

# Endovascular Management of Pseudoaneurysms Following Lower Limb Orthopedic Surgery

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**O** rthopedic procedures like joint arthroplasty and joint arthroscopy can lead to unrecognized arterial injuries that later cause the formation of pseudoaneurysms. Here we present 5 cases of patients who underwent successful endovascular management of pseudoaneurysms that developed after lower limb joint arthroplasty or arthroscopy.

## CASE REPORTS

### Case 1

A woman in her early 50s presented with worsening leg pain 2 weeks after right total knee arthroplasty (TKA). She had no relevant past medical history. On admission, her pulse rate was 76 bpm, and she was normotensive. The right leg was swollen and had some tenderness, but the foot appeared well perfused with palpable distal pulses bilaterally. A provisional diagnosis of deep venous thrombosis (DVT) was made. Duplex ultrasound examination did not provide any evidence of DVT but revealed a 3- to 4-cm right popliteal pseudoaneurysm. Digital subtraction angiography (DSA) confirmed a 4.6×2.9-cm pseudoaneurysm originating from the distal popliteal artery posterior to the tibial prosthesis (Figure 1). The feeding artery was selectively catheterized with a coaxial system (Tracker 18 microcatheter; Target Therapeutics, San Jose, Calif), and the neck of the pseudoaneurysm was embolized with two 4-mm microcoils.

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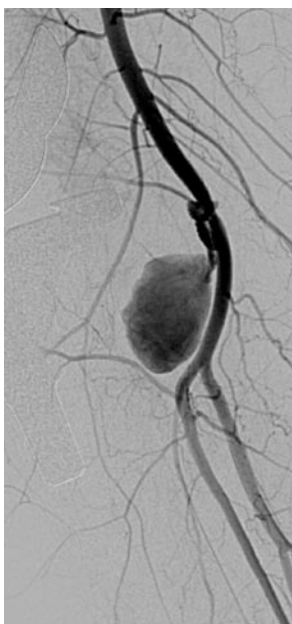
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Complete occlusion of the pseudoaneurysm was achieved (Figure 2) and was confirmed by duplex ultrasound scan 24 hours later. The patient was discharged from the hospital on postoperative day 2 with no complications.

### Case 2

A man in his mid-70s presented to the emergency department with painful swelling on the anteromedial aspect of the right knee 7 months after right TKA. Examination revealed a 3×1-cm tender swelling that was pulsatile but unrelated to any named vessel. Distal pulses were all present. Duplex ultrasound examination revealed a 2×3-cm mass with arterial flow. Angiography confirmed a 4-cm pseudoaneurysm, supplied by the medial inferior genicular artery (Figure 3). The medial inferior genicular branch was selectively catheterized with a 4Fr Cobra catheter (Cook, Bloomington, Ind). Three 4×3-mm coils were used. Satisfactory occlusion of the pseudoaneurysm was achieved (Figure 4) and was confirmed by duplex sonography 24 hours later.



**Figure 1.** Case 1—pre-embolization digital subtraction angiography shows posterior tibial artery pseudoaneurysm.



**Figure 2.** Case 1—post-embolization digital subtraction angiography shows complete exclusion of the pseudoaneurysm.



**Figure 3.** Case 2—digital subtraction angiography shows medial inferior genicular artery pseudoaneurysm.



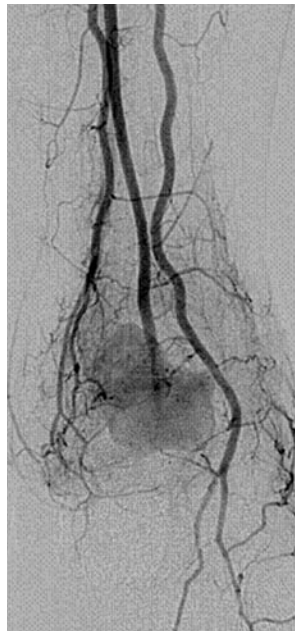
**Figure 4.** Case 2—digital subtraction angiography shows complete exclusion of the inferior genicular artery pseudoaneurysm.

### Case 3

A woman in her late 40s was referred for a vascular opinion regarding a painful 2×3-cm pulsatile swelling on the anterior aspect of the ankle. This swelling appeared 3 weeks after ankle arthroscopy for suspected osteoarthritis. The patient did not have any known medical comorbidities. She underwent DSA, which confirmed a 3-cm pseudoaneurysm arising from the distal anterior tibial artery (Figure 5). There was minimal flow in the dorsalis pedis artery distal to the pseudoaneurysm, and supply to the foot was predominantly through the posterior tibial artery. Exclusion of the pseudoaneurysm was performed by coil embolization using two 4×3-mm coils distal to the pseudoaneurysm and two 4×3-mm coils proximal to the aneurysm (Figure 6). After surgery, exclusion of the pseudoaneurysm was confirmed by duplex sonography. However, the dorsalis pedis pulse was still palpable distal to the pseudoaneurysm site because of an intact pedal arterial arch, thereby justifying the distal and proximal coiling.

### Case 4

A man in his early 60s with factor VIII deficiency presented with sudden arterial bleeding from a lump lateral to the patellar tendon of the right knee. The bleeding occurred under a port site 1 month after arthroscopy for knee pain. A duplex ultrasound scan of the joint showed a pseudoaneurysm eroding the skin and bleeding intermittently, which was confirmed by DSA (Figure 7). There was shunting to the draining vein and extensive neovascularity surrounding the knee (Figure 8). The lateral inferior geniculate artery was selectively embolized, but, because of the abnormal neovascularization, there was persistent filling from the



**Figure 5.** Case 3—distal anterior tibial artery pseudoaneurysm after ankle arthroscopy.



**Figure 6.** Case 3—successful coiling of the distal anterior tibial artery pseudoaneurysm.

adjacent geniculate arteries. The medial inferior geniculate, superior lateral geniculate, and branch coming superiorly from the proximal anterior tibial artery were also embolized. Although flow into the pseudoaneurysm was not completely abolished (Figure 8), flow reduction was expected to induce thrombosis. Because of recurrent low-grade bleeding, however, surgical excision of the bleeding pseudoaneurysm was ultimately required. The patient recovered without complication.

### Case 5

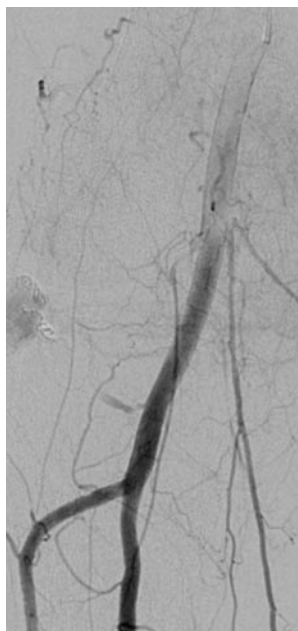
A woman in her late 50s presented with low-grade bleeding from a mass and skin breach on the posterior aspect of the left knee 7 days after unicompartmental knee replacement. She was hemodynamically stable. Examination of the left knee revealed a 5-cm pulsatile mass in the popliteal fossa with a swollen leg. Duplex ultrasound scan showed a pseudoaneurysm of the left popliteal artery, which was confirmed with urgent DSA (Figure 9). The pseudoaneurysm was found arising from an extensive defect in the artery and was therefore not suitable for embolization. Instead, a 38-mm Jomed covered stent graft (Jomed International AB, Helsingborg, Sweden) was deployed in the popliteal artery to successfully exclude the bleeding pseudoaneurysm (Figure 10). At 6-month follow-up, the patient was doing well, and the limb was well vascularized.

## DISCUSSION

Lower limb orthopedic procedures, ranging from joint replacement to joint arthroscopy, can be associated with pseudoaneurysm formation, and there are reports of pseudoaneurysms arising from the popliteal,<sup>1-3</sup> anterior tibial,<sup>4</sup>



**Figure 7.** Case 4—digital subtraction angiography shows pseudoaneurysm of the genicular artery with the extensive neovascularization common in hemophiliacs.



**Figure 8.** Case 4—despite digital subtraction coiling and PVA embolization, pseudoaneurysm continues to slowly fill.



**Figure 9.** Case 5—digital subtraction angiography shows pseudoaneurysm of the popliteal artery after digital subtraction coiling and PVA embolization.



**Figure 10.** Case 5—covered stent deployed on the popliteal artery excluding the pseudoaneurysm.

and posterior tibial<sup>5</sup> vessels. According to the literature, however, smaller vessels, such as the tibioperoneal trunk,<sup>6</sup> the genicular arteries,<sup>7-9</sup> and, distally, the pedal vessels,<sup>10,11</sup> can also be affected. The underlying mechanism of traumatic pseudoaneurysm formation is a vessel wall defect and persistent bleeding into an enclosed space leading to encapsulation by surrounding connective tissue.

The various vessel traumas that lead to pseudoaneurysms include blunt injury,<sup>12</sup> direct trauma, and branch avulsion. These injuries can occur with surgery around

with subcutaneous heparin, which is widely used in clinical practice. Similarly, patients with congenital bleeding diathesis (case 4) are for similar reasons also potentially at increased risk for pseudoaneurysm formation.

Although some pseudoaneurysms can thrombose spontaneously, they usually need treatment, as there is a risk for continued expansion leading to rupture (cases 3, 5), adjacent structure compression, infection, or embolization. Multiple management strategies can be applied to pseudoaneurysms; options range from ultrasound compression<sup>18,19</sup>

**“Radiologic coil embolization or endovascular stenting allows access to difficult feeding vessels and allows for precise treatment of more complex or established pseudoaneurysms.”**

knee joints<sup>13-15</sup> and ankle joints,<sup>16,17</sup> as in the present case series. In addition, use of a tourniquet in many lower limb orthopedic procedures may result in missed or underestimated bleeding from wounds and port sites, increasing the risk for pseudoaneurysm formation.

Apart from surgical injury, certain patient factors may predispose to pseudoaneurysm formation. Atherosclerotic peripheral vascular disease can lead to formation of collateral vessels and hence larger than expected vessels in unexpected positions that may not tamponade as expected.

In another predisposed group, patients receive anticoagulants, take longer to seal traumatized vessels, and are more likely to experience prolonged bleeding. This group includes patients with recently discontinued warfarin and

to thrombin injection,<sup>20,21</sup> radiologic intervention,<sup>22,23</sup> and surgery. Ultrasound compression is limited by position deep within muscle compartments, late presentations, and large pseudoaneurysm neck size making its use in orthopedic cases limited. Thrombin injection again is dependent on access and on appropriate pseudoaneurysm neck length, limiting its use. Radiologic coil embolization or endovascular stenting allows access to difficult feeding vessels and allows for precise treatment of more complex or established pseudoaneurysms. Although surgery remains the definitive technique for treating pseudoaneurysms, it is usually associated with increased morbidity and longer hospital stay and is increasingly reserved as a strategy in cases unsuitable for other modalities.



All 5 patients described in this series presented more than 1 week and up to 7 months after orthopedic intervention. In case 1, the patient presented with a suspected DVT 2 weeks after joint replacement surgery, and on duplex scanning a pseudoaneurysm was unexpectedly noted instead. In case 2, the patient presented 7 months after surgery and probably had slow progression because of the small caliber of the feeding vessel. In case 3, the patient's pseudoaneurysm was caused by direct trauma to a major pedal vessel, but the patient presented 3 weeks later and required inflow and outflow vessel coiling because of collateral flow. In case 4, the patient, who had a bleeding diathesis with a pseudoaneurysm after arthroscopy, failed coiling and ultimately required surgery. Case 5 is the only case in which coil embolization was not possible, because of the size of the pseudoaneurysm and the size of the vessel defect; the vessel defect had to be sealed with a covered stent to avoid an undoubtedly difficult surgical repair.

### CONCLUSIONS

We recommend a high level of awareness in arteriopathies and in patients who tend to bleed. In the case of ankle arthroscopy, the danger to the pedal vessels on port insertion should be kept in mind. Hemostasis and compression are critical after surgery, particularly surgery involving a tourniquet. Early detection of unusual pulsatile lumps, especially after orthopedic procedures, should initiate investigation with duplex scanning, as early treatment will increase the chances of success.

### AUTHORS' DISCLOSURE STATEMENT

The authors report no actual or potential conflict of interest in relation to this article.

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