

A novel approach of arteriovenous fistula formation in cultivation of an arm vein for use in infrainguinal surgical bypass grafting

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Autologous vein is preferable for use in lower limb arterial bypass rather than synthetic graft material. Suitable vein for grafting is often limited, particularly in patients who have had previous cardiac bypass grafting or varicose veins surgery. This case report describes the use of arteriovenous fistula formation to cultivate an arm vein of a suitable diameter for use in femorotibial bypassing. (*J Vasc Surg Cases* 2015;1:184-6.)

Autologous vein is preferable for use in lower limb arterial bypass rather than synthetic graft material. Suitable vein for grafting is often limited, particularly in patients who have had previous cardiac bypass grafting or varicose veins surgery. We describe a patient in whom we formed an arteriovenous fistula (AVF) to cultivate an arm vein of a suitable diameter for use in femorotibial bypassing. The patient provided informed consent to publish this case report.

CASE REPORT

A 70-year-old woman presented to the vascular outpatient clinic with symptoms of left lower limb rest pain and nonhealing ulcers with recurrent infections. Her medical history included hypertension, hypercholesterolemia, myocardial infarction, and smoking. She had previously undergone stripping of the left great saphenous vein (GSV) and avulsions.

As part of the initial workup, a computed tomography angiogram showed occlusion of the left superficial femoral artery at the level of the adductor canal and knee popliteal disease, with collaterals filling via the profunda. The angiogram confirmed that although there was arterial disease, the anterior tibial artery still provided in-line perfusion to the pedal circulation, making it the only suitable target for surgery. A femorotibial bypass was subsequently planned.

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Author conflict of interest: none.

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The editors and reviewers of this article have no relevant financial relationships to disclose per the Journal policy that requires reviewers to decline review of any manuscript for which they may have a conflict of interest.

2352-667X

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<http://dx.doi.org/10.1016/j.jvsc.2015.04.002>

The preoperative assessment found severe aortic stenosis. After a coronary angiogram, triple-vessel coronary artery bypass grafting and tissue aortic valve replacement were performed. Harvested right GSV was used after the radial artery was deemed unsuitable.

On review after cardiac optimization, she had ongoing lower leg bilateral ulcers, lower limb rest pain, and further infections. Vein mapping showed only small-caliber vessels in the upper limbs and no usable residual veins in the lower limbs.

A multidisciplinary discussion concluded that this patient would be at a high risk of infection should synthetic graft be used. Interventional radiology successfully performed angioplasty of the popliteal and anterior tibial artery through retrograde dorsalis pedis access; however, attempts to reopen the superficial femoral artery were unsuccessful. A further attempt with a subintimal approach was also ineffective.

With limited options available, it was suggested that bilateral radiocephalic fistulae could be used to improve the caliber of the arm veins. Bilateral AVF formation was performed under local anesthetic. Duplex scanning 32 days postoperatively showed an increase in diameters of the veins by up to 6 mm: the cephalic vein diameters increased from 2 mm bilaterally to 4 to 8 mm below the elbow and to 3 to 4 mm above the elbow, and the basilic vein increased from 2.5 to 5 mm above the elbow. Performing a femoroanterior tibial bypass using arm vein in addition to common femoral endarterectomy was now possible.

Despite a greater increase in diameter of the cephalic veins, the basilic veins were also used due to the uniform increase in diameter and better flow. The entire left cephalic and basilic veins were harvested and spliced (each segment reversed appropriately), thus creating a graft of sufficient length to reach the intended target vessel. A completion angiogram showed good flow in the graft, with a palpable dorsalis pedis pulse.

After a prolonged hypotensive period on the intensive care unit, the dorsalis pedis pulse was no longer be audible on Doppler. On return to the operating theater, a graft embolectomy was performed (early graft thrombosis being likely due to the period of sustained hypotension). The vein graft was then taken down, respliced, and retunnelled. A completion angiogram showed good flow within the graft. The patient was discharged on day 16 postoperatively because of an ongoing physiotherapy requirement.

On review at day 59 there was good granulation tissue formation over the left medial malleolus ulcer, with a decrease in diameter of ~50%. In addition, the patient was mobilizing well, with relief of her rest pain. Unfortunately, 6 months postoperatively and after loss to follow-up, the patient presented with graft occlusion, manifest as a claudication distance of 90 m.

DISCUSSION

Ipsilateral GSV remains the conduit of choice for infrainguinal bypass due to its length and superior patency rates.^{1,2} Autologous saphenous veins have reported secondary patency rates ranging from 86% to 93%^{3,4} at 3 years and from 74.4% to 86%^{3,5} at 5 years.

GSV availability is often limited due to previous cardiac bypass grafting, varicose vein treatment, or concurrent lower limb deep vein thrombosis.⁶ Other conduit options for femoropopliteal revascularization include arm vein, autologous composite vein, or prosthetic grafts.

Autologous arm veins have secondary patency rates of 70.3% at 3 years and 57.5% at 5 years.⁷ Secondary patency rates for human umbilical vein are 29% at 3 years⁸ and 57% to 76% at 5 years.^{9,10} Arterial cadaveric allografts have 3-year secondary patency rates of 42.1% compared with 25.9% at 5 years.¹¹ The 1-year secondary patency rate for cryopreserved vein allografts from cadavers is 42%.¹² Use of cadaveric grafts is further complicated by their high price and reduced length, thus limiting their applicability for lower limb bypass.

A Cochrane review¹³ concluded that autologous vein grafts achieved improved patency compared with synthetic materials for above-knee bypasses but the patency of prosthetic grafts is variable. Secondary patency rates for polytetrafluoroethylene are between 54% and 75% at 3 years^{14,15} and between 36% and 84.1% at 5 years.^{16,17} Dacron (DuPont, Wilmington, Del) has secondary patency ranging from 53% to 81%^{14,15} at 3 years and from 47% to 83.8% at 5 years.^{16,17}

The global increase in vein diameter by up to 3 mm in this patient is consistent with those found in a prospective cross-sectional study of hemodialysis patients.¹⁸ In those with a distal radiocephalic AVF, mean diameter of the vein was 2.05 mm compared with 3 mm in an antecubital AVF. In bypass studies, autogenous composite and GSV diameter criteria included a minimum diameter of 3.5 to 4 mm.^{2,6} Human umbilical vein grafts used a diameter of 5 or 6 mm,¹⁰ in contrast to 6 or 8 mm for Dacron or polytetrafluoroethylene.^{15,16}

Prosthetic graft infection is a consideration. Siracuse et al¹⁹ identified a graft infection rate of 3.8% at 27 months of follow-up associated with a major lower extremity amputation hazard ratio of 9.8. No significant difference was found among prosthetic graft materials, although redo bypass, female gender, and active infection at the time of bypass were all associated with a higher risk.

Use of autologous GSV as a graft was prevented in this patient due to prior coronary artery bypass grafting and treatment of varicosities. In addition, the presence of ulcers raised concerns regarding infection risk if synthetic grafts

were used, although the extent of infection risk remains unclear. The multidisciplinary team therefore adopted a novel management approach. Despite occlusion of the graft 6 months postoperatively, this innovative procedure indicates technical feasibility in a patient whose first-line treatment options were extremely limited.

The use of AVF formation for means of arm vein cultivation represents a novel approach for overcoming this problem. Arterialization of the veins provided a bypass graft of sufficient length and diameter and created a vessel that was easier to handle intraoperatively. In addition, the patient was provided with good symptomatic relief. The creation of bilateral AVFs provides a future option for revascularization of the right lower limb by using vein from the left AVF. We believe this option should be considered only when prosthetic or other allograft options are not available. There are no data currently on the optimal caliber that can be used from an AVF, with the theoretical risk that use of too large a caliber might lead to occlusion from a mural thrombus. We also believe that this is an inferior option for those with foot ulcers, because a delay in revascularization for >1 month, which is the time taken for the vein caliber to augment after AVF, has been suggested to risk limb loss.²⁰

Associated data on outcome and patency rates for this approach are lacking and a necessary focus for long-term follow up. In addition, successful implementation, as with this patient, relies heavily on multidisciplinary and interspecialty cooperation.

CONCLUSIONS

This case represents the use of a novel technique to overcome a common vascular scenario. It provides a further option to the use of prosthetic grafts in patients with insubstantial or absent vein for lower limb bypass. This is in the absence of other case reports to adequately assess patency rates and long-term outcomes and in light of limitations of the study.

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Submitted Jan 30, 2015; accepted Apr 16, 2015.