

The Safety of Genicular Nerve Radiofrequency Ablation

Zachary L. McCormick, MD,¹ Jaymin Patel, MD,² Aaron Conger, DO,¹ and Clark C. Smith, MD, MPH³ on behalf of the Spine Intervention Society's Patient Safety Committee

¹University of Utah School of Medicine, Department of Physical Medicine & Rehabilitation, Salt Lake City, Utah, USA;

²Emory University, Department of Orthopaedic Surgery, Atlanta, Georgia, USA;

³Columbia University, Department of Rehabilitation and Regenerative Medicine, New York, New York, USA

Myth: Genicular nerve radiofrequency ablation (RFA) is not associated with known clinically significant complications.

Fact: While genicular nerve RFA is generally considered a safe procedure, cases of septic arthritis, pes anserine tendon injury, third-degree skin burn, and clinically significant hematoma and/or hemarthrosis have been reported. As with any emerging procedure, other yet-to-be-reported complications are possible.

A growing body of literature on the efficacy and effectiveness of genicular nerve radiofrequency ablation (RFA) for the treatment of chronic knee pain has resulted in increasing interest and use in the pain medicine and orthopedic communities [1-6]. This literature has provided confidence that genicular nerve RFA results in both pain and functional improvement in a subset of patients with chronic knee pain. Few adverse events are described in these studies, suggesting that this procedure is not associated with significant complications. However, as a relatively new procedure, no large cohort studies have been published that might capture rare complications and allow for incidence estimation. Several case reports have emerged that demonstrate the possibility of various complications related to this procedure, including infection, tissue injury, and clinically significant bleeding.

A single case report describes the occurrence of septic arthritis in a morbidly obese patient with type II diabetes who underwent genicular nerve RFA [7]. There reportedly was no evidence of infection before the procedure. An aseptic preparation technique is described, and standard RFA electrode placements were used [8]. Signs of infection occurred within 24 hours of the procedure, and *Staphylococcus aureus* grew from an intra-articular aspirate. The patient ultimately underwent an uncomplicated total knee arthroplasty (TKA) five months after treatment with intravenous antibiotics.

A case of pes anserine tendon injury [9] due to inadvertent ablation was reported during RFA of the inferomedial genicular nerve using a standard electrode placement technique [8] under fluoroscopic guidance. Notably, the knee was placed in 25 degrees of flexion and intravenous sedation (2mg of midazolam and 25 mcg of fentanyl) was used. The patient presented two and four weeks later with new "burning" pain and swelling at the inferomedial genicular nerve site. An MRI demonstrated tissue changes and edema consistent with focal ablation of the sartorius and gracilis tendons near the pes anserine insertion footprint. The standard inferomedial genicular nerve approach may place the pes anserine attachment and/or distal tendons at risk of injury by the introducer needle and/or ablation during lesioning [9].

A case involving a third-degree skin burn overlaying the inferomedial genicular nerve was described in association with the use of a conventional 18-gauge electrode with a 10mm active tip [10]. A standard electrode placement position was used [8] and serial fluoroscopic images were obtained during lesioning to check for electrode migration, which reportedly did not occur. Two risk factors to consider for this complication include: minimal soft tissue underlying the skin at the site of the medial tibial flare in conjunction with the use of a large gauge RFA electrode.

Five cases of periarticular hematoma and/or hemarthrosis have been reported [11,12]. One patient was anticoagulated with apixaban, although this was discontinued for three days pre-procedure and then resumed in the evening post-RFA [11]. The patient reported pain and swelling eight days post-RFA, and a periarticular hematoma was evident in the distal vastus medialis fascia when imaging was obtained 28 days post-RFA. The hematoma resolved without intervention or further sequelae. A second patient was anticoagulated with warfarin, which was held for over five days with concurrent use of an enoxaparin bridge; the patient resumed warfarin 12 hours post-RFA [11]. Oozing from all three of the skin puncture sites as well as hemarthrosis occurred within two days of the RFA. The patient eventually underwent TKA due to continued

pain. In two additional patients, periarticular hematomas were discovered in the distal vastus medialis fascia (similar to the first patient) three to four days post-RFA [11,12]. Separately, hemarthrosis was described in one patient in a randomized trial of genicular nerve RFA [1]; however, it was reported more than four weeks post-procedure making a causal relationship to the RFA procedure unclear.

Providers should be aware of these reported complications in order to appropriately counsel patients on the potential risks of genicular nerve RFA. Further, providers should use knowledge of these potential complications in order to mitigate risk. Risk mitigation strategies specific to these complications include:

1. *Septic arthritis*: Assessment of risk factors for infection (and implementation of appropriate prevention strategies and/or procedure delay or cancellation), use of sterile pre-procedure preparation, and avoidance of violation of the joint capsule when possible. Pre-procedure laboratory testing for evidence of infection may be considered if a patient has significant risk factors including but not limited to smoking, uncontrolled diabetes mellitus, intravenous drug use, and immunocompromise.
2. *Pes anserine tendon injury*: Attention to patient positioning, awareness of local anatomy, and use of ultrasound guidance have been proposed as factors that may prevent injury to nearby structures. A new more inferior and posterior approach to the inferior medial genicular nerve target RFA site [9] compared to standard descriptions has been described but not directly studied.
3. *Skin burn*: Because RFA electrode gauge and length, lesioning time, and temperature all influence lesion size [13], these factors should be considered in relation to the depth of the nerve target as well as the patient's body habitus in this local region.
4. *Periarticular hematoma and/or hemarthrosis*: Anticoagulation guidelines specific to genicular nerve RFA have yet to be described, but providers must weigh the relative risks and benefits of holding versus continuing therapeutic anticoagulation. There is a risk of trespassing a rich vascular network, which surrounds the knee joint, especially in the region of the superomedial genicular nerve during this procedure [14].

Image guidance can be used to minimize the above adverse events. Electrode position should be confirmed prior to lesioning and re-assessed during the procedure. Ultrasound guidance may be preferable to detect and avoid vulnerable soft-tissue structures. High RFA generator impedance values may provide insight into intra-articular electrode position since synovial fluid may create a heat-sink effect. This phenomenon may also occur in the presence of a large developing hematoma. However, there are other causes for rising/high RFA generator impedance values, such as electrode proximity to bone.

Finally, larger cohort studies will be necessary to determine the incidence of these complications as utilization grows. The known and potential risks of this relatively new and evolving procedure need careful consideration when selecting appropriate patients for treatment.

References

1. Choi WJ, Hwang SJ, Song JG, Leem JG, Kang YU, Park PH, Shin JW. Radiofrequency treatment relieves chronic knee osteoarthritis pain: a double-blind randomized controlled trial. *Pain* 2011;152:481-7.
2. El-Hakeim EH, Elawamy A, Kamel EZ, Goma SH, Gamal RM, Ghandour AM, Osman AM, Morsy KM. Fluoroscopic guided radiofrequency of genicular nerves for pain alleviation in chronic knee osteoarthritis: a single-blind randomized controlled trial. *Pain Physician* 2018;21:169-177.
3. McCormick ZL, Korn M, Reddy R, Marcolina A, Dayanim D, Mattie R, Cushman D, Bhavne M, McCarthy RJ, Khan D, Nagpal G, Walega DR. Cooled radiofrequency ablation of the genicular nerves for chronic pain due to knee osteoarthritis: six-month outcomes. *Pain Med* 2017;18:1631-1641.
4. McCormick ZL, Reddy R, Korn M, Dayanim D, Syed RH, Bhavne M, Zhukalin M, Choksi S, Ebrahimi A, Kendall MC, McCarthy RJ, Khan D, Nagpal G, Bouffard K, Walega DR. A prospective randomized trial of prognostic genicular nerve blocks to determine the predictive value for the outcome of cooled radiofrequency ablation for chronic knee pain due to osteoarthritis. *Pain Med* 2018;19:1628-1638.
5. Davis T, Loudermilk E, DePalma M, Hunter C, Lindley D, Patel N, Choi D, Soloman M, Gupta A, Desai M, Buvanendran A, Kapural L. Prospective, multicenter, randomized, crossover clinical trial comparing the safety and effectiveness of cooled radiofrequency ablation with corticosteroid injection in the management of knee pain from osteoarthritis. *Reg Anesth Pain Med* 2018;43:84-91.

6. Santana Pineda MM, Vanlinthout LE, Moreno Martín A, van Zundert J, Rodriguez Huertas F, Novalbos Ruiz JP. Analgesic effect and functional improvement caused by radiofrequency treatment of genicular nerves in patients with advanced osteoarthritis of the knee until 1 year following treatment. *Reg Anesth Pain Med* 2017;42:62-68.
7. Khanna A, Knox N, Sekhri N. Septic arthritis following radiofrequency ablation of the genicular nerves. *Pain Med* 2019. [Epub ahead of print]
8. Reddy RD, McCormick ZL, Marshall B, Mattie R, Walega DR. Cooled radiofrequency ablation of genicular nerves for knee osteoarthritis pain: a protocol for patient selection and case series. *Anesth Pain Med* 2016;6:e39696.
9. Conger A, McCormick ZL, Henrie AM. Pes anserine tendon injury resulting from cooled radiofrequency ablation of the inferior medial genicular nerve. *PM R*.2019. [Epub ahead of print]
10. McCormick ZL, Walega DR. Third-degree skin burn from conventional radiofrequency ablation of the inferiomedial genicular nerve. *Pain Med* 2018;19:1095-1097.
11. Khan D, McCormick ZL, Nagpal G, Walega DR. Hematoma following cooled radiofrequency ablation of the genicular nerves: a case series. *Pain Med* September 2019. (SIS conference abstract – publication pending)
12. Strand A, Jorge P, Freeman J, D'Souza RS. A rare complication of knee hematoma after genicular nerve radiofrequency ablation. *Pain Rep* 2019;4:e736.
13. Cosman ER Jr, Dolensky JR, Hoffman RA. Factors that affect radiofrequency heat lesion size. *Pain Med* 2014;15:2020-36
14. Scapinelli R. Vascular anatomy of the human cruciate ligaments and surrounding structures. *Clin Anat* 1997;10:151-62.