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## Case Report

# Genicular artery embolization for recurrent hemarthrosis: A case report <sup>☆</sup>

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## ABSTRACT

A 44-year-old otherwise healthy male with a history of trauma and surgical interventions in his right knee presented to the emergency department with repeated hemarthrosis of the right knee. The patient underwent blood tests, X-rays, and magnetic resonance imaging of the knee. A computed tomography angiography revealed blushing of the synovium of the knee. The patient underwent successful embolization of the genicular artery branches. Hemarthrosis did not recur. The use of genicular artery embolization, in our case, not only successfully addressed recurrent hemarthrosis but also underscores its emerging role in comprehensive patient management. This minimally invasive approach, precisely targeting the vascular supply to the affected synovium, offers an effective alternative where conventional therapies may fall short. Beyond symptom relief, it holds promise for preventing hemarthrosis recurrence, a valuable addition to clinicians' interventions for challenging knee joint bleeding cases. Further investigation in larger cohorts and comparative studies may reveal its broader applicability and long-term efficacy, shaping treatment options for recurrent hemarthrosis.

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## Introduction

Hemarthrosis is characterized by knee joint hemorrhaging and is most often seen in the context of trauma. However, other notable nontraumatic causes include arthroscopy, post-

knee arthroplasty, and inherited or acquired bleeding disorders, such as hemophilia, which could be underlying reasons.

Most frequently observed pathology is hypertrophic vascular synovium. Additionally, arteriovenous fistula, pseudoaneurysm, pigmented villonodular synovitis, or prosthetic complications such as loosening, or instability should be con-

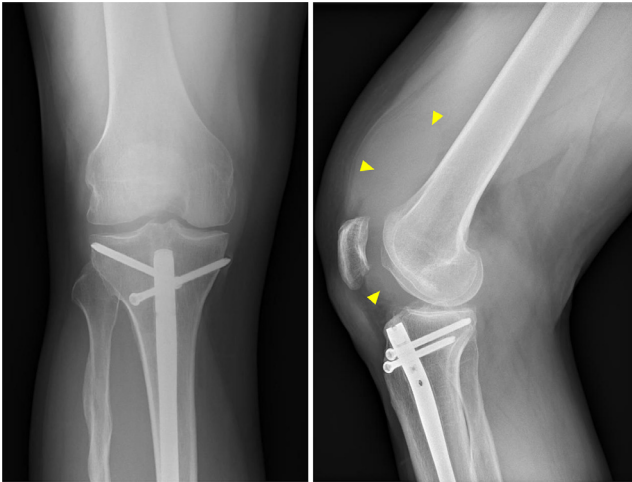
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**Fig. 1 – X-rays showed intraarticular effusion (yellow arrowheads) especially the suprapatellar recess without fractures, loosening or osteolysis of the tibial intramedullary nail.**

sidered. In all patients bleeding disorders, joint infection, and prosthetic complications should also be evaluated [1].

These nontraumatic causes can predispose patients to recurrent hemarthrosis. Although recurrent postoperative hemarthrosis after total knee arthroplasty is uncommon (occurring in 0.3%-1.6% of patients), it is typically refractory to conservative treatment and requires surgical treatment for definitive management [2]. Genicular artery embolization (GAE) is an effective, safe, and minimally invasive therapy for recurrent hemarthrosis treatment [1].

Here, we report a case of recurrent hemarthrosis that was successfully treated with embolization of the genicular artery branches with minimal complications.

## Case

A 44-year-old man with no notable medical history presented to the emergency department with recurrent swelling of the right knee and worsening pain. The patient reported chronic right knee pain after a previous anterior cruciate ligament (ACL) injury, which was treated nonoperatively, a meniscal injury in the right knee treated with arthroscopy and shaving, and a skiing accident in 2018, which resulted in a proximal tibia fracture that was treated with a locked intramedullary nail. The pain was reported to worsen after 2 weeks of physically demanding work on ladders and scaffolding in August 2022. Severe pain arose suddenly regardless of weight bearing on the affected leg or at rest. The patient also reported swelling and locking of the right knee. There was no new history of direct knee trauma or sprain, and the patient was not receiving anticoagulation treatment.

Radiographs revealed intraarticular effusion with no evidence of fracture, loosening, or osteolysis of the intramedullary nail (Fig. 1). The C-reactive protein level was 1.3 mg/L (normal value <8 mg/L), and hemoglobin was 8.9 mmol/L. Coagulation studies revealed that prothrombin time,

activated partial thromboplastin time, bleeding time, and platelet count were all within normal ranges.

Arthrocentesis was conducted to rule out infection, and hemarthrosis was observed. Fluid analysis revealed numerous leucocytes (70% mononuclear white cells). After 10 days, the cultures were negative. Magnetic resonance imaging (MRI) of the right knee (Fig. 2) revealed excessive intraarticular effusion, a previous complete ACL rupture, and some reaction around Hoffa's fat pad.

The patient received conservative treatment in the emergency department three times over a 6-month period, incorporating analgesia, rest, elevation, and joint aspiration. In August 2022, the first knee aspiration was performed, followed by a second aspiration in January 2023. In March 2023, the patient did not undergo aspiration but received pain management. During each aspiration, 80-90 mL of blood was aspirated. Despite these interventions, the patient experienced only short-term improvement, and the pain with recurrent hemarthrosis persisted. Subsequent arthroscopy revealed minimal degenerative changes that did not explain the recurrent hemarthrosis. Computed tomography (CT) angiography (Fig. 3) revealed a thickened synovium, local ectasia of the P2 segment of the popliteal artery, probably the result of a previous trauma, and contrast-enhanced, hypertrophic vascular synovium with synovial blush supplied by one or more genicular arteries.

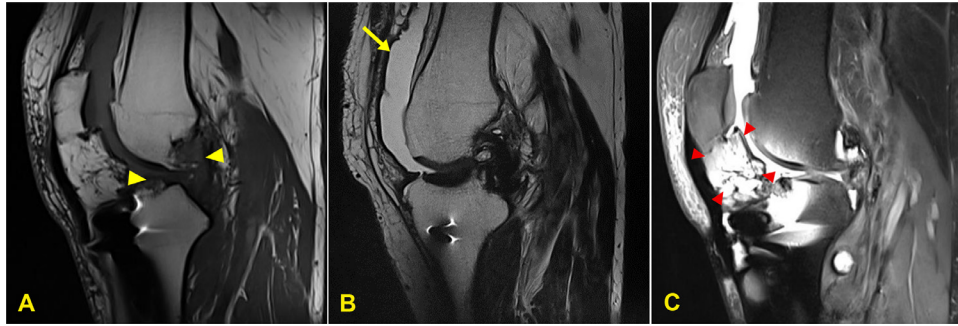
The patient was referred to Digital Subtraction Angiography (DSA) and underwent 2 sessions of selective embolization targeting the genicular artery branches.

In the first session, a  $2 \times 3$  mm Nester® 0.018 embolization coil (Cook Medical) was utilized to embolize a branch of the superior medial genicular artery (Fig. 4). Following the initial coiling, a 3-month follow-up was scheduled. At the 6-week follow-up consultation, no recurrence of hemarthrosis was observed. However, three weeks later, during the ongoing monitoring period, hemarthrosis recurred.

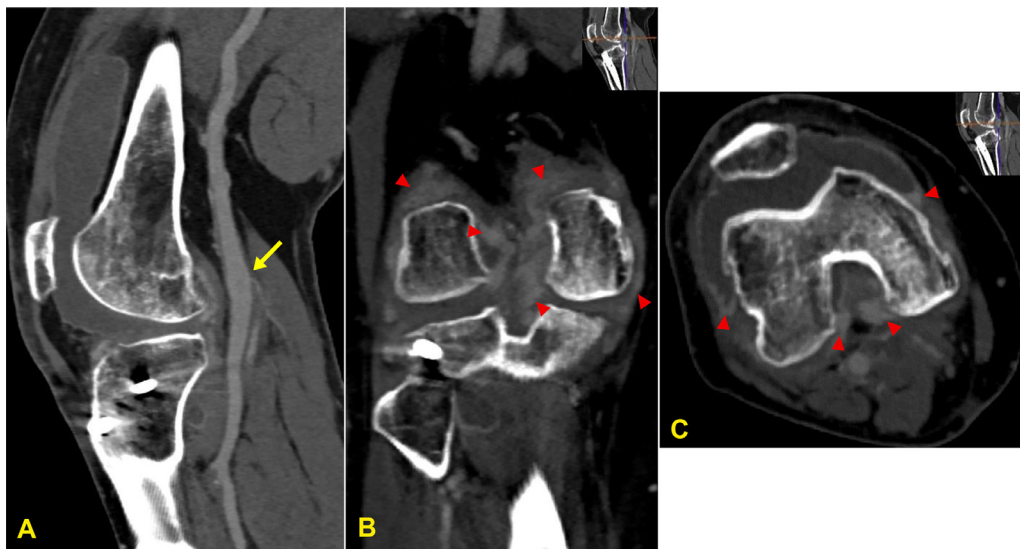
Subsequently, a second embolization session was conducted, employing HydroPearl™ (Terumo) 200- $\mu$ m embolization particles in the branches of the inferior medial and lateral genicular arteries (Fig. 5), along with a  $3 \times 7$  mm Nester® 0.018 embolization coil (Cook Medical) in the inferior lateral genicular artery (Figs. 6 and 7). The second session was successful, and hemarthrosis did not recur. Immediate complications were minimal. The patient experienced side effects of non-target embolization of the skin resulting in transient cutaneous erythema, which self-limitingly regressed over the next 6 weeks.

## Discussion

Spontaneous hemarthrosis is a challenging differential diagnosis for physicians. Most patients experience pain and knee effusion with or without a history of trauma; therefore, infection should always be ruled out. Arthrocentesis typically reveals hemarthrosis. A complete review of a patient's medical history should be performed, with particular emphasis on blood dyscrasia and the current or recent use of anticoagulant medications. A radiograph is useful to rule out pathologic fractures and osteolysis. The reported success rate of conser-



**Fig. 2 – MRI images. (A) T1 showing old Anterior Cruciate Ligament (ACL) injury (yellow arrowheads), (B) T2 showing significant intra-articular effusion in the suprapatellar recess (yellow arrow). (C) T2-with fat saturation showing reaction in Hoffa's fat pad (red arrowheads).**



**Fig. 3 – CT angiography (CTA). (A) vessel reconstruction shows local ectasia of the P2 segment of the popliteal artery (yellow arrow). (B) (coronal) / (C) (axial) shows thickened and contrast enhanced synovium with blush (red arrowheads).**

vative treatment, which involves up to three joint aspirations, rest, ice, compression, and antithrombotic drugs, is 83% [3]. Given this high success rate, we would recommend conservative treatment as the initial management option. However, in this case, conservative treatment failed.

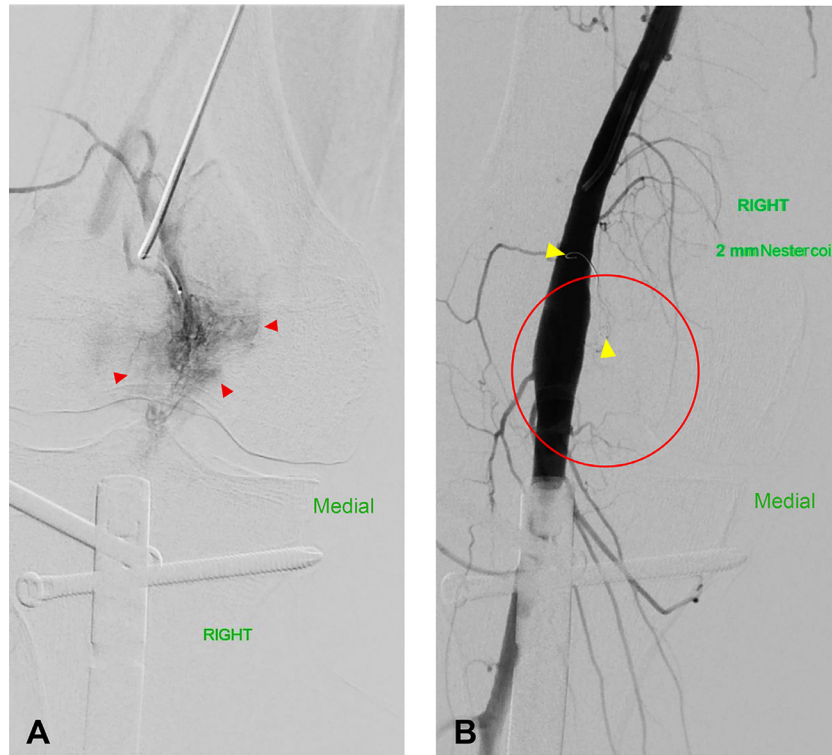
MRI and CT angiography can be used to investigate the cause of hemarthrosis when conservative treatment fails. Arthroscopy can also be used to perform a synovectomy if the synovium is identified as the cause of recurrent bleeds. In the current case, arthroscopy of the right knee revealed incipient osteoarthritic changes, wear-and-tear changes in both the medial and lateral menisci, a larger unstable injury in the medial meniscus, an old, ruptured ACL (Anterior Cruciate Ligament), and substantial irritation of the synovium, which did not explain the bleeding.

DSA can aid in the diagnosis of recurrent hemarthrosis, while therapeutic selective genicular artery embolization (GAE) provides satisfactory clinical results [4]. In alignment

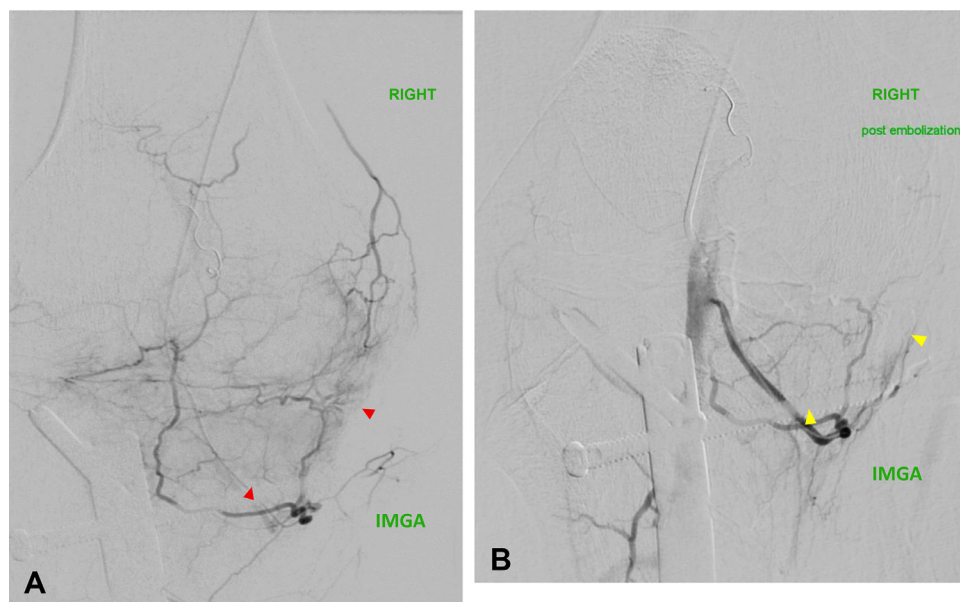
with published literature, GAE demonstrates notable effectiveness with an 86% success rate. These outcomes resonate with findings from prior investigations, reporting consistent technical success rates ranging from 99% to 100% and clinical success rates spanning 60%-92% [2]. There should be noted that the results are based on small population or case-based studies [5], utilizing a variety of different embolization techniques and follow up protocols.

Our contribution confirms the reliability of GAE with favorable success rates, offering valuable insights into its effectiveness. Complications of post-GAE are minor and transient. The most common documented complication is transient cutaneous erythema, which occurs in 12% of patients and typically resolves spontaneously within 1 month [6].

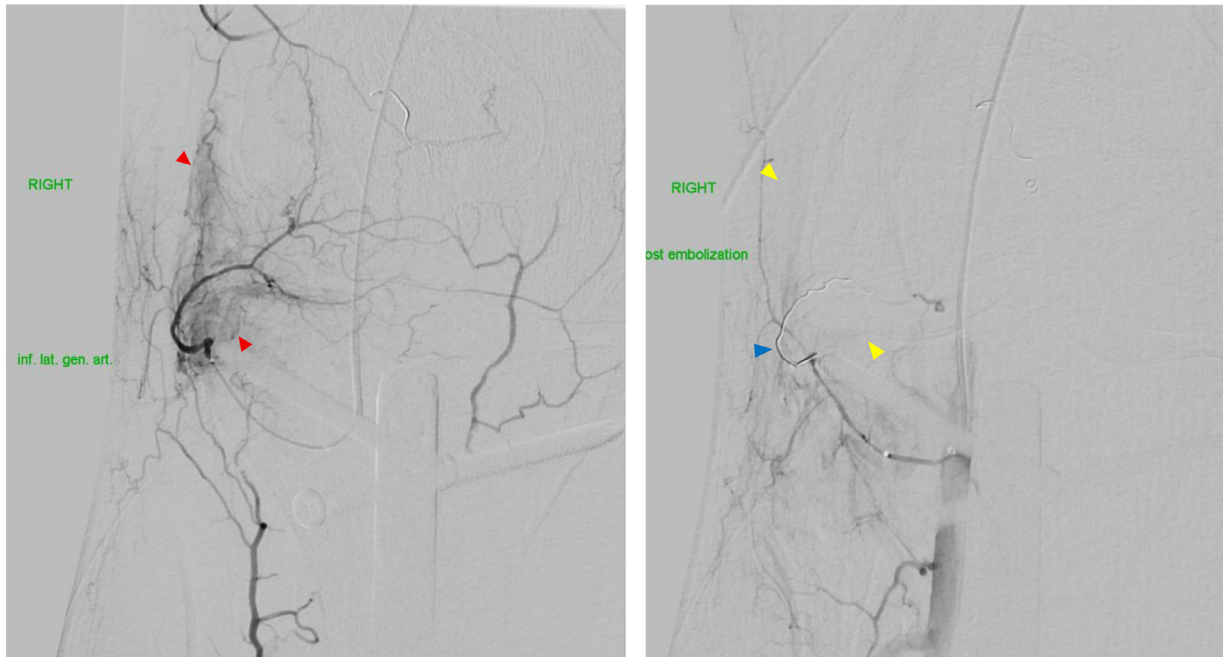
In case of failed conservative treatment, DSA combined with selective embolization should be considered as a reasonable and successful treatment choice.



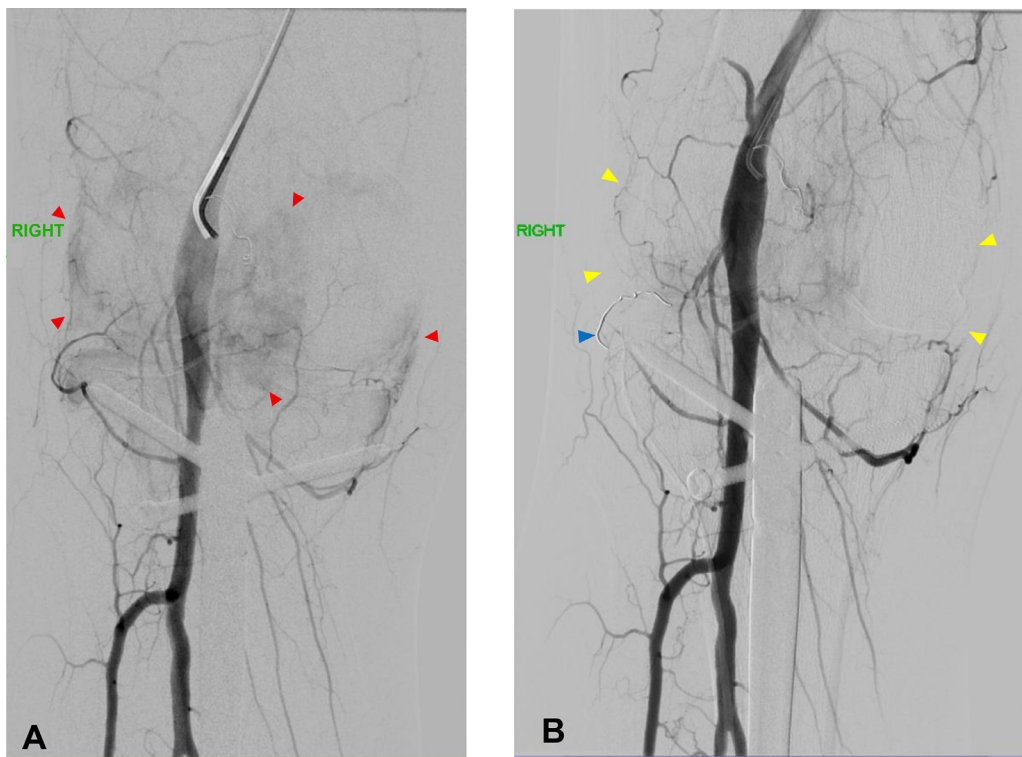
**Fig. 4 – Digital Subtraction Angiography (DSA) before and after the first embolization session. (A) Pre-embolization selective angiography image showing a tumor blush in the Superior Medial Genicular Artery supplying area (red arrowheads). (B) Postembolization image showing the disappearance of the tumor blush (red circle) after the insertion of a 2 × 3 mm Nester® 0.018 embolization coil (Cook Medical) (yellow arrowheads), in the Superior Medial Genicular Artery.**



**Fig. 5 – Digital Subtraction Angiography (DSA), selective angiography, before and after the second embolization session treating the Inferior Medial Genicular Artery (IMGA). (A) Pre-embolization image showing a 'tumor blush' (indicated by red arrowheads) in the IMGA supplying area. (B) postembolization image after the use of HydroPearl™ (Terumo) 200 μm embolization particles in the IMGA with subsequent disappearance of the tumor blush (yellow arrowheads).**



**Fig. 6 – Digital Subtraction Angiography (DSA), selective angiography, before and after the second embolization session treating the Inferior Lateral Genicular Artery (ILGA). (A) Pre-embolization image showing a tumor blush in the Inferior Lateral Genicular Artery supplying area (red arrowheads). (B) Postembolization image after the use of HydroPearl™ (Terumo) 200  $\mu$ m embolization particles and an additional 3 x 7 mm Nester® 0.018 embolization coil (Cook Medical) in the main Inferior Lateral Genicular Artery (blue arrowhead) with subsequent disappearance of the tumor blush (yellow arrowheads).**



**Fig. 7 – Digital Subtraction Angiography (DSA) before and after the second embolization session treatment . (A) Pre-embolization image showing a clear 'tumor blush' appearance (red arrowheads). (B) Postembolization control image illustrating significant reduction of tumor blush after the use of embolization particles in the IMGA and ILGA (yellow arrowheads) and an additional embolization coil in the main Inferior Lateral Genicular Artery (blue arrowhead).**

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## Conclusion

Our case emphasizes the critical role of a multidisciplinary diagnostic approach in evaluating recurrent hemarthrosis, particularly in patients with a history of knee instrumentation or trauma. A thorough consideration of differential diagnoses for hemarthrosis, including vascular injuries, is paramount. The collaboration of orthopedic surgeons, interventional radiologists, and potentially vascular surgeons within a multidisciplinary team is crucial for the accurate diagnosis of this condition and the determination of the most appropriate treatment options. Notably, targeted genicular artery embolization (GAE) emerges as a promising and effective treatment avenue when traditional conservative approaches prove inadequate. Larger multicenter studies should be considered to compare the different treatment strategies (conservative treatment, open surgical approach, and GAE) and complication risks to evaluate if GAE should be considered as a more initial treatment strategy.

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## Patient consent

Written informed consent was obtained from the patient regarding the publication of this case report, including all accompanying images.

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