Percutaneous Lower-Extremity Bypass

With the advent of sophisticated re-entry technology and self-expanding covered stents, a less-invasive method to achieve lower-extremity bypass may soon be realized.

BY JAMES D. JOYE, DO

CASE PRESENTATION

An 82-year-old man with a history of coronary artery disease, hypertension, and hyperlipidemia presented for evaluation of treatment options for profound left lower-extremity claudication, which reliably occurred on ambulation of distances less than one block. The patient had previously undergone right lower-extremity angioplasty and stenting of a long-segment SFA occlusion using the subintimal technique, after which he enjoyed resolution of his right leg symptoms but was persistently limited by left calf claudication. Duplex ultrasonography confirmed a distal SFA occlusion with reconstitution of the popliteal artery via genicular collaterals. An MRA performed for staging purposes further identified two-vessel run-off to the foot. Baseline angiography confirmed these findings and further identified significant calcification at the site of occlusion, as well as origin of the occlusion at the site of significant side branch vessels. These angiographic findings made the likelihood of safe subintimal passage of a hydrophilic wire into the lesion less likely, and also drew into question the long-term patency of a conventional endovascular approach. Open surgical bypass was discussed and abandoned as the initial approach due to a combination of advanced age, comorbidities, and patient preference. The patient was offered a novel approach to lower-extremity bypass using a percutaneous method.

INTERVENTIONAL APPROACH AND OUTCOME

The feasibility of percutaneous lower-extremity bypass had previously been extensively evaluated in cadaveric and animal studies. Several human procedures were successfully performed in our lab over the course of the previous year, which resulted in preserved patency and excellent patient outcomes. The first public demonstration of this new technique was unveiled as part of the live case demonstrations of the inaugural Vascular Interventional Advances (VIVA) meeting in Las Vegas, October 2003.

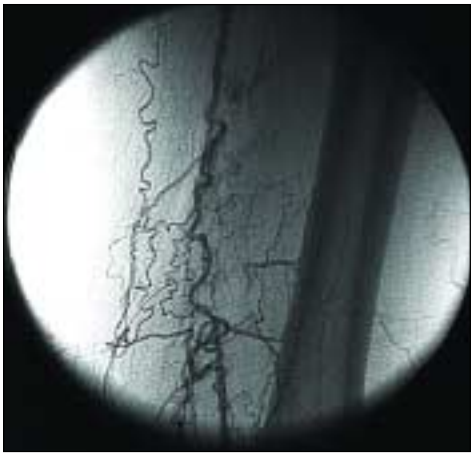

Figure 1. A baseline angiogram reveals a chronic occlusion of the distal left SFA with collateral reconstitution of the left popliteal artery.

Figure 2. The CrossPoint (Medtronic Inc., Santa Rosa, CA) catheter houses a distal IVUS probe and a nitinol hypotube needle that function together to safely guide transit into a vascular lumen.

An 8-F sheath was placed in the left common femoral artery in antegrade fashion, and baseline angiograms were obtained (Figure 1). A 0.014-inch Spartacore wire (Guidant Corporation, Indianapolis, IN) was advanced to the origin of the occlusion, and a CrossPoint catheter was advanced to a position 2 cm proximal to the lesion. The adjacent femoral vein was easily identified using the integrated IVUS probe (Volcano Therapeutics, Inc., Rancho Cordova, CA) of the CrossPoint catheter (Figure 2). After positioning the venous structure at the 12-o'clock position on the imaging screen, the nitinol hypotube needle of the CrossPoint catheter was advanced through the lateral wall of the artery and the medial wall of the vein to a depth of 7 mm. A 0.014-inch High Torque Floppy (Guidant Corporation) wire was then advanced through the needle and safely into the femoral vein. The wire was advanced down the femoral vein until resistance was met at a venous valve, and dilation of the proximal exit site was performed (Figure 3) with a 4-mm X 20-mm Maveric coronary balloon (Boston Scientific Corporation, Natick, MA). The 0.014-inch wire was then exchanged for a 0.035-inch Rosen wire (Boston Scientific Corporation) over a 4-F angled Glide Catheter (Terumo Medical Corporation, Ann Arbor, MI). The 0.035-inch wire and Glide Catheter were then advanced through two valves, and a venogram was obtained at the level of arterial reconstitution to confirm venous positioning (Figure 4). The Glide Catheter was then removed and the proximal exit site was stented with a 6-mm X 20-mm Aurora stent (Medtronic) and dilated with a 5-mm PTA balloon to facilitate passage of devices into the venous compartment. A 7-F Ansel Sheath (Cook Incorporated, Bloomington, IN) was then advanced over the 0.035-inch wire to the level of the proximal popliteal artery and the sheath was rotated in a position directed toward the popliteal artery. The 0.035-inch wire was then removed and replaced with the 0.014-inch Spartacore wire, and the CrossPoint catheter was advanced slightly distal to the end of the sheath.

Again, using IVUS guidance, the popliteal artery was identified and the integrated hypotube nitinol needle was advanced through the wall of the vein and the wall of the popliteal artery to a depth of 7 mm. The High Torque Floppy wire was then advanced back into the true lumen of the popliteal artery (Figure 5) and distally to the trifurcation vessels. The CrossPoint catheter was then removed and dilation of the distal re-entry site was performed with a 4-mm X 20-mm coronary balloon. A 6-mm X 30-mm Precise stent (Cordis Corporation, a Johnson & Johnson company, Miami, FL) was deployed at this site and dilated with a 5-mm PTA balloon to further facilitate graft delivery. The 0.014-inch guidewire was again exchanged for a 0.035-inch wire using an angled Glide Catheter, and the Ansel sheath was removed.

A 6-mm X 15-cm Viabahn endograft (W.L. Gore, Inc., Flagstaff, AZ) was then delivered to the popliteal artery and deployed, taking care to leave 3 cm of the graft securely within the popliteal artery. Therefore, the graft rested distally within the popliteal artery, traversed through the distal exit site (distal anastomosis), and the remainder resided within the femoral vein. In a similar manner, a second 6-mm X 15-cm Viabahn graft was deployed in an overlapping

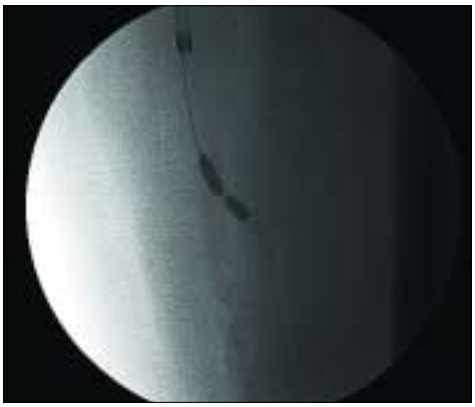

Figure 3. Predilation of the proximal anastomosis performed with a 4-mm coronary balloon shows a napkin-ring waist at the junction of the arterial and venous walls.

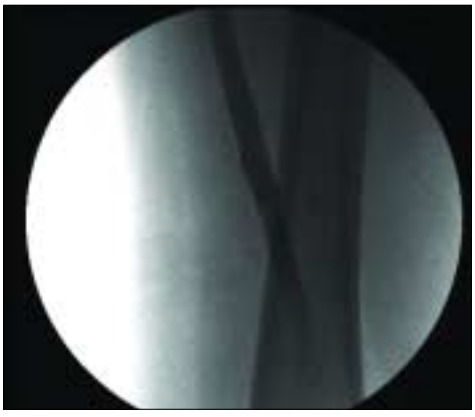

Figure 4. A femoral venogram confirms accurate positioning.

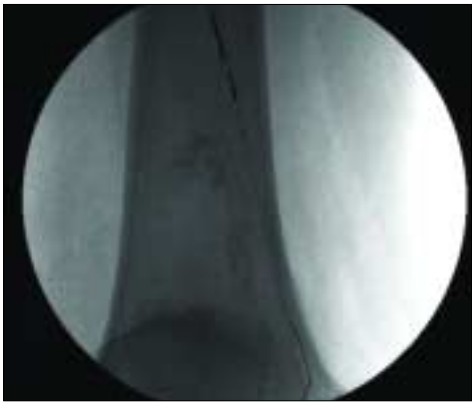

Figure 5. Formation of the distal anastomosis with the CrossPoint catheter is shown with the wire extending from the distal tip of the nitinol hypotube needle back into the true lumen of the popliteal artery.

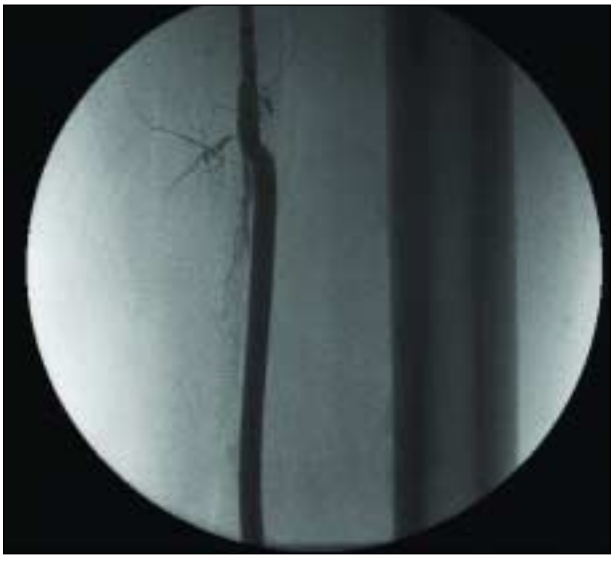

Figure 6. A final angiogram demonstrates the patency of the proximal half of the graft.

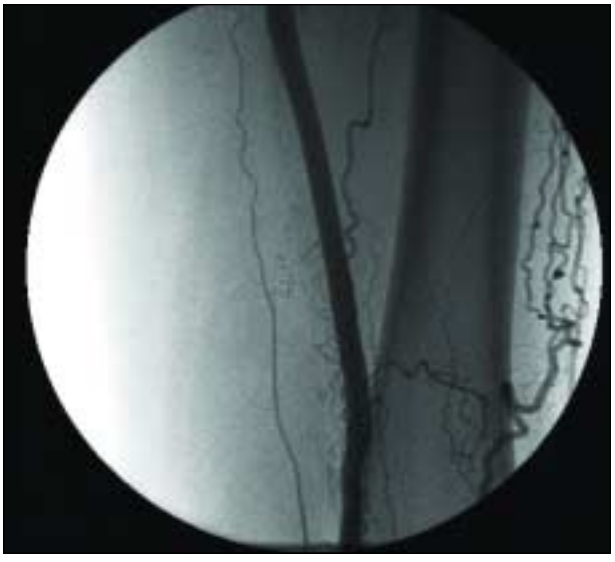

Figure 7. A final angiogram demonstrates the patency of the distal half of the graft.

fashion (3 cm of overlap) from the proximal aspect of the first graft, back through the proximal exit site (proximal anastomosis) and into the SFA above the site of the occlusion. Balloon dilation was then performed across the entire length of the stent graft with a 6-mm X 80-mm PTA balloon. Final angiograms were then obtained (Figures 6 and 7), which revealed a widely patent left femoropopliteal bypass graft originating in the mid-left SFA, extending to the mid-left popliteal artery via the left femoral vein. Brisk run-off to the trifurcation vessels was confirmed. The 8-F sheath was then removed over a wire and the puncture site was closed with an 8-F AngioSeal (St. Jude Medical, Inc., St. Paul, MN) closure device.

The patient recovered uneventfully and was discharged the following morning on a regimen of life-long ASA, 6 months of clopidogrel, and life-long warfarin. He was scheduled for Duplex ultrasonography every 3 months for the first year after the procedure, and annually thereafter. During his first office follow-up, he reported being able to walk a quarter of a mile without claudication symptoms.

DISCUSSION

Traditional open surgical bypass of the lower extremities remains an effective, time-tested operation for treatment of advanced peripheral vascular disease. Often, the operation is not made available to patients because of the inherent risks of surgery, the lack of native conduits, or because the symptoms are not deemed to be critical enough to warrant intervention. As the number of elderly patients with this disease process continues to grow, and as they present with increasingly more daunting medical comorbidities, it would be useful to have a less-invasive alternative to offer them. We have witnessed many such advances in other vascular arenas, and the lower extremities need not be excluded from innovation.

This case demonstrates an early attempt to provide the benefits of femoropopliteal bypass without the surgical risk and with a much more rapid recovery. Percutaneous bypass does not prevent subsequent open surgery if it were to be needed and, therefore, does not handcuff patient options. The use of an endograft within the femoral vein conceivably allows for bidirectional flow within the vein, thus preserving venous function and limiting concerns for subsequent venous insufficiency. Long-term anticoagulation with warfarin serves to protect patency of the endograft and to limit venous thrombosis. Case selection for this type of approach needs to be quite restricted, and formal evaluation of the technique in clinical trials is mandatory before it can be considered as a viable treatment strategy. The technology that already supports this procedure, coupled with newer polymers and drug-elution platforms, however, make it probable that percutaneous bypass may ultimately succeed. ■

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