Progressive stenosis of a popliteal artery stent graft by laminated thrombus

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ABSTRACT

We present a case of failed popliteal artery aneurysm repair using a Viabahn stent graft (W. L. Gore & Associates, Flagstaff, Ariz) due to laminated thrombus formation. A 75-year-old man presented with a symptomatic popliteal artery aneurysm. He was treated with a Viabahn stent graft. On follow-up, the patient complained of lower extremity claudication, and duplex ultrasound examination showed a focal intrastent stenosis. A computed tomography scan showed a significant stenosis within the stent graft, at the level of the knee joint creases. The patient underwent superficial femoral artery to distal popliteal surgery. This case report aims to expand on the mechanism of stent graft failure in popliteal aneurysms. (J Vasc Surg Cases and Innovative Techniques 2020;6:189-94.)

Keywords: Popliteal artery aneurysm; Endovascular therapy; in-stent stenosis

Popliteal artery aneurysm (PAA) is a relatively uncommon disease entity that constitutes the majority of peripheral artery aneurysms.[1] Forty percent of patients with PAA present with symptomatic lower limb ischemia, with a reported amputation rate of 20% to 40% if they present in the acute setting.[2,3] The "gold standard" for treatment of PAA remains open surgical repair.[3] However, with the advent of minimally invasive techniques, endovascular repair is used in up to 20% of patients.[3] The advantage of endovascular repair is shorter operative time,[1] decrease in postoperative morbidity, and shorter hospital stay.[4] A number of studies have demonstrated a patency advantage in open repair and recommend that it remain the gold standard therapy.[3,5] However, other studies have shown promising results with endovascular repair, with 4-year patency of 64% to 88%,[6] comparable to open repair.[7,8] The described causes of popliteal stent failure are several and include infolding, dislocation, stent fracture, endoleaks, and compression.[9] In this case report, we describe a case of in-stent stenosis by laminated thrombus as a cause of popliteal stent graft failure. Consent for the publication of this case along with imaging was obtained from the patient.

CASE REPORT

A 75-year-old man presented to the emergency department with acute pain and paresthesia in the right lower extremity. On physical examination, he had intact motor function and mild sensory loss. Doppler signals were not present in the right foot; he had a palpable left dorsalis pedis and anterior tibial pulse. The patient's past medical history included chronic obstructive pulmonary disease (on home oxygen), hypertension, hypercholesterolemia, obesity, peripheral vascular disease (limited to mild bilateral claudication on exertion), history of myocardial infarction status post percutaneous coronary angioplasty, and history of colonic cancer resection. The patient had a 90-pack-year smoking history. He was taking a statin and aspirin on presentation.

Computed tomography angiography revealed a 4.3- × 3.6-cm right PAA with a large intraluminal thrombus and distal embolization. The aorta and iliofemoral vessels were within normal limits and did not have any aneurysmal degeneration (Fig 1). The distal superficial femoral artery measured 8.3 mm, and the distal popliteal artery measured 7.5 mm.

A heparin drip was started, and the patient was taken to the operating room for popliteal artery stenting. A midthigh cutdown was performed, exposing the superficial femoral artery. Angiography confirmed the computed tomography angiography findings (Fig 1). A 9F sheath was inserted into the superficial femoral artery. The popliteal artery was crossed using a Glidewire (Terumo Inc, Ann Arbor, Mich) and a Quick-Cross catheter (AngioDynamics, Rochester, NY). After traversing the popliteal artery, a 9-mm × 15-cm Viabahn stent graft (W. L. Gore & Associates, Flagstaff, Ariz) was deployed, and then angioplasty was performed with a 7- × 8-cm balloon (Cordis Corp, Milpitas, Calif). A 6F Export catheter (Medtronic, Danvers, Mass) was used to extract the distal clot from the anterior tibial artery. There was residual distal thrombus in the distal

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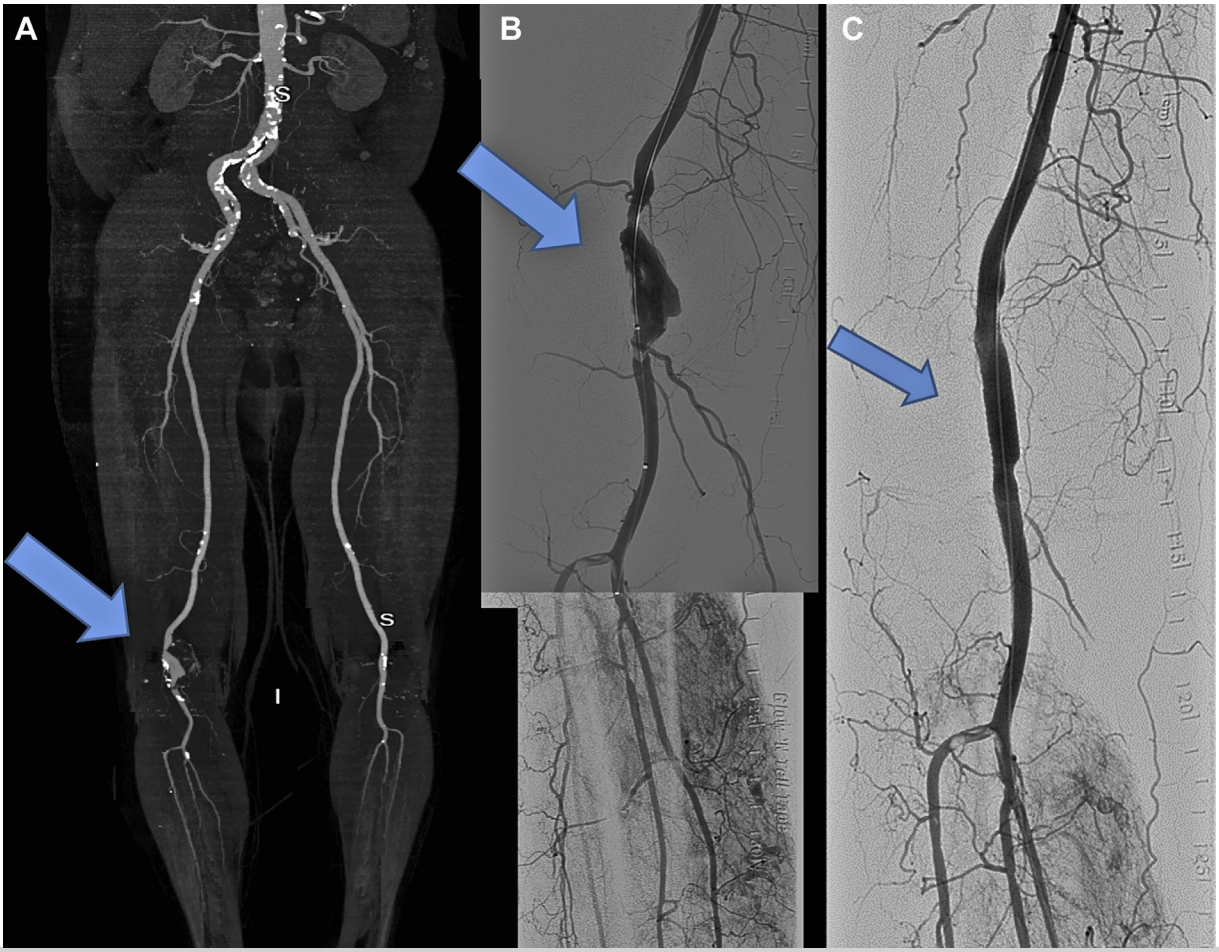

Fig 1. A, Preoperative computed tomography angiography image (*left*) shows popliteal artery aneurysm (PAA) with intraluminal thrombus. **B,** Intraoperative angiogram shows near-occlusion of right popliteal artery with distal embolization. **C,** Intraoperative angiogram after stent graft deployment.

infrapopliteal artery with minimal flow to the foot. Thereafter, a 4F infusion catheter was positioned into the distal popliteal artery. Tissue plasminogen activator infusion (at 0.5 mg/h) was initiated for distal thrombolysis for 24 hours. The patient was monitored in the intensive care unit and returned to the operating room the next day for repeated angiography. The patient was noted to have a one-vessel runoff through the anterior tibial artery with dorsalis pedis-posterior tibial signals. The thrombolysis was terminated, and the sheaths were removed. The patient did not have any significant bleeding overnight and did not require any blood transfusions. Placement of a covered stent across the popliteal artery before the tissue plasminogen activator was started may have prevented further thrombus from embolizing distally. The superficial femoral artery cutdown site was repaired. The patient was discharged home on aspirin and warfarin.

At the 1-month follow-up, the patient had no complaints. The ankle-brachial index was 0.8 for the right dorsalis pedis artery and 0.9 for the right posterior tibial artery, and the right great toe index was 0.65. A 6-month clinic follow-up again revealed no complications. There were no changes in the patient's ankle-brachial indexes, and duplex ultrasound revealed a widely patent stent graft. Warfarin was stopped. He was kept on aspirin. At the 1-year follow-up, the patient complained of right lower extremity claudication. The ankle-brachial index was 1.2 for the right dorsalis pedis artery and 0.8 for the right posterior tibial artery, and the right great toe index was 0.42. Duplex ultrasound revealed a tapered narrowing within the popliteal artery stent graft with moderate flow acceleration (Fig 2). Computed tomography angiography revealed areas in the middle of the stent graft (away from the proximal and distal ends) that were nearly completely occluded with laminated thrombus (Fig 3). The patient was scheduled for a femoral-popliteal bypass the following week. In the operating room, the patient underwent angiography of the right lower extremity, which confirmed the tapered narrowing in the middle of the stent graft. There was near-occlusion of the stent graft with flexion of the knee joint at the proximal end and areas of severe stenosis at the level of the knee joint creases (Fig 4). A superficial femoral artery to distal popliteal bypass was performed using the ipsilateral great saphenous vein.

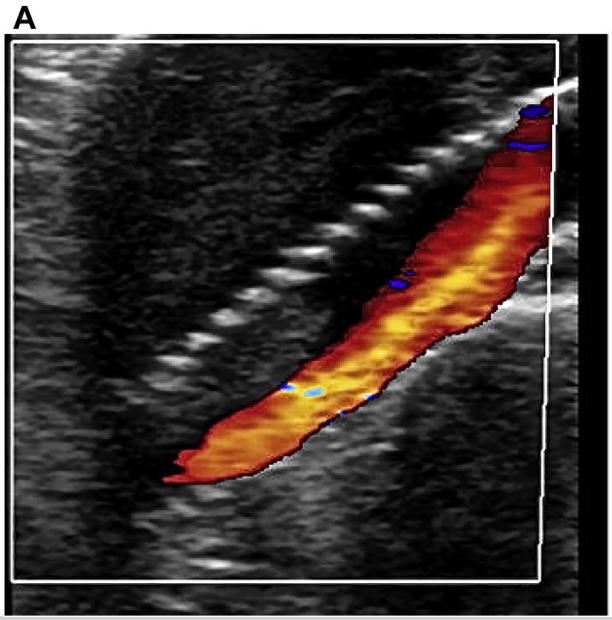

Fig 2. A, Duplex ultrasound image showing tapered narrowing within the popliteal artery stent graft. **B,** Flow velocity changes in the stent at 12 months postoperatively. *PSV,* Peak systolic velocity.

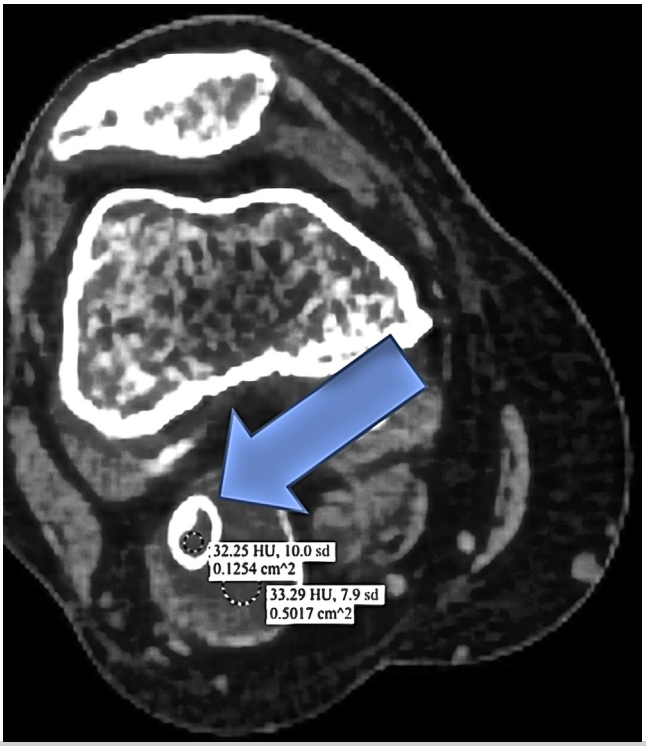

Fig 3. Computed tomography angiography image showing near-occlusion of the stent graft with laminated thrombus (*arrow*). Note that the Hounsfield units (*HU*) inside and outside the stent graft are close in value, indicating similar density. *sd,* standard deviation.

DISCUSSION

We present a case of a failing popliteal artery stent graft due to the formation of laminated thrombus.

The advantages of endovascular PAA repair (EPAR) include short operation time,[1] short hospital stay,[10] and minimal invasiveness (the procedure usually requires only a groin puncture or small cutdown). It is ideal for patients with multiple comorbidities and patients who have contraindications to general or spinal anesthesia.[11] Primary stenting of acutely thrombosed PAAs is feasible and can represent an alternative solution to classic open PAA repair approaches.[12] The introduction of perioperative thrombolysis allows successful restoration of patency to the popliteal and tibial vessels. The available literature guiding treatment of PAA is limited to mostly small, single-center experiences or larger database/registry-based studies in which many of the pertinent clinical data are absent. There are few randomized controlled trials[13] and numerous retrospective studies looking at outcomes of open repair vs EPAR.[14,15] In the most recent meta-analysis looking at open repair and EPAR,[16] it is noted that patency consistently favored open PAA repair.

Knee joint movements should be taken into account in the endovascular treatment of PAAs. Previous anatomic radiologic studies have found that the popliteal artery is fixed to the surrounding tissue at two points, a proximal point that corresponds to the origin of the descending genicular artery and Hunter canal and a distal point at the origin of the anterior tibial artery. Posterior movement of the popliteal artery between these two fixed points does occur during flexion, with the creation of flexures in the popliteal fossa. The tortuosity of the popliteal artery is more pronounced in elderly patients and does not disappear during knee extension.[17]

The Viabahn graft stent has several advantages. It is a self-expanding nitinol stent, internally covered by an

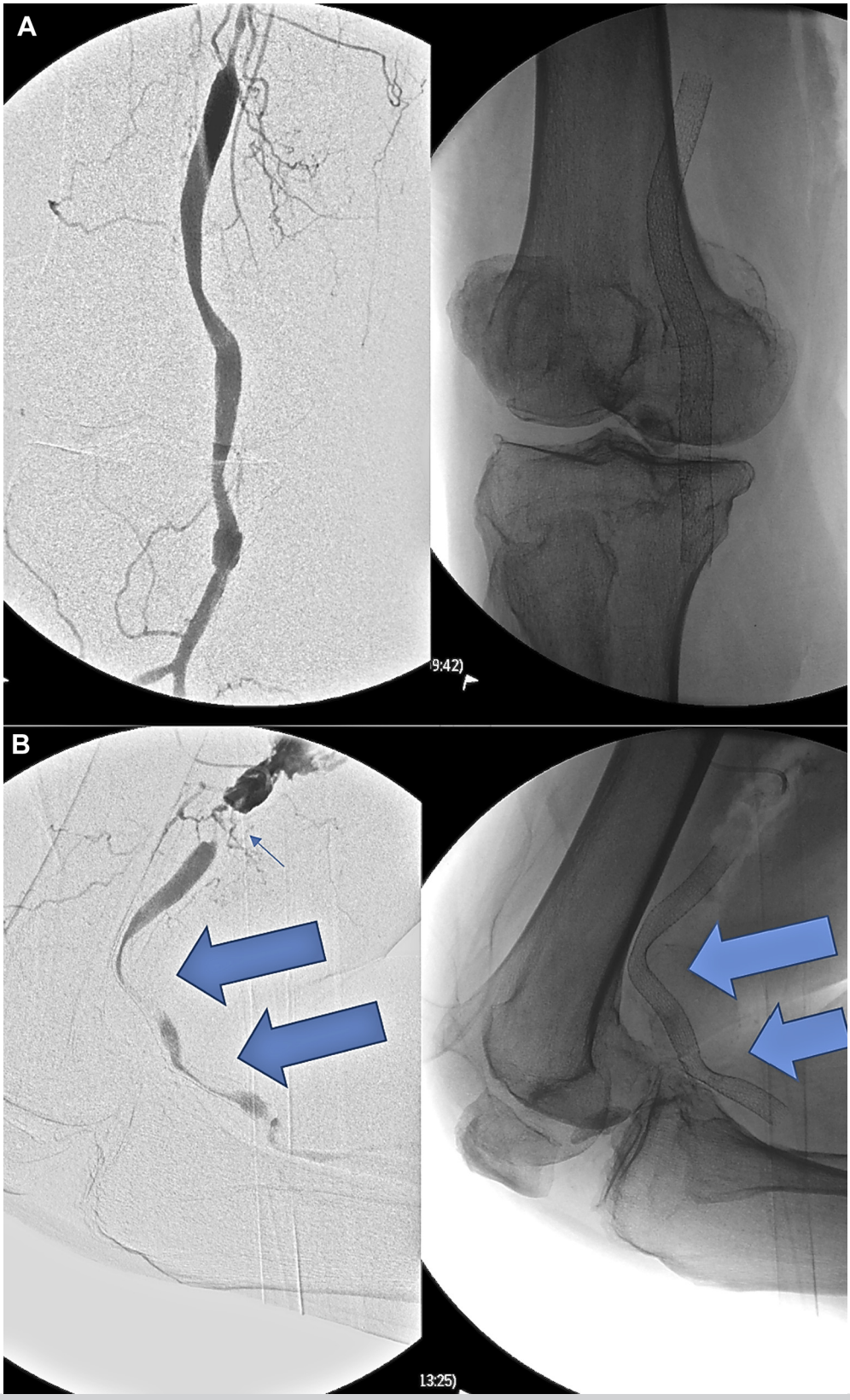

Fig 4. A, Angiogram showing smooth narrowing at two points with the knee straight. **B,** Angiogram with the knee bent showing near-occlusion of the artery at the proximal stent (*thin arrow*) and severe narrowing of the artery at the flexion points away from the proximal and distal ends (*large arrows*).

ultrathin polytetrafluoroethylene graft. It has good resistance to external compression so that occlusion and dislodgment are avoided.[13] It is biocompatible with a smooth, blood contact surface. It is also highly flexible and is longer than other available stent grafts.[18] However, graft occlusions have plagued the widespread use of EPAR. The mechanisms of stent graft failure in the popliteal fossa are multiple. Maraglino et al[9] reported failures due to infolding (10%), dislocation (5%), stent fracture (3%), endoleaks (8%), and compression from endotension (3%). Infolding was the result of oversizing, and it was noted that all infolding grafts thrombosed. However, in that series, as in most other studies, the most common associated cause of graft occlusion was the distal runoff score. This did not improve by combining angioplasty procedures in the tibial vessels. Stent fracture has been reported as a risk for occlusion, more in occlusive disease than in aneurysm disease. In a large prospective study of patients with femoropopliteal occlusive disease, Scheinert et al[19] reported that 37% of their patients had a stent fracture and that occlusion occurred in 55.5% of these cases with a mean follow-up of 11 months. Tielliu et al[20] showed that PAA stent fracture can subsequently lead to stent restenosis or occlusion, mostly in younger patients who are more active. Other causes of occlusion included intimal hyperplasia and kinking.[9,19]

Our case report highlights another cause for possible failure of the Viabahn peripheral stent graft. Our hypothesis is that the graft stent stenosis at the level of the knee crease was caused by layered thrombus formation due to flow turbulence. This may be due to the large size of the stent grafts that are needed in aneurysmal disease, which contributes to turbulent blood flow at the flexion points and thrombus generation in areas of low shear stress. In these areas, there is relative stasis in blood flow and layered thrombus formation as shown in Fig 3. This has been reported in Dacron grafts that were anastomosed to smaller arteries.[21] In retrospect, a lateral angiogram at the time of the stent graft placement with the knee in full flexion may have shown us the kink. In addition, the fact that the patient's outflow was partially thrombosed played a significant role in the flow stagnation and laminated thrombus formation. The patient was sent home on full anticoagulation for 6 months, then transitioned to aspirin. The laminated thrombus was discovered on follow-up after warfarin was discontinued. In this patient, lifelong full anticoagulation may have prevented the stenosis.

CONCLUSIONS

This case report explores different mechanisms of failure of stent grafts used for PAA repair. We describe a potential new method of failure in which laminated thrombus forms at the flexion points and causes in-stent narrowing. This may help with the design of new stent grafts that are specific for PAA. Close follow-up with duplex ultrasound should be mandatory in patients who undergo EPAR. This close follow-up helped us diagnose the severe in-stent stenosis in our patient and help us convert him to an open bypass before the graft occluded.

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