Is radiofrequency ablation effective in treating patients with chronic knee osteoarthritis? A meta-analysis of randomized controlled trials

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Background and aims: This meta-analysis aimed to evaluate the short-term and long-term efficacy of radiofrequency ablation (RFA) and explore the role of diagnostic genicular nerve blocks in predicting treatment outcomes.

Methods: A comprehensive literature search was conducted, and nine randomized controlled trials involving 714 participants were included in the analysis. Data extraction, risk of bias assessment, and subgroup analyses were performed. The primary outcome measures were pain scores at 6 and 12 months, assessed using visual analogue scale and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC). The quality of evidence was assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology.

Results: The meta-analysis revealed that RFA demonstrated a significant short-term efficacy in reducing pain compared to the control group at 6 months, as indicated by the pain scores [weighted mean difference (WMD): -2.69, 95% CI: -3.99, -1.40]. Similarly, WOMAC scores at 6 months favored the RFA group (WMD: -4.40, 95% CI: -7.12, -1.68). However, the long-term efficacy of RFA at 12 months remained uncertain for both pain scores (WMD: -0.88, 95% CI: -2.36, 0.61) and WOMAC (WMD: 0.03, 95% CI: -0.25, 0.32). Subgroup analysis suggested that a positive result from the diagnostic genicular nerve blocks test was associated with a more favourable short-term outcome.

Conclusion: This meta-analysis provides moderate-quality evidence supporting the short-term efficacy of RFA in reducing pain in patients with knee osteoarthritis. The inclusion of a diagnostic genicular nerve blocks test prior to RFA may help identify patients likely to benefit from the procedure. But it still needs more large sample studies to verify the results. However, further research is needed to determine the long-term efficacy of RFA in managing knee osteoarthritis pain.

Keywords: radiofrequency ablation, knee osteoarthritis, meta

Introduction

Knee osteoarthritis (OA) significantly impacts quality of life, with an estimated 45% lifetime risk of developing symptomatic knee OA[1]. While randomized controlled trials have demonstrated the superiority of total knee arthroplasty (TKA) over non-surgical treatment for end-stage knee OA[2], non-surgical treatment remains

crucial for certain patients. This group includes individuals with mild to moderate symptoms, those who are physically unable to undergo surgery, and those who decline surgical intervention for TKA[3–5].

Radiofrequency ablation (RFA) is a non-surgical treatment used to manage knee osteoarthritis by reducing pain and inflammation through the use of high frequency electrical currents to destroy nerve endings. A study by Davis et al.[6]. compared the safety and efficacy of RFA and corticosteroid injections in managing knee osteoarthritis pain. The results showed that RFA was comparable to corticosteroid injections in terms of pain relief and improved function, with a longer duration. The results of a randomized controlled trial by Choi et al.[7]. (only targeted the superior lateral genicular nerve, the superior medial genicular nerve and the inferior medial genicular nerve in the RFA group)

HIGHLIGHTS

- This meta-analysis provides moderate-quality evidence supporting the short-term efficacy of radiofrequency ablation (RFA) in reducing pain in patients with knee osteoarthritis.
- The inclusion of a diagnostic genicular nerve blocks test prior to RFA may help identify patients likely to benefit from the procedure.
- However, further research is needed to determine the long-term efficacy of RFA in managing knee osteoarthritis pain.

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showed significantly greater pain relief in the RFA group compared with the placebo group. Although a study by Kim *et al.*[8]. focused on the effectiveness of intra-articular pulsed radiofrequency and intra-articular corticosteroid injections for managing lumbar spine joint pain, it provides insight into the potential effectiveness of RFA in joint pain management.

In 2021, a meta-analysis study[9] was published on the effectiveness of RFA in patients with chronic knee osteoarthritis. This study demonstrated the effectiveness of RFA treatment, but it also identified some limitations. Specifically, the study did not analyze the long-term and short-term effects of RFA. In clinical practice, some clinicians rely on the results of diagnostic genicular nerve blocks to determine whether to perform RFA on patients[10–12]. However, this aspect was not addressed in the previous meta-analysis. The current meta-analysis not only offers some insights into this issue, but also includes literature published in the last 3 years that discusses related side effects. Therefore, our study can provide valuable references for clinical decision-making.

Methods

Our work has been reported in line with PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses)[13] and AMSTAR (Assessing the methodological quality of systematic reviews)[14] Guidelines. The program is registered with PROSPERO(CRD42023418048). The study is registered with research registry unique identifying number (UIN) of 1710 "https://www.researchregistry.com/browse-the-registry#registryofsystematicreviewsmeta-analyses/."

Data sources and searches

We conducted a comprehensive literature search using multiple databases, including PubMed, Embase, Web of Science, Cochrane Library, and ClinicalTrials.gov, covering publications up to June 18th, 2023. Our search terms (Supplementary Table 1, Supplemental Digital Content 3, http://links.lww.com/MS9/A311) included "radiofrequency ablation," "knee," and "osteoarthritis." Furthermore, we identified additional references by reviewing the reference lists of relevant studies and included reviews.

Selection of studies

The inclusion criteria for this study were as follows: (1) study topic: evaluation of the efficacy of RFA in patients with knee osteoarthritis (OA); (2) study design: clinical randomized controlled trial; (3) inclusion of patients who had failed conservative treatment for chronic knee osteoarthritis, such as physical therapy, oral analgesics, and endostatin injections; (4) follow-up period of at least 6 months after RFA treatment. The exclusion criteria were: (1) irrelevant topics or lack of a control group; (2) study designs such as review articles, case series, case reports, letters, conference abstracts, or reviews; (3) unobtainable data; (4) inadequate 6-month follow-up for the RFA group; and (5) duplicate articles. The search was limited to articles published in English.

After conducting a literature search, two researchers independently screened the title and abstract of each record. To ensure comprehensive data collection, only articles that clearly met the exclusion criteria were excluded during the title and abstract screening process. The full text of the remaining records was then carefully reviewed, and articles that met the inclusion criteria were included. Any disagreements between the two researchers during this process were resolved through discussion or by seeking the opinion of a third researcher.

Data extraction

The data extraction process for the study involved collecting the following information: (1) basic details such as the title, year of publication, and first author; (2) demographic characteristics including age, nationality, and sample size; (3) the type of RFA used and whether diagnostic genicular nerve blocks were performed; and (4) the visual analogue scale (VAS), numeric rating scale (NRS), or Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) that were used to evaluate the final outcome of relevant data. Two investigators independently conducted the data extraction, and any discrepancies were resolved through discussion or by seeking the opinion of a third investigator.

Assessment of article quality

The revised Cochrane risk-of-bias tool was employed to assess the quality of randomized trials. Biases, including sequence generation, allocation concealment, participant blinding, outcome assessor blinding, incomplete outcome data, and reporting bias, were considered during the evaluation process[15]. Each aspect of the assessment was categorized as having a low risk of bias, high risk of bias, or unclear risk of bias. This process was carried out independently by two investigators. Any discrepancies that arose were resolved through discussion or by seeking the opinion of a third investigator.

The quality of evidence for all outcomes was assessed using the Grading of Recommendations Assessment, Development and Evaluation (GRADE) methodology (GRADE Pro, version 3.6) by two researchers. This evaluation involved five indicators, namely risk of bias, inconsistency, indirectness, imprecision, and other considerations of bias, to assess each outcome. The levels of evidence were then categorized as high, moderate, low, or very low, based on the potential impact of further research on the confidence in the estimated effect.

Outcomes, adverse effects and statistical analysis

The primary outcome measures for statistical analysis were the VAS and Numeric Rating Scale (NRS), both rated on a 10-point scale. These scales are commonly referred to as the pain score. The secondary outcome measure was the WOMAC. The short-term efficacy was defined as the assessment conducted 6 months after the RFA operation[16]. The time period for assessing long-term efficacy was defined as 12 months following the RFA procedure[17]. A positive diagnostic genicular nerve block was defined as a recorded response indicating a decrease in numeric pain scores of at least 50% for a duration of more than 24 h. The side effects mentioned in each article will be monitored and documented in a table.

In our study, heterogeneity was measured using I^2 statistics[18]. Heterogeneity between studies can be classified as low or moderate when the I^2 statistic is less than or equal to 50%. In our study, we employed a fixed effects model to combine the effect values. If the I^2 statistic exceeds 50%, it indicates a high level of

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heterogeneity between studies, and we utilized a random-effects model to combine the effect values. Furthermore, we conducted subgroup analyses on the indicators. The data analysis was performed using Review Manager (RevMan) version 5.4, developed by the Nordic Cochrane Center in collaboration with the Cochrane Collaboration. Sensitivity analyses were conducted using STATA 12.

Results

Characteristics of the included studies

The process of selecting studies is depicted in Supplementary Figure 1, Supplemental Digital Content 1, http://links.lww.com/MS9/A309. We obtained a total of 284 records from various databases, including Medline (accessed through PubMed), Embase, Web of Science, Cochrane Library, and ClinicalTrials.gov. After removing duplicates and irrelevant papers, we evaluated 201 published reports to determine their eligibility for full-text evaluation. Ultimately, 9 RCT articles[7,10–12,19–23] (714 participants) were considered appropriate for inclusion in this meta-analysis (Table 1). Most of the study subjects included in the research were over the age of 60. The literature included three types of RF ablation techniques: "Percutaneous RF genicular neurotomy"[7,10–12,19–23], "Cooled RFA"[7,10–12,19–23], and "RF thermocoagulation"[7,10–12,19–23].

Risk of Bias

In terms of bias risk, the assessment outcomes of the included studies are displayed in Fig. 1. Three studies[10,21,22] did not mention how the random sequences were generated. Six studies[1,7,10,19–22] did not mention whether subjects and investigators might have predicted the allocation outcome. Blinding to study outcomes was not evaluated in any of the studies. The proportion of patients lost to follow-up in all studies was less than 20%, indicating a low risk of attrition bias. No other forms of bias were detected. The risk of bias for each item is expressed as a percentage of all trials, illustrating the bias risk ratio for each item (as shown in Fig. 1).

Outcomes of meta-analysis

Short-term efficacy

Pain score at 6 month

Five RCTs provided data on pain scores at 6 months. A random-effects model was used, with an I^2 value of 97%, and a weighted mean difference (WMD) of – 2.69; 95% CI: – 3.99, – 1.40 (Fig. 2). This indicates that the RFA group experienced significantly greater pain reduction compared to the control group.

WOMAC at 6 month

Three RCTs reported data on WOMAC at 6 months. A random-effects model was used, with an I^2 value of 98%, and a WMD of – 4.40; 95% CI: – 7.12, – 1.68 (Supplementary Figure 2, Supplemental Digital Content 1, http://links.lww.com/MS9/A309). This suggests that the RFA group had significantly more pain reduction than the control group.

Long-term efficacy

Pain score at 12 month

Four RCTs provided data on pain scores at 12 months. A random-effects model was used, with an I^2 value of 97%, and a WMD of – 0.88; 95% CI: – 2.36, 0.61 (Fig. 3). This indicates that the long-term effect of the RFA group compared to the control group is uncertain.

WOMAC at 12 month

Two RCTs reported data on WOMAC at 12 months. A random-effects model was used, with an I^2 value of 100%, and a WMD of 0.03; 95% CI: -0.25, 0.32 (Supplementary Figure 3, Supplemental Digital Content 2, http://links.lww.com/MS9/A310). This suggests that the long-term effect of the RFA group compared to the control group is uncertain.

Subgroup analysis

Diagnostic genicular nerve blocks

Some studies conducted the diagnostic genicular nerve blocks test, and if the result was positive, they proceeded with RFA. However, other studies did not perform this test. We categorized the studies into two groups based on whether the diagnostic genicular nerve blocks test was conducted or not. The group that had a positive result from the diagnostic genicular nerve blocks test consisted of 3 studies, which yielded a WMD of -1.06 (95% CI = – 1.96,-0.15). On the other hand, the other group comprised 2 studies, resulting in a WMD of -6.53 (95% CI = – 15.03, 1.98) (Supplementary Figure 4, Supplemental Digital Content 2, http://links.lww.com/MS9/A310). This suggests that if RFA is performed based on the results of the diagnostic genicular nerve blocks test, the final outcome is positive. However, if the diagnostic genicular nerve blocks test is not conducted, the final outcome remains uncertain.

Types of RFA

The included studies in the current analysis were categorized into three main types of RFA. The impact of Percutaneous radiofrequency genicular neurotomy and Cooled RFA on pain reduction was more evident, as indicated by the forest plot in Supplementary Figure 5, Supplemental Digital Content 2, http://links.lww.com/MS9/A310. However, it is important to note that the Cooled RFA group consisted of only 2 publications, while the Percutaneous radiofrequency genicular neurotomy group had only 1 publication.

Sensitivity analyses, meta-regression results, quality of the evidence and recommendation strengths

Figure 4 depicts the results of the sensitivity analysis, demonstrating the stability of the findings even when individual studies were excluded.

We performed meta-regression analyses on the variables "country, diagnostic genicular nerve blocks, and type of radiofrequency ablation". The p values for all variables were greater than 0.05, indicating no significant heterogeneity sources were found (Supplementary table 2, Supplemental Digital Content 3, http://links.lww.com/MS9/A312).

The quality of evidence for most of the findings ranged from low to moderate. While the included studies were randomized controlled trials (RCTs), some did not provide information on the

Table 1

Characteristics of included studies in this systematic review and meta-analysis.

First author	Journal	Country	Type of RFA	Kellgren–Lawrence grade	Diagnostic genicular nerve blocks	Mean age (years) RFA	Mean age (years) Con	Sample sizes (n) RFA	Sample sizes (n) Con	Sex (Male, n) RFA	Sex (Male, n) Con	Intervention
Choi et al.[7]	Pain	Korea	Percutaneous RF genicular neurotomy	2–4	Positive	68	67	17	18	2	3	RFA: electrode tip temperature was raised to 70° for 90s. Con: same procedure without effective neurotomy.
Davis et al.[11]	Reg Anesth Pain Med	America	Cooled RFA	2–4	Positive	63	66	76	65	26	26	RFA: 60°C for 150 sec. Control: intra-articular steroidinjection
El-Hakeim et al.[19]	Pain Physician	Egypt	Percutaneous RF genicular neurotomy	3–4	No diagnostic block was done	62	57	30	30	9	12	RFA: tip temperature was raised up to 80 °C for 270 sec (3 cycles of 90 sec). Con: oral paracetamol, nonsteroidal anti-inflammatory Diclofenac sodium.
Sari et al.[20]	Int J Rheum Dis	Turkey	Percutaneous RF genicular neurotomy	2-4	No diagnostic block was done	64	64	37	34	7	9	RFA: raising the electrode tip temperature to 80°C for 90s. Con: bupivacaine, morphine and betamethasone was injected via the inta-articular route.
Shen et al.[21]	Am J Ther	China	RF thermocoagulation	N/A	No diagnostic block was done	60	61	30	30	6	5	RFA: RF thermocoagulation was performed at 70°C for 120s. Con: injection of platelet-rich plasma and sodium hyaluronate.
Xiao et al.[22]	Exp Ther Med	China	RF thermocoagulation	N/A	No diagnostic block was done	57	62	49	47	12	11	RFA: 60, 70 and 80°C as the temperature cycle and 90s as the RF ablation time cycle. Con: Intra-articular injection of sodium hyaluronate.
Chen et al.[10]	BMC Musculoskelet Disord	America	Cooled RFA	2-4	Positive	63	63	89	68	37	28	RFA: 60°C for 150 seconds. Con: intra-articular hyaluronic acid injection.
Malaithong et al.[12]	Reg Anesth Pain Med	America	RF thermocoagulation	3-4	Positive	65	69	32	32	7	5	RFA: RF lesioning was initiated at 90°C for 180s, simultaneously generating 3 large contiguous lesions. Con: sham RF + injection of lidocaine and dexamethasone mixture.
Ghai et al.[23]	Korean J Pain	India	Percutaneous RF genicular neurotomy	2-3	No diagnostic block was done	61	57	15	15	6	3	RFA: 42°C and 45 V was performed for 3 cycles of 2 minutes each at all 3 genicular nerves. Con: injection of bupivacaine and methylprednisolone.

Con, control; RF, radiofrequency; RFA, radiofrequency ablation.

Positive, responses were recorded as positive if the participant experienced a decrease in numeric pain scores of at least 50% for more than 24 h.
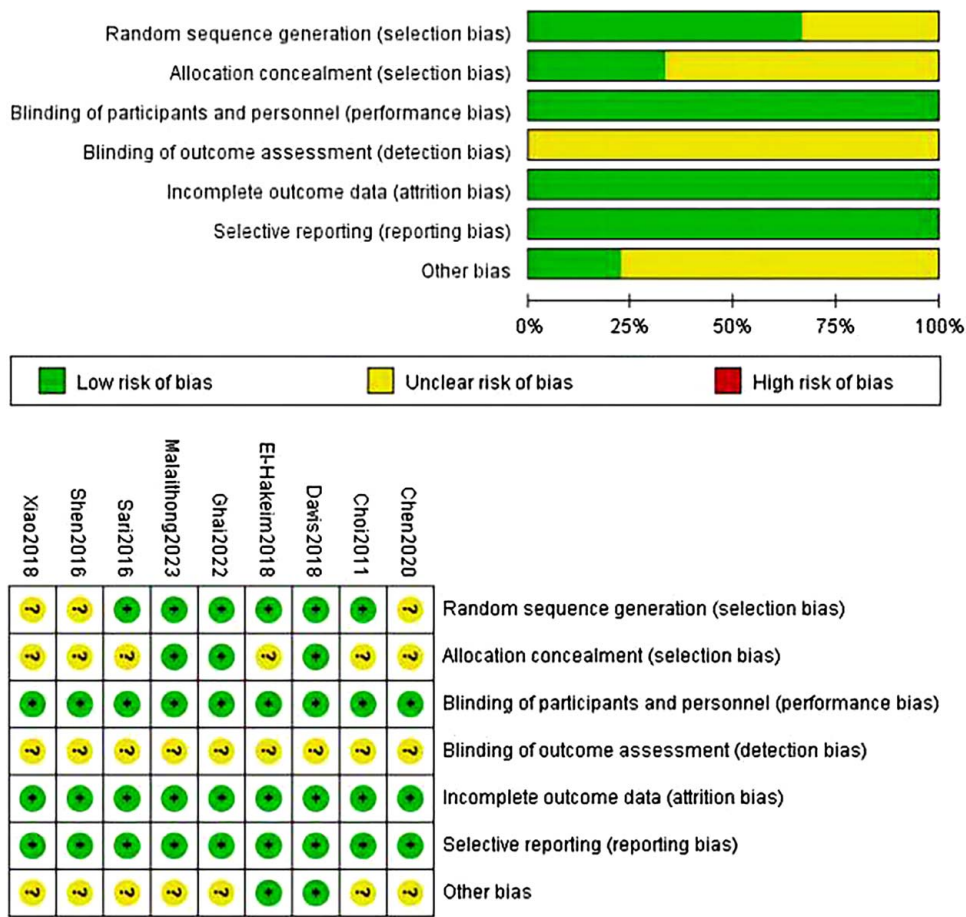
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Figure 1. Risk of bias.

generation of random sequences. Additionally, most studies did not address the potential for outcome prediction by subjects and researchers. Therefore, the overall level of evidence is considered moderate. Regarding the "WOMAC index at 12 months," the evidence level is low due to inconsistencies among the results of the included studies (Table 2).

Adverse effects

Table 3 provides a comprehensive summary of the side effects reported in all studies. Overall, no severe complications were observed in the RFA group, and the few serious complications that did occur were primarily attributed to the patients' pre-existing medical conditions rather than the RFA procedure itself. Additionally, the majority of studies reported no significant complications.

Discussion

Our study stands out as one of the few meta-analyses that evaluate the effectiveness of RFA in managing knee OA pain. Our study has yielded several significant findings. Firstly, we found
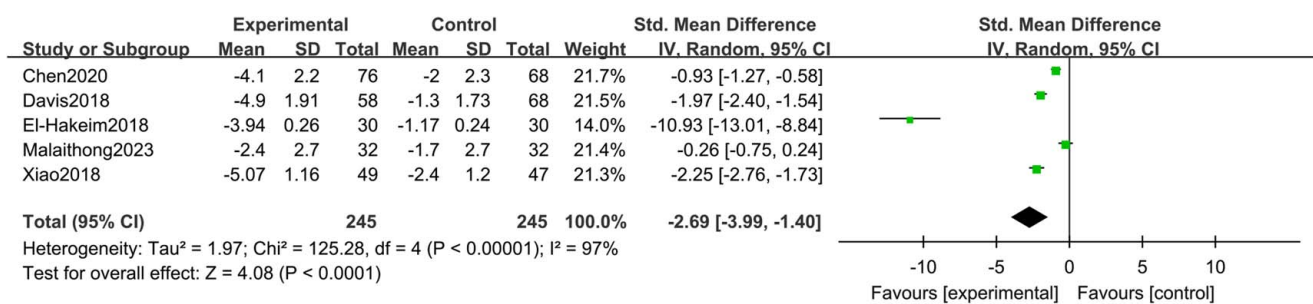

Figure 2. Meta-analysis of pain score at 6 month.

Study or Subgroup	Experimental Mean	SD	Total	Control Mean	SD	Total	Weight	Std. Mean Difference IV, Random, 95% CI
Chen2020	-4.1	2.4	66	-4	2.6	62	25.9%	-0.04 [-0.39, 0.31]
Davis2018	-4.2	2.34	52	-3.9	2.93	4	23.4%	-0.12 [-1.14, 0.89]
Malaithong2023	-2.3	2.8	32	-2.2	2.4	32	25.6%	-0.04 [-0.53, 0.45]
Xiao2018	-4.36	1.15	49	-0.52	1.16	47	25.1%	-3.30 [-3.92, -2.68]
Total (95% CI)			**199**			**145**	**100.0%**	**-0.88 [-2.36, 0.61]**

Heterogeneity: Tau² = 2.18; Chi² = 88.12, df = 3 (P < 0.00001); I² = 97%
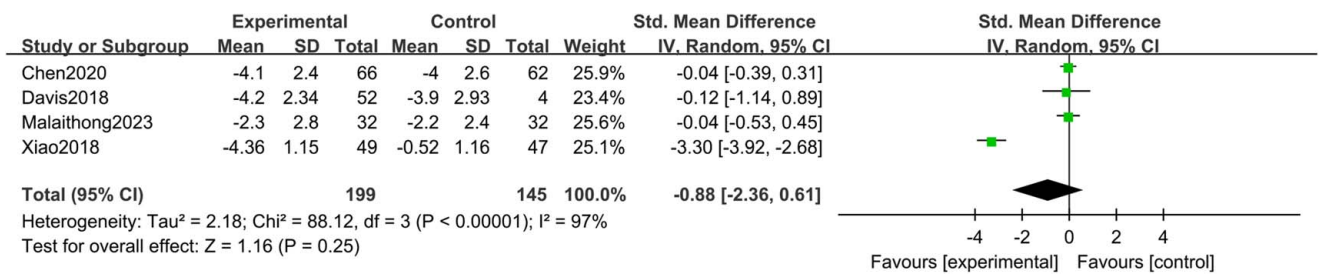Test for overall effect: Z = 1.16 (P = 0.25)

Figure 3. Meta-analysis of pain score at 12 month.

that RFA manipulation has a positive short-term effect on reducing pain in patients with chronic knee osteoarthritis. The results of our sensitivity analysis were consistent and reliable. Secondly, we were unable to determine the long-term efficacy of RFA, and the reduction in pain compared to the control group was not statistically significant. Thirdly, our subgroup analysis revealed that if the diagnostic genicular nerve blocks test yields positive results, the short-term efficacy of RFA is more certain. However, if this diagnostic test is not available, the short-term efficacy becomes uncertain. Lastly, although the short-term efficacy of the radiofrequency thermocoagulation group may not be significant, it is important to note that the inclusion of a limited number of studies in all three RF groups may affect the definitive nature of this result.

RFA is a current treatment option for chronic pain[24]. Its analgesic mechanisms involve inhibiting local excitatory c-fibres, thus blocking pain pathways, and suppressing the release of immune cells and pro-inflammatory cytokines (interleukin-1β, interleukin-6), thereby interrupting the vicious cycle of inflammatory responses[25].

RFA has a short-term effect in relieving pain for patients with chronic knee osteoarthritis, but the long-term effect is not significant. We believe that besides the limited follow-up data and research on the long-term effects of RFA, there are several reasons for this: First, although RFA can destroy nerve endings, nerve tissue has the ability to regenerate, which may lead to the recurrence of pain after a certain period of time[26]; Second, RFA only relieves the symptoms of pain, but does not treat the underlying cause of arthritis. If the degeneration of the joint continues, the

pain may reappear[27]; Third, RFA may cause complications such as infection and bleeding, which can affect the long-term results[6]. Meanwhile, it is worth noting that the efficacy of radiofrequency therapy in alleviating pain associated with knee osteoarthritis varies from person to person, according to clinical observations. While some patients report a significant relief of pain after treatment, others may experience limited benefits. Factors influencing the effectiveness of radiofrequency therapy for knee osteoarthritis also include the extent of joint damage. In the advanced stages of severe joint damage, radiofrequency therapy may not provide significant pain relief. Radiofrequency can be considered as part of a comprehensive treatment plan, including other approaches to treat knee osteoarthritis, such as physical therapy, anti-inflammatory medications or dietary supplements, infiltration therapy, and weight management. The effectiveness may depend on the synergistic effects of these therapies.

RFA has better treatment effects on patients with positive diagnostic knee nerve block tests, possibly because a positive diagnostic knee nerve block test indicates that the knee joint nerve may be the main source of pain. Radiofrequency ablation can directly target the knee joint nerve, thereby reducing or eliminating pain.

Table 3 offers a thorough overview of the adverse effects documented across all the studies. In general, the RFA group exhibited no severe complications, and the limited instances of serious complications were predominantly linked to the patients' pre-existing medical conditions, rather than being directly associated with the RFA procedure. Nevertheless, serious postoperative complications following RFA still encompass conditions like septic arthritis and bleeding.

In contrast to previous meta-analyses[28], our study excluded controversial literature[29] and incorporated recently published papers. Our findings are more specific and have undergone thorough subgroup analysis, which was lacking in previous studies. A pilot randomized clinical trial[30] suggests that preoperative manipulation of diagnostic genicular nerve blocks may not significantly impact the final outcome. However, based on our study results, we support the notion that repeating the RFA procedure based on the diagnostic genicular nerve blocks test results will provide clearer short-term effects.

Nevertheless, the effectiveness of the treatment may be influenced by the professional knowledge and experience of the physician performing the RFA procedure. Before undergoing RFA for knee osteoarthritis, it is crucial to discuss potential benefits, risks, and available alternatives with the patient. Communication involves more than just conveying information; it also includes listening to the patient, addressing their questions, and verifying their understanding of the information provided[31]. Explaining
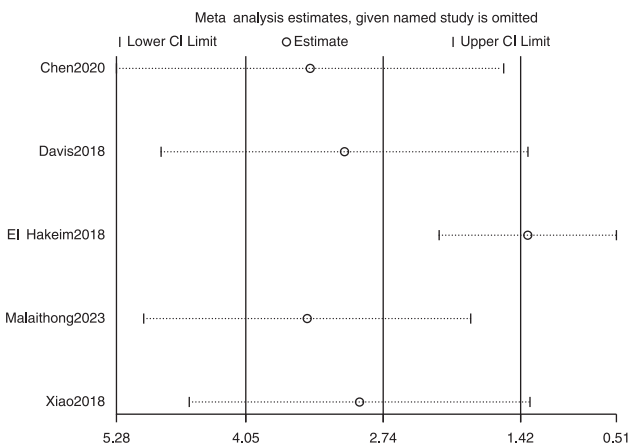
Meta analysis estimates, given named study is omitted

Figure 4. Results of sensitivity analysis.

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Table 2

Grade evidence profile.

Outcomes	Illustrative comparative risks (95% CI)	No. Participants (studies)	Quality of the evidence (GRADE)	Comments
Pain score at 6 month	The mean meta-analysis of pain score at 6 month in the intervention groups was 2.69 standard deviations lower (3.99 to 1.4 lower)	490 (5 studies)	⊖⊕⊕⊕ moderate[ab]	SMD − 2.69 (− 3.99 to − 1.4)
Pain score at 12 month	The mean meta-analysis of pain score at 12 month in the intervention groups was 0.88 standard deviations lower (2.36 lower to 0.61 higher)	344 (4 studies)	⊖⊕⊕⊕ moderate[ab]	SMD − 0.88 (− 2.36 to 0.61)
WOMAC index at 6 month	The mean meta-analysis of womac index at 6 month in the intervention groups was 4.4 standard deviations lower (7.12 to 1.68 lower)	267 (3 studies)	⊖⊕⊕⊕ moderate[ab]	SMD − 4.4 (− 7.12 to − 1.68)
WOMAC index at 12 month	The mean meta-analysis of womac index at 12 month in the intervention groups was 0.03 standard deviations higher (0.25 lower to 0.32 higher)	191 (2 studies)	⊖⊖⊕⊕ low[abc]	SMD 0.03 (− 0.25 to 0.32)

GRADE Working Group grades of evidence: High quality: Further research is very unlikely to change our confidence in the estimate of effect. Moderate quality: Further research is likely to have an important impact on our confidence in the estimate of effect and may change the estimate. Low quality: Further research is very likely to have an important impact on our confidence in the estimate of effect and is likely to change the estimate.Very low quality: We are very uncertain about the estimate.
[a]The method of generating random sequences was not mentioned in some studies; most of the studies also did not mention whether subjects and researchers might have predicted the assigned outcomes.
[b]All studies were not evaluated for blinding at the endpoint.
[c]There is inconsistency in the results of different studies.
SMD, Standardized Mean Difference.

and discussing potential alternatives are key elements of the disclosure process. In fact, patients may struggle to assess risks in abstract terms, so reliance on a comparative framework is necessary for making truly informed decisions.

Based on our analysis of the side effects reported in each study, we have concluded that RFA is a relatively safe procedure. The significance of our meta-analysis lies in its ability to provide clarity on the positive short-term effects of RFA in reducing pain, while acknowledging the uncertainty surrounding its long-term efficacy. Additionally, we advocate for the use of diagnostic genicular nerve blocks as a basis for deciding whether re-operation with RFA is necessary.

We conducted a GRADE evidence grading evaluation on the main conclusions. Although all the studies included were RCT trials, the evidence level for our main results is moderate due to the lack of mention of the methods used to generate random sequences at the start of the experiments and insufficient description of the blinding assessment in some studies.

However, it is important to acknowledge the limitations of our study. The number of included studies may not be extensive enough, and the evidence supporting subgroup analysis may be

Table 3

Adverse and serious adverse events in the included studies

First author (year)	Sample size	Adverse events	Serious adverse events
Choi et al.[7]	35	Some participants experienced temporary periosteal tenderness caused by radiofrequency cannulation during the procedure, but the pain was tolerable.	None
Davis et al.[11]	141	A total of 81 adverse events occurred in 42 patients undergoing RFA, but they were not severe.	Serious complications occurred in four cases within the RFA cohort, including blood/lymphatic and musculoskeletal infections, cardiovascular, respiratory, gastrointestinal, and skin events. However, these complications were not related to RFA.
El-Hakeim et al.[19]	60	None	None
Sari et al.[20]	71	None	None
Shen et al.[21]	60	Not mentioned	Not mentioned
Xiao et al.[22]	96	Not mentioned	Not mentioned
Chen et al[10]	157	During the 6–12 month period of the RFA cohort, a total of 47 side effects were reported among the subjects. These side effects encompassed haematologic/lymphatic, cardiovascular, endocrine, and cutaneous events. However, it was determined that these adverse event reports were not linked to the operation.	None
Malaithong et al.[12]	64	1 patient experienced significant swelling following the radiofrequency surgery, but it resolved and returned to normal within a span of 4 weeks.	None
Ghai et al.[23]	30	None	None

RFA, radiofrequency ablation.

insufficient. While the included studies were RCTs, some did not provide information on the generation of random sequences. Additionally, most studies did not address the potential for outcome prediction by subjects and researchers. Therefore, the overall level of evidence is considered moderate. Regarding the "WOMAC index at 12 months," the evidence level is low due to inconsistencies among the results of the included studies. Furthermore, the varying sample sizes across studies may introduce bias to our final results. Insufficient long-term follow-up studies and data may also hinder the assessment of long-term efficacy.

Conclusion

This meta-analysis presents moderate-quality evidence that RFA manipulation has a short-term efficacy in reducing pain for patients with chronic knee osteoarthritis. But it still needs more large sample studies to verify the results. However, the long-term efficacy remains uncertain. We recommend that clinicians conduct a positive diagnostic genicular nerve blocks test prior to performing RFA, as the short-term efficacy is relatively clear.

Ethical approval

Since the data were from published studies, this study did not need ethical approval.

Consent

Not applicable. The current study is a secondary analysis that did not involve patients.

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Author contributions

C.B.K. and L.Z.B.: project administration, software, validation, writingoriginal draft, writing review. Y.Y.: project administration, methodology, validation, writing-original draft. W.H.: Resources, visualization and data curation. G.X.F.: resources, visualization, data curation and validation. W.Z.Q.: investigation, formal analysis and validation and supervision. L.Z.B.: project administration and writing-review and editing

Conflicts of interest disclosure

The authors declare that they have no conflicts of interest.

Research registration Unique Identifying number (UIN)

1. Name of the registry:Prospero.
2. Unique Identifying number or registration ID: CRD420 23418048.

Guarantor

Zhibin Lan.

Availability of data and material

Data and material are available within the manuscript.

Provenance and peer review

Not commissioned, externally peer-reviewed.

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