



Efficacy of Cooled-Radiofrequency Ablation of the Genicular Nerve as a Treatment for Chronic Knee Pain – A Retrospective Study

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Introduction

Chronic knee pain significantly affects quality of life in the U.S.^{1,2} Various treatments, including invasive procedures and conservative methods, are used for pain management.

- Radiofrequency ablation (RFA) targets genicular nerves that transmit knee pain.
- Heat from RFA disrupts nerve function, reducing pain transmission.
- Performed under local anesthesia using fluoroscopic guidance.
- Traditional RFA ablates a small nerve area, while cooled RFA uses a water-cooled tip to facilitate larger area of ablation for more effective relief.³

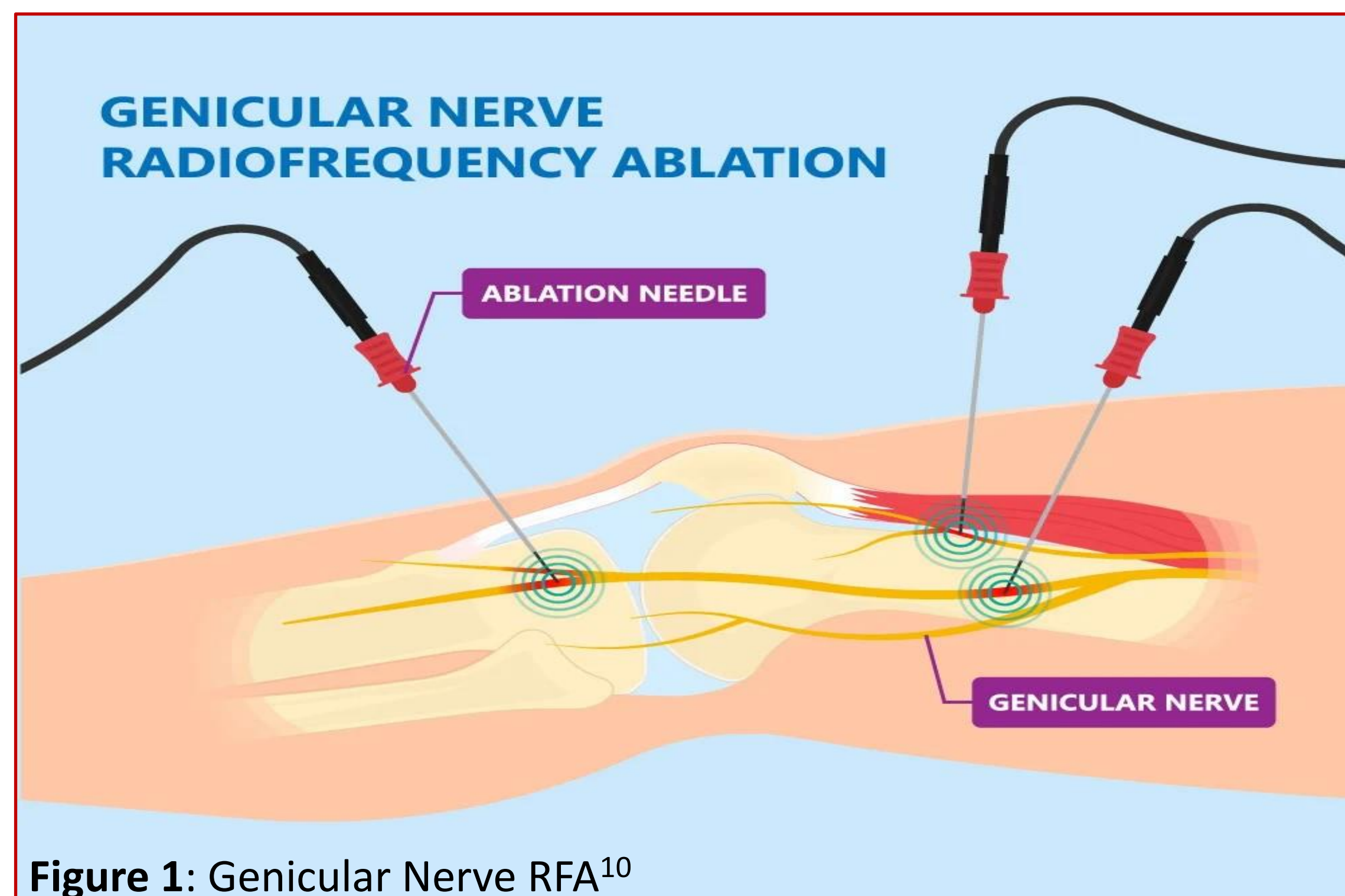


Figure 1: Genicular Nerve RFA¹⁰

This study evaluates the efficacy of cooled RFA in treating chronic knee pain, aiming to determine relief duration and adverse events. We hypothesized that RFA is a safe, effective alternative for chronic knee pain management.

Methods

This retrospective chart review analyzed 521 patients who underwent cooled radiofrequency ablation (c-RFA) of the genicular nerve for chronic knee pain (2015–2023). Data included demographics, diagnosis, pre/post-ablation pain scores, pain relief duration, and adverse events. A paired two-tailed test ($P \leq 0.05$) assessed significance between pre- and post-RFA pain scores. Of the procedures, 406 were included in the analysis. All patients had chronic knee pain unresponsive to conservative treatments and underwent a diagnostic block before RFA. IRB approval was obtained, and data confidentiality was maintained.

Results

Percent improvement and length of relief:

- The average pain score prior to the c-RFA procedure was 6.26 on VAS (M=6.26, SD=1.77, n=406).
- The average post-procedure RFA pain score was 2.59 on VAS (M=2.59, SD=2.32, n=406) (Table 2).
- The difference between pre- and post-RFA was found to be statistically significant with a $p < 0.0001$ and a power of 0.9509 ($\alpha = 0.05$ and aim of 0.80).
- The mean percent improvement was $59.3\% \pm 33.9\%$ for all procedures for which a postoperative pain score was available.
- For effective procedures (those with any amount of pain relief) with an available postoperative pain score, the mean percentage improvement was $65.5\% \pm 27.3\%$.
- The average duration of improvement was 7.20 months $\pm$ 6.56 months (Table 2). An additional 11 procedures reported ongoing relief and no return of symptoms or previous pain level.

Average VAS pain score pre-procedure (n=419)	6.26 $\pm$ 1.77
Average VAS pain score post-procedure (n=419)	2.59 $\pm$ 2.32
Mean % improvement (n=419)	59.3% $\pm$ 33.9
Mean % improvement in effective RFAs (n=382)*	65.5% $\pm$ 27.3%.
Average duration of improvement (n=264)	7.20 months $\pm$ 6.56 months

Table 1: Summary of results. The total number is provided as the nth value. *Procedures with a patient-reported percent improvement $>0.0\%$

Adverse events:

Fifty-four of the procedures reviewed reported adverse events following their procedure. None of the adverse events were found to persist longer than 6 months. The most common complaint was pain either during the procedure or immediately afterwards.

Adverse Events	Number
Paresthesia	6
Worsened pain following procedure	20
Numbness	8
Knee Swelling	6
Weakness	2
Leaking from injury	1
Procedure was painful	8
Burning Sensation Over knee	3

Table 2: Summary of Adverse Events.

Demographics:

Differentiating between the following categories: age, sex, BMI, and diagnosis showed no statistical significance between groups in pre-RFA VAS pain scores. However, post-RFA VAS pain scores were statistically significantly lower for age groups < 25 and female sex.

Total number of RFA	406
TOTAL # PATIENTS (N)	338
Sex	F= 236 M= 101
AVG AGE (YEARS)	61.0 $\pm$ 9.89
AVG BMI (KG/M ²)	35.80 $\pm$ 8.95

Table 3: Demographics.

Follow-Up Limitations and Data Exclusions:

A total of 521 procedures were reviewed on 337 patients. Sixty-seven procedures were excluded due to no reported pain score post-RFA/ lack of follow up after the procedure. 25 procedures listed qualitative improvement in the chart but did not give a post-RFA pain rating. Ten charts stated that the RFA procedure was not effective or minimally effective but did not give postoperative pain scores.

Discussion

Effectiveness of c-RFA:

- c-RFA targeting the genicular nerve resulted in a statistically significant reduction in knee pain ($P < 0.0001$).
- 65.5% average pain improvement** for effective procedures which is considered clinically significant, though response to treatment varied widely.
- Most patients experienced relief for 3-12 months, with an **average pain relief duration of 7 months.**

Patient Variability:

- Some patients had complete pain resolution, while others had minimal relief despite a successful diagnostic block.
- There were lower post-RFA pain scores in patients under the age of 25 and in females. There is not a proposed underlying cause to explain lower scores in females.

Comparative Studies:

- Literature shows consistent pain reduction, with studies reporting $>50\%$ relief in most patients for 6-24 months.^{5,6,7,8}

Adverse Events:

- 10.36% of procedures resulted in temporary adverse events (e.g., pain, numbness, tingling), with no severe or long-term complications.
- There are case reports of septic arthritis, pes anserine tendon injury, third-degree burns, hematomas, and hemarthrosis.⁴

Limitations:

- Retrospective design with challenges in follow-up and variability in pain score interpretations.
- Loss to follow-up and overlapping therapies make it difficult to fully attribute outcomes to c-RFA alone.

Clinical Implications:

- c-RFA may be a viable bridging therapy for patients awaiting total knee arthroplasty (TKA), particularly those needing to reduce BMI or HbA1c.
- Further research is needed on long-term efficacy, complications, and identifying which patients may benefit the most.

Conclusion

This retrospective analysis shows that radiofrequency ablation of the genicular nerve can be an effective, minimally invasive treatment for chronic knee pain, offering significant relief for extended periods. Compared to other therapies, it has a low risk of serious side effects, minimal patient burden, and the potential for longer-lasting pain relief. c-RFA should be considered as a low-risk option for patients whose chronic pain is unresponsive to conventional treatments.

Future Directions

Effectiveness of the procedure varies widely among patients, and future research should focus on identifying factors like patient demographics, knee pain etiology, and procedural variations that influence outcomes. Since RFA is generally not a permanent solution, further studies should also explore the safety of repeat procedures and potential adjunct therapies to enhance its effects.

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