ORIGINAL ARTICLE

An aggressive policy of bilateral saphenous vein harvest for infragenicular revascularisation in the era of multidrug resistant bacteria

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Background: The success of infragenicular revascularisation for lower limb ischaemia is limited by the high proportion of patients without ipsilateral long saphenous vein (LSV) of adequate length or quality. The aim of this study was to report the results of an autogenous vein only policy for infragenicular revascularisation utilising contralateral LSV when ipsilateral LSV is inadequate. The treatment and outcome of infection of autogenous grafts with methicillin resistant *Staphylococcus aureus* (MRSA) is also reported.

Patients and methods: The vascular audit database and patient case notes were reviewed retrospectively for patients with arterial occlusive disease requiring infragenicular reconstruction. There were 68 critically ischaemic legs in 65 patients of whom 48 were male: median age (range) 74 years (41-94), over a three year period.

Results: Thirty six patients (53%) underwent revascularisation (eight infragenicular femoropopliteal bypass, 28 femorodistal), 24 (35%) underwent primary amputation and a further eight (12%) were found to have unsuitable distal vessels for revascularisation after tibial vessel exploration and intraoperative angiography. Thirty three grafts (92%) utilised LSV and three (8%) were polytetrafluoroethylene grafts. Thirteen patients (39%) lacked adequate ipsilateral LSV of whom 12 had the contralateral leg explored providing suitable LSV in 10/12 (83%). Contralateral LSV was used as a single length conduit in two cases and as a venovenous composite graft in eight cases. Primary, primary assisted, and secondary patency rates at two years were 38%, 77%, and 81% respectively. Actuarial limb survival and patient survival rates at two years were 86% and 61% respectively. Eleven patients developed ipsilateral wound complications (30%) including seven (21%) who developed MRSA infection of the ipsilateral leg wound. MRSA wound infection was treated successfully in all cases by antibiotic therapy (intravenous vancomycin). No patient subsequently required saphenous vein harvesting for a secondary reconstruction or coronary artery bypass graft.

Conclusion: Excellent long term results can be achieved using autogenous vein for infragenicular revascularisation and the contralateral LSV is an excellent alternative in the absence of suitable ipsilateral LSV. Autogenous vein may confer some protection against severe complications observed with MRSA infection seen in vascular patients and therefore its use is recommended.

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Over the past two decades, bypass grafts to the infragenicular arteries have been shown to be effective in the management of patients with chronic critical limb ischaemia with secondary patency rates and limb salvage rates of 45%-64% and 54%-84% respectively at three years.¹⁻³ Several factors have been identified which determine the success of the procedure, including the preferential use of long saphenous vein (LSV) as a bypass conduit,⁴ the use of intraoperative digital subtraction angiography (DSA)⁵ to identify a suitable distal vessel, and effective postoperative graft surveillance.⁶

The success of infragenicular revascularisation is, however, limited by several factors one of which is the high proportion of patients without LSV of adequate length or quality. Autogenous vein is unavailable or inadequate in 15%-30% of patients undergoing primary revascularisation and as many as 50% having secondary procedures.⁷⁻¹¹ Alternatives in the absence of adequate ipsilateral LSV include polytetrafluoroethylene (PTFE) grafts either as a composite with autogenous vein,⁷⁻¹⁰ combined with an adjuvant venous cuff, and/or a distal arteriovenous fistula at the distal anastomosis¹²⁻¹³ or autogenous vein from other sites. Vein from alternative sites such as the contralateral leg, short saphenous vein, arm veins, and/or short distal bypasses may be used with good long term results,⁹⁻¹⁰⁻¹⁴⁻¹⁶ although they are inferior to ipsilateral LSVs in

the long term and reported patency rates approach those reported for PTFE grafts with vein cuff or patch or composite grafts at 3-5 years.⁹⁻¹⁰⁻¹⁷⁻¹⁸ An additional argument against the use of alternative sites of autogenous vein is the depletion of suitable vein for further distal revascularisation or coronary artery bypass grafting should it become required. A new consideration, however, in the field of vascular surgery is the increasing incidence of methicillin resistant *Staphylococcus aureus* (MRSA) infection.¹⁹ In vascular surgery, MRSA infection has a high morbidity (including limb loss), and mortality particularly if prosthetic material is used²⁰ and autogenous vein may offer some protection against major complications such as anastomotic bleeding or graft excision.²⁰

The purpose of this paper is to report our experience with an aggressive autogenous vein policy for infragenicular bypass grafting (see fig 1), utilising the contralateral LSV where necessary to achieve revascularisation. The outcome in terms of graft patency, patient survival, outcome of MRSA infection,

Abbreviations: DSA, digital subtraction angiography; LSV, long saphenous vein; MRSA, methicillin resistant *Staphylococcus aureus*; PTFE, polytetrafluoroethylene

Figure 1 Aggressive autogenous vein policy for infragenicular revascularisation (LSV, long saphenous vein; PTFE, polytetrafluoroethylene).

and subsequent requirements for contralateral saphenous vein is discussed in relation to other published observations.

PATIENTS AND METHODS

Preoperative assessment

A consecutive series of patients who presented with femoropopliteal arterial occlusive extending to the infragenicular level and critical limb ischaemia in lower limbs over a 36 month period were reviewed. There were 68 critically ischaemic legs in 65 patients of whom 48 were male: median age (range) 74 years (41–94). Follow up was complete; however, two patients opted not to enter a graft surveillance programme. For the purposes of the study critical limb ischaemia was defined as ischaemia threatening the whole or part of the leg.²¹ An aggressive approach to revascularisation was followed and all patients were assessed preoperatively using an 8 MHz Doppler velocimeter to measure the ankle systolic pressure and the ankle brachial pressure index. Preoperative DSA was performed in 67 cases and in one patient colour duplex imaging was the sole means of imaging the distal run off preoperatively. If preoperative DSA was of poor quality or failed to image distal vessels, the patient underwent operative exploration and an intraoperative DSA. Preoperative duplex ultrasound assessment of the LSVs was not performed routinely.

Operative technique

The most suitable vessel for the distal anastomosis, as predicted by the preoperative assessment, was explored and an intraoperative DSA performed via this vessel to confirm its patency and to exclude significant downstream stenosis. If a distal stenosis was demonstrated a more distal site or an alternative vessel was explored to locate a suitable site for the distal anastomosis.

Table 1 Patient details and presentation (values are number (%) unless otherwise stated)

	Attempted revascularisation	Primary amputation	Total
Total number of limbs	44	24	68
Median (range) age	77 (51–94)	72 (41–87)	74 (41–94)
Male	33 (75)	15 (63)	48 (71)
Elective	4 (9)	1 (5)	5 (7)
Urgent	25 (57)	15 (63)	40 (59)
Emergency	15 (34)	8 (33)	23 (34)
Rest pain	32 (73)	15 (63)	47 (69)
Ulcer	27 (61)	17 (71)	44 (65)
Gangrene	10 (23)	9 (38)	19 (28)
Diabetes	18 (41)	17 (71)	35 (51)
Hypertension	19 (43)	10 (42)	29 (43)
Ischaemic heart disease	28 (64)	20 (84)	48 (71)
Smoker			
Ex	19 (43)	10 (42)	29 (43)
Current	15 (34)	6 (25)	21 (31)
Never	10 (23)	8 (33)	18 (26)
Cerebrovascular accident	8 (18)	4 (17)	12 (18)
Chronic renal failure	7 (16)	10 (42)	17 (25)
Previous vascular surgery	2 (5)	0	2 (3)

The majority of vein grafts were reversed LSV grafts from the ipsilateral limb. If the ipsilateral LSV was unsuitable, or of insufficient length, additional vein was harvested from the contralateral lower limb. Whenever the length of conduit available in a single length of vein was insufficient to complete the bypass procedure two or more lengths of vein were anastomosed end to end to achieve the required length. All venovenous anastomoses were spatulated and performed using continuous 7.0 polypropylene suture. In the absence of suitable LSV from either limb a PTFE graft was used with a distal vein cuff in preference to vein from other sites. Completion assessment of the vein bypass was performed by completion DSA.

Postoperative follow up

Postoperatively all grafts were assessed hourly by a combination of clinical inspection of the revascularised limb and auscultation over the graft with a Doppler device for 24 hours. All vein grafts were entered into a graft surveillance programme and examined using duplex ultrasound scanning during the first postoperative year at six weeks, three months, six months, nine months, and 12 months. Thereafter grafts were examined annually. Doppler assessments were performed using an Acuson duplex scanner (Aspen, CA, USA) to identify changes in peak systolic velocity as described by Grigg *et al.*²² Conventional arteriography was performed if the duplex revealed a segmental peak velocity ratio >3, and all graft stenoses were initially treated by percutaneous transluminal angioplasty.

Statistical analysis

Graft patency is reported according to the recommendations of the ad hoc committee of the Society for Vascular Surgery.²³ Primary graft patency is defined as uninterrupted patency with no procedures performed on the graft or its anastomoses. Primary assisted patency is defined as uninterrupted patency but allows procedures performed on a still patent graft to prevent subsequent thrombosis. Secondary patency requires that flow is restored through most of the original graft, including at least one of its original anastomoses. Actuarial patency curves (Kaplan-Meier) and life tables were computed using SPSS for Windows 8.0 (Chertsey, UK).

RESULTS

Of 68 patients with critical limb ischaemia secondary to infragenicular arterial occlusive disease, 24 (35%) underwent

Table 2 Details of proximal and distal anastomoses for all autogenous vein bypass grafts (n=36)

Proximal anastomoses	Distal anastomoses				
	Below knee popliteal	Tibioperoneal trunk	Anterior tibial	Posterior tibial	Peroneal
Common femoral	8 (2)		5 (2)*	4	8 (3)
Profunda femoris					1
Superficial femoral (origin)			2*	5 (1)	1
Superficial femoral (mid-thigh)				1	
Above knee popliteal					1

Figures in parentheses represent number of venovenous composite grafts in each group.

*Indicates a reversed contralateral long saphenous vein graft without venovenotomy.

primary amputation, and 44 (65%) underwent attempted revascularisation. Of these 44 cases, 36 (82%) were successful (eight infragenicular femoropopliteal bypass, 28 femorodistal) and eight (18%) were found to have unsuitable distal vessels for revascularisation after vessel exploration and intraoperative DSA. Of these eight patients, two died in the postoperative period and six proceeded to amputation. Indications for primary amputation included: unreconstructable vessels on preoperative assessment (n=10; 42%), extensive tissue necrosis involving weight bearing areas of the foot (n=15; 63%), and patient comorbidity (n=8; 25%). The prevalence of risk factors for peripheral vascular disease, patient presentation, and patient demographics are shown in table 1.

Of 36 reconstructions, 33 (92%) utilised LSV and three (8%) were PTFE grafts. Thirteen patients (39%) lacked adequate LSV in the ipsilateral limb. This was because of inadequate vein diameter distally (n=9), a poorly developed long saphenous system (n=2), and previous harvesting for vascular reconstruction (n=2). Of these, 12 had the contralateral lower limb explored for LSV and one with a poor saphenous vein in the ipsilateral leg had a PTFE femorodistal graft with a vein collar. Of the 12 contralateral legs explored, 10 (83%) provided suitable autogenous vein and another two without suitable LSV in either lower limb had PTFE grafts with vein collars at the distal anastomosis (one femorodistal, one femoropop-

liteal). Contralateral LSV was used as a single length conduit in two cases and as a venovenous composite graft in eight cases. Sites of proximal and distal anastomoses are demonstrated in table 2.

Actuarial graft patency, limb salvage, and patient survival rates for autogenous grafts are shown in figs 2 and 3. Primary, primary assisted, and secondary patency rates at two years were 38%, 77%, and 81% respectively. Actuarial limb survival and patient survival rates at two years were 86% and 61% respectively. There was no significant difference in graft secondary patency or limb survival (both 100% v 89%, p=0.27 log rank, SE <0.1) at one year in patients who underwent grafting with contralateral vein and those who underwent grafting with ipsilateral vein only, respectively.

Morbidity and mortality

Complications occurred in 25 cases after revascularisation (70%) and major complications included: in-hospital mortality, n=7; re-exploration for bleeding, n=2; graft thrombosis, n=5 (PTFE two, vein three); limb amputation, n=5 (all above knee) due to graft thrombosis (n=4), and progressive tissue loss (n=1) despite a patent graft. Ten patients with patent vein grafts (30%) developed stenosis in the graft (n=6) or outflow vessel distal to the anastomosis (n=4), requiring percutaneous transluminal angioplasty. This including three venovenous composite grafts, all of which were located in an

Time	0	0.5	1	1.5	2
Primary patency	31	17	12	5	4
Primary assisted patency	31	18	18	9	6
Secondary patency	31	19	18	9	6

Figure 2 Cumulative graft patency curves for autogenous vein grafts demonstrating primary (squares), primary assisted (circles), and secondary (triangles) graft patency. Numbers of patients entering each time interval are demonstrated in the table below.

Time	0	0.5	1	1.5	2
Limb survival	33	22	22	15	10
Patient survival	33	24	24	16	12

Figure 3 Cumulative survival curves for patients with autogenous LSV grafts demonstrating limb (crosses) and patient (triangles) survival. Numbers of patients entering each time interval are demonstrated in the life tables below.

area of the graft other than the venovenotomy. Two PTFE grafts eventually thrombosed despite revision. One vein graft underwent two revisions after unsuccessful angioplasty of a proximal vein graft stenosis.

Eleven patients developed ipsilateral wound complications (30%) including seven (21%) who developed MRSA infection of the ipsilateral leg wound. MRSA wound infection was treated successfully in all cases by antibiotic therapy (intravenous vancomycin) and limited wound debridement performed on the ward. Two patients developed a wound infection in the contralateral wound (18%) leading to amputation (below knee) in one patient for persistent leg wound sepsis.

No patient subsequently required saphenous vein harvesting for a secondary or contralateral reconstruction or for coronary artery bypass grafting.

DISCUSSION

The results from this small study demonstrate that excellent rates of limb salvage can be achieved with an aggressive policy of bilateral LSV harvest for infragenicular revascularisation. These results are comparable to others reported in the literature for femorodistal revascularisation using autogenous vein. Beard *et al* reported secondary patency, limb salvage, and patient survival rates of 72%, 77%, and 83% respectively at two years,²⁴ while others report three year primary and secondary patency rates for femorodistal autogenous grafts of 29%–55% and 55%–64% respectively.^{1–3, 25} These results are also superior to series where PTFE grafts (including composite, distal vein cuff, patches, and collars) are used when ipsilateral LSV was inadequate.^{2, 3}

Overall a smaller proportion of patients underwent revascularisation (53%) than in other studies (75%–77%^{1, 2}) and those who underwent successful revascularisation had a higher mortality (62% patient survival at two years versus 77% at two years²⁴ and 75% at three years¹) than that reported by others. In particular the in-hospital mortality after revascularisation in this report was 16%, although this may represent the high proportion of patients with diabetes (40%) and/or renal failure (16%) in the operated group both of which are associated with poor survival (48% and 18% respectively at three years).^{26, 27} Another factor contributing to these results is that figures quoted include eight below knee femoropopliteal reconstructions. In spite of this, however, they suggest that a large proportion of patients undergoing infragenicular reconstruction survive with excellent long term limb survival and graft patency.

Contralateral LSV was chosen due to its superiority as an alternative conduit in comparison with other autogenous sources in the longer term (Donaldson *et al* report 49% two year⁹ and Abbott *et al* 40% three year¹⁷ secondary patency for non-LSV autogenous grafts). In the current study there was no difference in secondary graft patency and limb survival between legs grafted with contralateral or ipsilateral only LSV. The ipsilateral LSV was unsuitable in 39% of patients undergoing revascularisation, consistent with other reports (15%–45%),^{8–10} and the contralateral leg provided a suitable LSV in 83% of cases where the ipsilateral LSV was inadequate. These results are, however, tempered by potentially increased morbidity associated with the second leg wound. Patient numbers were too small to permit meaningful comparison of morbidity; however, one patient died due to MRSA infection in a contralateral leg wound. Twenty one per cent of autogenous grafts in this series comprised venovenous composite grafts and no patients developed an anastomotic stricture at the venovenostomy presumably reflecting the spatulated technique used in all cases. Venovenous composite grafts have excellent reported long term patency (two year secondary patency rates of 62%–83%^{2, 8, 9}) and the presence of a venovenostomy is not associated with reduced patency compared with reversed vein without venovenostomy.²

No patient subsequently required harvesting of the contralateral LSV for coronary or peripheral revascularisation. This is due to several reasons. Firstly, the excellent long term patency rates for all autogenous infragenicular grafts in the presence of effective graft surveillance will limit the number of patients requiring revision or a secondary procedure. Secondly, few patients proceed to bilateral bypass grafts and finally, the low cumulative survival of these patients, presumably due to the complications of coronary atherosclerosis, reduces the potential numbers surviving long enough to have problems with their vein graft or contralateral leg. Furthermore the argument for preserving vein for coronary grafting no longer holds merit. Popularisation of coronary grafting with the internal mammary and radial arteries has reduced demand for saphenous vein and very few vascular patients proceed to coronary bypass.²⁸ Studies have indicated that the incidence of coronary bypass after distal revascularisation ranges from 5.4%–5.8%^{28, 29} and that no vein is available as a result of previous use in infrainguinal reconstruction in 0%–0.4% of patient who require coronary operation.^{28, 30}

MRSA wound infection occurred in 21% of all autogenous reconstructions in this study, reflecting the increase in MRSA generally¹⁹ and the emergence of MRSA as a major problem in vascular patients. Previous reports of MRSA infection in vascular patients²⁰ have highlighted the risk of fatal haemorrhage, amputation, and death associated with MRSA infection in prosthetic grafts used for distal revascularisation. No such complications were observed in this study with autogenous tissue and, despite isolated reports in the literature of similar complications occurring with autogenous vein,³¹ it may be that native tissue confers some protection against serious complications in the presence of this organism. Infection control, however, remains the mainstay of strategies designed to reduce MRSA related morbidity. MRSA transmission occurs primarily from colonised or infected patients to other patients via the hands of healthcare personnel,³² therefore we see education of staff on the need for hand washing and the use of protective aprons and gloves when handling MRSA patients as more important. This is particularly so given the emergence of vancomycin resistant strains of MRSA in Japan and the USA.³³

In summary this report suggests that in the absence of suitable ipsilateral LSV the contralateral LSV provides suitable vein in a large proportion of patients and is associated with excellent patency and low morbidity. In addition MRSA wound infection in the presence of autogenous was not associated with major complications and for these reasons its use is recommended as an alternative to prosthetic grafts or non-LSV venovenous composite grafts.

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