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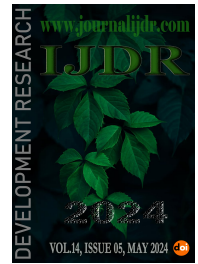
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RESEARCH ARTICLE

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EMBOLIZATION OF ARTERIOVENOUS MALFORMATION IN INFRAPATELLAR ARTERIES USING THE PLUG AND PUSH TECHNIQUE

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ABSTRACT

Background: Arteriovenous malformations (AVMs) characterized as high-flow, progressive anomalies without spontaneous regression, represent up to 20% of congenital vascular malformations. Peripheral AVMs are uncommon and present a wide range of symptoms. Diagnosis is generally made in adulthood by physical examination associated with angiography, though it may include magnetic resonance angiography and computed tomography angiography. Therapy depends on the stage of the AVM however no gold standard has been established yet. Treatment can be conservative, by sclerotherapy, transarterial embolization, or, in extreme cases, amputation. **Objective:** The objective of this report is to present the endovascular approach to an AVM in the lower limb. **Case presentation:** This case report describes the conduct adopted in a young patient with a peripheral AVM in a lower limb, highlighting its successful embolization employing the Plug and Push technique with tissue glue and coils. The postoperative evolution was favorable, stressing the importance of early diagnosis and adequate monitoring by an experienced team. **Conclusion:** This study contributes to future therapeutic approaches in similar cases, emphasizing the need for individualized strategies.

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INTRODUCTION

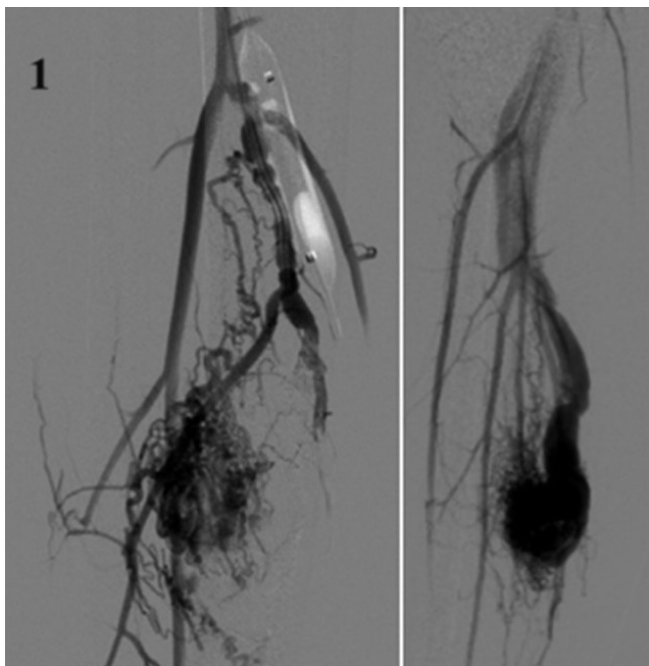
Arteriovenous malformations (AVMs) are high-flow, progressive anomalies without spontaneous regression and represent up to 20% of congenital vascular malformations. Peripheral AVMs are the least common form of presentation, with more variable evolution and clinical conditions when compared to lymphatic or venous malformations¹. The cause of this pathology remains unknown². In general, AVMs manifest symptoms from the beginning of adulthood with the clinical signs varying depending on the location of the anomaly. Possible symptoms of peripheral AVMs of the lower limbs include distinct skin color, local pain, edema, distal ischemia and weakness of the limb. In rare cases, they may present with skin ulceration, hemorrhage and secondary infections²⁻⁴. The literature indicates a better prognosis for young patients and those undergoing early interventions. On physical examination, a lower limb AVM may cause edema, hyperthermia, hyperemia, audible noise or bruit and palpation of a thrill^{2,3}. Angiography is the gold standard diagnostic method however, other tests, such as magnetic resonance angiography

and computed tomography angiography, are also important. The flow and size of the AVM are well elucidated by Doppler ultrasonography; they can be high-flow or low-flow². During AVM monitoring, it is important to classify changes using the Schobinger Classification (I - Quiescent or asymptomatic; II - Growth with subcutaneous infiltration associated with audible pulsatility; III - Deep infiltration, associated with cutaneous dystrophic changes, ulcerations, bleeding, superinfection and necrosis; IV - cardiac decompensation associated with skin complaints)⁵⁻⁷. The patient must be informed about the possibility of multiple approaches¹⁻³. Surgical management tends to have greater morbidity and relapse⁷ with occupation influencing the postoperative period¹. AVMs, especially in stages III and IV, have a chance of relapse making continued monitoring by the medical team important². The objective of this report is to present the endovascular approach to an AVM in the lower limb.

CASE REPORT

A 21-year-old Male patient, with painful nodulation in the right foot since 2013, had been followed up by the vascular surgery team from

2015. The mass was diagnosed as a hemangioma by ultrasound and magnetic resonance and absolute alcohol embolization was performed in March 2017 and again in November 2017. After discontinuing follow-up during the pandemic, the patient returned in 2023 complaining of pain in the right calf. No other complications (fever, edema, paresthesia) were noted. The patient reported no comorbidities, continued medication use or allergies. He has a surgical history of herniorrhaphy and lipoma excision. On physical examination, the femoral, popliteal and anterior tibial pulses were present in the right lower limb however, the posterior tibial pulse was absent. Moreover, a pulsatile mass was identified in the calf with local thrill. The physical examinations of the left lower limb and other systems were unremarkable. Vascular Doppler showed a high-flow arteriovenous malformation in the right leg. Arteriography of the fibular artery showed high flow through macrofistulas in the proximal segment, with drainage through ectatic venous branches to the popliteal vein resulting in early venous filling of the popliteal and femoral veins. Embolization was performed with ipsilateral arterial and venous puncture using the Plug and Push technique. The right superficial femoral artery and the right common femoral vein were punctured under ultrasound guidance.



Figures 1. Pre-procedure angiography

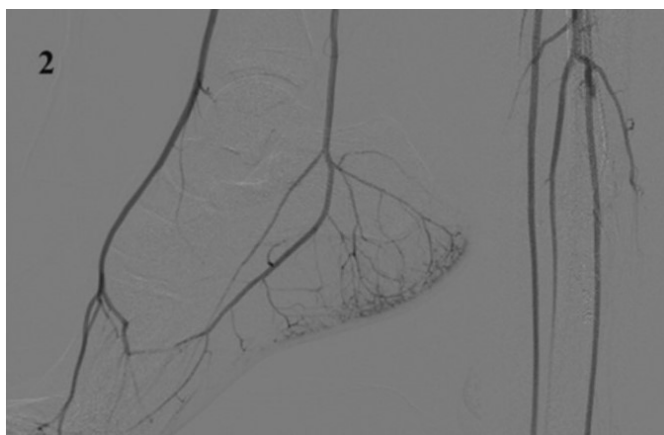


Figure 2. Post-therapeutic angiography

The posterior tibial artery was patent and without stenosis, but in its proximal segment there was one large caliber branch with multiple smaller caliber vessels with a massive arteriovenous fistula. An 8-Fr guiding catheter was positioned through a venous access in the main venous drainage branch of the AVM. A 10 x 40 mm semi-compliant

balloon catheter was then positioned in the venous drainage branch and was inflated thereby occluding the vessel. Embolization was achieved with glubran 2 surgical glue diluted in a 1:3 ratio with lipiodol starting at the AVM nidus. A subsequent control arteriography showed continued filling from the peroneal branches, and thus another embolization procedure was required using the same solution. A follow-up exam showed a significant reduction in the AVM flow. The venous branch was occluded with Axium Ev3 6 x 15 cm and 6 x 10 cm-controlled release coils. A final control angiography showed AVM occlusion with minimal delayed filling. The patient presented good postoperative evolution, with the presence of a posterior tibial pulse at the end of the procedure, which had not been palpable previously. He was discharged in the first post-operative period without complications. Upon outpatient return, the patient complained of local pain, but it was less compared to before the procedure. On physical examination of the right lower limb, the femoral, popliteal, and anterior and posterior tibial pulses were all present. There were no signs of pulsation in the calf, femoral thrill, bulging or hematoma.

DISCUSSION

The present case report describes an endovascular approach to treat a vascular malformation of the lower limb and the accompanying diagnostic and therapeutic difficulties. The first hypothesis was a hemangioma, and thus complementary exams were important during the diagnostic evolution. After diagnostic confirmation, the patient underwent magnetic resonance angiography. As there is no therapeutic gold standard, the literature recommends patient counseling, especially when a solution is available, as was offered in this case¹. Treatment can be conservative and expectant with compressive bandages when in Schobinger Stage I^{1,3,7}. Another form of treatment is alcohol sclerotherapy^{1,3,8}. For more advanced Schobinger Stages (III/IV), transarterial embolization with ethylene-vinyl alcohol copolymer (Onix liquid embolization system), tissue glues and embolization coils by microcatheter placement are recommended⁸. The aim is always to achieve complete occlusion of the nidus^{6,8}. Sometimes, depending on the extent and impairment associated with the AVM, an open surgical approach or even amputation may be required, especially if the peripheral AVM is associated with another diagnosis or is masked by another comorbidity². Studies have reported a reduction in ulcerative symptoms after using the alcohol sclerotherapy technique associated with histoacryl injection through super-selective transcatheter cannulation in elderly people and patients with previous comorbidities^{1,3}.

However, frequently, unlike the current patient, they required amputation¹. In the same study, a young patient also underwent amputation after alcohol sclerotherapy, showing the need for better developed techniques. The use of the Onyx technique in AVMs is effective but limited by financial issues¹. In a multicenter study, 50% of AVM cases were resolved with just one embolization session⁷. Therefore, as surgery is an expensive therapy with high morbidity and relapse⁷, embolization should be the interventional therapy of choice. There are reports of embolization using the Plug and Push technique as an adjuvant to surgical treatment to avoid hemorrhages, with dilution of the drugs to lower concentrations^{3,4}. Anh Binh Ho et al. associated 0.5 mL/0.5 mg of N-butyl-2-cyanoacrylate (NBCA) with 3.5 mL of lipiodol in a 1:7 ratio and a concentration of 12.5% was obtained, using 15-20 mL of the solution⁴. In the current patient, glubran tissue glue was used at a higher concentration, in a 1:3 dilution with lipiodol for initial filling of the AVM Nidus. The 1:3 ratio provided successful clinical improvement for the patient after just one intervention and no adjuvant surgical treatment was required. Lower limb AVM is difficult to treat. In studies, an average of two embolizations are necessary for each AVM⁸. It was also reported that a patient with an AVM in the right foot, a region similar to the present case, required four embolizations with the Onyx/Squid mixture, obtaining good results, but with persistent symptoms⁷. Therefore, an experienced team using good embolizing agents is needed for therapeutic success, as presented in our report.

CONCLUSION

Combined arterial and venous treatment allowed embolization to occlude a complex AVM with greater safety related to the migration of embolizing agents, as well as providing a satisfactory result.

Conflict Interest: The authors declared no have conflict interest.

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Author's contribution

- Design and conduct of the study: Cunha EF, Ferreira FH, Reis Net F, Olmedo GM, Godoy JMP
- Collection data: Cunha EF, Ferreira FH, Reis Net F, Olmedo GM, Godoy JMP
- Management: Cunha EF, Ferreira FH, Reis Net F, Olmedo GM, Godoy JMP
- Analysis and interpretation of the data: Cunha EF, Ferreira FH, Reis Net F, Olmedo GM, Godoy JMP
- Preparation: Cunha EF, Ferreira FH, Reis Net F, Olmedo GM, Godoy JMP
- Review: Cunha EF, Ferreira FH, Reis Net F, Olmedo GM, Godoy JMP
- Approval of the manuscript: Cunha EF, Ferreira FH, Reis Net F, Olmedo GM, Godoy JMP
- Decision to submit the manuscript for publication: Cunha EF, Ferreira FH, Reis Net F, Olmedo GM, Godoy JMP
- All authors agree the manuscript.

Data statement: The data used to support the findings of this study are included within the article.

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