EJVES Vascular Forum (2024) 62, 1—4

CASE REPORT

Residual Popliteal Aneurysm Perfusion Leading to Embolic Complications: A Case Report

Matteo Giardini [a,*], **Christoph A. Binkert** [a], **Thomas R. Wyss** [a,b]

[a] Department of Interventional Radiology and Vascular Surgery, Kantonsspital Winterthur, Winterthur, Switzerland
[b] Department of Vascular Surgery, Inselspital, Bern University Hospital, University of Bern, Bern, Switzerland

Introduction: Surgical management of popliteal artery aneurysms has been described for half a century. Long term development of the excluded aneurysm sac in the popliteal segment however remains widely unknown, with only a few small series describing outcomes. Residual aneurysm perfusion has the potential to lead to serious complications.

Report: A 63 year old man presents with skin and soft tissue necrosis of the right calf two years after proximal and distal aneurysm ligation and great saphenous vein bypass for a popliteal artery aneurysm. Computed tomography and magnetic resonance angiography show perfusion of the excluded aneurysm as well as extensive necrosis of the gastrocnemius muscle. Direct angiography of the aneurysm demonstrated retrograde aneurysm perfusion due to insufficient distal ligation with recurrent micro-embolisation to the calf via geniculate arteries. Coiling of the geniculate arteries was performed, plugging the connection to the tibiofibular trunk and embolisation of the aneurysm sac. After the intervention, no flow was seen in the aneurysm sac and the patient made full recovery.

Discussion: Residual aneurysm sac perfusion can lead to complications long after successful aneurysm exclusion. Follow-up after surgery of popliteal aneurysms should include observation of the excluded aneurysm sac with control of residual blood flow. For persistent sac perfusion, aneurysm enlargement or symptoms, further treatment should be considered. Surgical aspects such as complete transection of the artery after aneurysm ligation or end to end anastomosis of the bypass may be considered, to prevent such complications.

Article history: Received 19 January 2024, Revised 3 March 2024, Accepted 15 May 2024,

Keywords: Aneurysm perfusion, Bypass surgery, Popliteal aneurysm, Vascular surgery

INTRODUCTION

Popliteal artery aneurysms (PAAs) comprise 70% of all peripheral arterial aneurysms and, although often asymptomatic, up to 68% of patients with a PAA may develop complications in their lifetime.[1] Since the first description, the main therapy has remained exclusion from the circulation with ligation and bypass, preferably using the great saphenous vein.[2] The medial approach has been identified as the best approach for aneurysms extending above or below the popliteal fossa as access extension is easy and, to this day, this approach is the most frequently used.[3]

Despite this long experience in treating popliteal aneurysms, there is scarce knowledge about the excluded aneurysm sac. Residual perfusion and possible complications (i.e., embolisation, rupture) have been described in multiple smaller case series; however, the importance of residual aneurysm flow is unknown.[4] This case demonstrates a rare cause of residual aneurysm sac perfusion after ligation and bypass and entailing complications.

REPORT

The case is presented of a 63 year old patient with a symptomatic PAA 28 cm length with a diameter of 4 cm with Fontaine stage IIa claudication and restricted crural outflow due to chronic recurrent embolisation. A femorodistal bypass using the great saphenous vein was performed with a distal end to side anastomosis to the tibiofibular trunk. The aneurysm itself was excluded with proximal and distal non-absorbable polyester ligation.

The post-operative course was complicated by a superficial surgical site infection, which necessitated debridements. Due to poor distal outflow and a contralateral asymptomatic PAA (2.5 cm), the patient was discharged on oral anticoagulation (rivaroxaban, 20 mg) and single antiplatelet therapy (acetylsalicylic acid, 100 mg) due to recent renal artery stenting.

* Corresponding author. Department of Interventional Radiology and Vascular Surgery, Kantonsspital Winterthur, Brauerstrasse 15, 8401 Winterthur, Switzerland.

E-mail address: matteo.giardini@ksw.ch (Matteo Giardini).

https://doi.org/10.1016/j.ejvsvf.2024.05.010

At six weeks follow up, ultrasound demonstrated residual perfusion of the popliteal aneurysm sac without growth. The origin of the flow in the sac could not be determined: either retrograde through geniculate collaterals or from an insufficient ligation of the distal popliteal artery. Further measures were recommended, but the asymptomatic patient refused an angiogram to demonstrate and treat the leakage. During further follow up, stable findings were observed.

One year post-operatively, calf pain over a period of several days led to urgent contrast enhanced computed tomography angiography (CTA) which confirmed the above ultrasound findings of sac perfusion and demonstrated substantial malperfusion of the gastrocnemius muscle correlating to the calf pain. However, sufficient distal perfusion (ankle perfusion pressure 96 mmHg, ankle brachial index 0.79) and no aggravation on exercise were present. Further imaging with magnetic resonance angiography demonstrated extensive oedema and myonecrosis of the gastrocnemius muscle (Fig. 1).

It was postulated that the residual perfusion of the popliteal aneurysm sac presumably led to embolisation of parietal thrombus into the sural artery leading to muscle necrosis. Pathophysiologically, retrograde perfusion from the tibiofibular trunk to the thrombus lined aneurysm sac and antegrade flow in the geniculate arteries was suspected. However, this could not be proven with non-invasive imaging. Again, the patient rejected endovascular or open surgical treatment options.

Almost two years post-operatively, the patient presented with painful and infected extensive skin necrosis of the right calf (Fig. 2).

Finally, he agreed to invasive treatment, and it was decided to occlude the residual perfusion and completely thrombose the aneurysm sac (Fig. 3) using (1) ultrasound guided percutaneous access to the perfused part of the aneurysm (4 Fr sheath); (2) angiography confirming antegrade flow in two geniculate arteries; (3) coiling of the two geniculate arteries with one Vortex 3 mm (Boston Scientific, Marlborough, MA, USA) plus two Nester 2 mm (Cook Medical Inc., Bloomington, IN, USA) coils and one Vortex 5 mm plus three Nester 3 mm coils, respectively; (4) plugging of the 1 mm gap from the tibiofibular trunk to the aneurysm sac with an 8 mm Amplatzer Vascular Plug 4 (Abbott Laboratories, Chicago, IL, USA); and (5) aneurysm sac filling at the distal leakage point with 1.5 mL of ethylene vinyl alcohol copolymer (Onyx 34L, Microtherapeutics Inc, Irvine, CA, USA).

Figure 2. Extensive wounds of the right dorsal calf.

Post-interventional ultrasound showed no residual blood flow. The extensive wounds of the right calf healed properly over a course of 10 weeks and the patient remained asymptomatic in the further course with aneurysm shrinkage (from 4.0 cm to 2.6 cm) at four months' follow up.

DISCUSSION

Almost 55 years after the first publication on the management of PAA by ligation and bypass, this surgical practice remains widely unchanged.[2] Although vascular surgery has seen a rise in endovascular techniques, the popliteal artery remains in the domain of open surgery, as the latest Society for Vascular Surgery (SVS) guidelines show for treatment indication, open repair is recommended provided an adequate saphenous vein is present and the patient has a life expectancy of more than five years.[5]

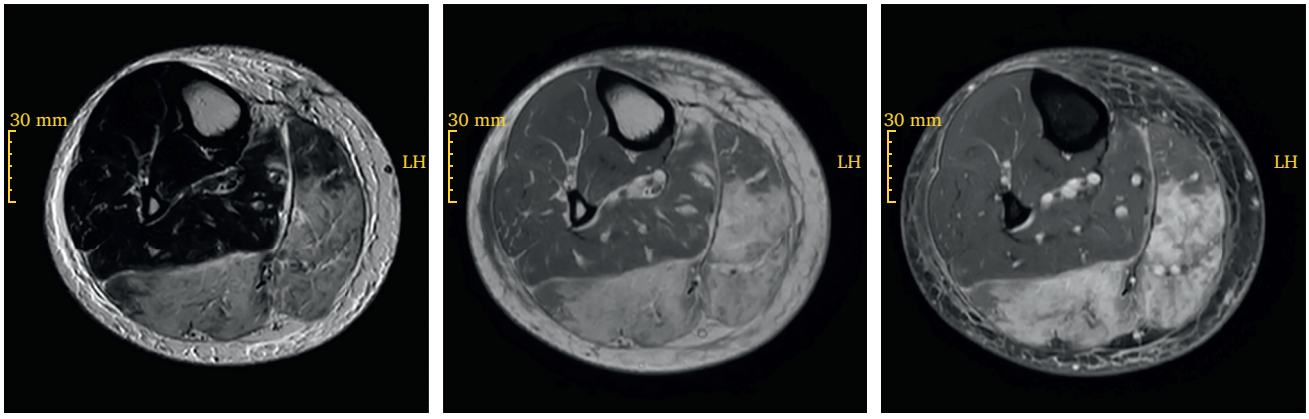

Figure 1. Magnetic resonance angiography of the right calf showing myonecrosis of the gastrocnemius muscle (axial images T2, T1, and contrast enhanced T1 fat saturated).

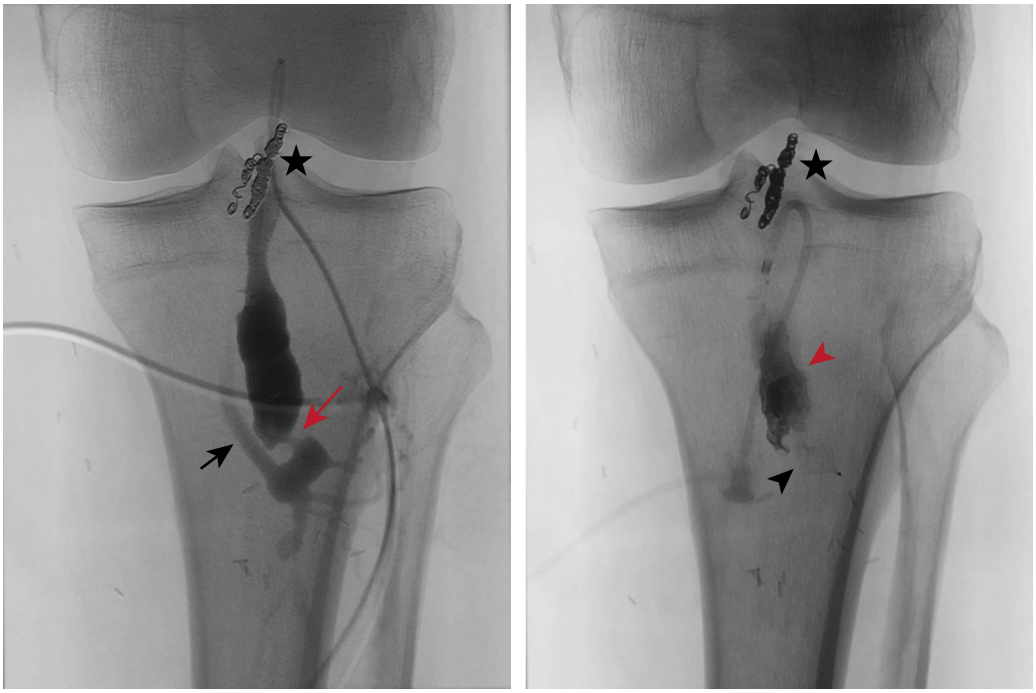

Figure 3. (Left) Angiography of the aneurysm sac after coiling of two geniculate arteries (black star) showing insufficient distal ligation (red arrow) and bypass (black arrow). (Right) Plugging of the insufficient distal ligation (black arrowhead) and additional embolisation of the distal part of the popliteal aneurysm (red arrowhead).

The medial approach remains the most frequently used, especially in aneurysms extending outside of the popliteal fossa.[3,6] This approach however does not allow the complete interruption of collateral geniculate arteries, thus leaving possible retrograde blood flow in the popliteal aneurysm sac after exclusion.

Literature regarding the excluded popliteal aneurysm is scarce. Using ultrasound, blood flow in the excluded popliteal aneurysm has been demonstrated in up to 38% of patients, with aneurysm enlargement in up to 32% of cases.[7,8] Residual perfusion can lead to complications such as embolisation and limb loss or rupture. This highlights a possible disadvantage of the medial approach, since using a dorsal approach, the collateral flow can be completely interrupted in most cases.[8]

Deglise *et al*. have evaluated the role of CTA in recognising residual blood flow in excluded popliteal aneurysms.[9] In a series of 21 excluded PAAs, 29% showed residual blood flow. Ebaugh *et al*. did not demonstrate a correlation between blood flow and aneurysm enlargement using ultrasound;[4] however, Deglise *et al*. observed a relationship between aneurysm growth and aneurysm perfusion.[9] Interestingly, no popliteal aneurysm growth was found without concomitant sac perfusion. CTA has proven helpful in recognising aneurysm perfusion and possible blood flow in collaterals, but without the capability of identifying blood flow direction.

The most common explanation for continuous blood flow is through retrograde flow in the collateral geniculate arteries. However, there has been speculation as to the possibility of anastomosis related blood flow in an excluded PAA.[9,10] This could be due to insufficient ligation proximally or distally, or through vascular remodelling over the years.

No case is known to describe and prove residual blood flow in an excluded PAA due to insufficient ligation, as described here. This aneurysm perfusion proved dangerous due to retrograde perfusion and subsequent embolisation. This highlights the importance of popliteal aneurysm sac evaluation (i.e., residual blood flow or sac growth) during follow up after femoropopliteal bypass surgery. This has also been recognised by the SVS and is addressed in the 2021 guidelines, in which ultrasound follow up with aneurysm sac size control is recommended.[5]

Standard practice has now been changed due to this complication. Side to end and end to side anastomoses will only be performed with complete transection of the artery, or end to end anastomoses will be chosen, depending on the individual morphology and surgeon's preference. This will certainly exclude the possibility of anastomosis related residual blood flow. Rigorous follow up is necessary as expressed by the guidelines. This case shows a hopefully rare complication, if not a technical error, after exclusion and bypass of a PAA and its management.

CONFLICT OF INTEREST

None.

FUNDING

None.

REFERENCES

1 Dawson I, Sie RB, van Bockel JH. Atherosclerotic popliteal aneurysm. *Br J Surg* 1997;**84**:293—9.

2 Edwards WS. Exslusion and saphenous vein bypass of popliteal aneurysms. *Surg Gynecol Obstet* 1969;**128**:829—30.

3 Grip O, Mani K, Altreuther M, Bastos Gonçalves F, Beiles B, Cassar K, et al. Contemporary treatment of popliteal artery aneurysms in 14 countries: a Vascunet report. *Eur J Vasc Endovasc Surg* 2020;**60**:721—9.

4 Ebaugh JL, Morasch MD, Matsumura JS, Eskandari MK, Meadows WS, Pearce WH. Fate of excluded popliteal artery aneurysms. *J Vasc Surg* 2003;**37**:954—9.

5 Farber A, Angle N, Avgerinos E, Dubois L, Eslami M, Geraghty P, et al. The Society for Vascular Surgery clinical practice guidelines on popliteal artery aneurysms. *J Vasc Surg* 2022;**75**(Suppl.): 109S. 20S.

6 Jungi S, Kuemmerli C, Kissling P, Weiss S, Becker D, Schmidli J, et al. Limb salvage by open surgical revascularisation in acute ischaemia due to thrombosed popliteal artery aneurysm. *Eur J Vasc Endovasc Surg* 2019;**57**:393—8.

7 Kirkpatrick UJ, McWilliams RG, Martin J, Brennan JA, Gilling-Smith GL, Harris PL. Late complications after ligation and bypass for popliteal aneurysm. *Br J Surg* 2004;**91**: 174—7.

8 Mehta M, Champagne B, Darling RC, Roddy SP, Kreienberg PB, Ozsvath KJ, et al. Outcome of popliteal artery aneurysms after exclusion and bypass: significance of residual patent branches mimicking type II endoleaks. *J Vasc Surg* 2004;**40**:886—90.

9 Deglise S, Qanadli SD, Rizzo E, Ducrey N, Doenz F, Haller C, et al. Long-term follow-up of surgically excluded popliteal artery aneurysms with multi-slice CT angiography and Doppler ultrasound. *Eur Radiol* 2006;**16**:1323—30.

10 Davies RS, Wall M, Rai S, Simms MH, Vohra RK, Bradbury AW, et al. Long-term results of surgical repair of popliteal artery aneurysm. *Eur J Vasc Endovasc Surg* 2007;**34**:714—8.