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Magnet Therapy versus Electroacupuncture for Knee Osteoarthritis: A Double-Blind Randomized Clinical Trial

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Abstract

Background: Knee osteoarthritis (KOA) is a prevalent degenerative joint disorder often managed with pharmacological therapies, which may cause adverse effects. This study aimed to evaluate and compare the effects of magnet therapy (MT) and electroacupuncture (EA) in the treatment of KOA.

Methods: A randomized, double-blind trial involved 93 KOA patients divided into three groups: MT, EA, and routine treatment (RT). Eligible participants had confirmed KOA, pain lasting over three months, and walking ability. Outcomes, assessed by a specialist, included pain intensity, 6-minute walk test (6MWT), and knee function, stiffness, and pain via the Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) at baseline, after 10 treatment sessions, and one-month post-treatment. The trial was registered with the Iranian Registry of Clinical Trials (IRCT20100129003220N11).

Results: Participants had a mean age of 67.44 ± 5.18 years. Significant differences were observed across groups in pain, 6-minute walk test, WOMAC scores, stiffness, and physical function ($P<0.001$). All variables showed significant changes over the three time points ($P<0.05$), with distinct trends in mean changes among groups ($P<0.001$).

Conclusion: MT outperformed EA and RT in reducing pain, stiffness, and WOMAC scores while improving physical function and 6MWT outcomes in KOA patients.

Keywords: Magnetic field therapy, Electroacupuncture, Osteoarthritis, Knee, Physical therapy modalities

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Introduction

Knee osteoarthritis (KOA) is a chronic joint disorder characterized by cartilage degradation and synovial inflammation, predominantly affecting older adults and women (1). The knee is the most commonly affected joint, with the KOA symptom prevalence estimated at 10% in men and 13% in women aged over 60 years (2). Due to an aging population and rising obesity rates, the prevalence of KOA is increasing (3). KOA is a major cause of disability, ranking 11th among global causes of disability in 2010, and is recognized by the World Health Organization (WHO) as a priority disease (4). Prevalence varies regionally, ranging from 19.2%–68% in the United States and 13.1%–71.1% in Asian countries among those over 45 years (5,6). In Iran, studies report KOA prevalence of 8.8% in Yazd and 15.5% in cities including Tehran and Sananda (7,8).

KOA is characterized by progressive cartilage degradation, synovial inflammation, and subchondral bone remodeling, driven by factors such as trauma, obesity, aging, and mechanical stress (9). At the molecular level, reduced anti-inflammatory cytokines, elevated matrix metalloproteinases, and increased production of nitric oxide, prostaglandins, and cyclooxygenase-2 contribute to inflammation, chondrocyte apoptosis, and cartilage destruction (10,11). These pathological changes impair joint function, leading to significant morbidity.

Pain is the primary symptom of KOA, initially alleviated by rest in early stages but persisting during rest in advanced disease (12). This pain drives healthcare-seeking behavior and is a key predictor of disability. Diagnosis primarily relies on plain radiography, which reveals characteristic features, including osteophytes, subchondral bone sclerosis, subchondral cysts, and joint space narrowing due to cartilage loss (12). Clinical assessment, including

patient history and physical examination, complements radiographic findings to confirm KOA diagnosis.

KOA management focuses on symptom relief through pharmacological and non-pharmacological interventions. Commonly used medications include acetaminophen, nonsteroidal anti-inflammatory drugs, and intra-articular corticosteroid injections, though these carry risks of adverse effects (13). Non-pharmacological therapies, such as magnet therapy (MT) and electroacupuncture (EA), offer safer alternatives with the potential to reduce pain and improve function (14,15).

MT involves applying artificial magnetic fields to the affected joint, potentially reducing inflammation and promoting tissue repair. It has been used for conditions including joint injuries, fractures, soft tissue trauma, and inflammatory disorders (14,16). EA, a modified acupuncture technique, involves inserting needles at specific points and applying a weak electrical current to stimulate pain-relieving pathways, possibly via endogenous opioid release. EA is widely used in physiotherapy for musculoskeletal pain, including back, neck, and joint disorders (15,17). Despite their promise, no studies have directly compared the efficacy of MT and EA for KOA management, based on a review of existing literature. This study aimed to evaluate and compare the effects of MT and EA on pain, function, and other clinical outcomes in patients with KOA, addressing this critical research gap.

Methods

Study design

This parallel, double-blind, randomized clinical trial involved three groups of 31 patients aged 45 -75 years with KOA referred to Fatemieh Physiotherapy Clinic in Rafsanjan, Kerman Province, Iran. After providing written informed consent, patients were randomized to three groups. For randomization, a physician evaluated patients for eligibility, and those meeting inclusion criteria were allocated to one of three groups using a random number table. The groups were MT, EA, and control (routine treatment [RT], multimodal physiotherapy). Inclusion criteria included a definitive KOA diagnosis, pain for > 3 months, ability to walk, joint space narrowing, knee crepitus, and grade 2–3 osteoarthritis per the Kellgren-Lawrence classification. Exclusion criteria comprised corticosteroid injection within the past month, history of knee surgery or fracture, grade 4 KOA, absent joint space, pregnancy, severe knee stiffness, or rheumatoid arthritis (18). No costs were imposed on participants, and all services were provided free of charge. The trial was registered with the Iranian Registry of Clinical Trials (identifier: IRCT20100129003220N11).

Sample size calculation

The sample size was calculated based on the studies by Harlow et al (19) and Shahimoridi et al (20), using the following formula, where $\alpha = 0.05$, $\beta = 0.1$, $\sigma_1 = 20$, $\sigma_2 = 8.42$, $\Delta = 12$. This yields 31 patients per group (MT, EA, RT), totaling 93 patients enrolled (Figure 1).

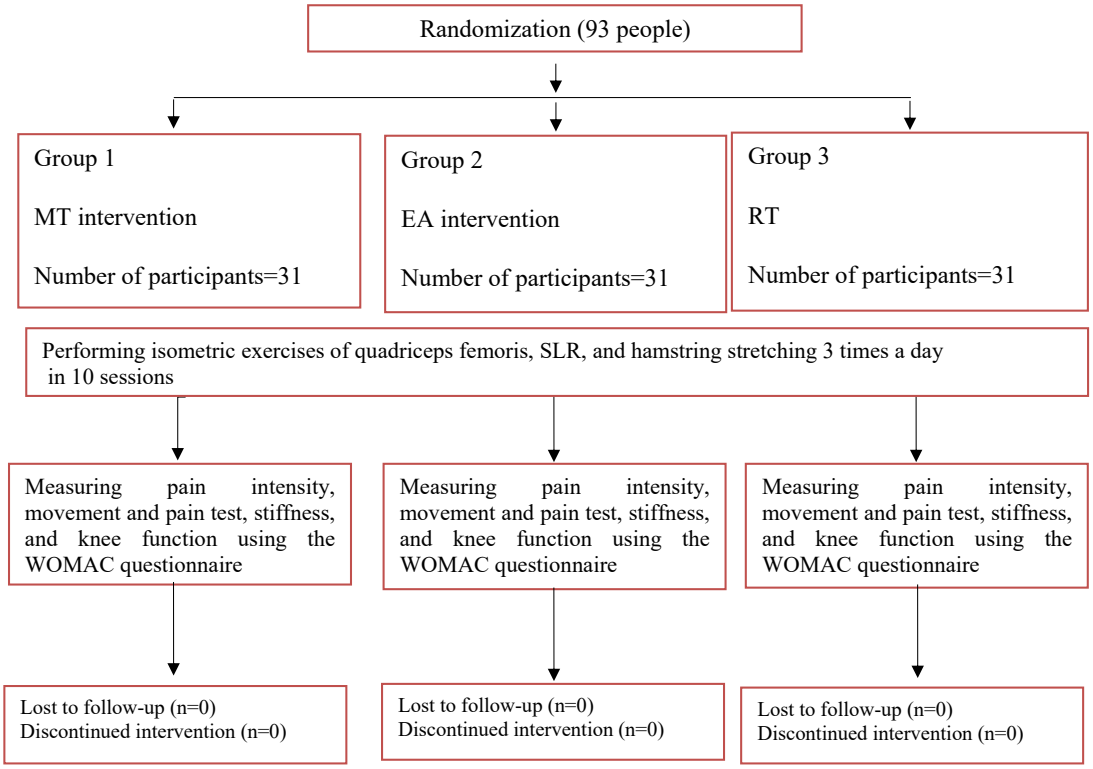

Figure 1. CONSORT flowchart of clinical trial

$$n_2 = n_3 = k \times n_1 = \frac{(Z_{1-\frac{\alpha}{2}} + Z_{1-\beta})^2 \times (\sigma_1^2 + \frac{\sigma_2^2}{k})}{\Delta^2}$$

Treatment methods and effect evaluation

In the MT group, patients with KOA received a 20-minute session using a Mango 915G device (Novin Company, Iran) at 20 Hz, 65 gauss, and a 70 cm solenoid (21). In the EA group, 5 cm needles were inserted at standardized acupuncture points (St.35 [inferolateral to the patella], St.36 [6 cm below the knee joint, upper tibialis anterior], St.44 [1 cm above the junction of the 2nd and 3rd metatarsals], Sp9 [below the lower tibial condyle], UB40 [midpoint of the posterior knee], UB60 [midpoint between the lateral malleolus and Achilles tendon], Ex31 [center of the upper patella], Ex32 [inside the patellar ligament], and LI4 [apex of the adductor pollicis muscle with the thumb adducted to the index finger]) (20,22). An electrical stimulation device (KWD 808, Ying Di Company, China) delivered a 3 Hz current at an intensity of 0.5–1.0 mA, adjusted to patient comfort, for 20 minutes. Needles were connected to the device via clamps. The control group (RT) received multimodal physiotherapy, including 5-minute ultrasound therapy (250P, Novin Company, Iran; 1 MHz, 1.5 W/m^2), 10-minute infrared therapy, and transcutaneous electrical nerve stimulation (TENS; 620F, Novin Company, Iran; 80 Hz, 10–20 mA, adjusted to patient sensation). All groups performed standardized KOA exercises (isometric quadriceps, straight leg raises, hamstring stretches; 10 repetitions, 3 times daily) taught by a physiotherapist across 10 sessions. A blinded rheumatologist evaluated outcomes at baseline, after the 10th session, and 1-month post-intervention. Pain intensity was measured using the visual analogue scale (VAS; 0 = no pain, 10 = worst pain) for pain at rest and during movement (23). Functional status was assessed with the 24-item Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC), with confirmed validity and reliability in its Persian version (24). The 6-minute walk test (6MWT) measured walking distance, and stiffness and physical activity were evaluated via WOMAC subscales. A demographic checklist was completed for all participants. Because device appearances differed across groups, patients were not blinded, but the rheumatologist and data analyst were blinded (double-blind). The intervention and evaluation period lasted 1 month.

Statistical analysis

Data were analyzed using SPSS version 20. A significance level of 5% was used. Quantitative variables were reported as mean ± SD, and categorical variables as numbers and percentages. To compare outcomes across groups and time points (baseline, 10th session, 1-month post-intervention), two-way repeated-measures ANOVA was used, followed by Tukey's multiple comparison test if significant. Demographic characteristics were compared using ANOVA and chi-square tests after confirming data normality with the Shapiro-Wilk test.

Results

This study included 93 patients randomized to three groups: MT, EA, and RT. No patients were lost to follow-up during the intervention period. Patients aged 45-75 years, with a mean age of 67.44 ± 5.18 years. Baseline mean values of age, weight, height, and body mass index (BMI) showed no significant differences between the three groups ($P > 0.05$). The frequency distributions of gender and occupation also showed no significant differences ($P = 0.869$ and $P = 0.989$, respectively) (Table 1).

Two-way repeated-measures ANOVA results, examining group, time, and group-by-time interaction effects, are presented in Table 2. The group effect indicated

Table 1. Determining and comparing the distribution of demographic and background variables in three groups of MT intervention, EA, and the control group

Variables	MT group (n = 31)	EA group (n = 31)	Control group (n = 31)	*P* value
Age (Mean ± SD)	67.32 ± 5.30	67.42 ± 5.43	67.58 ± 96.4	0.981
Weight (Mean ± SD)	82.35 ± 7.35	82.35 ± 6.96	82.65 ± 6.95	0.983*
Height (Mean ± SD)	167.71 ± 5.46	167.45 ± 5.54	167.71 ± 5.37	0.977*
BMI (Mean ± SD)	29.25 ± 1.97	29.38 ± 2.24	29.40 ± 2.35	0.961*
Gender				
Male	12 (38.7)	11 (35.5)	10 (32.3)	0.869**
Female	19 (61.3)	20 (64.5)	60 (64.5)	
Occupation				
Worker	6 (19.4)	5 (16.1)	5 (16.1)	
Farmer	5 (19.4)	6 (19.4)	5 (16.1)	0.989**
Employee	10 (32.3)	11 (35.5)	9 (29.0)	
Housewife	10 (32.3)	9 (29.0)	12 (38.7)	

Data are expressed as mean ± standard deviation (SD), or n (%).
* *P* value derived from one-way ANOVA.
** *P* value derived from Chi-square.

significant differences across the MT, EA, and RT groups for all variables, including pain scores at rest and during movement, 6MWT, WOMAC scores, stiffness, and physical activity ($P<0.001$), regardless of time point. The time effect showed significant differences across the three time points (baseline, 10th session, 1-month post-intervention) for all variables, regardless of group ($P<0.05$). The group-by-time interaction revealed that trends in mean changes for pain scores, 6MWT, WOMAC scores, stiffness, and physical activity differed significantly between the three groups over the study period ($P<0.001$) (Table 2).

For variables with a significant group effect, pairwise comparisons using Tukey's multiple comparison test showed significant differences between all pairs of groups (MT vs. EA, MT vs. RT, EA vs. RT) ($P<0.05$) (Table 3).

Trends in mean values of pain scores at rest and during movement, 6MWT, WOMAC scores, stiffness, and physical activity across the three groups and time points are shown in Figure 2A–G. For all variables, the MT group outperformed the EA and control (RT) groups (Figure 2).

Discussion

KOA is a degenerative joint disorder characterized by cartilage degradation and synovial inflammation, primarily associated with aging. Symptoms include mild to progressively worsening knee pain, stiffness, muscle atrophy, difficulty walking, and, in severe cases, disability. Despite various treatments, no curative non-surgical therapy exists, and total knee arthroplasty remains the primary option for end-stage pain management (25). Given the need for treatments with fewer side effects, this study compared the efficacy of MT and EA in managing KOA symptoms.

This study found that the MT and EA groups exhibited significant reductions in pain scores (at rest and during movement), stiffness, and WOMAC scores post-intervention, with these improvements persisting 1 month later without significant change. Notably, the MT group showed the greatest symptom reduction compared to the EA and RT groups. Additionally, the MT and EA groups demonstrated increased 6MWT distance and physical activity post-intervention, with the MT group showing greater improvements than the EA and RT groups.

MT is a non-invasive, safe, and accessible method that uses magnetic fields to promote tissue repair, reduce pain, and control inflammation (16). It has been widely used for conditions such as nonunion fractures, pseudoarthrosis, osteonecrosis, and chronic tendinopathy, with reported success rates of approximately 80% and minimal adverse effects (26). The MT is a practical and non-invasive method to induce cellular and tissue changes that can correct the patient's pathological disorders. The results

Table 2. The trend of changes in variables of pain at rest, pain during movement, pain intensity, WOMAC index, stiffness, and physical activity in all three groups over time

Variable		DF	Mean of squares	F	*P* value*
Pain at rest	Time	1.020	90054.181	1148.467	<0.001
	Group/Time	2.040	12558.263	160.156	<0.001
	Between groups	2	25918.498	142.397	<0.001
Pain during movement	Time	1.007	80277.440	761.221	<0.001
	Group/Time	2.014	1401.719	133.718	<0.001
	Between groups	2	29401.036	142.675	<0.001
6-minute movement test	Time	1.101	137.826	478.621	<0.001
	Group/Time	2.202	11.972	41.575	<0.001
	Between groups	2	31.645	30.017	<0.001
WOMAC index	Time	1.183	10676.977	617.768	<0.001
	Group/Time	2.366	914.247	52.898	<0.001
	Between groups	2	1886.806	16.799	<0.001
Pain intensity	Time	1.206	2181.169	979.869	<0.001
	Group/Time	2.412	292.908	131.586	<0.001
	Between groups	2	724.832	83.849	<0.001
Stiffness	Time	1.259	440.053	780.505	<0.001
	Group/Time	2.518	45.804	81.240	<0.001
	Between groups	2	122.434	46.682	<0.001
Physical activity	Time	1.020	27460.555	899.119	<0.001
	Group/Time	2.040	4557.291	149.216	<0.001
	Between groups	2	9231.746	67.003	<0.001

* Two-way repeated-measures ANOVA and Greenhouse-Geisser test.

Table 3. A pairwise comparison of the variables of pain score at rest and during movement, 6-minute test, WOMAC index, stiffness, pain intensity, and physical activity in the three study groups

Variable	Group I	Group J	Mean difference	Standard deviation	*P* value*
Pain at rest	MT	EA	-13.22	1.978	<0.001
		RT	-33.16	1.978	<0.001
	EA	MT	13.22	1.978	<0.001
		RT	-19.95	1.978	<0.001
	RT	MT	33.16	1.978	<0.001
		EA	19.95	1.978	<0.001
Pain during movement	MT	EA	-18.06	2.105	<0.001
		RT	-35.56	2.105	<0.001
	EA	MT	18.06	2.105	<0.001
		RT	-17.49	2.105	<0.001
	RT	MT	35.56	2.105	<0.001
		EA	17.49	2.105	<0.001
6-minute movement test	MT	EA	0.48	0.151	0.005
		RT	1.16	0.151	<0.001
	EA	MT	-0.48	0.151	0.005
		RT	0.68	0.151	<0.001
	RT	MT	-1.16	0.151	<0.001
		EA	-0.16	0.151	<0.001
WOMAC index	MT	EA	-4.16	1.544	0.024
		RT	-9.00	1.544	<0.001
	EA	MT	4.16	1.544	0.024
		RT	-4.84	1.544	0.007
	RT	MT	9.00	1.544	<0.001
		EA	4.84	1.544	0.007
Pain intensity	MT	EA	-3.94	0.431	<0.001
		RT	-5.40	0.431	<0.001
	EA	MT	3.94	0.431	<0.001
		RT	-1.46	0.431	0.003
	RT	MT	5.40	0.431	<0.001
		EA	1.46	0.431	0.003
Stiffness	MT	EA	-1.02	0.237	<0.001
		RT	-2.29	0.237	<0.001
	EA	MT	1.02	0.237	<0.001
		RT	-1.27	0.237	<0.001
	RT	MT	2.29	0.237	<0.001
		EA	1.27	0.237	<0.001
Physical activity	MT	EA	-11.10	1.721	<0.001
		RT	-19.88	1.721	<0.001
	EA	MT	11.10	1.721	<0.001
		RT	-8.78	1.721	<0.001
	RT	MT	19.88	1.721	<0.001
		EA	8.78	1.721	<0.001

MT: Magnet Therapy, EA: Electroacupuncture, RT: Routine Treatment.
*Two-way repeated-measures ANOVA and Tukey's multiple comparison test.

of studies have shown that exogenous magnetic and electromagnetic fields can have profound effects on a large number of biological processes (27). Chen et al. found that MT improved physical activity in KOA patients

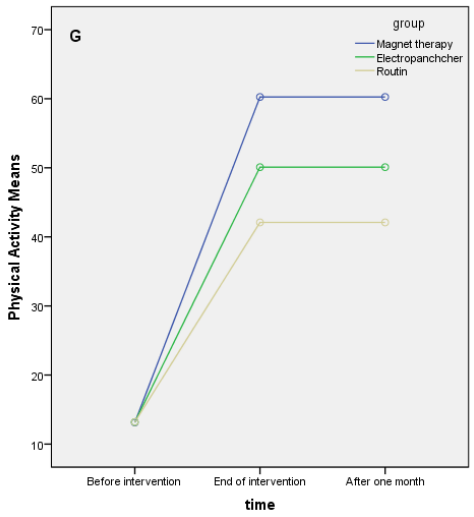

Figure 2. Trends in mean values of (A) pain at rest, (B) pain during movement, (C) 6-minute walk test, (D) WOMAC scores, (E) stiffness, and (F) physical activity at baseline, post-intervention, and 1-month post-intervention in the MT, EA, and control (RT) groups

but did not reduce WOMAC scores, pain, or stiffness, contrasting with our findings (28). Conversely, Wu et al (29) reported reduced pain and increased physical activity in osteoarthritis patients, and Ryang et al. (30) observed improved physical activity at weeks 4 and 8 compared to placebo. Park et al (31) also noted improved pain scores on the visual analogue scale (VAS) with MT in KOA patients, supporting our results.

MT may reduce edema and inflammation at the injury site, alleviating pain and stress to facilitate healing. It also promotes nerve repair, immune function, and endocrine activity, potentially via vascular modulation, phagocytosis, cell proliferation, and tissue remodeling (26, 27, 32). However, MT's efficacy depends on precise magnetic field dosing, which involves complex physical parameters that require careful calibration (33). One of the points that should be considered in MT is the magnetic field stimulation dose, which is more complex than other treatment methods, since it needs to understand several physical parameters determining the magnetic field generation system (27).

The results of the present study also showed that the EA treatment method can have a beneficial effect on the indices of pain during movement, pain at rest, pain intensity, muscle stiffness, movement time, and physical activity. These findings contrast with Wang et al, who reported significant improvements in pain, stiffness, and WOMAC scores with EA compared to RT but no significant group differences after 8 weeks (34). Similarly, Ashraf et al found EA ineffective for osteoarthritis treatment (21). Conversely, Ruan et al (35), Qi et al (15), and Shim et al (36) reported that EA reduced KOA-related pain and improved joint function, movement stiffness, and quality of life. Meta et al (37) also found that EA alleviated pain, stiffness, and disability in KOA patients, supporting our results.

EA offers rapid onset, sustained efficacy, minimal side effects, safety, and low cost. By integrating traditional acupuncture with electrical stimulation, where a small electric current passes through needles, EA enhances therapeutic efficacy compared to conventional acupuncture (38). EA activates peripheral and central nervous systems and specific brain regions, stimulating the release of hormones such as endorphins and enkephalins. These hormones modulate pain, inflammation, immunity, tissue repair, and vasodilation (37). Beyond pain relief, EA reduces local inflammation, including synovial and cartilage damage, and improves microcirculation. Stimulation of local acupuncture points also reduces soft tissue tension, softening tendons and enhancing motor function (35).

A key limitation of this study was the lack of investigation into the physiological mechanisms underlying MT and EA effects. Additionally, the efficacy of combined MT and EA therapy versus individual therapies was not explored.

Given the dose-dependent efficacy of magnetic field stimulation, future studies should investigate the effects of varying magnetic field intensities on KOA treatment outcomes. We also recommend studies with larger sample sizes to evaluate the efficacy of MT and EA, elucidate their mechanisms, and assess cellular and tissue responses to magnetic fields. Interdisciplinary collaboration among engineers, life scientists, and clinical specialists could enhance the development and optimization of these therapies.

Conclusion

The results of the present study demonstrated that MT and EA significantly improved pain, stiffness, and function outcomes in KOA. MT exhibited greater efficacy in reducing KOA symptoms compared to EA and the RT group. Given its minimal side effects, MT is recommended as a viable treatment option for KOA patients' symptoms and for reducing pain and severity of the disease.

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Authors' Contribution

Conceptualization: Mitra Abbasifard, Dadollah Shahimoridi.
Data curation: Mitra Abbasifard, Zahra Kamiab, Matin Laripour.
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Investigation: Mitra Abbasifard, Dadollah Shahimoridi, Matin Laripour, Zahra Kamiab.
Methodology: Mitra Abbasifard, Dadollah Shahimoridi, Zahra Kamiab.
Project administration: Mitra Abbasifard.
Resources: Mitra Abbasifard, Dadollah Shahimoridi.
Software: Mitra Abbasifard, Zahra Kamiab.
Supervision: Mitra Abbasifard.

Validation: Mitra Abbasifard.
Visualization: Mitra Abbasifard.
Writing–original draft: Mitra Abbasifard, Dadollah Shahimoridi, Zahra Kamiab.

Competing Interests
The authors declare that they have no conflicts of interest.

Ethical Approval
The study protocol was approved by the Ethics Committee in Biomedical Research of Rafsanjan University of Medical Sciences (IR.RUMS.REC.1399.125).

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References

1. Mobasheri A, Batt M. An update on the pathophysiology of osteoarthritis. Ann Phys Rehabil Med. 2016;59(5-6):333-9. doi: 10.1016/j.rehab.2016.07.004.
2. Brooks PM. The burden of musculoskeletal disease--a global perspective. Clin Rheumatol. 2006;25(6):778-81. doi: 10.1007/s10067-006-0240-3.
3. Zhang Y, Jordan JM. Epidemiology of osteoarthritis. Clin Geriatr Med. 2010;26(3):355-69. doi: 10.1016/j.cger.2010.03.001.
4. 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(7):1323-30. doi: 10.1136/annrheumdis-2013-204763.
5. Lawrence RC, Felson DT, Helmick CG, Arnold LM, Choi H, Deyo RA, et al. Estimates of the prevalence of arthritis and other rheumatic conditions in the United States. Part II. Arthritis Rheum. 2008;58(1):26-35. doi: 10.1002/art.23176.
6. Zamri NA, Harith S, Mohd Yusoff NA, Hassan NM, Ong YQ. Prevalence, risk factors and primary prevention of osteoarthritis in Asia: a scoping review. Elder Health J. 2019;5(1):19-31. doi: 10.18502/ehj.v5i1.1196.
7. Dehghan A, Soleimani Salehabadi H, Jamshidi A, Kamali Z, Mali M, Faezi ST, et al. Epidemiology of musculoskeletal symptoms, rheumatologic disorders, and disability in the Zoroastrian population in Yazd, Iran: a WHO-ILAR COPCORD study (stage 1). BMC Rheumatol. 2021;5(1):46. doi: 10.1186/s41927-021-00214-2.
8. Davatchi F, Sandoughi M, Moghimi N, Jamshidi AR, Tehrani Banihashemi A, Zakeri Z, et al. Epidemiology of rheumatic diseases in Iran from analysis of four COPCORD studies. Int J Rheum Dis. 2016;19(11):1056-62. doi: 10.1111/1756-185x.12809.
9. Doherty M, Bijlsma H, Arden N, Hunter D, Dalbeth N. Oxford Textbook of Osteoarthritis and Crystal Arthropathy. Oxford University Press; 2016.
10. Guilak F, Nims RJ, Dicks A, Wu CL, Meulenbelt I. Osteoarthritis as a disease of the cartilage pericellular matrix. Matrix Biol. 2018;71-72:40-50. doi: 10.1016/j.matbio.2018.05.008.
11. Kroon FP, Carmona L, Schoones JW, Kloppenburg M. Efficacy and safety of non-pharmacological, pharmacological and surgical treatment for hand osteoarthritis: a systematic literature review informing the 2018 update of the EULAR recommendations for the management of hand osteoarthritis. RMD Open. 2018;4(2):e000734. doi: 10.1136/rmdopen-2018-000734.
12. Im YG, Lee JS, Park JI, Lim HS, Kim BG, Kim JH. Diagnostic accuracy and reliability of panoramic temporomandibular joint (TMJ) radiography to detect bony lesions in patients with TMJ osteoarthritis. J Dent Sci. 2018;13(4):396-404. doi: 10.1016/j.jds.2018.08.006.
13. Katz JN, Arant KR, Loeser RF. Diagnosis and treatment of hip and knee osteoarthritis: a review. JAMA. 2021;325(6):568-78. doi: 10.1001/jama.2020.22171.
14. Gong Z, Liu R, Yu W, Wong TK, Guo Y. Development and evaluation of acu-magnetic therapeutic knee brace for symptomatic knee osteoarthritis relief in the elderly. J Text Inst. 2022;113(7):1355-71. doi: 10.1080/00405000.2021.1929703.
15. Qi L, Tang Y, You Y, Qin F, Zhai L, Peng H, et al. Comparing the effectiveness of electroacupuncture with different grades of knee osteoarthritis: a prospective study. Cell Physiol Biochem. 2016;39(6):2331-40. doi: 10.1159/000447925.
16. Iannitti T, Fistetto G, Esposito A, Rottigni V, Palmieri B. Pulsed electromagnetic field therapy for management of osteoarthritis-related pain, stiffness and physical function: clinical experience in the elderly. Clin Interv Aging. 2013;8:1289-93. doi: 10.2147/cia.S35926.
17. Navarro-Santana MJ, Sanchez-Infante J, Gómez-Chiguano GF, Cummings M, Fernández-de-Las-Peñas C, Plaza-Manzano G. Effects of manual acupuncture and electroacupuncture for lateral epicondylalgia of musculoskeletal origin: a systematic review and meta-analysis. Acupunct Med. 2021;39(5):405-22. doi: 10.1177/0964528420967364.
18. Kohn MD, Sassoon AA, Fernando ND. Classifications in brief: Kellgren-Lawrence classification of osteoarthritis. Clin Orthop Relat Res. 2016;474(8):1886-93. doi: 10.1007/s11999-016-4732-4.
19. Harlow T, Greaves C, White A, Brown L, Hart A, Ernst E. Randomised controlled trial of magnetic bracelets for relieving pain in osteoarthritis of the hip and knee. BMJ. 2004;329(7480):1450-4. doi: 10.1136/bmj.329.7480.1450.
20. Shahimoridi D, Mollahossini M, Eghbali M, Khajepour M, Sheikh Fathollahi M. Comparing the effects of electroacupunture, low level laser and celecoxib tablet on treatment of the knee joint osteoarthritis: a randomized single-blinded clinical trial. J Rafsanjan Univ Med Sci. 2018;16(9):819-34. [Persian].
21. Ashraf A, Zarei F, Hadianfard MJ, Kazemi B, Mohammadi S, Naseri M, et al. Comparison the effect of lateral wedge insole and acupuncture in medial compartment knee osteoarthritis: a randomized controlled trial. Knee. 2014;21(2):439-44. doi: 10.1016/j.knee.2013.12.002.
22. Chen X, Spaeth RB, Freeman SG, Scarborough DM, Hashmi JA, Wey HY, et al. The modulation effect of longitudinal acupuncture on resting state functional connectivity in knee osteoarthritis patients. Mol Pain. 2015;11:67. doi: 10.1186/s12990-015-0071-9.
23. Rezaei S, Afsharnejad T, Moosavi SV, Yousefzadeh S, Soltani R. Validation of the Persian version of pain self-efficacy scale: a psychometric chronic low back pain patients. J Fundam Ment Health. 2012;13(52):328-45. doi: 10.22038/jfmh.2011.922. [Persian].
24. 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 Anal Res Clin Med. 2015;3(3):170-7. doi: 10.15171/jarcm.2015.027.
25. Deyle GD, Allen CS, Allison SC, Gill NW, Hando BR, Petersen EJ, et al. Physical therapy versus glucocorticoid injection for osteoarthritis of the knee. N Engl J Med. 2020;382(15):1420-9. doi: 10.1056/NEJMoa1905877.
26. Bassett CA. Fundamental and practical aspects of therapeutic uses of pulsed electromagnetic fields (PEMFs). Crit Rev Biomed Eng. 1989;17(5):451-529.
27. Markov MS. Magnetic field therapy: a review. Electromagn Biol

Med. 2007;26(1):1-23. doi: 10.1080/15368370600925342.
28. Chen L, Duan X, Xing F, Liu G, Gong M, Li L, et al. Effects of pulsed electromagnetic field therapy on pain, stiffness and physical function in patients with knee osteoarthritis: a systematic review and meta-analysis of randomized controlled trials. J Rehabil Med. 2019;51(11):821-7. doi: 10.2340/16501977-2613.
29. Wu Z, Ding X, Lei G, Zeng C, Wei J, Li J, et al. Efficacy and safety of the pulsed electromagnetic field in osteoarthritis: a meta-analysis. BMJ Open. 2018;8(12):e022879. doi: 10.1136/bmjopen-2018-022879.
30. Ryang We S, Koog YH, Jeong KI, Wi H. Effects of pulsed electromagnetic field on knee osteoarthritis: a systematic review. Rheumatology (Oxford). 2013;52(5):815-24. doi: 10.1093/rheumatology/kes063.
31. Park SH, Park YH, Lee JH. Effects of magnetic field therapy after taping application on pain and function of patients with knee osteoarthritis. J Phys Ther Sci. 2017;29(9):1548-51. doi: 10.1589/jpts.29.1548.
32. Adey WR. Potential therapeutic applications of nonthermal electromagnetic fields: ensemble organization of cells in tissue as a factor in biological field sensing. In: Bioelectromagnetic Medicine. CRC Press; 2004. p. 21-35.
33. Markov M. Dosimetry in Bioelectromagnetics. CRC Press; 2017.
34. Wang TQ, Li YT, Wang LQ, Shi GX, Tu JF, Yang JW, et al. Electroacupuncture versus manual acupuncture for knee osteoarthritis: a randomized controlled pilot trial. Acupunct Med. 2020;38(5):291-300. doi: 10.1177/0964528419900781.
35. Ruan A, Wang Q, Ma Y, Zhang D, Yang L, Wang Z, et al. Efficacy and mechanism of electroacupuncture treatment of rabbits with different degrees of knee osteoarthritis: a study based on synovial innate immune response. Front Physiol. 2021;12:642178. doi: 10.3389/fphys.2021.642178.
36. Shim JW, Jung JY, Kim SS. Effects of electroacupuncture for knee osteoarthritis: a systematic review and meta-analysis. Evid Based Complement Alternat Med. 2016;2016:3485875. doi: 10.1155/2016/3485875.
37. Mata J, Cabrera S, Sanchís P, Valentí P, Hernández P, Fortuny R, et al. Electro-acupuncture for treatment of knee pain from osteoarthritis and the possible endocrinology changes: a study protocol for a randomized controlled trial. Trials. 2015;16:248. doi: 10.1186/s13063-015-0766-2.
38. Ahsin S, Saleem S, Bhatti AM, Iles RK, Aslam M. Clinical and endocrinological changes after electro-acupuncture treatment in patients with osteoarthritis of the knee. Pain. 2009;147(1-3):60-6. doi: 10.1016/j.pain.2009.08.004.