Accordingly, written informed consent was taken from all participants before any intervention. This study was part of the general medicine (M.D.) thesis of Pooria Yeganehfard at this university. Moreover, the trial protocol was approved by the Iranian registry of clinical trial (identifier: IRCT20190618043931N5; https://irct.behdasht.gov.ir/trial/75626). Ethical issues (including plagiarism, data fabrication, double publication) have been completely observed by the authors.

Funding/Support

Isfahan University of Medical Sciences as a part of an MD thesis project funded this study (Grant #3402688).

References

1. Hunter DJ, Bierma-Zeinstra S. Osteoarthritis. Lancet. 2019;393:1745-1759. doi: 10.1016/S0140-6736(19)30417-9.
2. Hunter DJ, Schofield D, Callander E. The individual and socioeconomic impact of osteoarthritis. Nat Rev Rheumatol. 2014;10:437-41. doi: 10.1038/nrrheum.2014.44.
3. Cross M, Smith E, Hoy D, Nolte S, Ackerman I, Fransen M, et al. The global burden of hip and knee osteoarthritis: estimates from the global burden of disease 2010 study. Ann Rheum Dis. 2014;73:1323-30. doi: 10.1136/annrheumdis-2013-204763.
4. Roos EM, Arden NK. Strategies for the prevention of knee osteoarthritis. Nat Rev Rheumatol. 2016;12:92-101. doi: 10.1038/nrrheum.2015.135.
5. Vaishya R, Pariyo GB, Agarwal AK, Vijay V. Non-operative management of osteoarthritis of the knee joint. J Clin Orthop Trauma. 2016;7:170-6. doi: 10.1016/j.jcot.2016.05.005.
6. Cole BJ, Karas V, Hussey K, Pilz K, Fortier LA. Hyaluronic Acid Versus Platelet-Rich Plasma: A Prospective, Double-Blind Randomized Controlled Trial Comparing Clinical Outcomes and Effects on Intra-articular Biology for the Treatment of Knee Osteoarthritis. Am J Sports Med. 2017;45:339-346. doi: 10.1177/0363546516665809.
7. Martin CL, Browne JA. Intra-articular Corticosteroid Injections for Symptomatic Knee Osteoarthritis: What the Orthopaedic Provider Needs to Know. J Am Acad Orthop Surg. 2019 Sep 1;27:e758-e766. doi: 10.5435/JAAOS-D-18-00106.
8. Szabo DA, Neagu N, Teodorescu S, Predescu C, Sopa IS, Panait L. TECAR Therapy Associated with High-Intensity Laser Therapy (Hilt) and Manual Therapy in the Treatment of Muscle Disorders: A Literature Review on the Theorised Effects Supporting Their Use. J Clin Med. 2022;11:6149. doi: 10.3390/jcm11206149.
9. Kim YJ, Park J-H, Kim J-h, Moon GA, Jeon H-S. Effect of high-frequency diathermy on hamstring tightness. Physical Ther Korea. 2021;28:65-71.
10. Barassi G, Mariani C, Supplizi M, Prosperi L, Di Simone E, Marinucci C, et al. Capacitive and Resistive Electric Transfer Therapy: A Comparison of Operating Methods in Non-specific Chronic Low Back Pain. Adv Exp Med Biol. 2022;1375:39-46. doi: 10.1007/5584_2021_692.
11. Sorrentino M, Ferrari D, Elena ZI. Effectiveness of a long-term Tecar Therapy treatment on Knee Pain: building TTESSK, an evaluating scale A systematic review and meta-analysis. Research Square. 2022. doi: 10.21203/rs.3.rs-1208847/v1
12. Notarnicola A, Maccagnano G, Gallone MF, Covelli I, Tafuri S, Moretti B. Short term efficacy of capacitive-resistive diathermy therapy in patients with low back pain: a prospective randomized controlled trial. J Biol Regul Homeost Agents. 2017;31:509-515.
13. Tashiro Y, Suzuki Y, Nakayama Y, Sonoda T, Yokota Y, Kawagoe M, et al. The effect of Capacitive and Resistive electric transfer on non-specific chronic low back pain. Electromagn Biol Med. 2020;39:437-444. doi: 10.1080/15368378.2020.1830795.
14. Schiphof D, Boers M, Bierma-Zeinstra SM. Differences in descriptions of Kellgren and Lawrence grades of knee osteoarthritis. Ann Rheum Dis. 2008;67:1034-6. doi: 10.1136/ard.2007.079020.
15. Huskisson EC, Jones J, Scott PJ. Application of visual-analogue scales to the measurement of functional capacity. Rheumatol Rehabil. 1976;15:185-7. doi: 10.1093/rheumatology/15.3.185.
16. Roos EM, Klässbo M, Lohmander LS. WOMAC osteoarthritis index. Reliability, validity, and responsiveness in patients with arthroscopically assessed osteoarthritis. Western Ontario and MacMaster Universities. Scand J Rheumatol. 1999;28:210-5. doi: 10.1080/03009749950155562.
17. Eftekhar-Sadat B, Niknejad-Hosseyni SH, Babaei-Ghazani A, Toopchizadeh V, Sadeghi H. Reliability and validity of Persian version of Western Ontario and McMaster Universities Osteoarthritis index in knee osteoarthritis. J Res Clin Med. 2015;3:170-7.
18. Coccetta CA, Sale P, Ferrara PE, Specchia A, Maccauro G, Ferriero G, et al. Effects of capacitive and resistive electric transfer therapy in patients with knee osteoarthritis: a randomized controlled trial. Int J Rehabil Res. 2019;42:106-111. doi: 10.1097/MRR.0000000000000324.
19. Hernández-Bule ML, Paíno CL, Trillo MÁ, Úbeda A. Electric stimulation at 448 kHz promotes proliferation of human mesenchymal stem cells. Cell Physiol Biochem. 2014;34:1741-55. doi: 10.1159/000366375.
20. Clijsen R, Leoni D, Schneebeli A, Cescon C, Soldini E, Li L, et al. Does the Application of Tecar Therapy Affect Temperature and Perfusion of Skin and Muscle Microcirculation? A Pilot Feasibility Study on Healthy Subjects. J Altern Complement Med. 2020;26:147-153. doi: 10.1089/acm.2019.0165.
21. Ida A, Neves E, Stadnik A. Effects of tecartherapy on body tissue: a systematic review. J Biomed Sci Eng. 2023;16:133-48.
22. LB KS, Anitha A, Kamalakannan M, Ramana K. A Study to Analyse the Effectiveness of Capacitive Resistive Diathermy on Patellofemoral Pain Syndrome Among Adult Population. Indian J Physiother Occup Ther. 2024;18:38-43.