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CASE REPORT
Reconstructive

Arteriovenous Vascular Loop Using a Bifurcated Greater Saphenous Vein

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Summary: High-energy lower limb trauma may result in complex defects with extensive vascular damage. Free flap reconstruction in these cases may require vein grafts to reach healthy proximal recipient vessels. Vascular loops are an increasingly popular technique in managing recipient vessels in reconstructive microsurgery, especially in the lower limb. The use of an entire omega segment of the greater saphenous vein had not been described before but offered two advantages: the caliber match for arterial repair was better using one of the limbs of the omega compared with the parent greater saphenous vein, and it allowed two venous anastomoses instead of one. A case report of a fully bifurcated segment of the greater saphenous vein as a vascular loop for microvascular reconstruction in the lower limb is presented. To the best of the authors' knowledge, no similar case has been reported previously. *(Plast Reconstr Surg Glob Open 2022;10:e4036; doi: 10.1097/GOX.0000000000004036; Published online 18 January 2022.)*

High-energy lower limb trauma may result in complex defects with extensive vascular damage. Free flap reconstruction in these cases may require vein grafts to reach healthy proximal recipient vessels. Vascular [or arteriovenous (AV)] loops have gained popularity as a convenient way of providing excellent quality recipient vessels close to the defect to be reconstructed. Vascular loops are optimized vein grafts that contribute to a safer and more flexible selection of the recipient vessels in microvascular reconstruction.[1–4] Vascular loops can be used as an acute, single-stage procedure or as a delayed, two-stage surgery in which the vascular loop is constructed in the first stage and used a few days later as the recipient for the free flap.[5,6]

The veins selected for vascular loops are usually large-caliber, named subcutaneous veins, most frequently the greater saphenous vein (GSV) in limb reconstruction and the cephalic vein in chest or head and neck cases. The constant anatomy of these named superficial veins favors their use as reversed grafts with two anastomoses or locally with one arterial anastomosis.[6]

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Significant anatomical variations of the GSV are rare. The most relevant anatomical variation with surgical implications is partial or complete duplication. Duplication reduces the caliber of either limb of the vein bifurcation and may make it unsuitable for bypass surgery.[7] The use of fully bifurcated, omega-shaped vein segments is not considered safe for arterial bypass surgery because of concerns of turbulence.[8,9]

CASE PRESENTATION

A 21-year-old male patient was treated for a Gustilo IIIc open tibial fracture. Temporary external fixation and revascularization were performed acutely. A free latissimus dorsi flap was performed for coverage after delimitation and necrosectomy on day 9, using the posterior tibial vessels end-to-side as recipients. Further skin necrosis over the distal calcaneal tendon developed and required a second free flap on day 20. A vascular loop was constructed using a segment of contralateral GSV. Due to a shortage of possible donor veins, a bifurcated, omega-shaped segment of the vein was used to construct a vascular loop (Fig. 1). The loop was anastomosed end-to-side to the tibioperoneal artery and vein. The loop was left under the previous latissimus dorsi flap for 24 hours because of turbulence concerns, causing an increased risk of thrombosis (Fig. 2). The following day, after checking the patency of the delayed AV loop, a free distal vastus lateralis flap was elevated and transferred. One artery and two venous anastomoses could be performed, using one proximal (arterial) limb and two distal (venous) limbs of the loop (Fig. 3). The postoperative evolution was uneventful.

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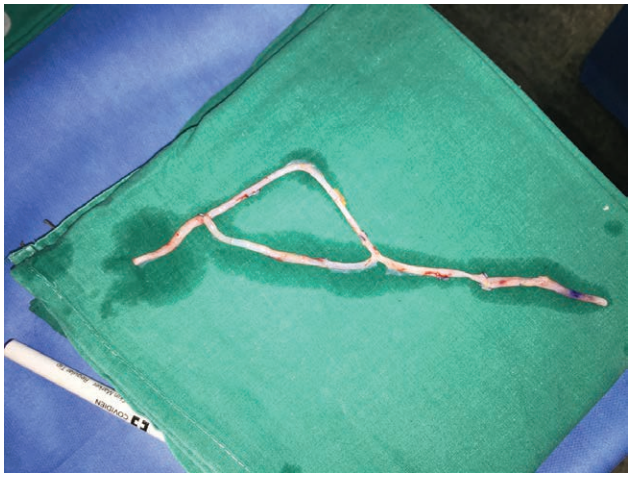

Fig. 1. The fully bifurcated segment of the GSV taken from the contralateral leg.

Fig. 2. The omega-shaped AV loop patent 24 hours after construction. The free vastus lateralis flap will be transferred to these recipient vessels. The double segment will serve to provide a smaller-caliber arterial limb and two venous limbs.

A free fibular flap was performed 2 months later for skeletal reconstruction, using the previous AV loop as the recipient for the end-to-side anastomoses of the fibular flap pedicle (Fig. 4). The patient is scheduled for posteromedial lengthening of the ankle for equinus deformity correction.

DISCUSSION

Vascular loops are an increasingly popular technique in managing recipient vessels in reconstructive microsurgery, especially in the lower limb. The use of single-stage AV loops does not increase the risk of failure of free flaps compared with direct-anastomoses without vein grafts, according to Momeni et al.[10] The advantages of AV loops have been well described in the literature, either as a single or a two-staged procedure.[5,6] The use of healthy vein grafts connected to healthy recipients is emphasized. Suboptimal vein grafts are to be avoided, except in extremely unfavorable cases. The literature seems to suggest a comparable result of one-stage versus two-stage AV loops, although the injury and patient pattern in which a two-stage procedure is chosen is a more unfavorable subset.[5,6] This would explain the remarkably higher complication and failure rate of two-stage AV loops reported by Lin et al.[11]

The author has been using AV loops for 25 years with overall encouraging results. The incidence of bifurcated GSV has been reported to be 2%–25%, depending on the diagnostic method.[12,13] Bifurcated vein segments have been classically avoided for AV loop constructs, due to concerns of turbulent flow or a drastic reduction of the distal caliber if one limb of the bifurcate vein is discarded. The lack of precedents of the use of partially duplicated GSV for AV loop construction and concerns of turbulence increasing the risk of thrombosis, led the author to use the AV loop as a staged procedure, allowing 24 hours to ascertain AV loop patency before free flap transfer. Although the literature seems to recommend longer intervals, it has been the author's experience that 24 hours is safe. The use of an entire omega segment of GSV had not been described before but offered two advantages. First, the caliber match for arterial repair was better using one of the limbs of the omega compared with the parent GSV, and second, it allowed two venous anastomoses instead of one (Fig. 4). However, the advantage of two versus one venous repairs in free flaps has never been demonstrated.

Depletion of usable veins due to trauma or prior use dictates second-choice donors. The lesser saphenous vein is a good alternative if uninjured; the cephalic and basilic veins are also good choices when not heavily punctured for IV access. The radial arteriovenous bundle is an excellent vascular construct when available, although the small caliber of the distal radial venae comitantes limit its use in certain free flaps. Scarred veins should be avoided at all cost. Orthoflow bifurcated veins are occasionally used for vein grafting, either arterial or venous defects. Full bifurcated, omega-shaped segments would theoretically be safe for vascular loop construction. The case reported herein seems to support this concept. Alternatives like radial composite AV bundles can be considered. AV bundles from the contralateral posterior tibial or anterior tibial should be avoided if the need for a free fibular flap is a real possibility because it would compromise two arteries in the contralateral, previously healthy leg.

In conclusion, although it is a single case report, the use of a fully bifurcated GSV does not preclude its use for AV loop construction in free flap reconstruction of the extremities. The advantage of allowing a smaller-caliber arterial limb and two venous limbs could be of some benefit.

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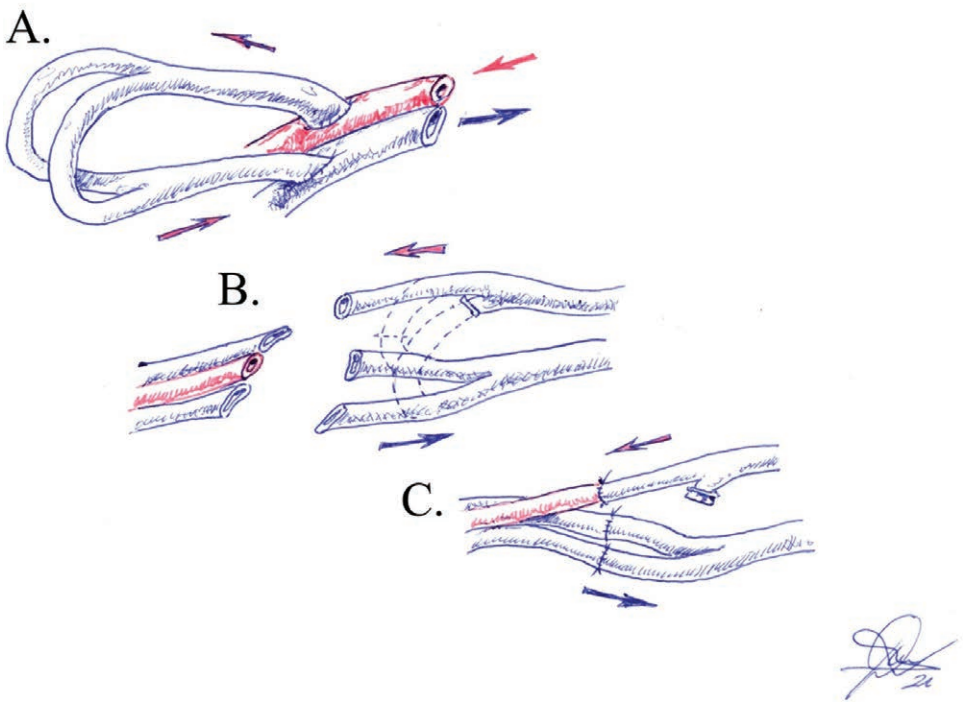

Fig. 3. Drawing of the vascular construct. A, the omega-shaped GSV vein graft anastomosed end-to-side to the tibioperoneal artery and vein. B, division of the AV loop 24 hours later. One limb of the arterial side of the loop was ligated short, and the other one was anastomosed end-to-end to the artery of the free flap. The two venous limbs of the divided AV loop were anastomosed end-to-end to the venae comitantes of the flap. C, completed anastomoses. The use of one limb of the arterial side of the AV loop allowed a better caliber match with the artery of the flap.

Fig. 4. The healed vastus lateralis over the heel region. Note the skin island of the subsequent free fibular flap connected end-to-side to the same loop later. Equinus deformity correction is still pending.

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