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Case Report

Distal Bypass Grafting Using the Basilic–Cephalic Loop Vein for Chronic Limb-Threatening Ischemia under Peripheral Nerve Blockades in a Patient with Severely-Reduced Heart Function and End-Stage Renal Disease

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A 51-year-old man with severe comorbidities required redo revascularization due to left chronic limb-threatening ischemia caused by a previous vein graft occlusion. The saphenous veins were not available due to previous surgeries. Femoro-posterior tibial artery bypass surgery was successfully performed using the basilic–cephalic loop vein under peripheral nerve blockades. This anesthesia allowed a series of surgical revascularizations without general anesthesia, and the postoperative courses were uneventful. The patient survived for 4 years with ambulatory status. In conclusion, loop graft can be an alternative single vein material for distal bypass when no saphenous veins are available.

Keywords: chronic limb-threatening ischemia, nerve block anesthesia, heart failure

Introduction

Chronic limb-threatening ischemia (CLTI) is associated with mortality, amputation, and impaired quality of life. Global Vascular Guidelines propound that patients with CLTI should be assessed for the following three clinically important factors: patient risk, limb severity, and arterial anatomic complexity for evidence-based revascularization.[1)] Especially, age, heart function, ambulatory status, vein availability, foot wound status, and stress due to surgery are factors related to clinical outcome of revascularization in patients with CLTI.[2,3)] Endovascular therapy (EVT) has been frequently performed for CLTI due to its minimally invasive course; however, some clinical studies have recommended the appropriate selection of surgical revascularization or EVT, considering patient's comorbidities, severity of foot ulcer/gangrene, anatomy of diseased arteries, and vein availability.[1,2,4)] In particular, for patients who are more likely to have good prognosis and ambulatory status, surgical revascularization using autogenous vein graft is preferred based on the durability of revascularization.[5)] However, patients with CLTI are susceptible to physical stress due to multiple comorbidities, such as diabetes mellitus (DM), end-stage renal disease (ESRD), reduced heart function, and malnutrition.[6)]

Bypass surgery under lower extremity peripheral nerve blockades (PNB) is a novel technique that reduces stressfulness as it uses only local anesthesia without administrating general anesthesia (GA).[7)] Herein, we present distal bypass grafting under PNB using the basilic–cephalic loop vein due to the limited availability of the saphenous veins for treatment of CLTI in a patient with severely deteriorated heart function and ESRD on regular dialysis.

Case

A 51-year-old man was referred to our hospital to treat both his lower limbs for rest pain due to CLTI. The patient

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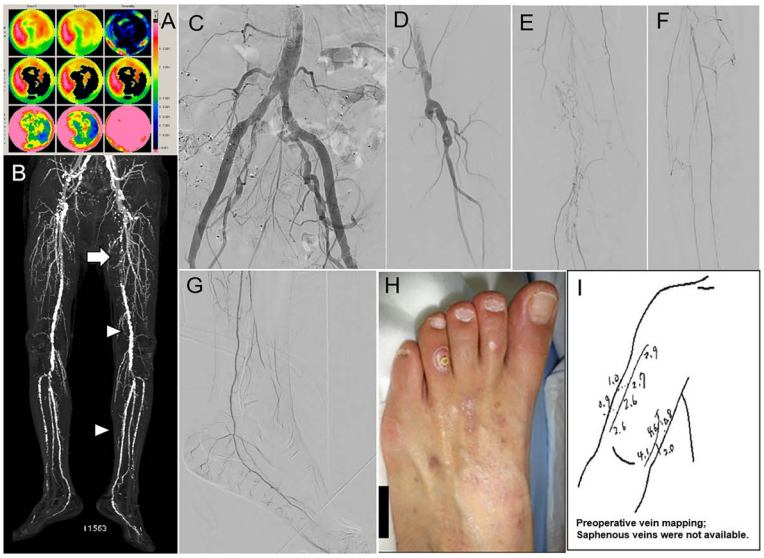

Fig. 1 Preoperative findings. Dipyridamole stress myocardial perfusion scintigraphy showing decreased accumulation in the apex and anterior–anteroseptal and inferior walls (**A**). Computed tomography angiography showing occlusion of the superficial femoral artery (SFA, arrow) as well as calcification of the popliteal and infrapopliteal arteries (arrowheads) (**B**). Intra-arterial digital subtraction angiography demonstrated no stenotic lesion of left iliac artery (**C**) and chronic total occlusion of SFA (**D**) and popliteal arteries (**E**). Left posterior tibial, peroneal, and plantar arteries were well visualized (**F** and **G**). A photograph of left foot with ulcers (**H**). Vein mapping ultrasound showing the availability of the right upper arm veins. Number means diameter (mm) (**I**).

had a significantly reduced heart function (ejection fraction of 13%, **Fig. 1A**), severe mitral regurgitation after myocardial infarction, and ESRD on regular dialysis due to diabetic nephropathy. His walking ability was completely preserved, and he has been working. The ankle brachial index (ABI) showed no wave (unmeasurable) in both legs, and his skin perfusion pressure (SPP) was <30 mmHg in the dorsum and plantar surfaces of both feet. He had already undergone patch plasty of the left common femoral artery (CFA) using the ipsilateral great saphenous vein (GSV) at a previous hospital. Computed tomography angiography and intra-arterial digital subtraction angiography demonstrated that both superficial femoral and popliteal arteries were occluded with severe calcifications. The infrapopliteal arteries were also severely calcified, indicating difficulty of revascularization by EVT, and surgical revascularization was preferable (**Figs. 1B–G**). Bilateral GSV was available for distal bypass surgery (GSV diameter >3.0 mm), but not small saphenous veins owing to their small diameter (<2.0 mm). Ultrasound-guided PNB was applied for the following bypass surgeries to prevent perioperative complications possibly caused by GA. In the first operation in our hospital, the right CFA to peroneal artery bypass grafting was placed in an in situ manner under PNB. In the second operation, the left CFA in below-the-knee popliteal artery bypass grafting was performed 1 month after the first revascularization for contralateral limb. Part of left GSV was poorly dilated, resulting in the use of spliced vein graft. The left graft had been functional for 5 months after the surgery; however, the patient presented with graft occlusion during his regular visits at our institution. He was followed up without revascularization for additional 6 months due to his reduced heart function, but the patient subsequently developed ulcers in multiple toes of his left foot that presented with rest pain (**Fig. 1H**). Left ABI was still showed no wave, and SPP showed 20 mmHg in the dorsal surface and 23 mmHg in the plantar surfaces of left foot, which was classified as clinical stage 3 of Wound, Ischemia, foot Infection classification (wound 1, ischemia 3, and foot infection 0). Next, we decided to perform redo bypass surgery because he wanted to continue his work with functional limb. At that time, veins of the right arm were the only available vein materials based on preoperative vein mapping (**Fig. 1I**). Veins of the left arm were already used as a vascular access for hemodialysis, which was never repaired. Preoperative ultrasound sonography confirmed that the vascular access was well developed and long-term patency was expected. Left deep femoral artery–posterior tibial artery (PTA) bypass was performed using the veins in the right arm under PNB of both right interscalene brachial plexus (**Fig. 2A**) and left lower extremity. The basilic vein and cephalic vein in his right arm were used as a single vein graft, sequentially harvesting them like a loop (**Fig. 2B**). The loop vein graft was placed with the basilic vein section

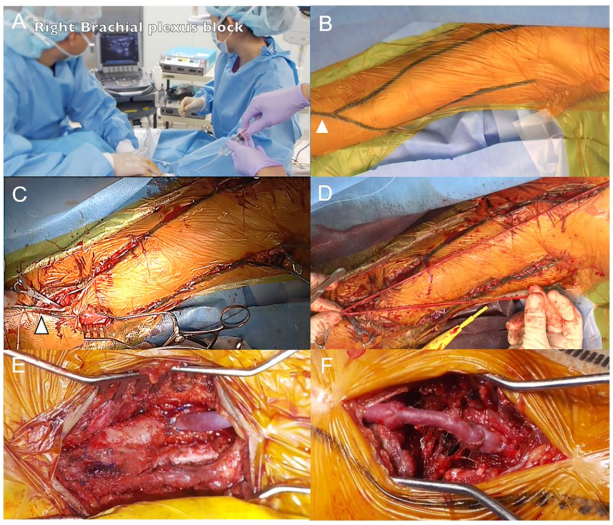

Fig. 2 A series of operative findings of right basilic and cephalic vein loop grafting. Right interscalene brachial plexus block and left lower extremity nerve blockade were performed by anesthesiologists (**A**). Vein mapping, including the median cubital vein (MCV), by ultrasonography (arrow) (**B**). The veins were dissected with a skip incision manner, and valves of the basilic vein were destructed from MCV (**C**). Loop vein graft long enough for femorotibial bypass grafting (**D**). Proximal anastomosis to the deep femoral artery (**E**) and distal anastomosis to the posterior tibial artery (**F**).

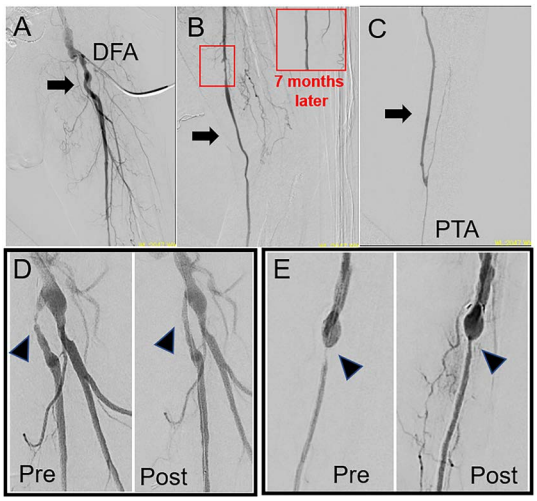

Fig. 3 Intraoperative completion angiography and findings of reintervention. A proximal anastomosis was at the deep femoral artery (DFA) (**A**). Middle segment of the vein graft was shown. A small caliber segment was found (red square) but naturally expanded 7 months after the placement (**B**). The vein graft reached the posterior tibial artery (PTA), a distal anastomosis site (**C**). A proximal segment of vein graft and stenosis of PTA distal to the anastomosis site (arrowheads) were treated with plain old balloon angioplasty (**D** and **E**).

for inflow and the cephalic vein section for outflow. Valvulotomy was only performed on the valves of the basilic vein through the middle cubital vein using the 1.5-mm HYDRO LeMaitre® Valvulotome (LeMaitre Vascular Inc, Burlington, Massachusetts, USA) (**Fig. 2C**). A section of cephalic vein was placed as reversed vein graft. Distal anastomosis was performed with vein patch plasty owing to severe calcification of the PTA. The loop vein graft was long enough for femorotibial bypass grafting (**Figs. 2D–F** and **Figs. 3A–C**). His rest pain in the left foot improved, and the ulcers were also healed after the surgery. Although this graft was subjected to balloon angioplasty owing to a focal stenosis of the graft and that of the PTA distal to the distal anastomosis at 7 months after the surgery, the primary-assisted patency has been maintained (**Figs. 3D–E**). He has survived for almost 4 years after the primary surgery. Patient consent was obtained to publish this report.

Discussion

We showed the following points through this case: (1) the loop vein graft was sufficiently long to reach the mid tibial level, which can be a suitable alternative when GSV is unavailable, and (2) PNB, instead of GA, allowed our patient with severe high risks to undergo a series of surgical revascularizations without perioperative complications.

The treatment strategy for the current case was decided based on the clinical results of the SPINACH study and ESC/ESVS guidelines. The SPINACH study indicates which revascularization is favorable, EVT or bypass surgery, for each patient using the favorability score. In the current case, the score for surgery was calculated as 0, which totaled −2 points for non-adherence to cardiovascular management and DM and +2 points for prior revascularization after CLTI onset and bilateral CLTIs (minus point means in favor of EVT, and plus point means in favor of surgical reconstruction).[2] The SPINACH score of the present case was categorized into a borderline case, indicating that the patient can select either EVT or surgical reconstruction. ESC/ESVS guidelines indicate that for patients who are not at high risk for surgery, bypass surgery can be indicated for long superficial femoral artery lesions when an autologous vein is available, and life expectancy is >2 years.[3] Although the current case had no saphenous vein available and uncertain expectancy of >2 years preoperatively, surgical reconstruction was selected owing to reasons, such as the arterial lesion severities and availability of alternative vein conduits. Furthermore, one of the reasons for our inclination toward surgical reconstruction in the current case is that he wanted to continue his work with the functional limb, which needed durable revascularization. As previously stated, avoiding of GA by using PNB made this selection possible. The advantages of using this technique are hemodynamic stability, early recovery, and less occurrence of heart-related complications.[7] PNB can be applied in the

right upper extremity and left lower extremity at same time, as shown in the current case; PNB instead of GA may reduce postoperative complications. The patient successfully underwent several revascularizations and achieved limb salvage without any heart-related complications. Thus, PNB could help perform surgical revascularization in cases with extremely reduced heart function.

LoGerfo et al. have introduced the loop vein graft technique for distal bypass when the saphenous vein is not available.[8] When using such technique, the patency of the median cubital vein is technically important as valvulotomy of the basilic vein is performed through the vein. Ultrasonography is useful to identify the patency of the median cubital vein if there are uncertainties. In addition, authors were concerned about the difficulty in cutting the first valve at the central end of the basilic vein due to its large size. Although excision of the valve with scissors under direct visualization after eversion can be performed, the valve cutter from LeMaitre was enough to cut all the valves of the basilic vein in the current case; thus, there were no residual valves found on duplex ultrasonography during the postoperative follow-up. The use of this technique has some advantages. The use of a vein with a large diameter is associated with superior patency of the vein graft.[9] The loop vein graft is long enough for femorotibial bypass grafting with a single vein graft, as shown in **Fig. 3**. The cumulative patency rate at 1 year was 74.4%, as reported by Holzenbein et al.[10] The single vein graft had lower incidence of graft failure compared to spliced vein graft in a series of patients who underwent distal bypass surgery.[6] Less size mismatch confirmed that the large basilic vein matched with the femoral artery and the smaller cephalic vein matched with the PTA (**Figs. 2E–F**). Although vein graft dilatation due to the thin vein wall is considered as a disadvantage of arm vein graft, it has been not recognized in regular graft surveillance. In addition, upper extremity veins could be used as vascular access for dialysis patients. Use of the veins for distal bypass surgery should be considered after evaluation of an existing vascular access regarding patency and stenotic lesion.

Conclusion

We present a patient with CLTI and reduced heart function who underwent distal bypass using a loop arm vein graft. PNB is a useful technique for carrying out distal bypass surgery in patients with severe comorbidities.

Disclosure Statement

All authors declare no conflict of interest.

Additional Note

Patient consent was obtained to publish this report.

Author Contributions

Surgical procedures: all authors
Writing: YT, SK, NA
Critical review and revision: all authors
Final approval of the article: all authors
Accountability for all aspects of the work: all authors

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