Endovascular approach to arterial branches mimicking a type II endoleak after popliteal artery aneurysm exclusion and bypass

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ABSTRACT

The management of popliteal artery aneurysms (PAAs) has continued to evolve. Open surgical treatment remains an excellent option. Aneurysm exclusion with saphenous vein bypass through a medial incision remains a preferred approach. After PAA exclusion, however, a possibility remains of sac expansion from geniculate arterial branches. This can mimic a type II endoleak occurring after endovascular aortic aneurysm repair. In the present report, we have described an endovascular technique used to treat an enlarging PAA after exclusion and bypass. (J Vasc Surg Cases and Innovative Techniques 2020;6:659-63.)

Keywords: Popliteal artery aneurysm enlargement following exclusion

Traditional medial aneurysm exclusion with a bypass graft has remained a durable treatment option despite reports of comparable short-term outcomes with endovascular stent grafts.[1] Studies have reported the occurrence of excluded popliteal artery aneurysms (PAAs) enlarging and rupturing after surgery.[2,3] Such patients will more often present with local compressive symptoms and discomfort.[4] Endoaneurysmorrhaphy and ligation of branches within the sac has been the main treatment for such cases.[5] In the present report, we have described the unique case of a patient who had presented to our clinic for surveillance of an enlarging PAA after bypass and exclusion. We performed successful transfemoral coil embolization. The patient provided written informed consent for the report of his case details and images.

CASE REPORT

A 75-year-old man had presented with new left leg claudication. He had a significant surgical history of open abdominal aortic aneurysm repair in the previous year. An office duplex ultrasound scan revealed a 3.5-cm left PAA laminated with thrombus. A computed tomography (CT) angiogram demonstrated a partially thrombosed PAA with three-vessel runoff (Fig 1). Open and endovascular approaches and their associated risks and benefits were discussed with the patient. Surgical bypass was performed via medial exposure using a nonreversed, ipsilateral great saphenous vein. Aneurysm exclusion was performed by arterial division and oversewing of the proximal and distal stumps. The isolated PAA segment was approximately 5 to 7 cm according to the preoperative CT angiogram and operative report description. The bypass was tunneled anatomically, with each anastomosis fashioned end to end. Postoperatively, the patient's claudication resolved, and his anticoagulation therapy was maintained at 81 mg of aspirin daily.

Bypass duplex ultrasound surveillance at 2 years postoperatively demonstrated a patent bypass and flow within the left PAA that had not been present on the previous imaging studies (Fig 2, *A*). The aneurysm had expanded from 3.7 cm to 4.6 cm during the 2-year period, and a CT angiogram demonstrated geniculate branch retrograde filling of the PAA (Fig 2, *B*). In addition to the PAA expansion, the left superficial femoral artery (SFA) showed moderate to severe stenosis proximal to the bypass. The association of the proximal SFA lesion and the development of excluded sac perfusion at 2 years postoperatively is unclear. One could theorize that the proximal stenosis might have influenced the development of robust collaterals and changed the pressure differentials within the sac, resulting in sac perfusion and growth. The patient was asymptomatic from both entities. The decision was made to treat the SFA stenosis to preserve bypass patency, in conjunction with transluminal embolization of the enlarging aneurysm, given the patient's active lifestyle and low operative risk.

Because of the patient's surgical history of a bifurcated aortic graft repair of his abdominal aortic aneurysm, the left common femoral artery was accessed percutaneously in an antegrade fashion with ultrasound guidance. The patient was systemically heparinized, and the focal SFA lesion was crossed and treated with a 6-mm noncompliant balloon and a 7- × 20-mm self-expanding stent. The sheath was advanced into the bypass, and an angled glide support catheter was positioned in the

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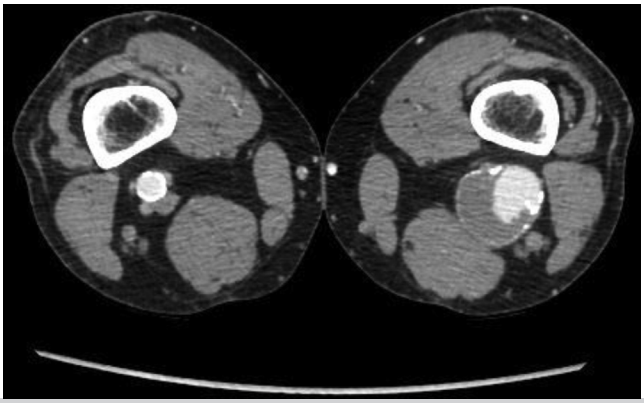

Fig 1. Computed tomography angiogram demonstrating a 3.5-cm popliteal artery aneurysm with a large amount of mural thrombus.

anterior tibial artery just proximal to the branch communicating with the aneurysm. Using roadmap guidance, the geniculate branch was selected with a microwire and microcatheter through the triple coaxial system platform (Fig 3). After angiographic confirmation of our microcatheter location within the PAA, 14-, 12-, and 10-mm detachable coils were deployed to pack the sac completely. A medial branch was coiled individually with 6- and 8-mm coils (Fig 4). The microwire and catheter were withdrawn into the anterior tibial artery, and coil embolization of a secondary branch to the PAA was performed (Fig 5, *A*). A completion angiogram demonstrated successful coil embolization of the aneurysm (Fig 5, *B*). The procedure was completed with the patient under conscious sedation. The patient was discharged home the same day with instructions to take 75 mg of clopidogrel daily and 81 mg of aspirin for 6 months, followed by life-long, daily aspirin of 81 mg. At the 1-month follow-up examination, the patient was doing well, and the duplex ultrasound scan displayed a completely thrombosed 4.4-cm PAA. Repeat duplex ultrasonography was scheduled for 6 months and, if no flow or growth is present, annual examinations thereafter.

DISCUSSION

The Edward technique of saphenous vein bypass through two small medial incisions with PAA suture ligation and exclusion was introduced in the late 1960s. This approach became the most popular method among surgeons owing to the ease of performance, reduced operative time, preservation of valuable collateral vessels, and a decreased incidence of surgical site complications.[6,7] However, the technique of collateral preservation can result in retrograde filling and possibly lead to PAA expansion and rupture.[8] Mehta et al[5] reported a risk of popliteal rupture of 12% in 26 patients who had been followed up for ≥2 years after bypass and aneurysm exclusion.

Jones et al[9] reported the long-term outcomes for 36 of 41 bypasses and exclusions at a mean follow-up period of 46 ± 42 months. Postoperative duplex ultrasound surveillance demonstrated the following: 2 PAAs (5.6%) had remained patent despite ligation, 5 thrombosed PAAs (13.8%) had patent feeding collaterals, and 12 PAAs (33.3%) had enlarged significantly during the follow-up period (from 2.2 ± 0.9 cm to 2.8 ± 1.0 cm; $P = .002$). The single ligation method of exclusion, increased length of the isolated segment, and presence of feeding collaterals were risk factors for PAA expansion on univariate analysis.

Similar late complications of PAA expansion after exclusion and bypass have been reported by several other studies to be ~15% to 33%, with almost one half requiring reintervention.[2,3,5,10,11] The reintervention performed was an open posterior approach to the popliteal fossa and endoaneurysmorrhaphy and ligation of the feeding collaterals from within the sac. In one of the largest series to date, Huang et al[12] reported the outcomes of 358 PAAs in 289 patients. Reinterventions were performed for recurrent PAAs in seven limbs (2%) compared with none required for the patients who had undergone endoaneurysmorrhaphy with bypass and exclusion. Their group, as well as others (Mehta et al[5] and Ebaugh et al[2]), have recommended the performance of endoaneurysmorrhaphy in conjunction with bypass and exclusion. This technique requires full access of the popliteal artery by transection of the intervening tendons and extension of the medial incision.[13]

A systematic literature search of studies evaluating the treatment of PAA expansion after bypass and exclusion was performed. In addition to continued surveillance, the management reported was endoaneurysmorrhaphy and ligation of the branches within the PAA. One case report described successful endovascular treatment of a ruptured, previously bypassed, PAA with microcatheter coil embolization of a geniculate branch, combined with ultrasound-guided percutaneous thrombin injection.[14] The technique of packing the PAA and feeding branches with coils avoids the risk of inadvertent embolization of the glue or hemostatic agent into the distal runoff. Direct sac injection with ultrasound guidance of ethylene vinyl alcohol copolymer dissolved in dimethyl sulfoxide (Onyx; Micro Therapeutics, Inc, Irvine, Calif) has been described for type II endoleaks after endovascular aneurysm repair, with expanding use in the periphery.[15] However, studies have reported distal embolization of Onyx (Micro Therapeutics, Inc) when injected percutaneously as solo therapy.[16,17]

Others have reported a hybrid approach to the initial PAA operation.[18] Before completing the proximal anastomosis, the PAA is ligated distally, with coils packed into the PAA sac transluminally or percutaneously. Next, the proximal anastomosis is completed and the PAA excluded proximally by suture ligation. The advantage of this technique includes avoiding the disruption of the collateral circulation from extensive dissection and perigenicular incisional morbidity. Despite the belt and suspenders approach, treatment failure was reported in

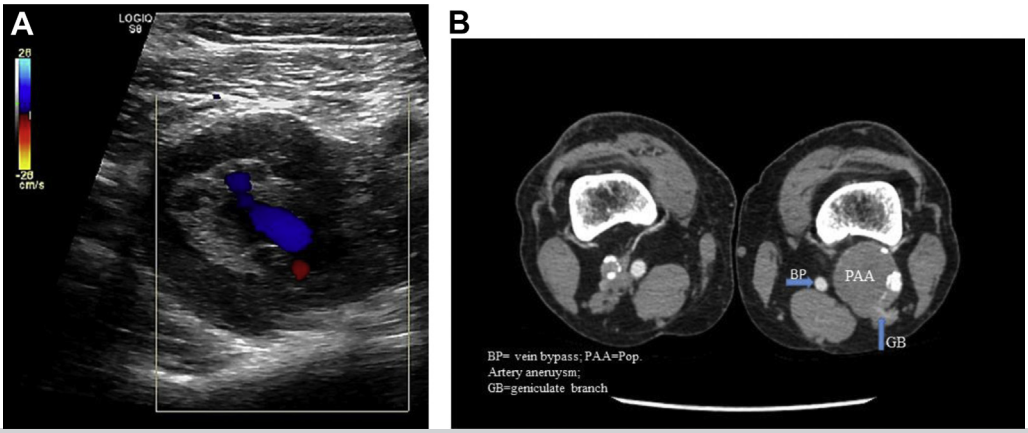

Fig 2. A, A color flow duplex ultrasound scan of blood flow within the previously excluded popliteal (*Pop.*) artery aneurysm (*PAA*). **B,** Computed tomography angiogram demonstrating a patent bypass (*BP*; *arrow*) and retrograde filling of a previously excluded PAA via a geniculate branch (*GB*; *arrow*).

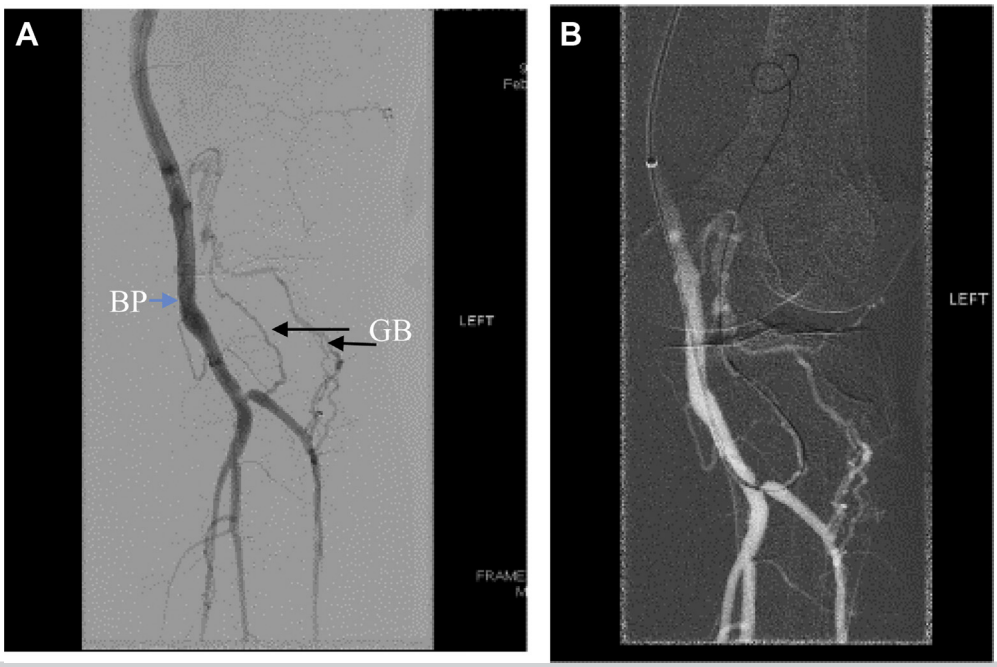

Fig 3. A, Digital subtraction angiogram (*DSA*) obtained within the bypass (*BP*) showing retrograde filling of the popliteal artery aneurysm (PAA). The ostium of the anterior tibial (AT) artery might have had a stenosis; however, it did behave like a significant lesion with the guidance catheter and wires passing easily and brisk flow present to the foot via the AT artery. The *blue arrow* indicates the vein bypass and the *black arrows* indicate the geniculate branches filling the excluded poplitea aneurysm. **B,** DSA road map image of the angiogram shown in Fig 3, *A* to facilitate transarterial coil embolization of the PAA via the geniculate branch.

a small series (n = 13).[19] One patient had developed early bypass occlusion, and one had had persistent PAA growth requiring open endoaneurysmorrhaphy and ligation of the branches from within the sac.[19]

The use of an ipsilateral, antegrade access provides a stable coaxial catheter platform for microwire superselection of the geniculate branches and delivery of the coils via the microcatheter. It is vital to perform digital subtraction angiography within the PAA to confirm the microcatheter location before coil embolization of the sac and to visualize the inflow and outflow arteries. In the present case, a total of 20 coils were used and included a mix of Interlock (Boston Scientific, Marlborough, Mass) and Nester (Cook Medical, Bloomington, Ind) coils. The size of microcoils and costs could vary depending on the available inventory. The goal of treating PAAs using this method is to achieve a significant packing density within the aneurysm sac and sacrifice

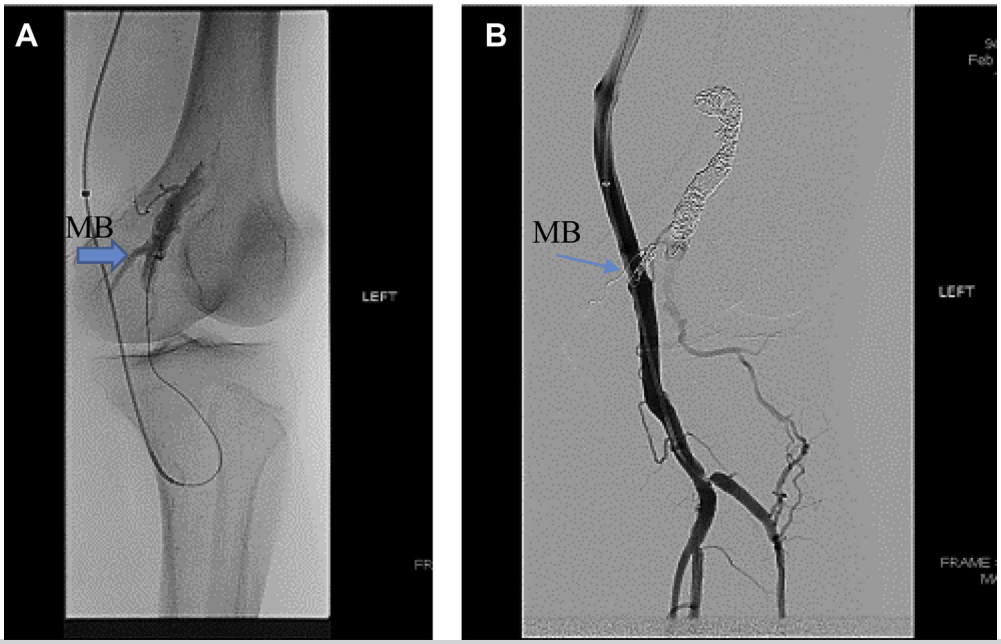

Fig 4. A, Digital subtraction angiogram confirming the catheter position within the popliteal artery aneurysm (PAA) and identification of a feeding medial branch (*MB*). **B,** Deployment of multiple coils within the PAA and coil embolization of the MB. The *blue arrow* indicates the medial branch feeding the aneurysm.

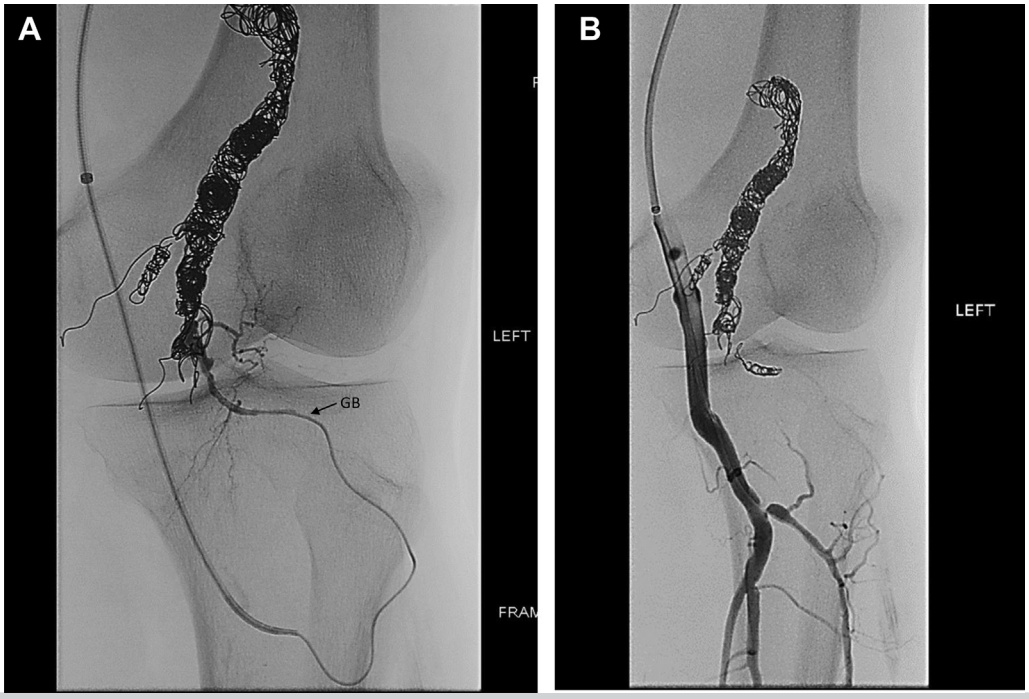

Fig 5. A, Selective microcatheter embolization of secondary geniculate branch (*GB*). **B,** Completion digital subtraction angiogram demonstrating no further filling of the popliteal artery aneurysm.

of the feeding vessels. A packing density of <25% was associated with treatment failure. Given the increasing scrutiny of procedural costs, it is important to choose the right embolic agent for each case because the cost can vary by several thousand dollars among the microcoil systems. The costs associated with the present case in terms of inventory was $16,000 USD. The limitation of the approach we used could be the cost and increased radiation exposure compared with open surgery and percutaneous injection therapies. One could

consider a hybrid approach with endovascular coiling to prevent distal embolization supplemented by direct puncture of the aneurysm sac and filling it with a liquid embolic agent.

CONCLUSION

PAA exclusion and bypass via a medial approach has remained a popular method in the endovascular era. Close duplex ultrasound surveillance postoperatively is necessary for early recognition of persistent aneurysm sac filling and expansion. Endovascular treatment of a type II endoleak after endovascular aneurysm repair has facilitated the application of endovascular coiling to this analogous situation. An endovascular approach to PAA enlargement after exclusion might reduce the surgical morbidity, hospital length of stay, and patient convalescence.

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