

Saphenous Vein Interposition Grafts in Lower Extremity Reconstruction: Appraisal of Technique and Case Series

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Summary: Vascular microanastomosis is technically challenging in patients with calcified recipient and donor vessels. Inside-to-outside suturing can prevent plaque rupture and ensure full-thickness intimal approximation. Although this is the preferred technique for anastomosis of atherosclerotic vessels, direct connection of calcified arteries necessitates outside-to-inside suturing on one side of the anastomosis. Furthermore, it is difficult to achieve optimal vessel wall approximation in the setting of luminal size mismatch and rigid vasculature. We previously reported on the use of a saphenous vein interposition graft as a novel technique to achieve a flow-sparing anastomosis in patients with diffuse atherosclerosis who are undergoing free tissue transfer. This study further assesses outcomes of this technique in a series of patients and demonstrates a flap success rate of over 93% in patients with calcified recipient and donor microvasculature. (*Plast Reconstr Surg Glob Open* 2022;10:e4536; doi: 10.1097/GOX.0000000000004536; Published online 23 September 2022.)

INTRODUCTION

Atherosclerotic disease is a risk factor for free flap failure in lower extremity (LE) reconstruction due to loss of vessel elasticity and propensity for thrombosis and occlusion secondary to luminal narrowing and plaque rupture.¹⁻³ In patients with severe atherosclerosis, there is often only a single vessel perfusing the extremity, necessitating end-to-side microvascular anastomosis to preserve distal perfusion. This can be technically challenging in patients with rigid atherosclerotic vessels; the lack of pliable tissue does not allow for optimal pedicle lay. Furthermore, inside-to-outside suturing, which can mitigate the risk of plaque rupture, is not possible when calcified vessels are encountered at both the recipient and donor vessels. Our group previously reported on the use of a saphenous vein interposition graft (SViG) to achieve flow-sparing microanastomosis during free tissue transfer (FTT) in patients with atherosclerotic recipient and

donor vessels.⁴ This case series further assesses outcomes of this technique.

PATIENTS AND METHODS

Patients undergoing LE FTT reconstruction by the senior author (K.K.E.) were retrospectively reviewed. Only patients with atherosclerotic recipient and donor vessels necessitating the use of an SViG were included. Primary outcomes of interest included flap outcomes, postoperative complications, and progression to amputation.

Surgical Technique

Achieving control of flow through the recipient vessel may be difficult in patients with diffusely calcified vasculature. It is typically not possible to achieve occlusion with standard microsurgery Bulldog clamps. Instead, we often prefer to use vascular clamps such as Satinsky or DeBakey clamps, but care should be taken to avoid vessel injury and/or plaque rupture.⁵

The saphenous vein graft is harvested via direct subcutaneous undermining anterior/proximal to the medial malleolus. A longitudinal slit arteriotomy corresponding in length to the diameter of the harvested vein graft is created at the recipient site using an angled ophthalmic knife. The distal end of the graft is inset in an end-to-side fashion, first securing the toe proximally with tapered 9-0 nylon in an inside-to-outside fashion. Sutures along the heel and sidewall are left long and tied sequentially to allow for precise placement under direct visualization. The proximal end of the graft is then divided at 2 cm and anastomosed to the calcified donor artery in an end-to-end fashion using the technique described above. Once patency of

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the anastomosis is confirmed, the hinged pedicle is carefully placed to avoid kinking and/or turbulent flow (Fig. 1).⁴

RESULTS

Fifteen patients were included (Table 1). The studied cohort had a mean Charlson Comorbidity Index of 5.2 ± 1.6 , corresponding to an estimated 10-year survival of less than 21%. All patients had a diagnosis of diabetes mellitus. Seven patients (46.7%) were current or previous smokers at the time of surgery.

Defect etiologies included diabetic wounds ($n = 9$) and chronic wounds due to arterial insufficiency ($n = 6$). Preoperative angiogram demonstrated three vessel run-off (VRO) in four patients (26.7%), two VRO in six patients (40.0%), one VRO in four patients (26.7%), and zero VRO in one patient (6.7%). Ten patients (66.7%) required endovascular intervention before definitive FTT reconstruction. Preoperative venous duplex imaging revealed deep venous thrombosis in one (6.7%) patient and venous reflux in 11 (73.3%) patients.

The most common free flap type was vastus lateralis (VL; $n = 7$, 46.7%). Other flap types included anterolateral thigh (ALT; $n = 6$, 40.0%) and chimeric ALT/VL ($n = 2$, 13.3%). Ischemia time was documented for 12 cases with a mean of 71.8 ± 32 minutes.



Fig. 1. All arterial anastomoses were performed in an end-to-end fashion between the flap artery and the proximal end of the saphenous vein interposition graft, followed by an end-to-side anastomosis between the distal end of the saphenous vein interposition graft and the recipient artery.

TAKEAWAYS

Question: Can a saphenous vein interposition graft (SViG) facilitate successful microanastomosis of calcified donor and recipient vessels in lower extremity free tissue transfer?

Findings: In this retrospective review of patients in whom an SViG was used to facilitate microanastomosis between calcified donor and recipient vessels, there was a free flap success rate of 93.3% and a limb salvage rate of 80%.

Meaning: These findings suggest that use of an SViG can expand the application of free tissue transfer for lower extremity reconstruction to patients who might otherwise be poor candidates for limb salvage.

Outcomes

Revision of arterial anastomosis during the index operation was required for one flap. There was one takeback on postoperative day (POD) 1 for venous anastomosis revision and the flap was successfully salvaged. One flap required emergent takeback on POD 5 due to arterial thrombosis and ultimately resulted in the only flap loss in this series, yielding a total flap success rate of 93.3%. Three patients ultimately progressed to amputation due to the development of new wounds or recurrent infection for an overall limb salvage rate of 80% at a mean follow-up of 13.7 months.

DISCUSSION

Microsurgical anastomosis of calcified vessels is challenging; the loss of vascular elasticity and compliance, luminal narrowing impeding visualization, risk of intimal separation with suturing, and rigid pedicle-kinking during inset all contribute to the increased risk of thrombosis and subsequent free flap failure. The pliability and length provided by an SViG mitigates some of these risks by allowing for optimal pedicle arrangement and extending pedicle length for a tension-free anastomosis. Furthermore, the SViG allows for enhanced visualization and accuracy of suture placement using the inside-to-outside suturing technique, reducing the risk of intimal separation and subsequent thrombosis and/or occlusion.

Our findings suggest that use of an SViG can provide a reliable flow-sparing alternative to conventional end-to-end anastomosis and end-to-side anastomosis. Kim et al⁶ investigated the utility of venous interposition grafts for end-to-side anastomoses of free flaps in the setting of calcified recipient vessels. In a series of 18 patients, the authors report flap survival and limb salvage rates comparable to the present series (83.3% vs 93.3% and 93.7% vs 80%, respectively). Notably, the authors harvested venous grafts from the cutaneous vein venae comitantes of the flap pedicle or recipient vessel rather than the saphenous vein. The greater saphenous vein is easily identifiable and has the added benefit of being in the same field, simplifying positioning in the operating room. It can be harvested as the flap is elevated, allowing for a two-team approach that does not add any significant operative time. Importantly, in

Table 1. Characteristics of Included Cases

Patient	Age (y)	Sex	CCI	DM	PVD	CKD	Wound Etiology	VRO Pre	VRO Post	Type of Flap	Recipient Vessel	Ischemia		Follow-up (mo)
												Time (min)	Flap Success	
1	49	F	5	Yes*	Yes	Yes	Arterial	1	1	VL	AT	114	Yes‡	15.8
2	72	M	5	Yes*	No	No	Diabetic	2	2	VL	AT	NR	Yes	33.7
3	75	M	8	Yes*	Yes	Yes	Arterial	0	1	ALT	AT	29	No§	8.1
4	60	M	5	Yes*	No	Yes	Diabetic	2	2	ALT	PT	90	Yes‡	20.3
5	59	M	2	Yes†	No	No	Diabetic	2	2	Chimeric (ALT + VL)	AT	86	Yes	0.4
6	58	M	5	Yes*	No	Yes	Diabetic	3	3	VL	AT	NR	Yes	14.0
7	73	M	8	Yes*	Yes	No	Arterial	3	3	VL	PT	35	Yes	3.7
8	68	M	4	Yes*	Yes	No	Arterial	2	2	VL	PT	52	Yes	12.1
9	54	M	6	Yes*	Yes	Yes	Diabetic	1	2	VL	PT	102	Yes	17.3
10	43	M	5	Yes*	Yes	Yes	Arterial	3	3	VL	AT	38	Yes	13.9
11	41	M	2	Yes*	No	No	Diabetic	3	3	ALT	PT	42	Yes	11.4
12	61	M	6	Yes*	Yes	No	Arterial	1	2	ALT	AT	120	Yes	0.7
13	79	M	6	Yes*	Yes	No	Diabetic	1	2	Chimeric (ALT + VL)	PT	82	Yes	0.5
14	61	M	6	Yes*	Yes	No	Diabetic	2	3	ALT	PT	71	Yes	2.1
15	70	F	4	Yes*	No	No	Diabetic	2	2	ALT	AT	NR	Yes	0.7

*DM with end-organ damage.

†Uncomplicated DM.

‡Ultimately required amputation due to the development of new wounds or recurrent infection (not due to flap failure).

§Required takeback on POD 5 for arterial thrombus.

||Required revision of arterial anastomosis during index operation.

CCI, Charlson comorbidity index; CKD, chronic kidney disease; DM, diabetes mellitus; PVD, peripheral vascular disease.

our study, the SViG was performed in instances where *both* the recipient and donor vessels were noted to be severely atherosclerotic. Our findings build upon those reported by Kim et al and suggest that venous interposition grafts can be used as a reliable conduit in the setting of diffuse calcific disease.

Despite concerns that vein grafts may increase the incidence of free flap thrombosis,^{2,7} several studies have demonstrated that using vein grafts may not compromise overall flap success rates.^{7,8} In this case series, arterial thrombosis leading to flap failure occurred in only one patient. The flap success rate and limb salvage rates in this series suggest that the possible risk of thrombosis posed by venous grafts should not preclude the use of this technique. This case series is inherently limited by its retrospective design and lack of a control group, but our findings demonstrate the potential benefits of this technique.

CONCLUSIONS

The incorporation of a pliable SViG provides a reliable flow-sparing alternative to conventional end-to-side anastomosis, facilitates inside-to-outside suturing, and allows for favorable pedicle arrangement in patients with diffuse atherosclerotic disease. With a success rate of over 93%, this technique expands the application of FTT for LE reconstruction to patients who might otherwise be deemed poor candidates for limb salvage.

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