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Efficacy of Radiofrequency ablation of Genicular nerves prior to total knee replacement on postoperative pain: Systematic review

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ABSTRACT

Background: The most economical method of treating knee osteoarthritis is still total knee replacement. However, a lengthy recovery is frequently linked to the surgery. The purpose of this study was to ascertain how early postoperative pain management and subjective outcomes following total knee replacement were affected by a preoperative radiofrequency ablation intervention. **Method:** The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guideline was followed in the conduct of this investigation. Two independent reviewers looked for relevant studies published between January 2019 to August 2024 in electronic databases (PubMed, Google Scholar, and Cochrane Library). **Results:** Six publications from January 2019 to August 2024 are included in this evaluation; the total number of patients included in the trials is 265,713. Three of the included studies found that genicular nerve RFA had no therapeutic effect on postoperative opioid consumption, pain, or functional evaluations at any time when compared to control group; one study found some improvement; and two studies found that traditional RFA combined with fluoroscopy produced positive outcomes for both pain and knee function for those who experienced persistent pain following TKR. **Conclusion:** Most of the analyzed studies found no significant effect of preoperative RFA on postoperative opioid use, analgesic use, or postoperative function. According to two studies, patients who experience chronic pain following TKR significantly improve with conventional RFA and fluoroscopy.

Keywords: Radiofrequency ablation, Genicular nerves, total knee replacement, postoperative pain



1. INTRODUCTION

Knee osteoarthritis can still be effectively treated with total knee replacement (TKR) at a reasonable cost. However, a lengthy recovery is frequently linked to the surgery. Convalescence carries a considerable risk of complications and expenses. The necessity to minimize hazards and maximize recovery from knee arthroplasty is well-established (Kamaruzaman et al., 2017). The postoperative use of analgesic drugs is linked to a number of medical problems associated with TKR, including as nausea, constipation, urine retention, malaise, changes in mental state, misuse, and addiction (Fuggle et al., 2019). Consequently, one of the current common goals in the area of orthopedic surgery is the creation of pain management guidelines that reduce the usage of opioids in TKR.

Studies assessing the effectiveness of non-opioid alternatives for orthopedic pain treatment are needed (Heckman and Swiontkowski, 2020). Over the past ten years, thermal peripheral sensory nerve ablation—also referred to as radiofrequency ablation (RFA)—has become more popular as a treatment for localized pain. Ball, (2014) claims that this method takes use of the present anatomical understanding of terminal afferent-only nerve endings, enabling a targeted strategy to block the transmission of unpleasant impulses from those terminals using minimally invasive methods. Reversible axonal injury is the may occur after heating the tissue after inserting a radiofrequency probe into the nerve's anatomic site in the conventional form of this technology (t-RFA).

A more sophisticated method called cooled RFA (c-RFA) permits a greater region of nerve ablation by shielding the tissues very next to the probe tip from excessive heat (Kapural and Deering, 2020). Theoretically, c-RFA would have a higher chance of achieving neurotomy than t-RFA since the anatomic path of the geniculate nerves can be altered and the probe can be positioned according to fluoroscopic landmarks (Franco et al., 2015). Preoperative neurotomy of the terminal endings of those nerves has been hypothesized to reduce surgical and postsurgical pain Dasa et al., (2016), as the majority of knee joint pain is believed to be transmitted from geniculate afferent branches. This would improve other aspects of recovery from TKR, such as opioid usage, pain scores, and validated functional scores. This study was out to ascertain how RFA affected clinical measures following TKR.

2. METHOD

This study was conducted according to The Preferred Reporting Items for Systematic reviews and Meta-Analyses (PRISMA) statement. Two independent authors searched electronic databases (PubMed, Google Scholar, and Cochrane Library) for research published between January 2019 to August 2024: Search terms include, total knee replacement, total knee arthroplasty, knee pain, radiofrequency ablation, genicular nerve, genicular nerve ablation, and cryoneurolysis. We looked over the results of this search in relation to our inclusion criteria. To ensure we didn't overlook any more pertinent research, we additionally went over all of the references in the completely retrieved papers. Relevant full-text publications were obtained, abstracts were examined, and article names were filtered.

We initially collected 101 articles, after removing duplicates and irrelevant articles we included 6 studies in the review. In this analysis, we incorporated all trials where TKR pain was managed in conjunction with genicular nerve RFA. Additionally, all articles written in English or with English translations were included. Patients having genicular nerve RFA in a knee without an artificial knee—including those who had both a total and partial uni knee replacement—were not included in our study. Studies where RFA was used on patients who still had TKR pain in the non-genicular nerve distribution were also disqualified. This review did not contain any review articles or cadaveric investigations.

3. RESULT AND DISCUSSION

This review include 6 articles (Figure 1) conducted in the period from 2019 to 2024, studies include 265,713 patients in general (Table 1). According to 3 of the included studies, when compared to sham controls, genicular nerve RFA had no therapeutic effect on postoperative opioid consumption, pain, or functional evaluations at any point in time, one study found some improvement and 2 studies found that for those who experienced persistent pain after TKR, conventional RFA in conjunction with fluoroscopy resulted in favorable results for both pain and knee function (Table 2). Recent studies have focused on predicting and avoiding extended opioid usage in individuals who have had TKR, with preoperative use being the most significant risk factor for prolonged use (Politzer et al., 2018).

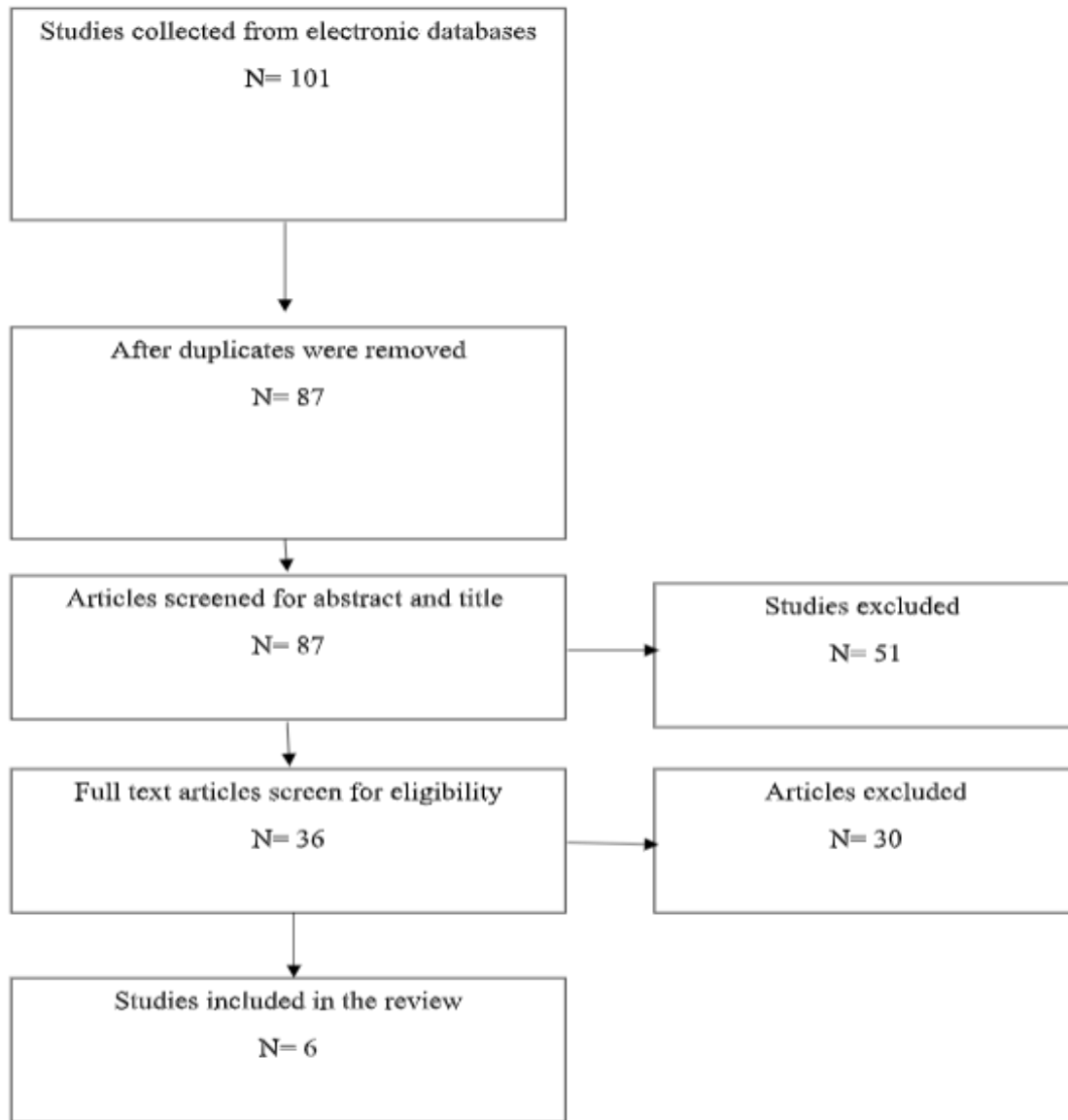


Figure 1 PRISMA consort chart of study selection

Table 1 Characteristics of the included articles

Citation	Sample size	Study objective	Pain improvement
Walega et al., 2019	67	To determine if preoperative RFA of the genicular nerve would enhance the results of postoperative pain management after TKR.	No improvement
Lyman et al., 2023	143	To ascertain how two preoperative RFA therapies affected the subjective results and early postoperative pain control following TKR.	No improvement
Mishra et al., 2021	60	The study assessed whether preoperative conventional thermal genicular nerve RFA led to meaningful improvements in function and discomfort after TKR.	No improvement

Stake et al., 2022	255, 910	To assess the rates of extended postoperative opioid use and 2-year postoperative complication rates between individuals receiving TKR following prior genicular nerve RFA and those undergoing TKR alone.	Some improvement
Gönüllü and Tekin, 2020	28	To find out how well RFA combined with fluoroscopy works for individuals who had complete knee replacements and had no other cause for their ongoing pain.	Significant improvement
Yoshimura et al., 2019	14	To assess the effectiveness of genicular nerve RFA guided by ultrasonography in patients experiencing persistent knee pain following TKR	Significant improvement

Prior published results have been inconsistent and less favorable about geniculate nerve RFA effectiveness on opioid usage, despite the fact that it has been regularly demonstrated to be beneficial, improving WOMAC ratings for pain stiffness and function (Kapural et al., 2019; Reddy et al., 2016). After six months, Chen et al. found that the cooled GNRFA group had a lower total daily dosage of nonopioid drugs in a randomized clinical study comparing GNRFA with hyaluronic acid injection for chronic knee pain. However, they were unable to detect any patterns in opioid intake (Chen et al., 2020). Lyman et al., (2023) study looked at whether RFA technology given before to TKR may enhance recovery in the short-term following TKR, but they didn't find any appreciable differences between the RFA or sham groups.

Additionally, they discovered no appreciable variations in the duration of hospitalization, patient-reported pain levels, opioid use, or time to stop using opioids. Additionally, WOMAC ratings did not differ among patients undergoing RFA, or sham treatments. The RFA procedures have generally minor side effects. The findings of Lyman et al., (2023) study has the same findings as Mishra et al., (2021) and Walega et al., (2019) studies that demonstrated no discernible impact of RFA done two to six weeks prior to TKR-on-TKR outcomes. Additionally, compared to a placebo Walega et al., (2019) study showed no reduction in post-operative pain at 1, 3, and 6 months after surgery.

More recently, Stake et al., (2022) found that patients undergoing preoperative RFA had lower risks of requiring blood transfusions, urinary tract infections, and chronic narcotic usage than a database group. The potential advantages of cryoablating the geniculate nerves before TKR were previously discussed by (Dasa et al., 2016). In contrast to RFA, cryoablation involves freezing geniculate nerves rather than heating them in order to interfere with their function. More recently, Mihalko et al. reported that cryoablation of the geniculate nerves before TKR may enhance functional results and reduce opioid consumption and pain ratings (Mihalko et al., 2021).

Previous well-designed trials have demonstrated a cost-effective advantage in comparison to established methods, as well as considerable efficacy from RFA in the nonoperative therapy of knee pain (Chen et al., 2020; Hunter et al., 2020). Compared to the majority of prior RFA trials, the mean pre-treatment and pre-arthroplasty pain levels were lower in Lyman et al., (2023) study in which pretreatment NRS pain score ranged from 3.7 to 4.4. This finding is in line with prior findings of knee osteoarthritis before surgery (Nguyen et al., 2016). In a multicenter RCT, Davis et al., (2018) contrasted RFA with intra-articular steroid knee injection using a different cooled Genicular nerve RFA technique.

Pain and overall perceived impact significantly improved in the cooled Genicular nerve RFA group at 6 months. Similarly, Sari et al., (2018) reported that after a 1-month follow-up, Genicular nerve RFA was linked to significantly lower pain and improved function compared to intra-articular steroid in an RCT comparing conventional Genicular nerve RFA with intra-articular steroid knee injections. Despite these encouraging results, the majority of the available data on the possible advantages of preoperative geniculate nerve RFA for post-TKR pain and function is unfavorable. These disparities might have a number of causes.

First, geniculate nerve RFA seems to be useful for treating persistent osteoarthritis pain, however post-TKR patients may suffer pain that is different in location and type (Franco et al., 2015). The RFA method was performed without the use of a diagnostic geniculate nerve block in the investigations by (Stake et al., 2022; Walega et al., 2019). Diagnostic geniculate nerve blocks are still often carried out in normal practice despite evidence that they do not increase the rate of geniculate nerve RFA treatment success (McCormick et al., 2018).

Table 2 Main findings of the included articles

Citation	Main findings
Walega et al., 2019	Genicular nerve RFA showed no therapeutic impact on postoperative opioid intake, pain, or functional assessments at any time point when compared to sham controls.
Lyman et al., 2023	RFA had no effect on inpatient length of stay, pain ratings, or opioid use as compared to sham controls. At any stage after TKR, there were no decreases in WOMAC scores, pain scores, or time to opioid discontinuation.
Mishra et al., 2021	The primary endpoint, pain intensity at rest at 6-week follow-up, did not significantly improve in patients receiving genicular nerve RFA when compared to sham controls. At any follow-up evaluation, secondary outcomes such as discomfort while walking and physical function did not significantly differ across groups.
Stake et al., 2022	In patients receiving TKR, preoperative genicular nerve RFA reduces the incidence of extended postoperative opioid usage without raising the risk of complications. The results of this database analysis need to be confirmed by prospective studies in the future.
Gönüllü and Tekin, 2020	Conventional RFA combined with fluoroscopy produced positive outcomes for individuals experiencing chronic pain following TKR in terms of both pain and knee function.
Yoshimura et al., 2019	WOMAC was 76.9 and the baseline NRS was 7.1. At two, four, and eight weeks, there was a substantial improvement in knee function and a significant decrease in pain as compared to baseline values. No patient had any significant complications.

4. CONCLUSION

Preoperative RFA had no discernible impact on postoperative opioid usage, analgesic use, or function after surgery, according to the majority of the reviewed trials. In two articles, conventional RFA and fluoroscopy produce significant improvement in those with persistent pain after TKR.

List of abbreviations

TKR: Total knee replacement

WOMAC: Western Ontario and McMaster Universities Osteoarthritis Index

NRS: Numeric rating scale

TKR: Total knee replacement

RFA: Radiofrequency ablation

t-RFA: Traditional radiofrequency ablation

c-RFA: Cooled radiofrequency ablation

Ethical approval

Not applicable.

Informed consent

Not applicable.

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Conflict of interest

The authors declare that there is no conflict of interests.

Data and materials availability

All data sets collected during this study are available upon reasonable request from the corresponding author.

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