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Needle fenestration of popliteal artery covered stent graft to salvage inadvertent stent misdeployment

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ABSTRACT

Endovascular methods have transformed treatment of lower extremity peripheral arterial disease but can still present technical challenges. We report the case of a 69-year-old man with rest pain who underwent superficial femoral artery recanalization with covered stents. During completion angiography, the distal stent was discovered to have been misdeployed into an anterior geniculate branch overlying the behind-the-knee popliteal artery. Subsequently, an endovascular reentry device was used to fenestrate the stent posteriorly to enter the lumen of the popliteal artery. Cutting balloons were used to enlarge the fenestration in the stent fabric, with placement of an additional 6 × 50-mm covered stent bridging from the popliteal artery into the fenestrated misdeployed covered stent. Completion angiography demonstrated no evidence of distal embolization and patent two-vessel runoff. The patient had an uncomplicated recovery and at 2 years of follow-up remained asymptomatic with documented popliteal stent patency. (J Vasc Surg Cases Innov Tech 2023;9:1-4.)

Keywords: Femoropopliteal endovascular therapy; Needle fenestration; Stent misdeployment

Lower extremity peripheral arterial disease (PAD) affects >200 million adults worldwide, including 8.5 million in the United States, and is the third leading cause of atherosclerotic morbidity after coronary heart disease and stroke.[1] The superficial femoral artery (SFA) is a common location of atherosclerotic disease and is a well-described site for endovascular intervention when anatomically favorable.[2] The widespread use of endovascular techniques has been called into question regarding the efficacy and durability, with one study using patient-reported outcomes suggesting only a 32% sustained benefit at 2 years for endovascular intervention for PAD.[3] Multiple modalities are available of endovascular treatment of femoropopliteal atherosclerotic disease, none of which has demonstrated clear superiority over the others. Atherectomy, drug-coated balloon angioplasty, bare metal stents, and covered stents have all been proposed as effective methods to treat femoropopliteal lesions.[4] The data are mixed; however, the longest reported follow-up duration is 2 years for atherectomy and drug-coated balloon angioplasty outcomes, with a target lesion revascularization rate of ∼80%.[5] Covered stenting with the Viabahn stent (W.L. Gore & Associates) has been evaluated for long and complex lesions of the femoropopliteal segments, with a reported primary patency of 24% to 84% at ≤3 years of follow-up.[1,5,6] We report a clinical scenario of a misdeployed stent and the novel use of an Outback reentry device (Johnson & Johnson) to successfully complete an intended intravascular covered stenting procedure for limb salvage, saving the patient the morbidity of undergoing open bypass. The patient provided written informed consent for the report of his case details and imaging studies.

CASE REPORT

The patient is a 69-year-old man with significant right leg claudication and an ankle brachial index of 0.41. His medical history included coronary artery disease, hypertension, atrial fibrillation, and PAD. The patient's surgical history included coronary artery bypass grafting to treat his diffuse atherosclerotic disease but no previous lower extremity procedures. Lifestyle modification, including enrollment in a walking program, did not provide meaningful relief for his claudication.

Initial computed tomography angiography demonstrated a TASC (Trans-Atlantic Inter-Society Consensus Document on Management of Peripheral Arterial Disease) D occlusion of the proximal SFA with reconstitution at the above-the-knee

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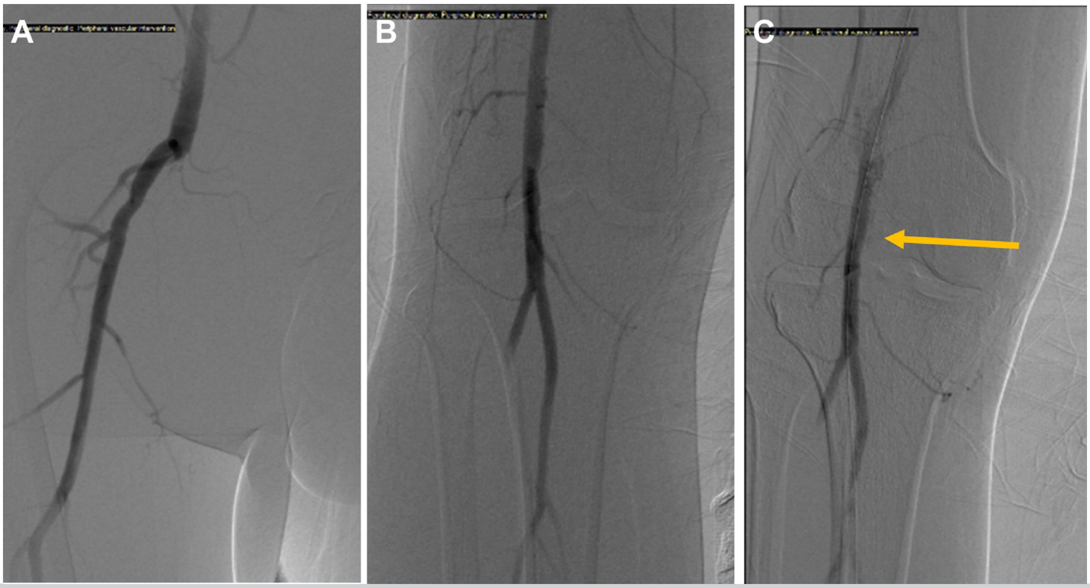

Fig 1. A, Occlusion of the superficial femoral artery (SFA) at the origin. **B,** Reconstitution of above-the-knee popliteal artery. **C,** Appearance after angioplasty with the proposed location for stent placement (*yellow arrow*).

popliteal artery (Fig 1). After discussion with the patient regarding the goals of treatment, endovascular interventional treatment was offered. Left femoral artery access was established for diagnostic angiography and demonstrated patent aortoiliac segments. The right common femoral and profunda femoris arteries were patent, with occlusion of the SFA from the origin and reconstitution at the above-the-knee popliteal artery (P1 segment) with patent behind-the-knee (P2) and below-the-knee (P3) segments (Fig 1, *A* and *B*). Two-vessel runoff was present to the foot through the posterior tibial and peroneal arteries. The lesion was crossed using a standard subintimal recanalization technique with a Glidewire and Trailblazer catheter (Medtronic). Angiography demonstrated that intraluminal reentry was achieved. The reentry site was determined to be in the behind-the-knee popliteal artery.

A 5-mm balloon (Medtronic) was used to prepare the artery for stenting, with continued dissection noted at the reentry point (Fig 1, *C*). Therefore, covered stenting was performed from the SFA origin down to the P2 segment. Completion angiography showed sluggish flow in the proximal stent, with flow absent distally. On further imaging, the distal end of the covered stent was found to be pinched and narrowed (Fig 2, *A*), with inadvertent deployment into an anterior geniculate artery overlying the course of the popliteal artery. Initially, a 5-mm balloon was used to try to accordion the stent back into the popliteal artery but without success. Subsequently, an Outback reentry device (Johnson & Johnson) was chosen to perform needle fenestration through the current stent back into the popliteal artery after orienting the device posteriorly (Fig 2, *B*). A series of cutting balloons was used to enlarge the fenestration in the stent (Fig 2, *C*). A new 6 × 50-mm Viabahn stent was placed into the intended P2 segment (Fig 3, *A*), with completion angiography demonstrating preserved two-vessel runoff to the foot (Fig 3, *B*).

The patient had an uncomplicated recovery and was discharged home later that day. At 2 years of clinical and ultrasound follow-up, no increased velocity had occurred through the popliteal stented segments on the first postoperative or most recent duplex ultrasound scan, with an ankle brachial index at all postoperative visits >1. The patient also has symptomatic relief from claudication and is receiving dual antiplatelet therapy for life. The crushed anterior geniculate stent can be observed on an arterial duplex ultrasound scan (Fig 3, *C*).

DISCUSSION

Endovascular modalities have experienced significant growth during the past two decades, with tools such as atherectomy, angioplasty, and stenting, all used in different combinations to prolong primary patency of femoropopliteal lesions treated endovascularly. Although atherectomy use has increased, it has not been shown to have improved results compared with angioplasty and stenting.[7] Also, evidence is mounting that restenosis rates can be exacerbated by the misuse of atherectomy.[3,8] Because of concerns regarding restenosis and occlusion, which plague any endovascular intervention to the femoropopliteal segment, different strategies have been used, including covered stents, which theoretically only have a risk of restenosis and occlusion at the margins of the stent, because neointimal ingrowth cannot occur in the body of the stent graft itself. The use of covered stents has resulted in good success in limited series.[9,10] Other more innovative techniques involve the use of reentry catheters to enter the subintimal plane proximal to the occlusion to allow for crossing of the lesion and assisting reentry into the lumen distally to create a new channel in uncrossable

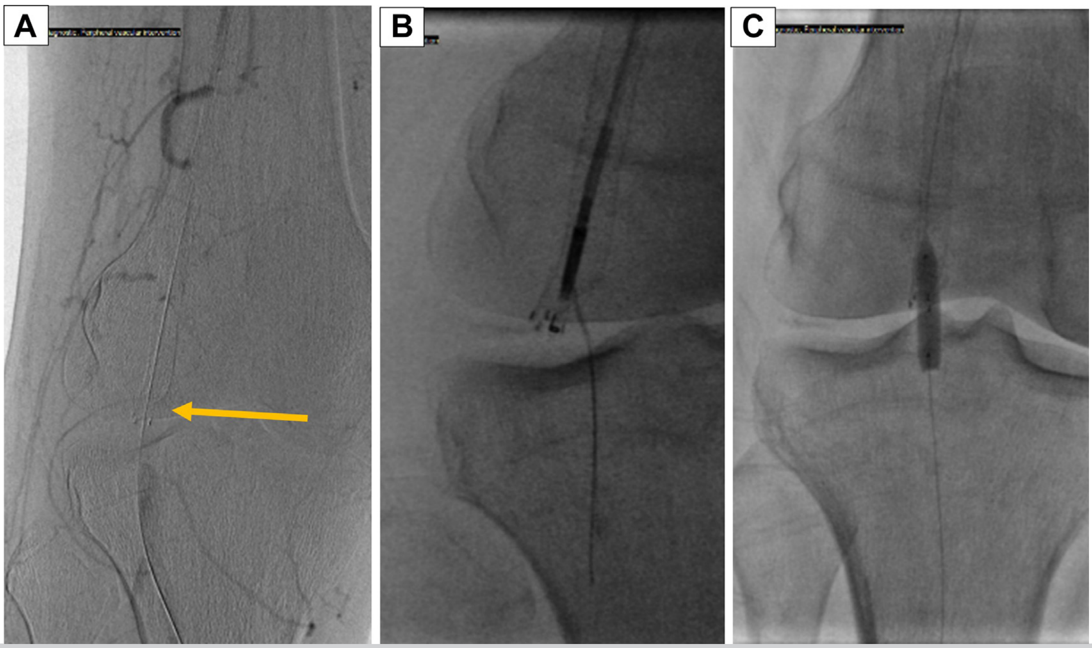

Fig 2. **A,** Covered stent misdeployed into anterior geniculate branch. Note the tapered appearance of the distal stent (*arrow*). **B,** Outback device used to reenter the popliteal lumen. **C,** Cutting balloon fenestration to the covered stent.

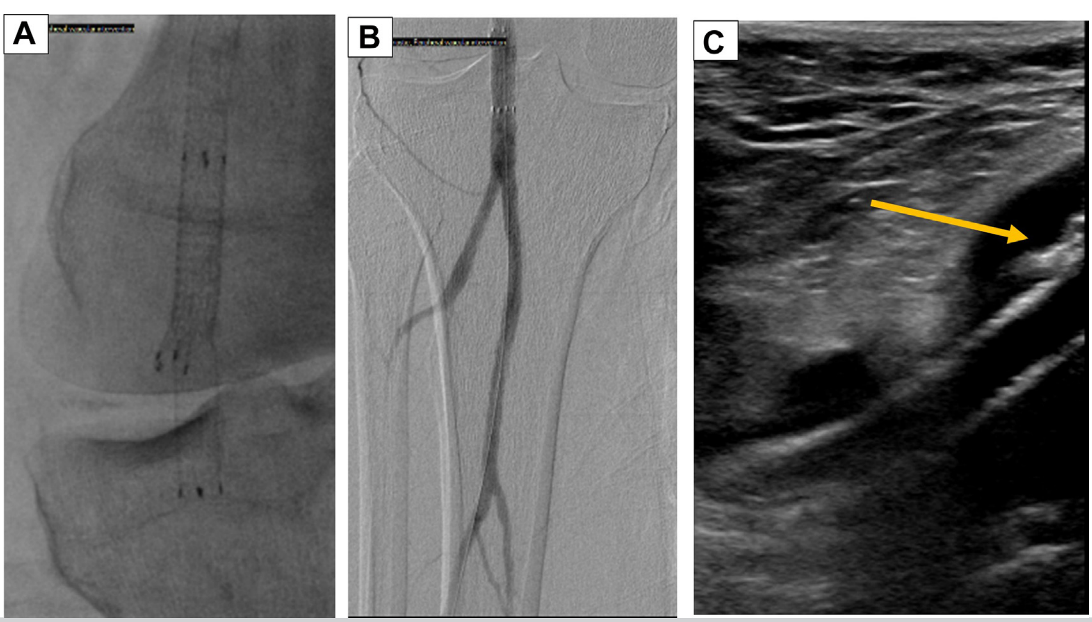

Fig 3. **A,** Fenestrated covered stent into the P2 segment. **B,** Completion angiogram showing preserved vessel runoff. **C,** Postoperative duplex ultrasound demonstrating anteriorly placed stent into anterior geniculate branch (*yellow arrow*).

lesions, also called subintimal tracking.[11] Following on from this paradigm includes percutaneous bypass procedures either via the femoral vein or simply in the subcutaneous space using a reentry device to perforate the artery and reenter distally.[12,13]

In the present case, we used the Outback catheter to fenestrate the posterior portion of the Viabahn stent to access the jailed popliteal artery. Misdeployment of the stent occurred after inadvertent repositioning of the wire into the anterior geniculate artery, which appeared to be within the popliteal artery. The tapering of the stent in the anterior geniculate provided an immediate clue that the stent had been misdeployed (Fig 2, *A*). Historically, a bypass operation from the above-the-knee to the below-the-knee popliteal artery would have been required to restore distal perfusion.

To the best of our knowledge, a description of this technique of fenestration to a peripheral stent has not been previously reported. However, Tan et al[14] described using the Outback reentry catheter to fenestrate a thoracic endograft for stenting of a left subclavian artery. Similar to our case, they also used a cutting balloon to increase the size of the fenestration and subsequently place a covered stent.[14]

The present case has demonstrated the proof of concept that Viabahn covered stent grafts can be fenestrated and adequately dilated to accommodate stent grafting through the fabric. Viabahn stent grafts have been modified for arterial bypass in the peripheral arteries and the thoracoabdominal aorta.[15,16]

CONCLUSIONS

This report highlights the importance of distal wire control in any endovascular procedure and confirmation with a critical view before committing to an irretrievable step, such as stent placement. Once placed, an oversized stent is almost impossible to reposition. However, our described bailout technique could have applicability in other settings, such as situations in which coverage of an arterial bifurcation might be necessary, with options for preservation of both arterial branches, such as the femoral or carotid artery territories or, perhaps, the iliac arteries. We present this case to demonstrate the feasibility of in situ modification of Viabahn covered stents should a clinical scenario occur that warrants the use of this technique.

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