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# Genicular Nerve Radiofrequency Ablation Before and After Magnetic Resonance Imaging Anatomical Mapping: Case Study

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**Background:** Chronic knee pain is a significant cause of morbidity for which radiofrequency ablation (RFA) of genicular nerves (GN) may be considered. However, treatment effectiveness depends on accurate placement of RFA probes, and there remains uncertainty on GN anatomical location.

**Case Report:** A 21-year-old man presented with 2 months of severe knee pain following a canoe trip. Hoffa's fat impingement was diagnosed with magnetic resonance imaging (MRI), and a subsequent fat pad injection was unsuccessful. After GN blocks, RFA provided 90% relief for 4 weeks. At this time, RFA was performed with probe placement determined by the patient's MRI-mapped GN neurovascular bundle location. At 8 weeks, the patient continues to have 100% left knee pain relief.

**Conclusion:** This case suggests that MRI-mapped GNs may assist in planning genicular RFA to improve probe and nerve apposition.

**Key words:** Genicular nerve, magnetic resonance imaging, radiofrequency ablation

## BACKGROUND

Chronic knee pain is a significant cause of morbidity, with a prevalence of 15-25% (1). Radiofrequency ablation (RFA) of genicular nerves (GN) is a treatment option for refractory knee pain (2). However, debate continues on the osseous landmarks that signify the location of clinically significant GN branches (3). It is understood that the accuracy of placement of RFA probes, relative to the GNs, significantly impacts treatment effectiveness (4). The classic locations for GN RFA probe placement were described in the original 2011 study by Choi et al (5). These locations were the superomedial and superolateral GN branches at the intersection of the femoral shaft and the medial and lateral femoral condyles, respectively, on anterior-posterior view. The inferomedial GN branch target was the tibial shaft and the medial tibial epicondyle. The depth target was understood, based on description and figures in the study, as centering the RFA lesioning tip at the halfway position of the tibial or femoral cortex in lateral view. Early GN RFA review articles pointed out both inconsistencies in technique and clinical results among the early trials (6). Importantly, studies have specifically focused on the variation of the nerve course on depth in lateral, or sagittal, view (7). It has been shown that the nerve commonly courses outside the lesioning area of probes placed according to published landmarks (6).

As the literature on genicular RFA grew, authors drew on anatomical studies to propose updated targets (7-9). Several of these studies proposed updated targets

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based on osseous anatomy (7,10), while others sought to account for the anatomic variability in the course of the GNs by locating the genicular neurovascular bundles with ultrasound guidance (11).

One common theme throughout the anatomical studies has been the inconsistency of the course of the GN branches. This may be due to inherent limitations of cadaveric dye studies, which some authors argue do not accurately mimic RFA lesions (12). Three-dimensional modelling of the GN course has also been reported, though also in cadaveric specimens (11).

Another approach is available in appropriate cases. The genicular neurovascular bundles may be visualized in vivo on MRI. At least one study (13) has looked at genicular neurovascular bundle location on MRI compared to published landmarks. This report relates the use of GN mapping on MRI to guide RFA probe placement, including depth on sagittal or lateral views.

## CASE REPORT

A 21-year-old man was referred to an outpatient Sports Medicine clinic after describing a history of 2 months of left knee pain that began after a canoe trip. The patient reported that during the 2-hour trip he kept his left leg positioned in extension and abduction. Immediately afterward, the patient was unable to bear weight on his left knee. He reported no prior history of injury or surgery of the left knee. The patient presented to urgent care twice, and was unsuccessfully treated with naproxen, brace, and straight cane. His pain was localized to the left lateral knee joint line; he characterized the pain as aching and sharp. He reported a pain intensity ranging from 2-8/10 on a visual analog scale, worse with prolonged standing, walking, and stair climbing. The physical exam was unremarkable. Roentgenogram of the left knee showed minimal lateral patellar tilt.


Fig. 1. Lateral view of first genicular nerve radiofrequency ablation, performed using traditional osseous landmarks.

The patient participated in 7 months of physical therapy with minimal improvement. Thereafter, an MRI of the left knee was obtained, and findings were consistent with Hoffa's fat pad impingement. After informed consent, the patient then underwent left Hoffa's fat pad injection, which provided 2 days of 60% pain relief. After informed consent, he then underwent GN block (using classic landmarks, as described above), which provided 100% relief for 2 days. This was repeated, with identical results. GN RFA, performed using single standard lesions at each of the revised targets proposed by Conger (9), provided 90% relief for 4 weeks, after which the pain returned as before. A repeat MRI of the left knee showed no significant changes.

At this time, the patient was offered another RFA of the left knee, but this time with probe placement guided by patient's MRI-mapped genicular neurovascular bundle locations. It was anticipated that this image-guided intervention would provide longer lasting analgesia than the previous RFA. After an informed consent discussion and agreement, the patient agreed, and measurements were made of the patient's superomedial, superolateral, and inferomedial genicular neurovascular bundles in both sagittal and axial views. Measurements were made on axial cuts in relation to the posterior margin of the tibia and femur. The patient then underwent RFA again, and RFA probe placement was compared to the images and measurements made on the MRI. Measurements taken from procedural images showed that the average difference from the center of the lesioning probe to the center of the nerve branch (measured on MRI, relative to bony anatomy) was 2.5 mm. The nerve branch diameter was found to be 2.0-3.5 mm. This places the nerve branches within the lesion area of 10 mm radiofrequency probes (14). At 8 weeks post-procedure, the patient continues to have 100% left knee pain relief and significant improvement in function.

## DISCUSSION

RFA can be an effective treatment for chronic knee pain. This case reinforces the point that variability in the course of the GNs may contribute to failure of genicular RFA in patients who underwent multiple successful GN blocks. A particular advantage of MRI mapping is that the probe may be positioned with confidence relative to the known position of the nerve on lateral or sagittal view. MRI-guided genicular RFA may be most expedient and cost effective in cases where MRI of the knee has already been obtained.

## CONCLUSION

This case suggests that MRI mapping of GNs may assist in planning genicular RFA to improve probe and nerve apposition.

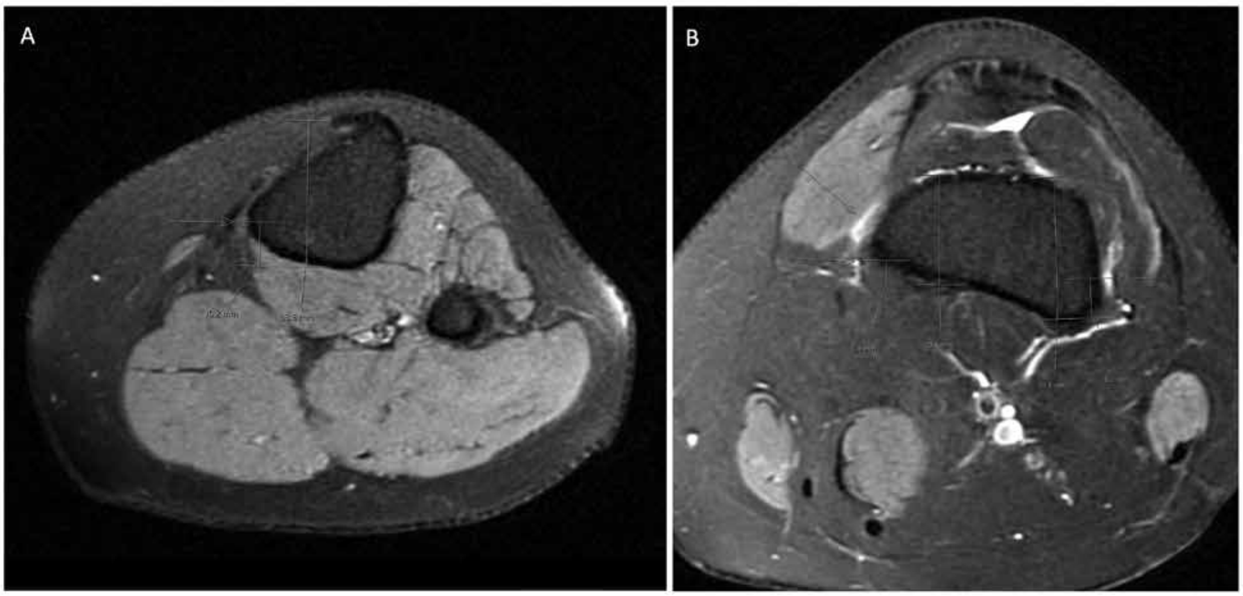


Fig. 2. MRI mapping of genicular neurovascular bundles. (A) demonstrated mapped position of the right inferomedial genicular nerve branch, relative to the posterior margin of the tibia. (B) demonstrates mapped positions of the superomedial and superolateral genicular nerve branches, relative to the posteromedial and posterolateral margins of the femur, respectively.

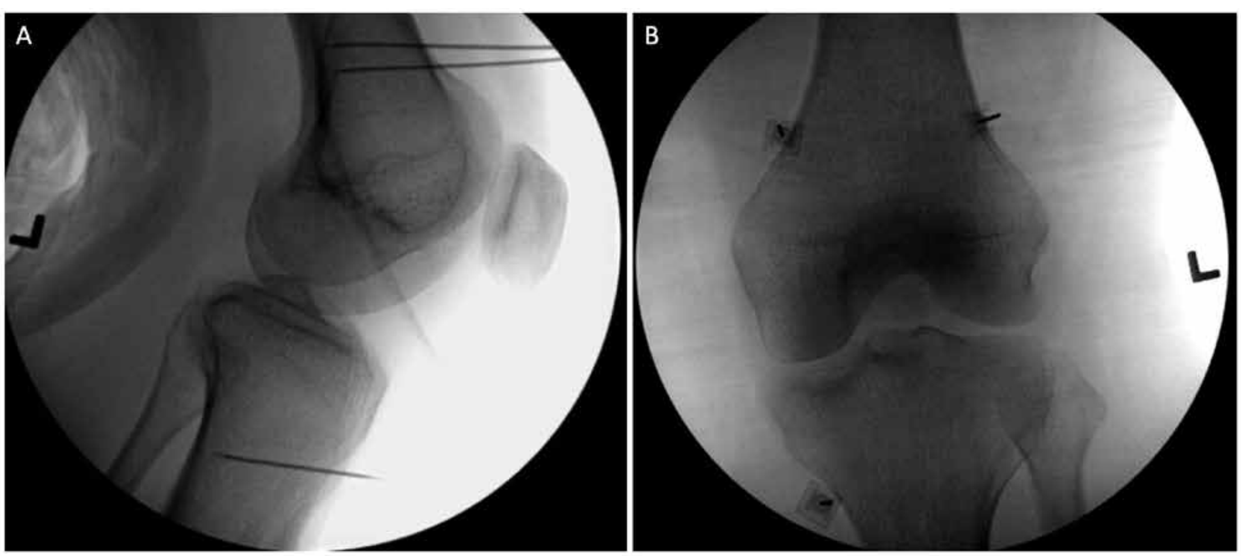


Fig. 3. Lateral (A) and anteroposterior (B) views of second genicular nerve radiofrequency ablation. Probes were driven to predetermined positions informed by MRI mapping of the genicular neurovascular bundles.

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