A case of occluded femoropopliteal saphenous vein bypass with threatening limb ischemia treated with endovascular stent graft relining

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ABSTRACT

A 61-year-old man presented with chronic limb threatening ischemia due to reocclusion of a femoropopliteal (FP) bypass using a saphenous vein graft (SVG). After performing endovascular intervention using plain angioplasty and drug-coated balloon and drug-eluting stent implantation of the proximal anastomosis of FP bypass, refractory early reocclusion occurred during the perioperative period. Thus, we decided to alternatively place a stent-graft in the occluded FP bypass. After the SVG had been dilated using a high-pressure balloon, a stent-graft was successfully placed. This alternative therapy using a stent-graft prevented SVG FP bypass reocclusion, and the patient's ulcers had completely healed within 1 month. (J Vasc Surg Cases and Innovative Techniques 2021;7:74-7.)

Keywords: Chronic limb threatening ischemia; Endovascular therapy; Femoropopliteal bypass; Saphenous vein; Stent-graft

Although guidelines have recommended surgical femoropopliteal (FP) bypass with a saphenous vein graft (SVG) as first-line therapy for complex FP lesions,[1] a substantial incidence of reocclusion after FP bypass with a SVG has been reported.[2] Also, up to one third of patients with SVG bypass failure could need additional treatment.[2] Several strategies are available for secondary intervention to salvage SVG bypass failure, and it has been reported that drug-coated balloon (DCB) usage will prevent restenosis and prolong the period to reintervention.[3] However, some studies have reported that the clinical results after DCB use do not differ from those with conventional therapy.[4] The best alternative therapy for refractory SVG restenosis has remained controversial. In the present report, we have described a previously unreported alternative therapy in which a stent-graft was used for a reoccluded SVG FP bypass. The patient provided written informed consent for the report of his case details and images.

CASE REPORT

A 61-year-old man with ischemic ulcers on his right toes presented to our center for treatment. His medical history included chronic kidney disease requiring dialysis, dyslipidemia, and hypertension. Approximately 2 years before his current presentation, a right FP bypass anastomosed from the right common femoral artery to the below-the-knee popliteal artery using an SVG was conducted to treat chronic limb threatening ischemia (CLTI). Bypass restenosis repeatedly occurred during follow-up, with plain angioplasty performed each time.

His second and third right toes had already been amputated, and new ulcers had appeared in his first, fourth, and fifth right toes. His composite WIFI (wound, ischemia and foot infection) score was 5 (wound, 2 [deeper ulcer with exposed bone], ischemia, 3 [ankle brachial index <0.4], and foot infection, 0 [no signs of infection]), indicating a considerably high risk of major amputation.[5] His right ankle brachial index was immeasurable. Alternatively, the skin perfusion pressure, which can measure perfusion directly by identifying the onset of tissue perfusion, was 13 mm Hg at the dorsalis region and 9 mm Hg at the plantar region, indicating insufficient perfusion for wound healing.[6] Duplex ultrasound surveillance revealed complete reocclusion of the right FP bypass. Blood flow of the right dorsal and posterior tibial arteries could not be detected. We subsequently diagnosed CLTI due to SVG FP bypass failure. After admission, we performed repeated interventions using plain angioplasty on day 1 (Fig 1, *a* and *b*), DCB placement on day 8 (Fig 1, *c*), and drug-eluting stent implantation in the proximal anastomosis of the FP bypass on day 15 (Fig 1, *d*). However, early occlusion occurred, and it was difficult to maintain patency of the FP bypass. The ulcers in the patient's toes worsened during this period, and major amputation was strongly recommended because of the early recurrence. However, the patient refused major amputation outright, and an alternative infrainguinal revascularization strategy was planned with consensus from vascular specialists. With the patient under intravenous anesthesia, after a 5000-U

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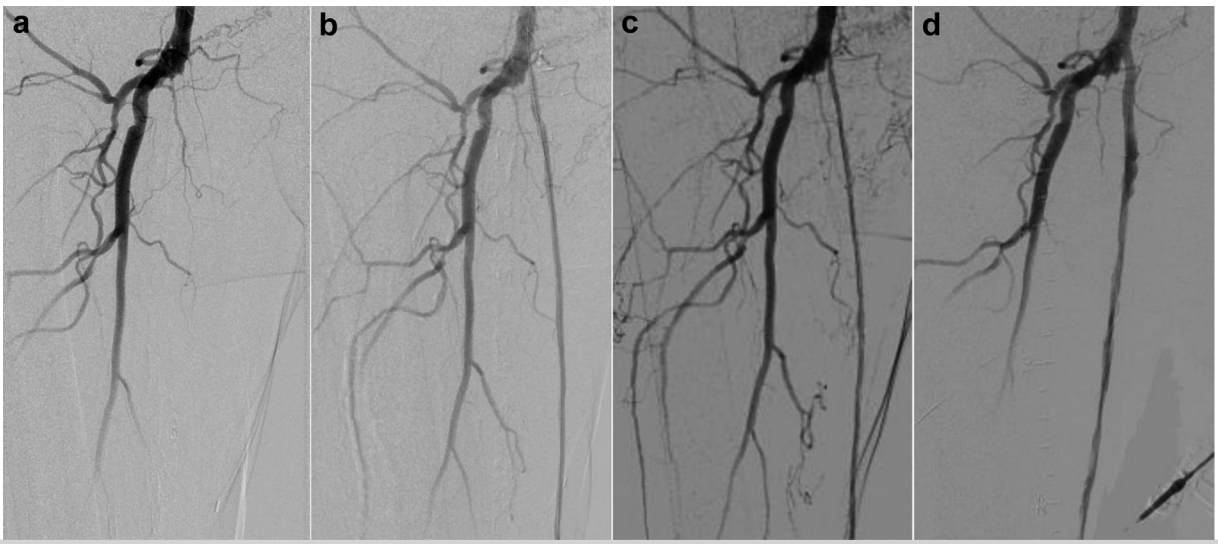

Fig 1. Initial and completion angiograms after differential endovascular approach. **a,** Initial angiogram revealing totally reoccluded right femoropopliteal (FP) bypass from the ostium on day 1. **b,** Completion angiogram after plain balloon angioplasty showing improvement of FP bypass. **c,** After reocclusion had occurred after plain angioplasty performed on day 1, a drug-coated balloon (DCB) was used for the ostium of the FP bypass, with successful restoration of flow achieved on day 8. **d,** Early reocclusion was again confirmed, and we finally decided to implant a drug-eluting stent in the ostium of the FP bypass on day 15.

bolus of intra-arterial heparin, a 6F, 45-cm sheath (Destination; Terumo Corp, Tokyo, Japan) was placed into the left common femoral artery, advanced over the bifurcation, and positioned proximal to the graft proximal anastomosis. Initial angiograms showed total reocclusion of the right FP bypass from the proximal anastomosis. A 0.035-in. guidewire accompanied by a support catheter (CXI; Cook Medical, Bloomington, Ind) was initially used. We subsequently changed to a 0.014-in. guidewire (Gladius; Asahi Intec, Aichi, Japan), which was successfully advanced to the distal anterior tibial artery (ATA). The initial intravascular ultrasound scan (VISICUBE; Terumo Corp) showed that the diameter of the SVG used as the bypass conduit was extremely narrow, approximately 2.5 mm. We, therefore, decided to perform stent-graft placement to execute the so-called endo-conduit strategy for the very small SVG.[7] The lesion was dilated to the balloon's full nominated diameter using a high-pressure 5-mm balloon (SHIDEN HP; Kaneka Medix Corp, Osaka, Japan) inflated to 30 atm. After successful vessel preparation, a coronary drug-eluting stent (XIENCE Xpedition 4.0 mm × 48 mm; Abbott Vascular Inc, Menlo Park, Calif) was implanted from the ATA ostium to the distal popliteal artery to structure a landing zone for subsequent deployment of the stent-graft. Two stent-grafts (5.0 mm × 250 mm and 6.0 mm × 250 mm; VIABAHN Endoprosthesis; WL Gore and Associates, Newark, Del) were deployed from distally to proximally, overlapping the drug-eluting stent. A 6-mm high-pressure balloon (SHIDEN HP; Kaneka Medix Corp) was used after dilation, again to 30 atm. The completion angiogram revealed an excellent angiographic result as the blood flow had improved dramatically to the distal end of the FP bypass site. Good runoff to the ATA was also visualized (Fig 2). After revascularization, his fourth toe was amputated by a plastic surgeon, and complete wound healing was achieved (Fig 3). He has continued dual antiplatelet therapy.

DISCUSSION

We have described our experience of treating a case of CLTI rescued using an alternative therapy by placing a stent-graft in reocclusion of SVG FP bypass failure. Autologous infrainguinal bypass grafts are widely used for the treatment of extensive FP arterial occlusive disease because of the excellent long-term patency, with reported 5-year patency rates of 60% to 85%.[8] However, one third of patients will develop significant stenosis in the SVG, predominantly in the first year after surgery, and maintaining patency has generally been difficult for patients with a failing FP bypass graft, especially in occlusion.[2] Recently, endovascular approaches using DCBs have been established as secondary intervention strategies for autologous bypass failure. However, the patency has been suboptimal at <30% after 1 year of follow-up. Also, SVG FP bypass restenosis or reocclusion has been encountered in daily clinical practice at a substantial frequency.[4]

The present patient's leg and life were saved by stent-graft deployment using a unique endo-conduit strategy. The "pave and crack" technique was first described for an endo-conduit in iliac arteries causing controlled rupture to facilitate the safe introduction of aortic stent-grafts through diseased access vessels.[9] In contrast, the percutaneous technique uses aggressive predilation and covers the artery to provide the opportunity to implant a larger diameter stent-graft to treat heavily calcified

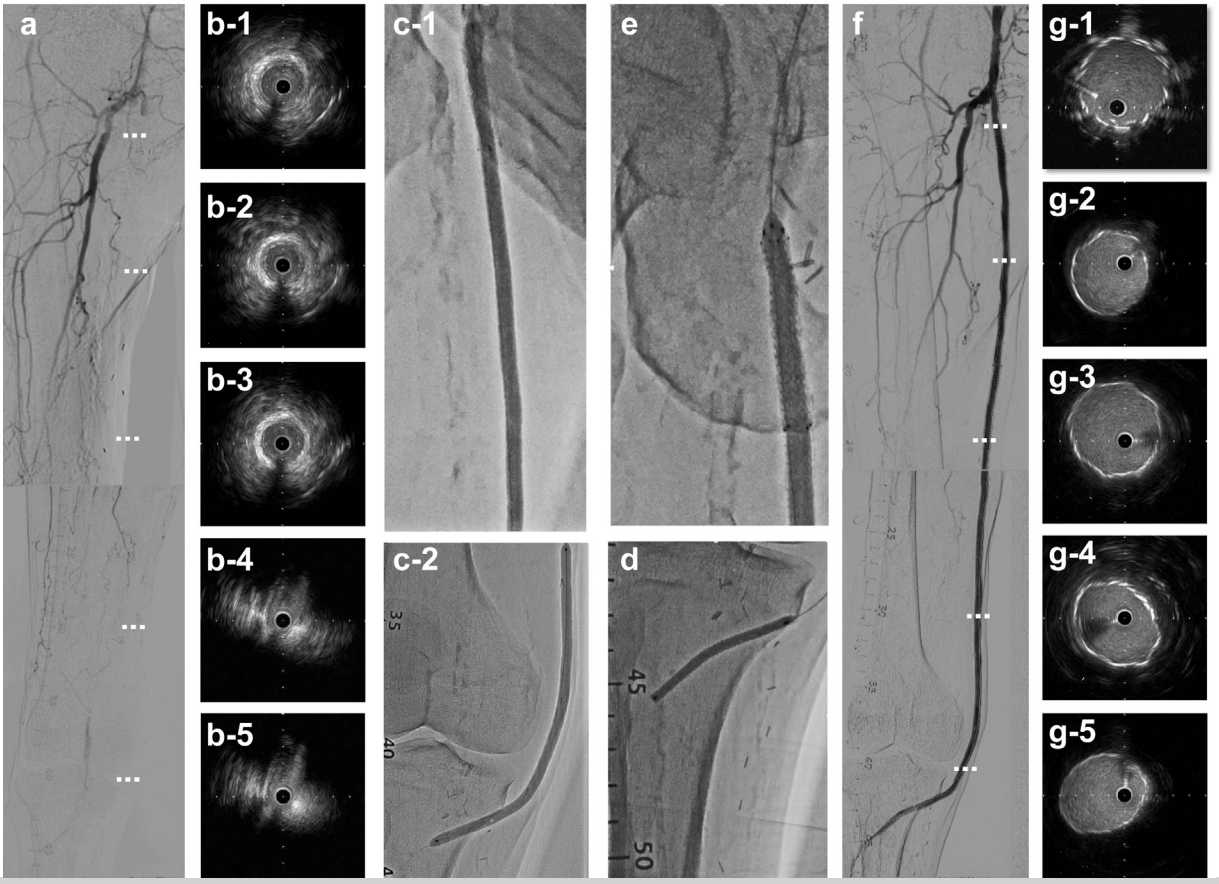

Fig 2. Procedural steps of stent-graft replacement using the endo-conduit "pave-and-crack" strategy. **a,** Initial angiograms showing total reocclusion of the right femoropopliteal (FP) bypass from the ostium. After the wire was successfully advanced to the distal portion of the FP bypass, **(b1-5)** intravascular ultrasonography showed the diameter of the saphenous vein graft (SVG) used as the bypass conduit was extremely narrow, approximately 2.5 mm. We therefore, decided to perform intentional SVG rupture after stent-graft implantation, the so-called endo-conduit strategy for the very small SVG. **c1,2,** The lesion was aggressively dilated by 5 mm using a high-pressure balloon inflated to 30 atm. **d,** After successful vessel preparation, a coronary drug-eluting stent was implanted from the anterior tibial artery (ATA) ostium to the distal popliteal artery to structure a landing zone for subsequent deployment of the stent-graft. Two stent-grafts (5.0 mm × 250 mm and 6.0 mm × 250 mm) were deployed from distally to proximally, overlapping the drug-eluting stent. **e,** A 6-mm high-pressure balloon was used for postdilation, again to 30 atm. **f,** Completion angiogram revealing an excellent angiographic result as blood flow improved dramatically. **g1-5,** Final intravascular ultrasound scan showing round shaped expansion, 5 to 6 mm, after stent-graft replacement using the endo-conduit "pave-and-crack" strategy.

femoropopliteal lesions.[10] Similar to this method, we first cracked the vessel with a larger size balloon and then lined the vessel with stent-graft implantation. Although predilation with a smaller balloon was considered to deliver only the stent-graft, we feared underexpansion of the stent-graft. Thus, cracking was performed first, followed by relining, and the threatened bleeding did not occur. This strategy could be an additional option for highly complex lesions. The VIABAHN stent-grafts (WL Gore and Associates), sometimes referred to as "endoluminal bypass," are covered stents that have provided excellent results, especially in long and complex superficial femoral artery lesions.[11] These stents have also shown superiority for the treatment of in-stent restenosis.[12] One recent study demonstrated the effectiveness of VIABAHN stent-graft (WL Gore and Associates) placement as a potential treatment option for occluded prosthetic FP bypass grafts.[13]

The role of the anticoagulation approach is currently the subject of intense investigation. A recent study showed that rivaroxaban significantly reduces the risk of acute limb ischemia,[14] and another study showed that warfarin significantly reduced prosthetic graft occlusion compared with aspirin.[15] Thus, a more aggressive anticoagulation approach could also be used, with consideration of the high bleeding risks.

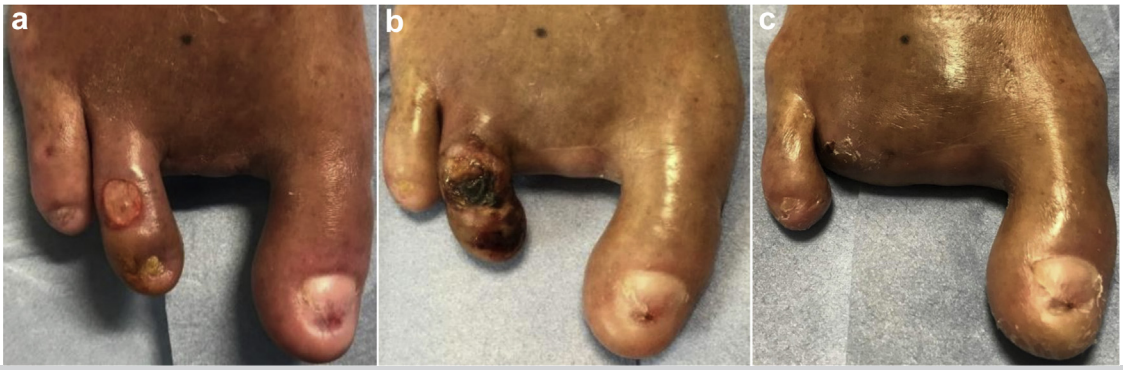

Fig 3. Photographs showing time course of wound healing. **a,** His second and third right toes had already been amputated, and newly ischemic ulcers had appeared in his first, fourth and fifth toes on admission. **b,** After repeated reocclusion of the femoropopliteal (FP) bypass during the perioperative period, the ulcer in the patient's toe had gradually worsened. **c,** Finally, after successful revascularization, his fourth toe was amputated by a plastic surgeon, and complete wound healing was achieved.

CONCLUSIONS

We have demonstrated successful stent-graft placement using the endo-conduit "pave-and-crack" strategy. We used this previously unreported alternative strategy as a last effort after repeated early SVG FP bypass reocclusion. However, more experience is needed to confirm the safety and efficacy of this technique.

REFERENCES

1. Aboyans V, Ricco JB, Bartelink MEL, Björck M, Brodmann M, Cohnert T, et al. 2017 ESC guidelines on the diagnosis and treatment of peripheral arterial diseases. Eur Heart J 2018;39:763-816.
2. Wilson YG, Davies AH, Currie IC, Morgan M, McGrath C, Baird RN, et al. Vein graft stenosis: incidence and intervention. Eur J Vasc Endovasc Surg 1996;11:164-9.
3. Linni K, Ugurluoglu A, Aspalter M, Hitzl W, Hölzenbein T. Paclitaxel-coated versus plain balloon angioplasty in the treatment of infrainguinal vein bypass stenosis. J Vasc Surg 2016;63:391-8.
4. Björkman P, Kokkonen T, Albäck A, Venermo M. Drug-coated versus plain balloon angioplasty in bypass vein grafts (the DRECOREST I-study). Ann Vasc Surg 2019;55:36-44.
5. Mills JL, Conte MS, Armstrong DG, Pomposelli FB, Schanzer A, Sidawy AN, et al. The Society for Vascular Surgery lower extremity threatened limb classification system: risk stratification based on wound, ischemia, and foot infection (WIfI). J Vasc Surg 2014;59:220-34.e1-234.2.
6. Castronuovo JJ Jr, Adera HM, Smiell JM. Skin perfusion pressure measurement is valuable in the diagnosis of critical limb ischemia. J Vasc Surg 1997;26:629-37.
7. Asciutto G, Aronici M, Resch T, Sonesson B, Kristmundsson T, Dias NV. Endoconduits with "pave and crack" technique avoid open ilio-femoral conduits with sustainable mid-term results. Eur J Vasc Endovasc Surg 2017;54:472-9.
8. Midy D, Papon X, Patra P, Hassen Kodja R, Feugier P, Plissonnier D, et al. Randomized study of noninferiority comparing prosthetic and autologous vein above-knee femoropopliteal bypasses. Ann Vasc Surg 2016;31:99-104.
9. Hinchliffe RJ, Ivancev K, Sonesson B, Malina M. "Paving and cracking": an endovascular technique to facilitate the introduction of aortic stent-grafts through stenosed iliac arteries. J Endovasc Ther 2007;14:630-3.
10. Dias-Neto M, Matschuck M, Bausback Y, Banning-Eichenseher U, Steiner S, Branzan D, et al. Endovascular treatment of severely calcified femoropopliteal lesions using the "pave-and-crack" technique: technical description and 12-month results. J Endovasc Ther 2018;25:334-42.
11. Ohki T, Kichikawa K, Yokoi H, Uematsu M, Yamaoka T, Maeda K, et al. Outcomes of the Japanese multicenter VIABAHN trial of endovascular stent grafting for superficial femoral artery lesions. J Vasc Surg 2017;66:130-42.
12. Bosiers M, Deloose K, Callaert J, Verbist J, Hendriks J, Lauwers P, et al. Superiority of stent-grafts for in-stent restenosis in the superficial femoral artery: twelve-month results from a multicenter randomized trial. J Endovasc Ther 2015;22:1-10.
13. Fujimura N, Obara H, Iwasa K, Hattori T, Yamamoto H, Watada S, et al. Preliminary experience of VIABAHN stent graft inside the occluded prosthetic bypass graft for the treatment of above knee femoropopliteal bypass occlusion. Cardiovasc Intervent Radiol 2020;43:223-30.
14. Capell WH, Bonaca MP, Nehler MR, Chen E, Kittelson JM, Anand SS, et al. Rationale and design for the Vascular Outcomes study of ASA along with rivaroxaban in endovascular or surgical limb revascularization for peripheral artery disease (VOYAGER PAD). Am Heart J 2018;199:83-91.
15. Ariesen MJ, Tangelder MJD, Lawson JA, Eikelboom BC, Grobbee DE, Algra A, et al. Risk of major haemorrhage in patients after infrainguinal venous bypass surgery: therapeutic consequences? The Dutch BOA (bypass oral anticoagulants or aspirin) study. Eur J Vasc Endovasc Surg 2005;30:154-9.

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