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CASE SERIES
Cardiovascular surgery

A case series: patients with complicated popliteal artery entrapment syndrome successfully treated with a hybrid surgical and interventional treatment

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Background Popliteal artery entrapment syndrome (PAES) is an underreported and underdiagnosed condition that affects the lower extremities. Previous case reports mainly presented young and uncomplicated PAES. Here, we report the cases of complicated PAES in middle-aged patients. Furthermore, we discuss the importance of a multidisciplinary team approach from diagnosis to treatment to obtain favourable clinical outcomes against this rare disease.

Case summary Two middle-aged patients presented with recent claudication and were diagnosed with popliteal artery obstruction due to a complicated PAES. At the multidisciplinary meeting, the decided treatment plan was to prioritize the gastrocnemius tendon accessory transfer and surgical thromboendarterectomy. In case the popliteal artery patency was unsatisfactory, an additional on-site percutaneous intervention was planned. Follow-up lower extremity computed tomographic angiography showed a patent popliteal artery without any claudication in both two cases.

Discussion Popliteal artery entrapment syndrome is a rare vascular disorder. Clinical suspicion and advanced imaging modalities can lead to an accurate diagnosis. A multidisciplinary team approach helps in obtaining favourable clinical results using minimally invasive hybrid surgical and interventional treatments.

Keywords Popliteal artery entrapment syndrome • Multidisciplinary team • Hybrid treatment • Case series

ESC Curriculum 9.3 Peripheral artery disease • 2.1 Imaging modalities

Learning points

- To diagnose a rare disease, such as PAES, through clinical suspicion and advanced imaging modalities.
- To combine surgical thrombectomy and balloon angioplasty to achieve patent flow in patients with PAES.
- To use a multidisciplinary team approach to achieve successful clinical outcomes in PAES.

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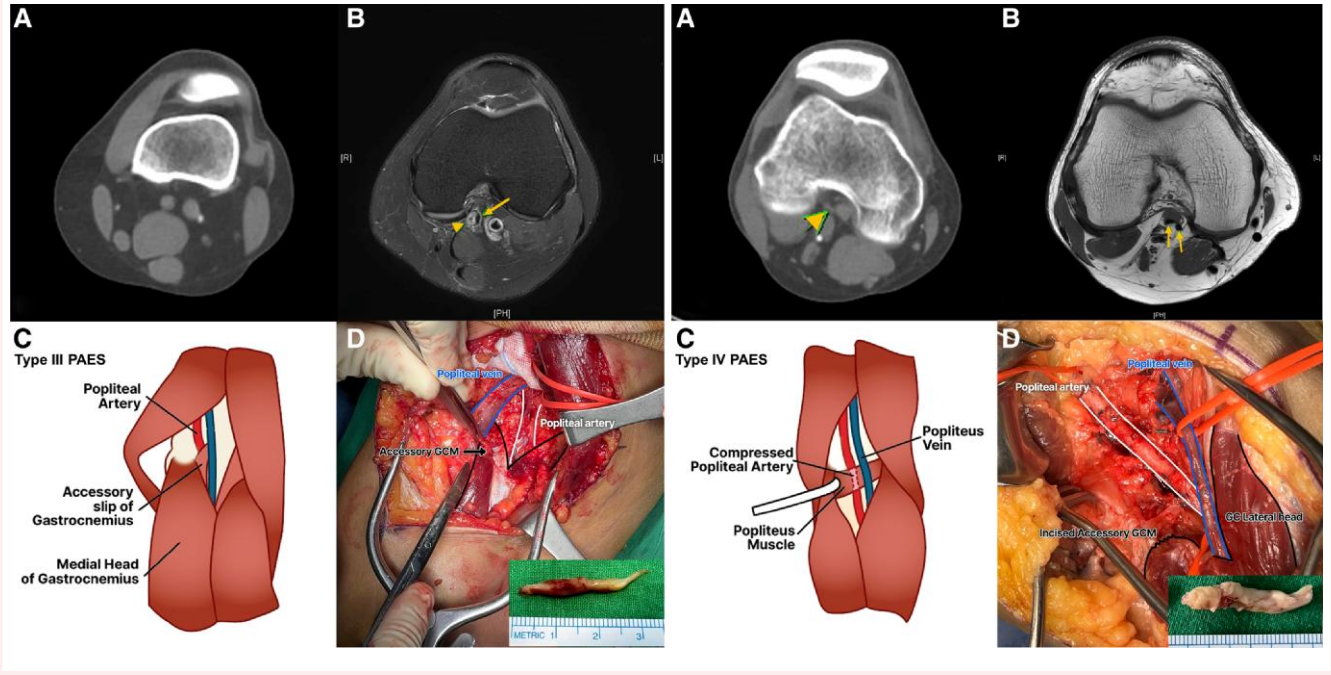
Introduction

Popliteal artery entrapment syndrome (PAES) is an underreported and underdiagnosed condition that affects the lower extremities.[1] Previous case reports have mainly focused on the early diagnosis of relatively young patients with uncomplicated PAES.[2] Here, we report the cases of two middle-aged patients presenting with recently aggravated severe claudication, diagnosed with complicated PAES with undetermined optimal treatment methods. Furthermore, we discuss the importance of a multidisciplinary hybrid treatment approach using both surgical and interventional methods to obtain favourable clinical outcomes in patients with these rare diseases.

Summary figure



Case summary

Case 1

A 48-year-old woman with a Fontaine IIb grade claudication that had persisted in her left calf for the previous 3 months visited an outpatient clinic. There was no specific past history. Physical examination and laboratory results revealed no specific findings apart from mildly elevated low-density lipoprotein (LDL) levels (137 mg/dL) and anaemia (haemoglobin level: 9.8 g/dL). Lower extremity computed tomography (CT) angiography showed an abrupt obstruction from the left distal superficial femoral artery to the popliteal artery without any atherosclerotic change in other vascular lesions, except small deep vein thrombosis (DVT) of the calf vein (*Figure 1*). She tested negative for autoimmune diseases, including lupus, rheumatic arthritis, and antiphospholipid antibody. She was prescribed oral anticoagulation therapy for DVT, and peripheral artery intervention was planned. After 2 weeks, she complained of menorrhagia with anaemia due to uterine leiomyomas and underwent myomectomy. Because of this incident, the percutaneous intervention was postponed until the anaemia improved. A multidisciplinary meeting of orthopaedic surgeons, vascular surgeons, and interventional cardiologists was held to discuss the unclear cause of the patient's vascular disease. As the possibility of PAES was not clear from the CT images, we decided to perform magnetic resonance imaging (MRI) of the knee. The MRI revealed that a fibrous band of the gastrocnemius muscle was compressing the popliteal artery; this was compatible with type 3 PAES (*Table 1* and *Figure 2*). At the multidisciplinary meeting, we decided to prioritize tendon transfer for the accessory gastrocnemius muscle and perform surgical thromboendarterectomy. If the popliteal artery patency was found to be unsatisfactory, an additional on-site percutaneous intervention was planned. Anticoagulation was stopped before surgery. The patient underwent the sequential surgeries, and we achieved sufficient revascularization immediately after the surgical thrombectomy and additional thrombectomy using a 3-Fr Fogarty arterial embolectomy catheter (Edwards Lifesciences, Irvine, CA) (see Supplementary material online, *Video S1*). A follow-up CT scan of the extremities showed a patent left popliteal artery. The pathology of the extracted thrombus was classified as thrombi. Dual anti-platelet therapy, including aspirin 100 mg and clopidogrel 75 mg and a highly potent statin (rosuvastatin 20 mg), was administered postoperatively. No claudication occurred during the follow-up period of more than 12 months.

Case 2

A 57-year-old man complained of aggravated right calf claudication (Fontaine III) that had persisted for 4 months. There was no specific past history, and normal findings were observed on electrocardiogram and physical examination. Patient did not complain any chest discomfort or cardiac-related symptom. Laboratory tests were normal, apart from elevated LDL levels (177 mg/dL). Computed tomography

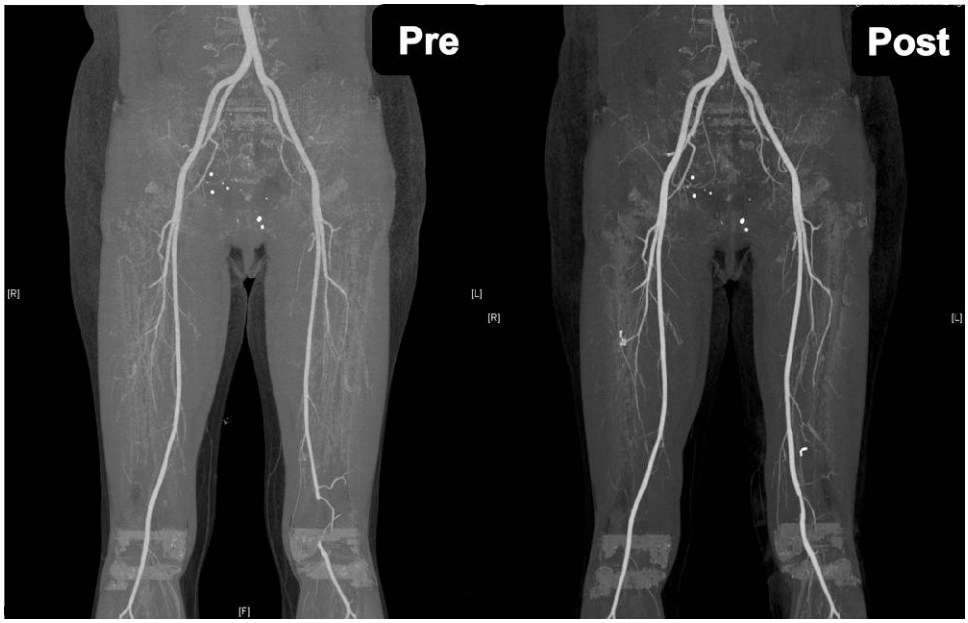


Figure 1 Computed tomography angiographic multiplane image reconstruction pre- and post-operation in Case 1.

Table 1 Types of popliteal artery entrapment syndrome

Type I	The popliteal artery has an internal deviation and is medial to the internal tendon of the gastrocnemius muscle, inserted in the internal condyle of the femur
Type II	The popliteal artery is normal and anterior to the internal tendon of the gastrocnemius muscle that is inserted more lateral than usual, compressing the artery
Type III	The gastrocnemius muscle has an additional tendon or fibrous band that inserts laterally, compressing the artery
Type IV	In embryologic development, the popliteal artery is initially deep to the popliteal muscle, becoming superficial to it posteriorly. In this type, the popliteal artery remains deep to the muscle causing its compression although normal anatomy of the gastrocnemius muscle
Type V	Types I–IV associated with simultaneously popliteal vein compression
Type VI	Muscular hypertrophy with normal constitution, resulting in functional compression of the popliteal artery and vein

angiography and MRI of his lower extremities revealed an abrupt obstruction and accessory gastrocnemius medial head override and compression of the right popliteal artery, which was compatible with type 4 PAES (*Table 1* and *Figure 3*). The treatment strategy was similar to that of the previous case based on a multidisciplinary team decision. However, the popliteal artery patency result was unsatisfactory in spite of the sequential surgeries, including tendon transfer for the accessory gastrocnemius muscle and thromboendarterectomy. The interventional cardiologists treated the popliteal artery by balloon angioplasty using a 4.0 mm × 60.0 mm IN.PACT™ Admiral™ drug-coated balloon (Medtronic Santa Rosa, CA, USA) and achieved sufficient patency (*Figures 4* and *5*). Follow-up CT angiography revealed a patent right popliteal artery, and the ankle–brachial index was 0.91. Most of the claudication disappeared, and there was leg swelling due to venous congestion during the first month after surgery, but this improved after 1 month. The medications administered after surgery were the same as those in Case 1. No recurrence of claudication occurred during the follow-up period of more than 12 months.

Discussion

Popliteal artery entrapment syndrome is a rare vascular disorder characterized by compression of the popliteal artery by aberrant myotendinous structures in the popliteal fossa.[1] Since structural modifications vary according to the subtype, there is a high possibility of delayed or erroneous diagnosis. Popliteal artery entrapment syndrome is suspected if there is an abrupt obstruction of the popliteal artery without atherosclerosis of other blood vessels, especially in young patients without risk factors. The differential diagnoses should include exertional compartment syndrome, neurogenic claudication, and atherosclerotic peripheral arterial disease. A useful differential factor is the location of the pain. In PAES, the pain and tightness are always present in the calf, whereas the pain from exertion syndrome is more common in the anterolateral aspect of the leg. Pain involving the spine often occurs posteriorly, and commonly bilaterally, along the length of the affected leg.[3] Although the ankle–brachial index and dynamic duplex ultrasound were initially used with relative ease, both methods have a high rate of false positives and are not helpful for complicated PAES. Advanced imaging techniques, both CT and MRI angiography, are comparably useful for detecting PAES.[4] Computed tomography angiography provides accurate grading of popliteal artery stenoses or occlusion, and 3D reconstruction reveals vascular abnormalities. Magnetic resonance imaging provides surgically relevant anatomic details and a higher level of soft tissue resolution than CT. Based on our experience with a limited number of cases, MRI

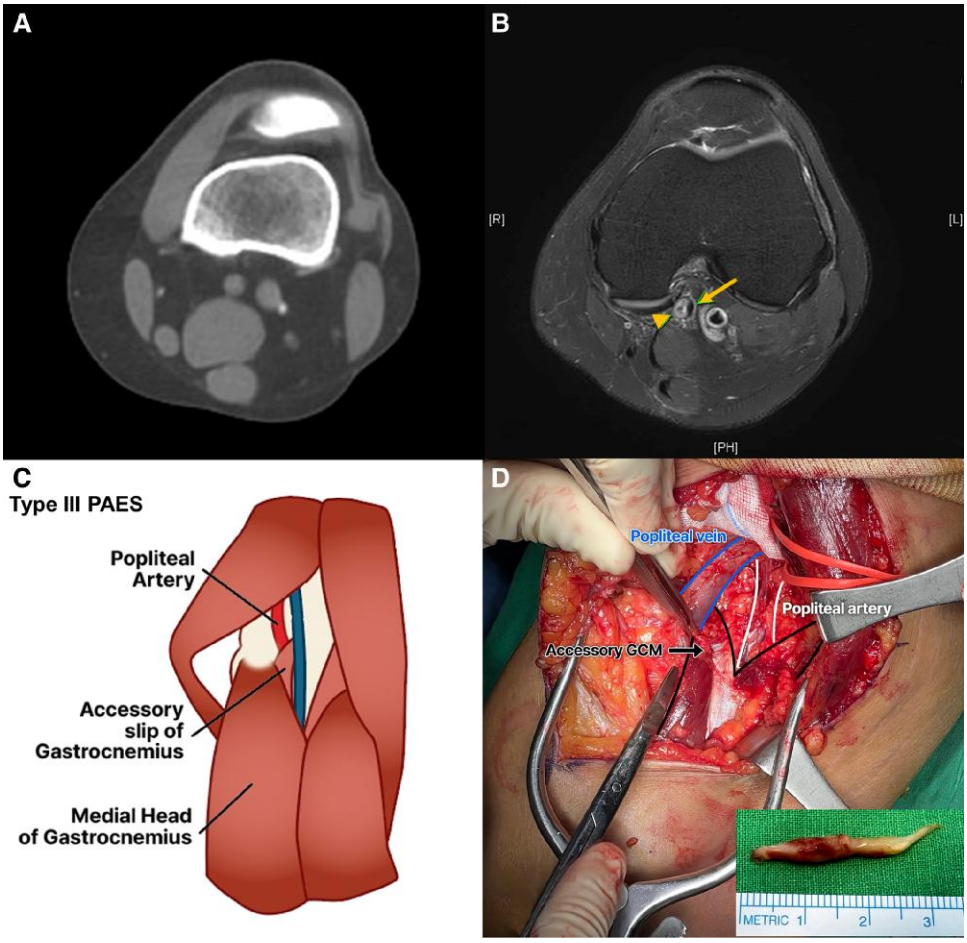


Figure 2 Key images of Case 1. The fibrotic band is unclear in the computed tomography section (*A*) but is clearly visible on the magnetic resonance imaging (green arrow) (*B*), which helps explain the anatomical abnormality (*C*) in PAES Type 3. The organized thrombus was removed by thrombectomy alone (*D*).

angiography is needed if small fibrotic bands, such as PAES Subtype 2 or 3, are present.

Surgical decompression of the offending musculotendinous structure is crucial. Vascular injury repair is complicated in PAES. In previously reported cases, the obstructed popliteal artery was treated by femoropopliteal bypass or popliteo-popliteal interposition graft with reversed saphenous vein, which showed acceptable patency only in those patients whose arterial occlusion was confined to the popliteal artery.[5,6] The clinical outcomes of thromboendarterectomy were inferior to those of bypass surgery only in patients with non-occlusive PAES.[7] Thromboendarterectomy has seldom been performed in cases of complicated PAES.

Our two patients were treated for PAES using thromboendarterectomy followed by surgical decompression. Subsequently, when confronted with suboptimal artery patency, expeditious recourse was sought. We supposed the simultaneous presence of organized thrombi and atherosclerotic vascular stenosis in complicated PAES. This decision was rooted in the favourable clinical outcomes previously observed in drug-eluting balloon treatment for chronic obstructive femoropopliteal artery disease. As a result, prompt implementation of percutaneous balloon angioplasty utilizing a drug-eluting balloon was undertaken to address the underlying pathophysiological factors.[8] This hybrid approach, combining minimally invasive surgery with interventional treatment, resulted in favourable clinical outcomes. Moreover, the multidisciplinary team decision-making from the initial diagnosis to the final treatment was beneficial in detecting PAES and achieving successful treatment results in these rare, complicated cases.

Conclusion

Popliteal artery entrapment syndrome is a rare vascular disorder. Clinical suspicion and advanced imaging modalities can lead to an accurate diagnosis. A multidisciplinary team approach using minimally invasive hybrid surgery combined with interventional treatments is helpful in obtaining favourable clinical results.

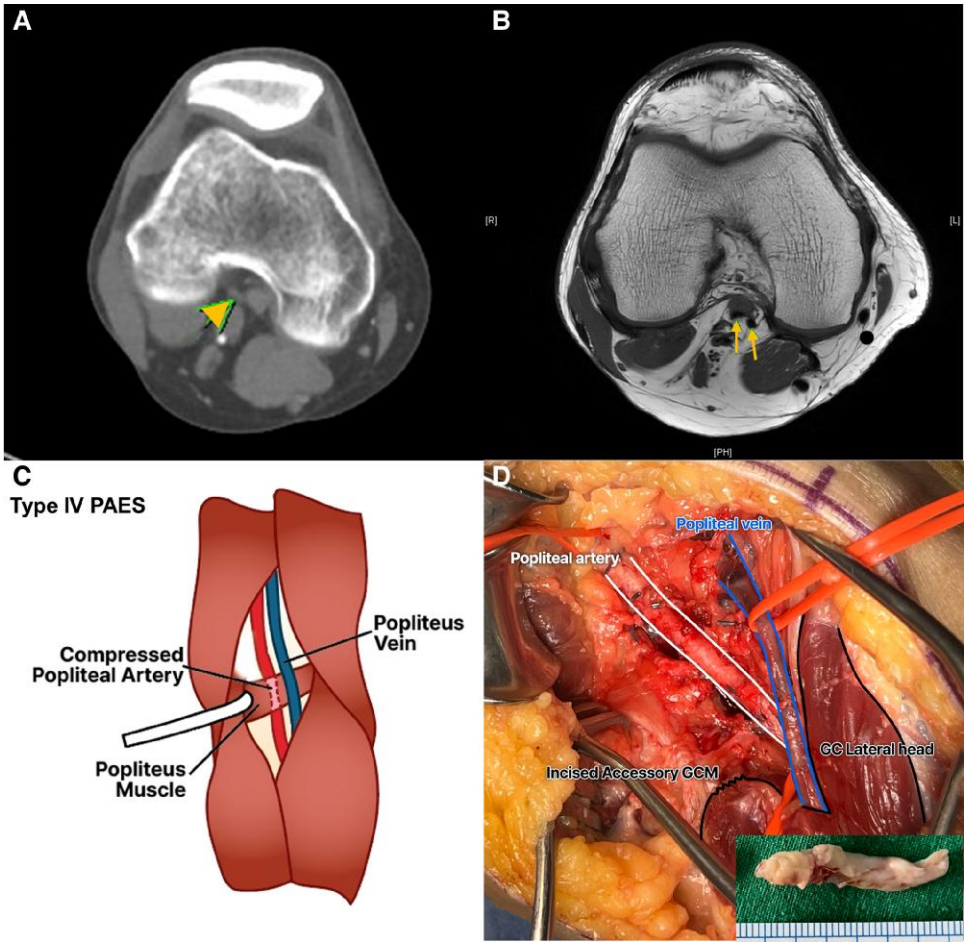


Figure 3 Key images of Case 2. Both computed tomography (*A*) and magnetic resonance imaging (*B*) clearly showed the popliteal muscle (green arrow) compressing the popliteal artery, compatible with the graphic illustration (*C*) and surgical findings. After thromboendarterectomy, organized thrombus and adherent artery intima were revealed (*D*).

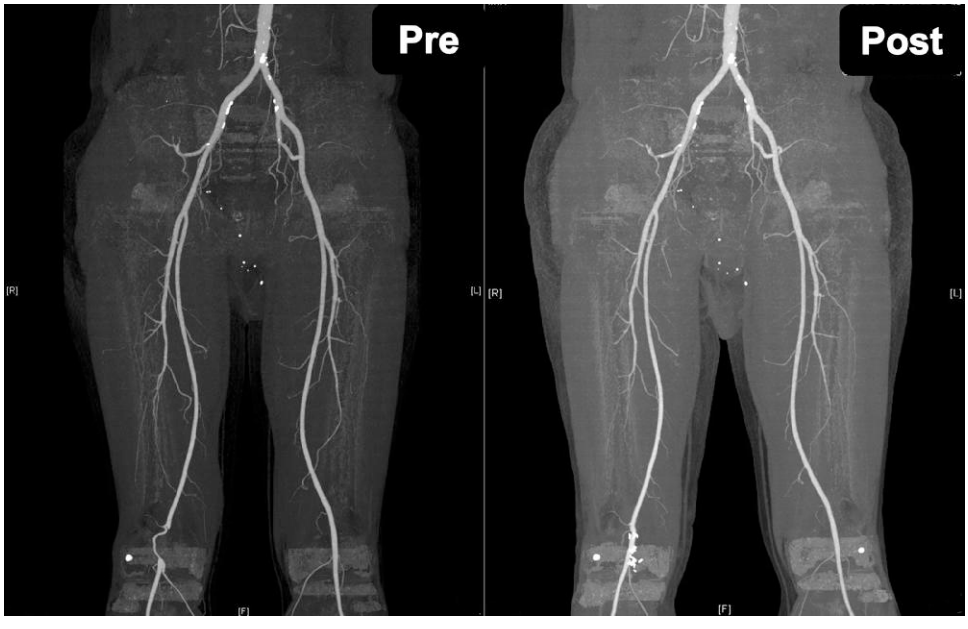


Figure 4 Computed tomography angiographic multiplane image reconstruction of pre- and post-operation in Case 2.

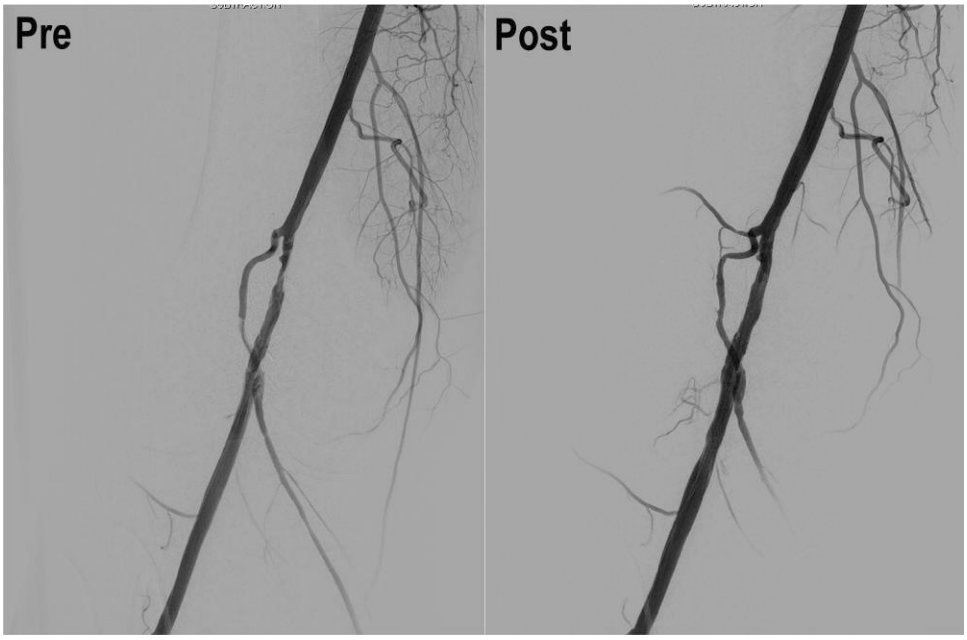


Figure 5 Left popliteal artery after drug-eluting balloon angioplasty.

Lead author biography

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Supplementary material

Supplementary material is available at *European Heart Journal – Case Reports*.

Consent: The authors confirm that written consent for submission and publication of this case report including image(s) and associated text has been obtained from the patient in line with COPE guidance.

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Data availability

The data underlying this article are available in the article and in its Supplementary material online.

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