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IDEAS AND INNOVATIONS

Reconstructive

Free Flaps in Patients with Advanced Arteriosclerosis of the Tibial Vessels: Mini Vein Graft to the Peroneal Artery

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Summary: Lower extremity reconstruction with free flaps in patients with only peroneal artery runoff remains a challenge. Here, we present a novel technique for reconstruction of medial defects in the distal leg using a medial approach to the peroneal artery and a short interposition vein graft anastomosed end to side to the peroneal artery. A retrospective, single-center study was performed including all patients who underwent lower extremity reconstruction with free flaps anastomosed to the peroneal artery using a mini vein graft from November 2020 to March 2022. The primary outcome measure was limb salvage. Secondary endpoints were flap survival and postoperative complications. Seven patients received lower extremity free flap reconstruction with a mini vein graft to the peroneal artery. Flap loss rate was 0%. Limb salvage was achieved in five patients (71%). At 6-month follow-up, all patients were ambulatory. One patient died 1 month after surgery due to heart failure. Mini vein graft to the peroneal artery allows reliable and safe free flap reconstruction of distal leg defects in patients with only peroneal artery runoff.
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INTRODUCTION

In patients with occlusion of the anterior and posterior tibial arteries and a medial soft-tissue defect of the distal leg, free flap reconstruction is challenging. Arteriovenous (AV) loops joined to the popliteal artery and vein have been proposed for such situations.[1] However, these long vein grafts (VGs) are associated with high complication rates.[2] Often, the only alternative for these patients with distal lower leg wounds is amputation. Here, we describe an alternative approach for the reconstruction of medial defects of the distal leg using a mini VG interposed between the peroneal artery and the flap artery. The flap vein is anastomosed to the posterior tibial vein.

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PATIENTS AND METHODS

We performed a retrospective single-center study of consecutive patients with only peroneal artery runoff undergoing lower extremity free flap soft-tissue reconstruction for medial distal leg defects between April 2020 and March 2022. The primary end point was limb salvage. Secondary endpoints were flap survival and postoperative complications.

Preoperative Imaging

All patients underwent diagnostic angiography with possible therapeutic intervention (balloon dilatation and/or stenting). All patients also underwent duplex ultrasonography to evaluate venous backflow of the posterior tibial veins.

Flap Harvest and Recipient Site Preparation

Flap harvest was performed as previously described.[3] The peroneal artery was exposed in the middle third of the lower leg through a medial approach by partial division of the soleus muscle and dissecting anterior to the posterior tibial vessels and the tibial nerve. Through the same access the posterior tibial veins were exposed.

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A short segment (5–10 cm) of the greater saphenous vein was harvested from the ipsilateral leg. A peroneal slit arteriotomy measuring approximately 5–6 mm was created. The reversed VG was anastomosed end-to-side to the peroneal artery by a vascular surgeon (T.W. or E.M.). Frequently, peroneal artery proximal and distal control were accomplished with 2 French Fogarty catheters due to extensive peroneal artery calcification. The flap artery was then anastomosed in an end-to-end fashion to the VG, whereas the flap vein was anastomosed in an end-to-end fashion to the posterior tibial vein (Figs. 1–3). [**See figure, Supplemental Digital Content 1**, which displays an intraoperative picture of the mini VG (X), anastomosis to the free flap artery (arrow) and venous outflow (XX) from the free flap. **http://links.lww.com/PRSGO/D209**.]

Statistical Analysis

Median and SDs were calculated to summarize continuous variables using Microsoft Excel (Microsoft Corporation, Redmond, Wash.).

RESULTS

Patient demographic data and flap characteristics are provided in Table 1. Median soft-tissue defect size was 81 ± 72.8 cm^2 (median ± SD) (range 15.6–220 cm^2). One patient required return to the operating room within the

Takeaways

Question: Is there an alternative to amputation or the use of long arteriovenous loops for the reconstruction of anteromedial defects of the lower leg requiring autologous free tissue transfer in patients with a peroneal artery single-vessel runoff?

Findings: Mini vein grafts, anastomosed in an end-to-side fashion to the peroneal vessel through a medial approach, were successfully applied in the treatment of lower leg defects of patients with a single-vessel leg supply.

Meaning: This work demonstrates an alternative reconstructive approach to the current treatment options with autologous free tissue transfer for the reconstruction of distal lower leg defects in patients with a single-vessel supply of the leg.

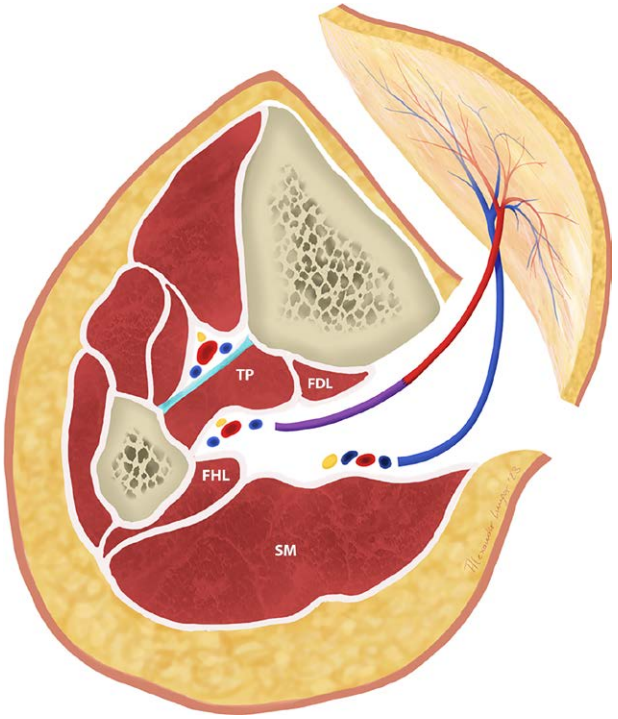

Fig. 1. Schematic illustration of a cross section view of the distal third of the lower leg showing the medial approach to the peroneal artery. The mini VG (purple) is anastomosed to the peroneal artery in an end-to-side fashion and in an end-to-end fashion to the pedicle artery. FDL, flexor digitorum longus; FHL, flexor hallucis longus; SM, soleus muscle.

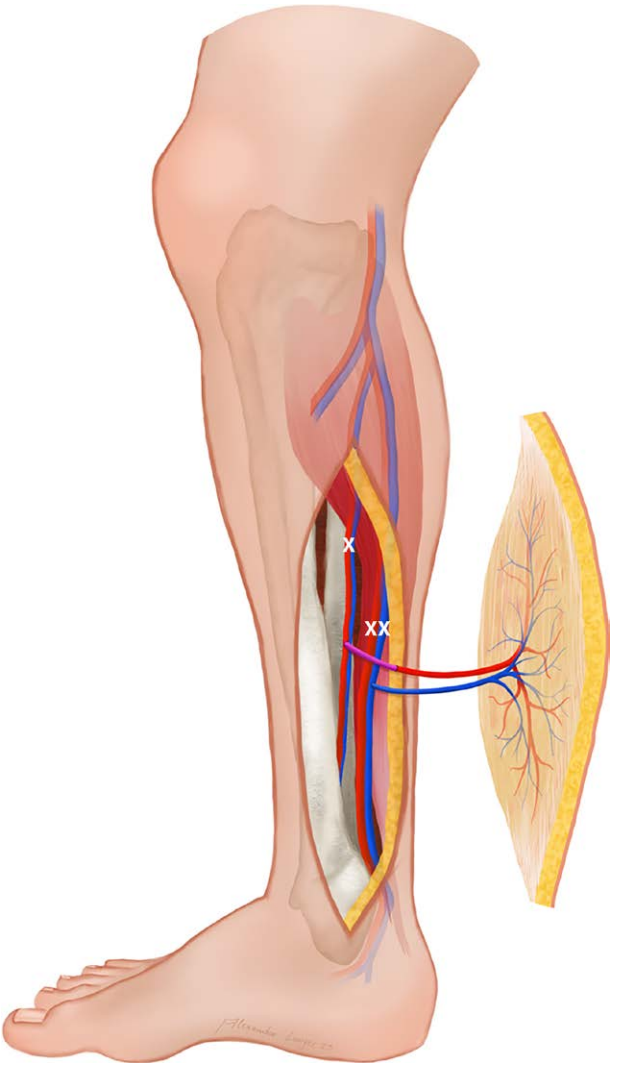

Fig. 2. Schematic illustration showing the medial approach with the flap anastomosed to the mini VG (purple). The VG is further anastomosed to the peroneal artery (X). Direct anastomosis of the pedicle vein to the venae comitantes of the posterior tibial vessels was conducted (XX).

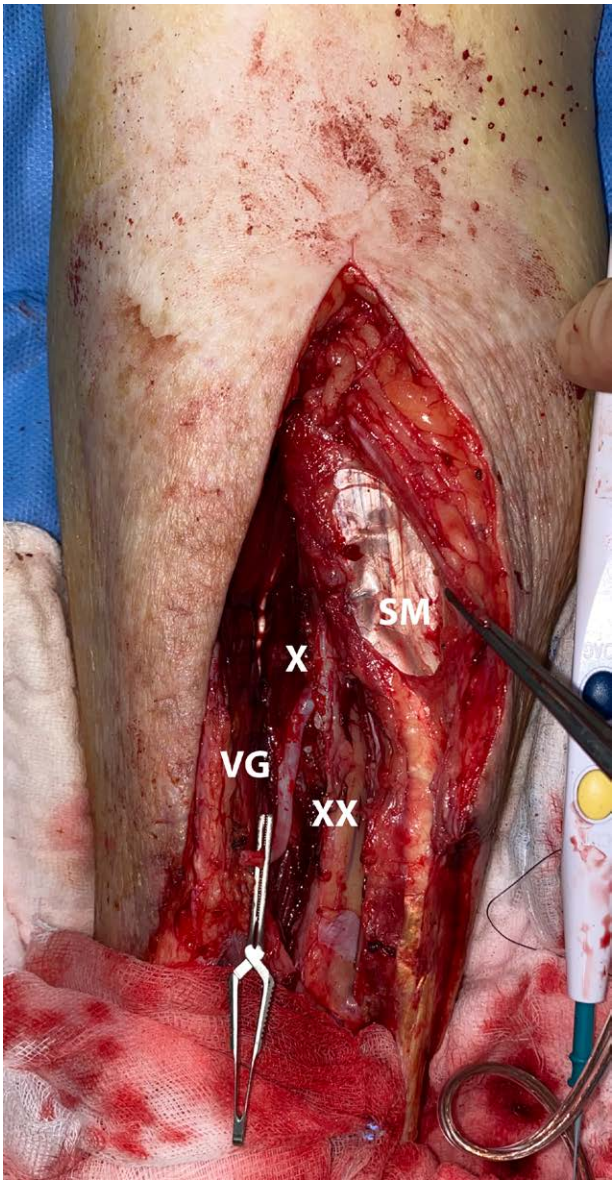

Fig. 3. Intraoperative picture with a 5-cm-long VG anastomosed to the peroneal artery (X). The VG runs anterior to the posterior tibial artery, tibial nerve (XX), and SM. SM, soleus muscle.

first 24 hours postoperatively due to VG thrombosis. The outcome in this case was flap salvage. Follow-up ranged between 15 and 20 months. All flaps survived. One patient died 1 month postoperatively due to heart failure. Two patients underwent below-knee amputation for refractory osteomyelitis. Supplemental Digital Contents 1 and 2 provide a case illustration of a patient undergoing soft-tissue reconstruction of the anteromedial lower leg with an anterolateral thigh flap. (**Supplemental Digital Content 1,** http://links.lww.com/PRSGO/D209; **See figure, Supplemental Digital Content 2,** which displays a case of a 62-year-old patient with a chronic ulcer. Intraoperative photograph of an 8×13 cm defect, http://links.lww.com/PRSGO/D210.)

Table 1. Patient Demographics, Defect, and Flap Characteristics

Characteristic	Value
No. patients	7
Age, mean ± SD (y)	74 ± 7.6
Sex	
Male (%)	6 (86%)
Female (%)	1 (14%)
ASA status	
III (%)	4 (57%)
IV (%)	3 (43%)
Diabetes mellitus (%)	3 (43%)
History of tobacco use (%)	3 (43%)
Previous successful PTA within 6 mo of surgery (%)	3 (43%)
Previous femoropopliteal bypass surgery within 6 mo of surgery (%)	1 (14%)
No. free flaps used	7
ALT (%)	5 (72%)
Latissimus (%)	1 (14%)
Gracilis (%)	1 (14%)
Defect etiology	
Chronic ulcer (%)	6 (86%)
Infection (%)	1 (14%)

ALT, anterolateral thigh; ASA, American Society of Anesthesiologists; BMI, body mass index; PVD, peripheral vascular disease; PTA, percutaneous transluminal angioplasty.

DISCUSSION

Patients with only peroneal artery runoff and distal leg defects present a unique challenge. Locoregional flaps, including peroneus brevis and reverse sural, are unreliable in this population, leaving free flaps or amputation as the only options. The mini VG to the peroneal artery allows safe and reliable free flap reconstruction of medial defects without compromising perfusion of the foot. Others have described segmental fibula removal to expose the peroneal vessels.[4] By contrast, our medial approach spares this morbidity and provides a more direct pedicle position for medial defects.

In advanced atherosclerotic disease of the tibial vessels, peroneal artery–only runoff is frequent. Therefore, the peroneal artery is a common target in bypass surgery and vascular surgeons are familiar with the medial approach to the peroneal artery and an end-to-side anastomosis of a VG to the peroneal artery. An alternative to the mini graft would be direct end-to-side anastomosis of the flap artery to the peroneal artery. However, we advocate for our approach because of the different surgical techniques, which were used for the anastomosis: the VG is anastomosed with a parachute technique with Prolene 6-0 to facilitate anastomosis within the deep posterior compartment to an often heavily calcified recipient vessel. Also, the abundant length of the VG allows for mobility and shortening. This prevents shortening of the flap artery which would lead to shortening of the pedicle and decrease of the diameter. This above-mentioned standard bypass vascular surgery technique and suture material is not our first choice for safe microsurgical flap anastomosis in this high-risk patient population. Here, we prefer an easily accessible and safe end-to-end flap anastomosis

to a healthy, uncalcified graft vessel at the surface with Nylon 9-0. Another alternative is an AV loop, where the flap artery and vein are anastomosed to VGs.[5] However, in patients with peripheral artery disease, the posterior tibial veins are typically not diseased and are suitable. Using an AV loop involves an increased number of VGs and VGs of longer length, thus increasing failure rates. Our grafts were harvested longer than necessary, usually around 8 cm, but were shortened as necessary to avoid kinking. They are significantly shorter than the VG needed to the popliteal vessels with an AV loop.[5] VG availability may also be limited in this patient population due to previous harvest for bypass surgery or vein stripping.

It remains elusive whether an end-to-side anastomosis of a free flap leads to a significant steal phenomenon at the recipient site.[6,7] In our case series, we did not encounter evidence for decreased peripheral circulation. However, the choice of the flap used might be more important in the development of a steal phenomenon than the size of the arteriotomy. Existing literature suggests that muscle flaps are associated more commonly with a steal phenomenon than fasciocutaneous flaps due to their lower vascular resistance and, thus, higher blood flow.[6–8]

The major limitations of our study are its retrospective design, small number of patients, and lack of a control group. Compared with other studies using VGs for lower extremity reconstruction, we report a similar limb salvage rate of 71% and an excellent 100% flap survival.[9,10] However, the small number of patients in our study does not allow any conclusions regarding superiority of the treatment.

CONCLUSIONS

The use of a mini VG to the peroneal artery in patients with only peroneal artery runoff is a safe and effective option for the treatment of medial defects in the distal leg with a free flap. This approach combines techniques commonly used in vascular surgery and free flap surgery and should be included in the armamentarium of microvascular surgeons performing complex lower extremity reconstruction.

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DISCLOSURE

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PATIENT CONSENT

All patients consented for participation in this study in accordance with institutional policies.

ETHICAL APPROVAL

All procedures performed in this study were in accordance with the ethical standards of the regional research committee and with the 1964 Declaration of Helsinki and its later amendments or comparable ethical standards. This retrospective cohort study was approved by the Cantonal Ethics Committee (EKNZ number 2023-00721).

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