



FACTFINDERS FOR PATIENT SAFETY

GENICULAR NERVE RADIOFREQUENCY ABLATION AND RISK OF GENICULAR ARTERY INJURY RESULTING IN KNEE OSTEONECROSIS

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MYTH: Genicular nerve radiofrequency ablation (GNRFA) carries a substantial risk of knee osteonecrosis resulting from genicular artery injury, with risk increasing as the number of treatment targets has expanded over time.

FACT: There are no documented cases of subsequent knee osteonecrosis, patellar or otherwise, after GNRFA. GNRFA is a procedure that can be performed with likely very little risk of causing knee osteonecrosis based on current evidence.

Background

The technique and utility of GNRFA are well established, supporting its use in treating knee pain [1-5]. It is known that the genicular arteries, which lie in close proximity to the genicular nerves, play a critical role in blood supply to the patella, distal femur, and tibia. The technique has progressed from the original three nerve targets described by Choi *et al.*; there are now at least nine nerve targets for effective GNRFA [5,6].

Notably, patellar osteonecrosis as a result of thermal damage to surrounding genicular arteries has been theorized as a potential complication after GNRFA. Furthermore, given that the genicular arteries also supply the distal femur and proximal tibia, there is also a theoretical risk of osteonecrosis of these structures. The expansion of neural targets, necessitating more radiofrequency lesions, has increased the concern for knee osteonecrosis [6]. However, within the literature documenting complications after GNRFA, there are no cases of osteonecrosis affecting the patella or other knee osseous structures.

Documented GNRFA Complications

Eight cases of adverse sequelae after GNRFA have been specifically cited in a retrospective literature review: septic arthritis, pes anserine tendon injury, third-degree skin burn, and five cases of periarticular hematoma and/or hemarthrosis [7]. Despite five cases of hematoma and/or hemarthrosis following GNRFA, there are no known instances of symptomatic knee osteonecrosis; furthermore, the hematoma and hemarthrosis could occur following venous disruption [7].

A 2016 literature review of genicular arterial injuries near GNRFA targets identified only 27 cases, specifically involving the superior lateral, superior medial, and medial inferior arteries [8]. While the review stated in the abstract that “these vascular injuries result(ed) in the formation of pseudoaneurysm, AVF (arteriovenous fistula), hemarthrosis, and/or osteonecrosis of the patella”, in the actual text, none of the 27 cases actually described a complication of osteonecrosis of the patellar or any other knee articular osseous structures.

A 2024 retrospective cohort study compared GNRFA to alternative treatment options of over 1,000 patients and complication rates at 30 and 90 days for deep vein thrombosis (DVT), pulmonary embolism (PE), infection, bleeding, seroma, swelling, nerve injury, septic arthritis, and thermal injury [9]. Osteonecrosis was not reported. The authors do not specify why these complications were selected, although osteonecrosis was not reported in the IBM MarketScan Commercial Claims and Encounters and Medicare Supplemental and Coordination of Benefit databases.

While there are cases of hematoma, seroma, and bleeding after GNRFA due to vascular injury, even in these known cases of vascular injury, subsequent osteonecrosis has not been identified and published in the literature.

A Synopsis of Knee Osteonecrosis in the Literature

Interventional Radiology Genicular Arterial Embolization (GAE) Outcomes

The patellar and genicular arterial systems have been thoroughly investigated in numerous cadaveric studies to enhance safety during orthopedic surgeries and to provide improved targets for genicular artery embolization (GAE) [8,10-11]. It appears from the orthopedic and interventional radiology literature that patellar osteonecrosis is rare, likely due to preservation of the peripatellar vascular anastomotic ring [10-33]. Genicular arterial embolization is a minimally invasive procedure that selectively targets and embolizes abnormal neovasculature around the knee joint to treat knee pain.

Furthermore, the medial, lateral, and patellofemoral arteries are well-defined targets for GAE in the interventional radiology literature utilized in clinical practice [8,10-12]. The objective of GAE is to prune the distal abnormal neovascular supply in hyperemic and inflamed synovial areas while preserving the genicular arteries [8,10-12]. Embolization occurs through the injection of permanent particles, such as Embosphere (trisacryl gelatin microspheres), or temporary embolic agents [11,12]. The particle sizes are devised to occlude small abnormal vessels while maintaining the patency of larger parent vessels [11,12]. Specifically, the descending, superior medial, superior lateral, middle, inferior medial, and inferior lateral genicular artery branches are all targets for embolization as a safe and efficacious intervention for knee pain secondary to osteoarthritis [11,12].

The lack of knee osteonecrosis reported in the GAE literature is likely multifactorial, related to the selective pruning technique, which focuses on maintaining flow in the parent vessels, and to the peripatellar vascular anastomotic ring, which provides the circumferential arterial supply to the patella [10].

Documented cases of knee osteonecrosis

Among known cases of knee osteonecrosis, including patellar osteonecrosis, documented causes include steroid-induced osteonecrosis, total knee replacement, knee arthroscopy, traumatic patellar fracture followed by surgical fixation and quadriceps V-Y plasty, and idiopathic [13-34]. There are no reported cases of knee osteonecrosis following GNRFA.

Conclusions

- GNRFA is a reliably safe procedure.
- GNRFA procedures are unlikely to result in clinically relevant damage to genicular arteries.
- If genicular arteries are damaged during GNRFA procedures, subsequent patellar osteonecrosis is unlikely to occur due to the presence of a robust collateral blood supply.
- There are no documented cases of osteonecrosis of any knee osseous structures after GNRFA.

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