Directional atherectomy for retained valves in a femoropopliteal saphenous vein bypass graft

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ABSTRACT

We describe the case of a 62-year-old man presenting 2 months after a reversed great saphenous vein femoropopliteal bypass performed for critical limb ischemia. He was found to have early, high-grade bypass graft stenosis on duplex ultrasound. Subsequent angiography demonstrated flow limitations secondary to two areas of retained venous valves in the proximal and mid-portions of the vein graft. The culprit valve lesions were successfully lysed endovascularly with a HawkOne (Medtronic) directional atherectomy device. This case demonstrates a safe, novel use of a directional atherectomy device for treatment of remnant valves causing hemodynamically significant flow problems in peripheral vein grafts. (J Vasc Surg Cases Innov Tech 2024;10:101406.)

Keywords: Critical limb ischemia; Endovascular; Saphenous vein graft; Atherectomy

We present the case of a patient after femoropopliteal bypass with a reversed great saphenous vein (GSV) who had early graft stenosis due to retained venous valves. The stenosis was treated with a directional atherectomy device for effective endovascular valve lysis. The patient provided written informed consent for the report of his case details and imaging studies.

CASE REPORT

A 62-year-old man with a history of hypertension, hyperlipidemia, deep vein thrombosis, and known peripheral arterial disease with previous bilateral endovascular interventions presented with worsening right lower extremity lifestyle-limiting claudication and rest pain. Noninvasive arterial studies showed an ankle brachial index of 0.54 in the right lower extremity with absent digital waveforms and a toe brachial index of 0. His unaffected left lower extremity showed a normal ankle brachial index (1.16) and toe brachial index of 0.83. Arterial duplex ultrasound showed 50% to 99% stenosis of the proximal right superficial femoral artery (SFA), with total occlusion of the mid- to distal SFA and evidence of tibial occlusive disease.

A right lower extremity angiogram was performed, demonstrating chronic total occlusion of the distal SFA, with reconstitution of the popliteal artery with two-vessel runoff via the peroneal and posterior tibial arteries. His SFA occlusion was unable to be traversed endovascularly, and the patient subsequently underwent right femoral artery to below-knee popliteal artery bypass with a reversed GSV. Completion angiogram of the vein graft demonstrated a widely patent reconstruction with no retained valves or evidence of technical issues (Fig 1). He recovered well postoperatively with resolution of claudication and rest pain. Two months after the procedure, the patient developed recurrent claudication. Surveillance arterial duplex ultrasound demonstrated high-grade stenosis of the proximal graft (velocity 623 cm/s) and low velocities (17 cm/s) in the mid- and distal graft, indicating impending graft failure (Fig 2, *A*).

The patient was subsequently taken to the operating room for endovascular intervention. The left common femoral artery was accessed via micropuncture, with placement of 5F sheath over a wire. Once the right common femoral artery was selected with a glidewire, intravenous heparin 100 U/kg was administered. The sheath was replaced with a 6F Destination sheath (Terumo Interventional Systems). The bypass graft was selected with an angled glide catheter and a command wire before use of the atherectomy device. A right lower extremity angiogram was performed, which demonstrated >90% stenosis of the proximal bypass graft due to a fibrosed, retained venous valve (Fig 2, *A*). A second retained valve was noted at the mid-segment of the vein graft, near the adductor canal. The valves were crossed with a 0.014-in. wire, and a model H1-M, 2.2-mm HawkOne (Medtronic) directional atherectomy device was used to resect the retained valve segments. Two passes, after directing the cutting surface orthogonally to the takeoff of each valve leaflet, were required for removal of the retained valve. Balloon angioplasty was subsequently performed using a 4-mm IN.PACT Admiral drug-coated balloon (Medtronic), with complete resolution of the stenosis (Fig 2, *B*). A single pass resulted in complete removal of the retained valve without the need for angioplasty on the distal valve remnant (Fig 2, *B*). The resected cusps were removed from the device by disassembling the front of the cutting device chamber in sterile fashion (Fig 3). At the end of the procedure, the access site was closed using a ProGlide device (Abbott Cardiovascular). Follow-up duplex ultrasound 1 month later demonstrated wide patency of bypass graft, with restoration of normal velocities (Fig 2, *B*).

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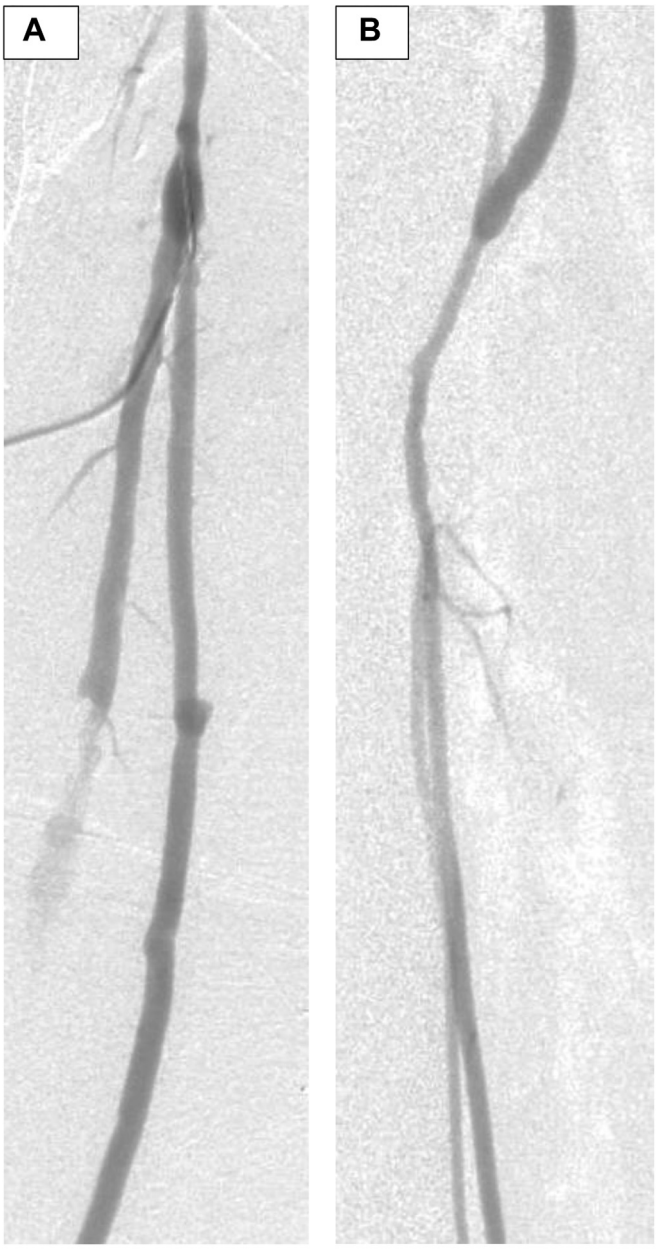

Fig 1. Proximal **(A)** and distal **(B)** great saphenous vein (GSV) bypass graft completion angiogram immediately after open revascularization. This demonstrated wide patency without visualization of retained valves.

DISCUSSION

Ipsilateral saphenous vein grafts remain the preferred conduit for lower extremity bypass due to their excellent long-term patency, especially for infrapopliteal arterial occlusive disease.[1] Vein graft failure is most commonly due to errors in surgical technique (ie, injury of the vein endothelium during graft preparation, tunneling-related graft obstruction, anastomotic stenosis) or myointimal hyperplasia.[2] In theory, the use of a reverse vein graft should negate the innate one-way function of venous valves. Although rare, intact valves remain a concern in reversed GSV bypass due to the potential for luminal narrowing and, thus, a source of significant flow disturbance.[3] Most stenotic areas occur at the proximal or mid-graft positions, likely due to the small caliber of the proximal portion of a reversed saphenous vein graft. A 2001 study assessing retained valves within reversed saphenous vein grafts showed

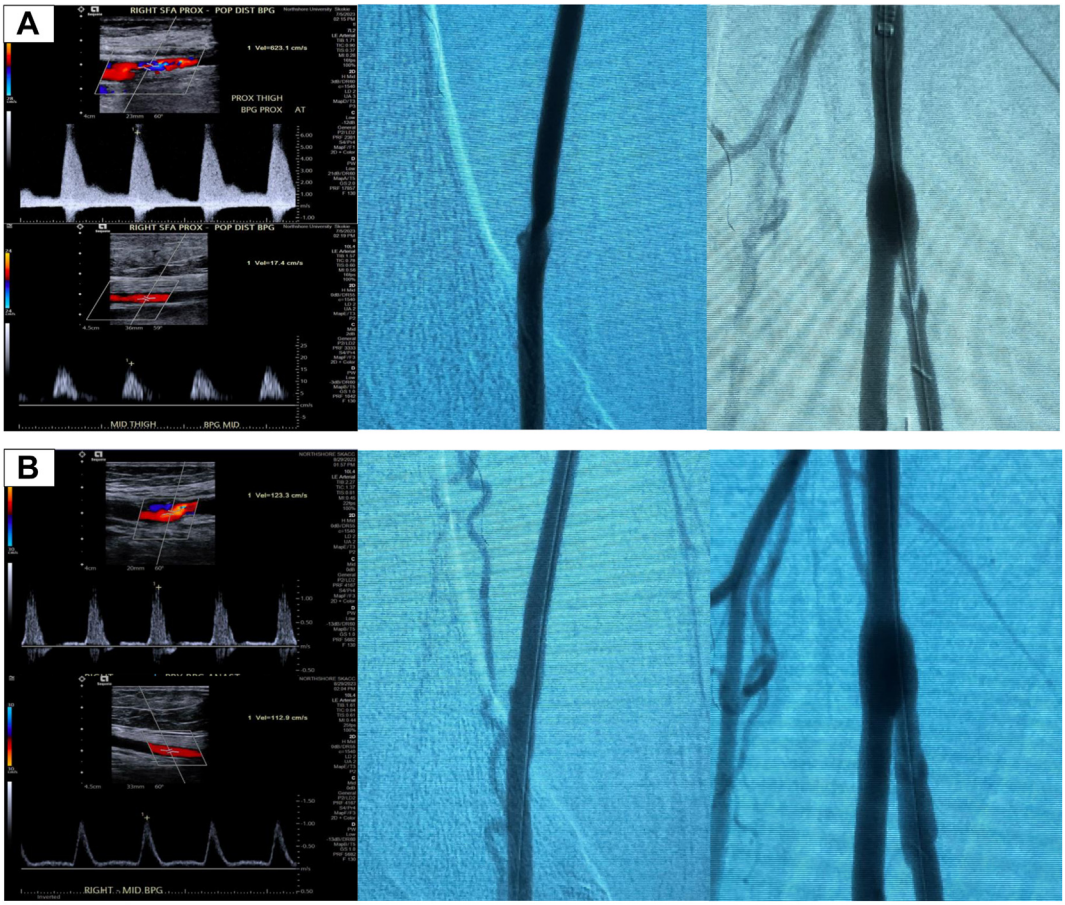

Fig 2. Right lower extremity duplex ultrasound and angiography before and after the procedure. **A,** Preprocedure duplex ultrasound with a velocity of 623 cm/s in a focal area of the proximal bypass graft, indicating high-grade stenosis, and a velocity of 17 cm/s in the mid-bypass graft, indicating impending graft failure. Retained valves shown before intervention. **B,** Postprocedure duplex ultrasound with a velocity of 112.9 cm/s in the proximal bypass graft, indicating resolution of previous high-grade stenosis, and velocity of 123.3 cm/s in the mid-bypass graft, indicating wide patency. Postprocedure angiogram after atherectomy showing resolution of valve-related stenosis.

only 2.5% of retained valves caused hemodynamically significant stenosis requiring reintervention. Of those requiring revision, 10% were found at the proximal anastomosis and 40% at the mid-graft. The "frozen" position of these valves is thought to be due to medial fibrosis and subendothelial proliferation.[4] Many recommend routine intraoperative angiography at the time of vein bypass to assess the conduit for remnant valves and other potential technical issues. There is, however, no standard method to approach treatment of remnant valves when graft complications result. Percutaneous techniques using angioplasty and, at times, stent placement, for recalcitrant areas of stenosis are widely accepted but can result in unnecessary endothelial trauma to a larger endoluminal surface of the vein and initiate device-induced intimal hyperplasia. A technique that minimizes endothelial trauma with focused lysis of the stenotic valve segment would be ideal in such situations.

Directional atherectomy has proved to be an effective endovascular strategy for mechanical removal of atherosclerotic plaque and debulking of vessels without the need for adjunctive stenting.[3] Comparative to other atherectomy options, directional devices cut plaque en face to the arterial wall (side cutting), allowing the operator to control the direction of the mechanical debulking, preferable for eccentric lesions. Complications of device use include creation of pseudoaneurysm, dissection, or perforation due to excessive thinning of the media; however, the incidence is low, and the overall patency at 1 year remains high.[5] Because the operator can orient the cutting surface of the device, directional atherectomy devices could serve well for focused lysis of retained bicuspid vein valves. There is some existing

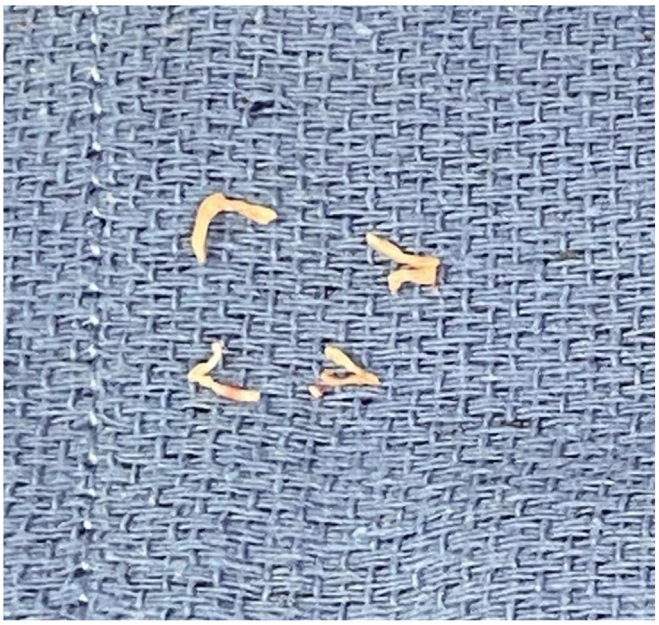

Fig 3. Resected venous valve specimens.

literature demonstrating the successful use of directional atherectomy to treat vein graft stenoses in coronary bypass grafts.[6-8] However, no existing literature has described this method for lower extremity vein grafts or specific to retained vein valves. We demonstrate off-label application of this endovascular tool as a safe, minimally invasive approach to addressing retained vein valves with excellent short-term outcomes.

DISCLOSURES

None.

REFERENCES

1. Almasri J, Adusumalli J, Asi N, et al. A systematic review and meta-analysis of revascularization outcomes of infrainguinal chronic limb-threatening ischemia. *J Vasc Surg*. 2018;68:624–633.
2. Guo Q, Huang B, Zhao J. Systematic review and meta-analysis of saphenous vein harvesting and grafting for lower extremity arterial bypass. *J Vasc Surg*. 2021;73:1075–1086.e4.
3. Krishnan P, Tarricone A, Chen S, Sharma S. The role of directional atherectomy in critical-limb ischemia. *Ther Adv Cardiovasc Dis*. 2021;135:17539447211046953.
4. Vesti BR, Primozich J, Bergelin RO, Strandness E. Follow-up of valves in saphenous vein bypass grafts with duplex ultrasonography. *J Vasc Surg*. 2001;33:369–374.
5. Picazo F, Kwok RCH, Hockley JA, Garbowski MW, Samuelson SD, Jansen SJ. Directional atherectomy of the common femoral artery: complications and outcomes. *Ann Vasc Surg*. 2020;66:621–630.
6. Holmes DR, Topol EJ, Califf RM, et al. A multicenter, randomized trial of coronary angioplasty versus directional atherectomy for patients with saphenous vein bypass graft lesions. CAVEAT-II Investigators. *Circulation*. 1995;91:1966–1974.
7. Holmes DR, Garratt KN, Isner JM, et al. Effect of subintimal resection on initial outcome and restenosis for native coronary lesions and saphenous vein graft disease treated by directional coronary atherectomy. A report from the CAVEAT I and II investigators. Coronary Angioplasty versus Excisional Atherectomy Trial. *J Am Coll Cardiol*. 1996;28:645–651.
8. Grines CL, Marshall JJ. Directional coronary atherectomy revisited. *Catheter Cardiovasc Interv*. 2022;100:59–60.

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