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Perspectives in Vascular Surgery
and Endovascular Therapy
XX(X) 1–5

DOI: 10.1177/1531003511400623
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Emergency Endovascular Treatment of Popliteal Aneurysms

Athanasios Saratzis[1], Nikolaos Melas[2], Hannah Dixon[1], and Nikolaos Saratzis[2] [AQ: 1]

Abstract

Popliteal artery aneurysm (PAA), despite being rare, is the most common peripheral aneurysm. It can present as acute thrombosis and occlusion of the aneurysmal segment, and distal embolization, causing either chronic or acute limb ischemia. It has traditionally been treated with open surgical reconstruction. Endovascular repair of PAAs has recently been applied electively with a favourable early and mid-term outcome; however there is a lack of reports on the endovascular treatment of PAAs presenting with acute complications. This report describes the treatment of a thrombosed PAA in a 58 year old male using an endovascular stent-graft and also provides a systematic review of the literature on the emergency endovascular treatment of PAAs.

Keywords

endovascular repair, popliteal artery aneurysm, acute limb ischemia

Introduction

Popliteal artery aneurysm (PAA) is a rare pathology; however, it accounts for the majority of peripheral aneurysms. The most common complications of a PAA include acute thrombosis and occlusion of the aneurysmal segment and distal embolization. The 5-year cumulative risk for complications has been reported to be as high 68%[1] and acute ischemia with or without associated limb loss has been reported in as many as 40% of patients.[2] Chronic limb ischemia may also develop, following chronic distal embolization of mural thrombi. The indications for repair, typically open surgical treatment with a venous bypass graft, remain debatable. Most authors consider a cut-off point diameter of 20 mm as the primary criterion for treatment, even though treatment of smaller aneurysms in the presence of mural thrombus has also been advocated.[1,3-5]

One of the major factors affecting the patency rate of a PAA reconstruction is whether the repair was performed for acute ischemia or in the elective setting.[2,6,7] Endovascular repair of PAAs has previously been proposed as a minimally invasive alternative and is now being applied in an elective basis. However, there is a serious lack of reports investigating the application of endovascular repair in PAAs presenting in the acute setting (acute limb ischemia or rupture). The current report describes the successful endovascular treatment of a thrombosed PAA in a patient presenting with acute limb ischemia. It also provides a systematic review of the literature to assess the feasibility, technical considerations, applications, and results of the technique in an acute setting.

Case Report

A 58-year-old, man was admitted to our institution's (tertiary referral center) emergency department reporting a 4-hour sudden onset severe right lower limb pain, affecting the calf and the foot, and associated with pallor. His past medical history included arterial hypertension, coronary artery disease (recent myocardial infarction), and smoking (60 packs per year). The patient had no history of claudication or peripheral arterial disease. On examination, there were no palpable pedal or popliteal pulses on the right side; pedal and popliteal pulses were present on the left side—femoral pulses were present bilaterally. Motor power was normal. An urgent ultrasound scan (duplex) in the emergency department revealed a thrombosed right popliteal aneurysm of 3.2 cm in diameter

[1]George Eliot Hospital, Nuneaton, UK
[2]Aristotle University of Thessaloniki, Thessaloniki, Greece

Corresponding Author:
Athanasios Saratzis, George Eliot Hospital, College Street, Nuneaton, Warwickshire, CV10 7DJ, UK
Email: a_saratzis@yahoo.gr

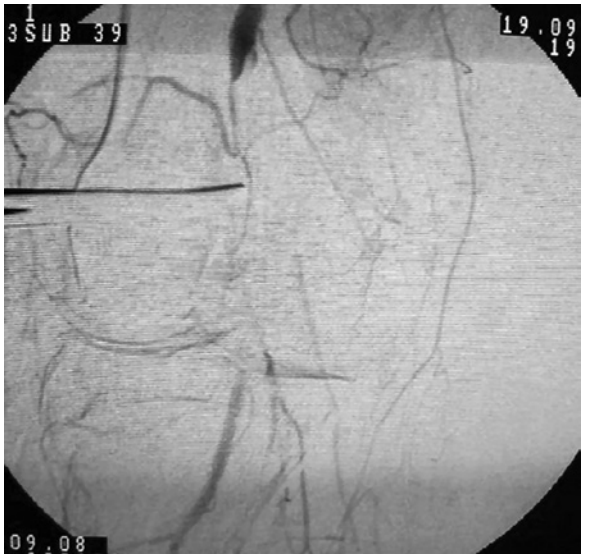

Figure 1. Initial intraoperative angiogram depicting the thrombosed aneurysm (level of the knee joint)

Figure 2. Completion intraoperative angiogram

(images unavailable). No abdominal or peripheral aneurysms were detected. A decision was made to promptly exclude the popliteal aneurysm and reperfuse the ischemic limb using an endovascular device.

The procedure was undertaken in a fully equipped operating theatre under fluoroscopic control using a portable C-arm (Siremobil 2000, Siemens, Erlangen, Germany) and a nonionic contrast agent (Iopromide, Ultravist 300, Bayer Schering Pharma AG, Berlin, Germany). The left femoral artery was punctured percutaneously under local anesthesia (lidocaine and bupivacaine; Figure 1). Heparin was administered intravenously (100 IU/kg). A total of 2 Viabahn (Gore, Flagstaff, AZ) devices were deployed—6 mm × 15 cm and 6 mm × 10 cm—with a 3-cm overlap. The devices were dilated using a 5-mm wide balloon, postdeployment. The duration of the procedure was 45 minutes. A completion angiogram (Figure 2) revealed no sign of endoleak or other associated complication. The patient was started on double antiplatelet therapy (aspirin and clopidogrel 75 mg) on the first postoperative day. He was discharged on the second postoperative day; all ischemic symptoms had subsided. No evidence of endoleak, kinking, or other complication was noted on the 22nd postoperative month computed tomographic angiography.

Discussion

PAAs, however rare, constitute the most common peripheral aneurysms. They may lead to chronic or acute limb ischemia, with or without limb loss. Traditional repair is by means of open surgical reconstruction, preferably using a venous graft. Bypass graft patency differs, according to the type of graft, the surgical approach, and presentation. Five-year patency is between 80% and 85% in asymptomatic patients but is as low as 60% in symptomatic patients.[8-10] Additionally, traditional surgical repair may lead to substantial morbidity and mortality, especially in symptomatic patients.[3,6,9-11] Endovascular repair of PAA, as a minimally invasive alternative, has been proposed as early as 1994.[12] Endovascular repair is currently an established modality in the treatment of abdominal aortic aneurysms (AAAs) with well-described short- and medium-term results; however, the smaller arterial diameter, the mobility of the peripheral arteries, the associated arterio-occlusive disease, and the design of the currently available devices make the application of endovascular repair in PAAs challenging. Compared with open reconstruction, endovascular repair for PAAs has a number of potential advantages, given its minimally invasive nature. These include decreased blood loss, and hospitalization, as well as decreased perioperative morbidity and mortality in patients at high surgical risk.

Stent kinking and subsequent occlusion caused substantial concern in the early years of endovascular repair for PAAs but improved patency rates have been observed in patients treated electively with new generation covered stent grafts.[12-19]

A systematic review of the literature by Siauw et al[20] in 2006 regarding elective endovascular repair for PAAs

Table 1. Summary of the Available Literature Regarding the Endovascular Management of Popliteal Artery Aneurysms Presenting With Acute Complications

Reference	n	Presentation	Age (Years)	Size (cm)	Device[a]	Follow-Up	Outcome
Gerasimidis et al (2003)[16,b]	3	Rupture	N/A	N/A	N/A	N/A	N/A
Ihlberg et al (2000)[24]	1	Acute limb ischemia	56	6	Hemobahn	5 months	No complication
Rits et al (2009)[25]	1	Rupture	86	7	Viabahn	1 year	No complication
Schimmer et al (2009)[26]	1	Rupture (mycotic aneurysm)	80	N/A	Viabahn	6 months	No complication
Etezadi et al (2010)[18,b]	1	Acute limb ischemia	N/A	N/A	Viabahn	N/A	N/A
Tielliu et al (2005)[15,b]	5	Acute limb ischemia	N/A	N/A	Hemobahn and Viabahn	N/A	N/A
Pratesi et al (2010)[27]	1	Rupture and arteriovenous fistula	66	6	Viabahn	3 months	No complication
Lamoca et al (2010)[28]	1	Rupture	88	9.1		2 days	Died second postoperative day (respiratory collapse)
Smith et al (2010)[29]	1	Rupture	N/A	N/A	Amplatzer	N/A	N/A
Mohan et al (2006)[23,b]	3	1 acute limb ischemia, 1 venous compression, 1 embolization	N/A	N/A	N/A	N/A	N/A
Tielliu et al (2007)[14,b]	6	Acute limb ischemia	N/A	N/A	Viabahn	N/A	N/A
Bürger et al (1998)[30]	1	Acute limb ischemia	69	N/A	Hemobahn	6 months	No complication
Tielliu et al (2002)[31]	1	Acute limb ischemia	65	3	Hemobahn	6 months	No complication

Abbreviation: N/A, not available.
[a]Amplatzer—AGA Medical Corporation, Plymouth, MN, USA; Wallgraft—Boston Scientific, Natick, MA, USA; Hemobahn/Viabahn—Gore, Flagstaff, AZ, USA.
[b]No separate data available for the group of patients treated as an emergency.

concluded that long-term follow-up data are seriously lacking; however, early results have been promising. Early thrombosis of stent grafts occurred in 10% of patients in this review, which only included one randomized trial. More recently, Curi et al[19] reported 15 cases of endovascular repair for PAAs in a group of 56 patients undergoing open or endovascular repair of a PAA, prospectively followed up for a mean of 16 months. Fifteen patients were treated with Viabahn stent grafts; 41 patients underwent aneurysm exclusion and bypass with either a saphenous vein graft (n = 29) or a polytetrafluoroethylene (PTFE) graft (n = 12). All symptomatic patients had undergone surgical repair. Technical success was 100% for endovascular repair and surgical repair and primary patency (83% vs 88%), secondary patency (100% vs 92%), and survival (90% vs 90%) did not differ significantly. However, wound infection and hospital stay were significantly decreased in the endovascular group. Endoleaks were observed in 3 patients, all of which were successfully treated percutaneously. Rajasinghe et al[13] treated 16 patients with 23 PAAs (Viabahn stent grafts), followed up for a mean 7 months. Technical success rate was 100%, and primary patency rate was 93%. Antonello et al[21] evaluated 42 asymptomatic patients with 48 PAAs who were offered endovascular repair with Viabahn stent grafts (21 cases) or surgical repair (27 cases). Patency rates were similar for both groups at 72 months.

Idelchik et al[22] electively treated 33 PAAs in 29 symptomatic patients, using Wallgraft and Viabahn stent grafts (prospective case series). All had symptoms of claudication; 4 patients presented with popliteal venous thrombosis, and 28 PAAs had associated mural thrombus. The primary and secondary patency rates, respectively, were 93.9% and 100% at 6 months, 93.9% and 96.9% at 1 year, 87.5% and 96.8% at 2 years, and 84.8% and 96.8%, at 4.5 years. No endoleaks, rupture, thromboembolism, or limb loss occurred throughout follow-up.

Table 1 summarizes the currently available literature regarding the endovascular treatment of PAAs in the acute setting (acute limb ischemia or aneurysmal rupture). A total of 26 patients have been treated for acute ischemia or rupture using various devices. Eighteen of these cases come from case series reporting single-center outcomes for endovascular repair in PAAs. Unfortunately, the authors have not provided results separately

for the emergency treatment group in any of these articles. Gerasimidis et al[16] treated 11 patients, with 12 popliteal aneurysms, 6 of whom underwent elective and 3 emergency endovascular repair due to rupture. A Hemobahn stent graft was inserted in 6, Wallgraft in 2, and Passager in 1 case. During a mean follow-up of 14 months, 2 early (<30 days) and 2 late thromboses had occurred. Patency rates at 1 and 12 months were 64% and 47% (primary patency) and 88% and 75% (secondary patency), respectively. Etezadi et al[18] treated 18 patients, who were followed up for 15 months (retrospective data). Thirteen aneurysms (72.2%) were partially thrombosed and 12 patients (66.6%) had symptoms of lower limb ischemia (11 chronic and 1 acute). Technical success rate was 94%, intraprocedural embolization and endoleak occurred in 1 and 2 patients, respectively. No perioperative mortality or limb loss was reported. The primary patency rate at 6 months was 86%. Tielliu et al[15] in 2005 treated 57 PAAs using endovascular repair, 5 of which were treated emergently for acute ischemia. A total of 12 devices had (21%) occluded at 24 months' follow-up. Primary and secondary patency rates were, respectively, 80% and 90% at 1 year, and 77% and 87% at 2 years. Mohan et al[23] treated 30 PAAs; 5 were symptomatic and 25 asymptomatic. Patients were treated with the Hemobahn/Viabahn stent graft (26), Passager (2), Aneurx (1), and a PTFE homemade device (1). Over a 24-month median follow-up, primary patency was 92.9% at 1 month and 74.5% at 36 months. Cumulative secondary patency was 96.5% at 1 month and 83.2% at 36 months.

Overall, endovascular repair is an appealing alternative to open repair in patients with PAAs presenting with acute complications. In the vast majority of the cases reported so far, the procedure was completed within 60 minutes. Additionally, because of the relatively small diameter of the introducing sheaths of the stent grafts, the procedure can easily be performed percutaneously, thus minimizing blood loss and avoiding large incisions in ischemic limbs. The patient can also ambulate immediately after the operation and wound complications are significantly lower compared with open repair. New-generation stent grafts, such as the Viabahn and the Wallgraft, are highly flexible and easily conform to the angulation forces during ambulation, minimizing the risk of occlusion secondary to kinking of the device. Another advantage of the Viabahn, used in our patient, is that the graft is situated in the luminal surface of the device; therefore there is no direct contact of the stent and blood flow. Given the high angulation forces at the level of the popliteal artery, an adequately long proximal and distal landing zone should be employed to avoid migration of the device. Previous investigators have reported that a 3-cm cut-off point, in terms of length, is reasonable.[14,15] Overlapping stent grafts should be used in case the proximal and distal fixation does not suffice. The overlapping zone should also be at least 3 cm long.[15] Another reason why overlapping should be employed is a diameter mismatch between proximal and distal landing zones.[15] However, interventionists should avoid placing the end of an overlap zone in the bending zone of the knee (upper margin of the patella), as this may lead to a stent fracture and occlusion of the device.

A review of the literature in 2006 reported a 10% incidence of acute stent graft thrombosis following endovascular repair of PAAs.[20] A prospective study of 17 patients with 7 femoral artery aneurysms and 13 PAAs treated with Wallgrafts[32] in 2002 reported procedural success rate of 92.3% for PAAs; device thrombosis was seen in 31% of PAAs. One of the devices had thrombosed secondary to migration. More recent reports have reported significantly lower rates. An important observation made by Tielliu et al[14,15] was the fact that double antiplatelet therapy postoperatively, significantly affected stent graft thrombosis. We believe that double antiplatelet therapy is mandatory, and we have successfully applied a protocol of double antiplatelet therapy in all patients undergoing endovascular repair for abdominal or peripheral aneurysms over the last decade.[33]

Declaration of Conflicting Interests

The author(s) declared no conflicts of interest with respect to the authorship and/or publication of this article. [AQ: 2]

Funding

The author(s) received no financial support for the research and/or authorship of this article. [AQ: 3]

References

1. Dawson I, Sie R, van Baalen JM, van Bockel JH. Asymptomatic popliteal aneurysm: elective operation versus conservative follow-up. *Br J Surg*. 1994;81:1504-1507.
2. Dawson I, Sie RB, van Bockel JH. Atherosclerotic popliteal aneurysm. *Br J Surg*. 1997;84:293-299.
3. Shortell CK, DeWeese JA, Ouriel K, Green RM. Popliteal artery aneurysms: a 25-year surgical experience. *J Vasc Surg*. 1991;14:771-776.
4. Aulivola B, Hamdan AD, Hile CN, et al. Popliteal artery aneurysms: a comparison of outcomes in elective versus emergent repair. *J Vasc Surg*. 2004;39:1171-1177.
5. Szilagyi DE, Schwartz RL, Reddy DJ. Popliteal arterial aneurysms. Their natural history and management. *Arch Surg*. 1981;116:724-728.
6. Mahmood A, Salaman R, Sintler M, Smith SR, Simms MH, Vohra RK. Surgery of popliteal artery aneurysms: a 12-year experience. *J Vasc Surg*. 2003;37:586-593.
7. Blanco E, Serrano-Hernando FJ, Moñux G, et al. Operative repair of popliteal aneurysms: effect of factors related

to the bypass procedure on outcome. *Ann Vasc Surg*. 2004;18:86-92.
8. Carpenter JP, Barker CF, Roberts B, Berkowitz HD, Lusk EJ, Perloff LJ. Popliteal artery aneurysms: current management and outcome. *J Vasc Surg*. 1994;19:65-72.
9. Sarcina A, Bellosta R, Luzzani L, Agrifoglio G. Surgical treatment of popliteal artery aneurysm. A 20-year experience. *J Cardiovasc Surg (Torino)*. 1997;38:347-354.
10. Duffy ST, Colgan MP, Sultan S, Moore DJ, Shanik GD. Popliteal aneurysms: a 10-year experience. *Eur J Vasc Endovasc Surg*. 1998;16:218-222.
11. Huang Y, Gloviczki P, Noel AA, et al. Early complications and long-term outcome after open surgical treatment of popliteal artery aneurysms: is exclusion with saphenous vein bypass still the gold standard? *J Vasc Surg*. 2007;45:706-713.
12. Marin ML, Veith FJ, Panetta TF, et al. Transfemoral endoluminal stented graft repair of a popliteal artery aneurysm. *J Vasc Surg*. 1994;19:754-757.
13. Rajasinghe HA, Tzilinis A, Keller T, Schafer J, Urrea S. Endovascular exclusion of popliteal artery aneurysms with expanded polytetrafluoroethylene stent-grafts: early results. *Vasc Endovascular Surg*. 2006-2007;40:460-466.
14. Tielliu IF, Verhoeven EL, Zeebregts CJ, Prins TR, Bos WT, Van den Dungen JJ. Endovascular treatment of popliteal artery aneurysms: is the technique a valid alternative to open surgery? *J Cardiovasc Surg (Torino)*. 2007;48: 275-279.
15. Tielliu IF, Verhoeven EL, Zeebregts CJ, Prins TR, Span MM, van den Dungen JJ. Endovascular treatment of popliteal artery aneurysms: results of a prospective cohort study. *J Vasc Surg*. 2005;41:561-567.
16. Gerasimidis T, Sfyroeras G, Papazoglou K, Trellopoulos G, Ntinas A, Karamanos D. Endovascular treatment of popliteal artery aneurysms. *Eur J Vasc Endovasc Surg*. 2003;26: 506-511.
17. Kudelko PE 2nd, Alfaro-Franco C, Diethrich EB, Krajcer Z. Successful endoluminal repair of a popliteal artery aneurysm using the Wallgraft endoprosthesis. *J Endovasc Surg*. 1998;5:373-377.
18. Etezadi V, Fuller J, Wong S, et al. Endovascular treatment of popliteal artery aneurysms: a single-center experience. *J Vasc Interv Radiol*. 2010;21:817-823.
19. Curi MA, Geraghty PJ, Merino OA, et al. Mid-term outcomes of endovascular popliteal artery aneurysm repair. *J Vasc Surg*. 2007;45:505-510.
20. Siauw R, Koh EH, Walker SR. Endovascular repair of popliteal artery aneurysms: techniques, current evidence and recent experience. *ANZ J Surg*. 2006;76:505-511.
21. Antonello M, Frigatti P, Battocchio P, et al. Endovascular treatment of asymptomatic popliteal aneurysms: 8-year concurrent comparison with open repair. *J Cardiovasc Surg (Torino)*. 2007;48:267-274.
22. Idelchik GM, Dougherty KG, Hernandez E, Mortazavi A, Strickman NE, Krajcer Z. Endovascular exclusion of popliteal artery aneurysms with stent-grafts: a prospective single-center experience. *J Endovasc Ther*. 2009;16: 215-223.
23. Mohan IV, Bray PJ, Harris JP, et al. Endovascular popliteal aneurysm repair: are the results comparable to open surgery? *Eur J Vasc Endovasc Surg*. 2006;32:149-154.
24. Ihlberg LH, Roth WD, Alback NA, Kantonen IK, Lepantalo M. Successful percutaneous endovascular treatment of a ruptured popliteal artery aneurysm. *J Vasc Surg*. 2000;31:794-797.
25. Rits Y, Erben Y, Ricotta JJ 2nd. Endovascular repair of a ruptured giant popliteal artery aneurysm. *Perspect Vasc Surg Endovasc Ther*. 2009;21:190-194.
26. Schimmer W, Somjen GM. Endovascular repair of a ruptured, mycotic popliteal aneurysm. *ANZ J Surg*. 2009;79: 560-561.
27. Pratesi G, Marek J, Fargion A, Pulli R, Dorigo W, Pratesi C. Endovascular repair of a ruptured popliteal artery aneurysm associated with popliteal arteriovenous fistula. *Eur J Vasc Endovasc Surg*. 2010;40:645-648.
28. Lamoca LM, Alerany MB, Hernando LL. Endovascular therapy for a ruptured popliteal aneurysm. *Catheter Cardiovasc Interv*. 2010;75:427-429.
29. Smith RJ, Gajendragadkar PR, Winterbottom AP, Cooper DG, Hayes PD, Boyle JR. Endovascular occlusion of a ruptured popliteal artery aneurysm. *Vasc Endovascular Surg*. 2010;44:298-301.
30. Burger T, Meyer F, Tautenhahn J, Halloul Z, Fahlke J. Initial experiences with percutaneous endovascular repair of popliteal artery lesions using a new PTFE stent-graft. *J Endovasc Surg*. 1998;5:365-372.
31. Tielliu IF, Verhoeven EL, Prins TR, van Det M, van den Dungen JJ. Stent-graft repair of a recurrent popliteal arteriovenous fistula. *J Endovasc Ther*. 2002;9: 375-378.
32. Howell M, Krajcer Z, Diethrich EB, et al. Wallgraft endoprosthesis for the percutaneous treatment of femoral and popliteal artery aneurysms. *J Endovasc Ther*. 2002;9: 76-81.
33. Saratzis A, Saratzis N, Melas N, Kiskinis D. Pharmacotherapy before and after endovascular repair of abdominal aortic aneurysms. *Curr Vasc Pharmacol*. 2008;6: 240-249.