Outcomes of cold-stored venous allograft for below-knee bypasses in patients with critical limb ischemia

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Objective: **Critical limb ischemia (CLI), the most advanced form of peripheral arterial disease, is associated with strikingly high morbidity and mortality rates. Autogenous single-segment great saphenous vein (GSV) remains the optimal conduit for infrainguinal revascularization. Unfortunately, GSV is unavailable in up to 20% of patients. There is no consensus about the alternative graft that should be used for infragenicular bypass grafting when the GSV is unavailable. Currently, there are no outcome data for cold-stored venous allograft use in regard to recent safety and efficacy objective performance goals described by the Society for Vascular Surgery.**

Methods: **This is a retrospective analysis of 118 infragenicular revascularizations performed for CLI with cold-stored venous allografts obtained from varicose vein stripping surgery in a single institution from November 2002 to August 2013.**

Results: **Mean age (± standard deviation) was 75 ± 12 years (male, 76%; diabetes, 73%; dialysis, 16%), and 38% (n = 45) had a history of failed ipsilateral revascularization. None had suitable autogenous conduit for even composite vein bypass. The distal anastomosis was performed to an infrapopliteal artery in 85 cases (72%). At 30 days, perioperative death rate was 6.8%, major adverse cardiovascular event rate was 7.6%, and major adverse limb event rate was 11.9%. Mean follow-up was 34 ± 29 months (range, 1-113 months). At 1 year, freedom from major adverse limb event or perioperative death, limb salvage, survival, amputation-free survival, and secondary patency rates were, respectively, 64.9%, 82.5%, 85.4%, 73.3%, and 58.3%. Ejection fraction <45% and dialysis were the most significant factors predicting failure of revascularization.**

Conclusions: **Cold-stored venous allografts may be used for performing infragenicular revascularization for CLI with acceptable safety and efficacy results despite poor long-term patency. Their level of performance remains inferior to autologous vein sources but seems comparable to alternative allografts or prosthetic conduit. Their availability is a major advantage compared with other biologic alternative sources. (J Vasc Surg 2015;62:974-83.)**

Critical limb ischemia (CLI) remains a challenging issue for vascular surgeons. The prognosis for patients with CLI is poor. At 1 year after initial presentation, up to 25% of patients will require major amputation and up to 25% will die.[1] In >50% of the cases, arterial lesions are located below the knee.[2] For limb loss to be avoided, a multidisciplinary approach is recommended by the TransAtlantic Inter-Society Consensus (TASC) II guidelines.[1] Revascularization is the optimal treatment for CLI patients. Endovascular therapy is recommended for TASC A or B lesions and for patients deemed at high operative risk. Bypass therapy using autologous great saphenous vein (GSV) remains the revascularization strategy of choice for TASC C or D lesions, achieving a high limb salvage rate and proper long-term patency. Unfortunately, up to 45% of patients with CLI will have no GSV or an unsuitable vein for vascular reconstruction.[3,4] The use of a prosthetic graft to an infragenicu-late artery is associated with poor limb salvage and patency rates and a high risk of infection because of the presence of ulceration or gangrene.[5] In such circumstances, alternative autologous conduits had been proposed, such as an arm vein,[6] lesser saphenous vein,[7] or composite conduit.[8] In addition, various allogeneic materials, such as cryopreserved venous[9] and arterial[10] allografts, had been evaluated. However, reported patency and limb salvage rates are still lower than those achieved with autologous GSV, but these conduits remain an alternative for limb salvage when autologous GSV is unavailable.

Cryopreserved vessel allografts are one of the favorite biologic alternative conduits, but specific complications have been reported, such as aneurysmal degeneration and intimal lesions.[9] These allografts were obtained in most series from donors as part of the multiple-organ harvesting program, and availability of allografts remains an issue. Cold-stored venous allografts can be an alternative to

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Table I. Patient demographics

Age, years	75 ± 12
Age ≥65 years	94 (80)
Age ≥80 years	49 (42)
Male sex	76 (64)
Smokers	51 (43)
Hypertension	76 (64)
Diabetes	73 (62)
Dyslipidemia	60 (51)
Coronary artery disease	38 (32)
Ejection fraction <45%	21 (18)
Stroke	21 (18)
Renal insufficiency	30 (25)
Dialysis	16 (14)
COPD	11 (9)
Neoplasia	14 (12)
Previous anticoagulant therapy	19 (16)
Statins	55 (47)

COPD, Chronic obstructive pulmonary disease.
Continuous data are shown as mean ± standard derivation and categorical data as number (%).

Table II. Infrapopliteal artery patency

No. of patent infrapopliteal vessels	*No.*	*%*
3	13	11.0
2	26	22.0
1	78	66.1
0	1	0.9

Table III. Bypass anastomosis sites

	No.	*%*
Proximal anastomosis		
Iliac artery	1	0.8
Common femoral artery	98	83.1
Superficial femoral artery	11	9.3
Above-knee popliteal artery	2	1.7
Below-knee popliteal artery	6	5.1
Distal anastomosis		
Below-knee popliteal artery	33	28.0
Tibioperoneal trunk	3	2.5
Anterior tibial artery	29	24.6
Posterior tibial artery	27	22.9
Peroneal artery	25	21.2
Pedal artery	1	0.8

Table IV. Safety outcomes at 30 days

Outcome	*30-day event, % (95% CI)*
MACE	7.6 (3.5-14.0)
Death	6.8
MI	0.8
CVA	0
MALE	11.9 (6.6-19.1)
Above-ankle amputation	2.5 (0.5-7.3)

CI, Confidence interval; *CVA,* cerebrovascular accident; *MACE,* major adverse cardiac event; *MALE,* major adverse limb event; *MI,* myocardial infarction.

cryopreservation.[11-16] In our institution, since 2002, we have used cold-stored venous allografts obtained from ablation of varicose GSVs. The aim of this study was to assess our long-term results of below-knee revascularizations using a cold-stored venous allograft in patients with CLI.

METHODS

Patients. From November 2002 to August 2013, 132 cold-stored venous allografts were used for below-knee femoropopliteal or femorodistal bypasses. Autologous GSVs or alternative autologous conduits were unavailable in all these patients. Lower and upper extremity vein exploration was systematically performed with preoperative venous duplex ultrasound. Ten patients treated for acute limb ischemia and four patients treated electively for an asymptomatic popliteal aneurysm were not included in this study. A total of 111 patients were treated for CLI with use of cold-stored venous allografts to perform 118 below-knee revascularizations. All patients provided written informed consent before all procedures. Study protocols were in accordance with the Declaration of Helsinki and were approved by the Nîmes Institutional Review Board for patient data to be collected from a prospectively maintained database and to be shared with a scientific journal. Demographics of patients are reported in Table I.

CLI was defined as ischemic rest pain or tissue loss combined with an ankle pressure <50 mm Hg (or toe pressure <30 mm Hg) for more than 2 weeks, according to the TASC II definition.[1] Forty-five cold-stored venous allograft reconstructions (38.1%) were secondary or even tertiary procedures after a previous failed revascularization: 40 cases after failed surgical reconstruction (33.9%) and 5 cases (4.2%) after a failed endovascular procedure. Indications for limb salvage were ischemic rest pain (ie, Rutherford class 4) for 13 cases (11.0%), minor tissue loss (ie, Rutherford class 5) for 81 cases (68.6%), and major tissue loss (ie, Rutherford class 6) for 24 cases (20.3%).

Twenty-four patients (20.3%) presented to the hospital with sepsis related to CLI. None of the patients had any preoperative open toe or transmetatarsal amputations or drainage to control infection. Preoperative antibiotic therapy was administered only in the case of sepsis. Revascularization was performed when sepsis was controlled.

All patients underwent preoperative computed tomography scan or arteriography. On preoperative imaging, all of the lesions were classified as TASC C or D and were considered unsuitable for endovascular therapy if operative risk was considered acceptable. A multidisciplinary approach to evaluation included surgeons and anesthesiologists. General condition and type of surgery were discussed for all of our patients. The downstream vascular bed was also assessed. Patency of distal arteries is reported in Table II.