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Patency and Limb Salvage after Distal Prosthetic Bypass Associated with Vein Cuff and Arteriovenous Fistula

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Objective. To assess the usefulness of vein cuff with or without arteriovenous fistula interposition as adjuvant techniques for improving patency and limb salvage in patients undergoing femorodistal bypass surgery using prosthetic grafts.

Method. We undertook a retrospective study of 65 consecutive patients treated over a 5-year period with 67 prosthetic femorodistal bypasses with vein cuff, in whom an arteriovenous fistula was constructed at the distal anastomosis in 35. Patients were followed for a median time period of 23 months

Results. Primary patency rates were 68, 53 and 44% at 1, 2 and 3 years, respectively. The corresponding figures for secondary patency, limb survival and patients' survival were 73, 64 and 58% for 1 year, 78, 76 and 73% for 2 years and 72, 66 and 63% for 3 years.

None of the criteria analyzed influenced patency or limb salvage on prosthetic bypasses using adjuvant techniques. No statistical differences were found between patency and limb salvage rates in patients for whom the vein cuff was constructed with or without an arteriovenous fistula. But patients who managed with a supplementary arteriovenous fistula had significantly fewer distal residual arteries in the limb ($p = 0.001$).

Conclusion. Although results in patients treated with adjunctive techniques differed little from those in patients treated with direct prosthetic bypasses procedures, those who eventually had an adjunctive procedure had inferior runoff. This indicates that an arteriovenous fistula might be a valuable supplement in patients with poor runoff who have distal revascularisation using a prosthetic graft.

Key Words: Bypass; Polytetrafluoroethylene; Vein cuff; Arteriovenous fistula; Limb salvage.

Introduction

The material providing the best limb salvage rates for distal bypass surgery is the saphenous vein.^{1–3} When an autogenous saphenous vein is unavailable most vascular surgeons use prosthetic graft material. Prosthetic grafts yield disappointing results for patency and limb salvage especially for distal bypasses on arteries below the knee. Other graft procedures—spliced veins, composite bypass, sequential bypass, allografts, and forearm veins—also yield disappointing or contradictory results. The past few years have seen the development of adjuvant techniques for prosthetic bypasses, such as interposition vein cuff and distal arteriovenous fistula. Most of the published series using adjuvant techniques for

prosthetic bypasses report contradictory results based on a small number of bypasses or non-homogeneous techniques.

This retrospective, single-center study was conducted in a homogeneous series of patients, in whom no venous material was available, undergoing distal artery bypass surgery using the same prosthetic graft material and standardized adjuvant techniques such as interposition vein cuff and arteriovenous fistula on distal anastomoses, and the data was analyzed for mortality, patency and limb salvage. We particularly sought information on the influence of adjuvant techniques on these outcome variables.

Methods

Between December 1994 and January 2000 a consecutive series of 65 patients (41 men and 24 women), aged 75 years (range 45–93) were referred to the vascular

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surgery department at the Catholic Institute of Lille, France, with chronic critical leg ischemia and underwent distal bypass surgery using prosthetic grafts and adjuvant techniques. All patients were treated in the same center, by the same surgical team. In two of the 65 patients, the presence of a popliteal aneurysm with subjacent embolization was considered as a vascular risk factor. On admission all patients were in critical clinical conditions according to the European consensus of 1991⁴ and were staged according to the Leriche and Fontaine clinical classification (Table 1). The mean arterial pressure, available for only 38% of the patients owing to the high percentage of diabetic patients (35%) and the non-systematic measurement of ankle brachial pressure index, was 0.48 ± 0.07 .

All 65 patients underwent below-the-knee revascularization; 67 surgical procedures were undertaken on 67 limbs. Two patients had bypasses in both legs. All limbs were repaired with 6 mm polytetrafluoroethylene (PTFE) grafts. The distal anastomosis was constructed using a vein cuff according to Miller's technique.⁵ For 35 bypasses the vein cuff was associated with a side-to-side arteriovenous fistula and the vein cuff was then sutured on this common ostium. The Rutherford Society of Vascular Surgery/ISCVS classification⁶ was impossible to determine, owing to the poor visibility or failure to explore the plantar arcade. We defined an artery as residual when imaging studies showed 50% or more of its anatomical length below the knee. In 17 bypasses, an associated

surgical procedure was required: one iliac angioplasty, three aortobifemoral reconstructions, four lumbar sympathectomies and nine proximal femoral reconstructions (Table 2).

Unless otherwise specified all data are expressed as median and range (2.5, 97.5 percentile). All events data were calculated using the cumulated actuarial method of event outcome probability, graphics curves were constructed with the Kaplan–Meier method and the log-rank statistic was used for all comparative data. The Bonferroni correction was used for all the multiple comparisons. The relationship between clinical parameters and mortality, patency or limb salvage was studied with the Cox proportional hazards model. *P* values $p < 0.05$ were considered to indicate a statistical significance.

Results

The primary patency rate was $68 \pm 6\%$, $53 \pm 5\%$ and $44 \pm 6\%$ at 12, 24 and 36 months, respectively (Fig. 1). Similarly, the secondary patency rates were $73 \pm 6\%$, $64 \pm 5\%$ and $58 \pm 6\%$. None of the 14 criteria analyzed influenced patency on distal prosthetic bypasses using adjuvant techniques: gender, vascular risk factors, diabetes, indication for surgery, previous distal arterial reconstruction externally reinforced prosthesis, proximal anastomosis on an arterial or a graft site, right or left side, anatomical positioning of graft vs. extra-anatomic, level of distal anastomosis, distal artery revascularized and distal runoff and postoperative anticoagulant treatment. None of these variables was

Table 1. Characteristics of the 65 patients

	No. of patients (%)
Gender	
Male	41 (64)
Female	24 (36)
General risk factors	
Coronary artery disease	23 (16)
Cerebral ischemic stroke	7 (11)
Severe pulmonary disease	25 (38)
Vascular risk factors	
History of smoking	38 (58)
Diabetes mellitus	23 (35)
Hypertension	47 (71)
Hyperlipidemia	8 (12)
Popliteal aneurysm	2 (3)
Stage of disease*	
Stage III	27 (42)
Stage IV	38 (58)
Previous distal revascularization	31 (48)
Proximal vascular reconstruction	12 (18)
Associated amputations	
Minor ipsilateral distal amputation	7 (11)
Major contralateral amputation	5 (8)

* $p = 0.005$.

Table 2. Technical data for the distal prosthetic bypasses

	In total (%)	Without AVF (%)	With AVF (%)
Number of residual distal arteries*			
Three	8 (12)	6 (19)	2 (6)
Two	21 (31)	14 (44)	7 (20)
One	38 (57)	12 (37)	26 (74)
Level of distal anastomosis			
1/3 >	33 (49)	17 (53)	16 (46)
1/3 < >	22 (33)	9 (28)	13 (37)
1/3 <	12 (18)	6 (19)	6 (17)
Artery for distal anastomosis			
Tibial peroneal trunk	4 (6)	3 (9)	1 (3)
Tibial anterior artery	22 (33)	10 (31)	12 (34)
Tibial posterior artery	9 (13)	4 (13)	5 (14)
Peroneal artery	32 (48)	15 (47)	17 (49)
Course of graft			
Internal	33 (49)	16 (50)	17 (49)
External	34 (51)	16 (50)	18 (51)

AVF, arteriovenous fistula.

* $p = 0.005$.

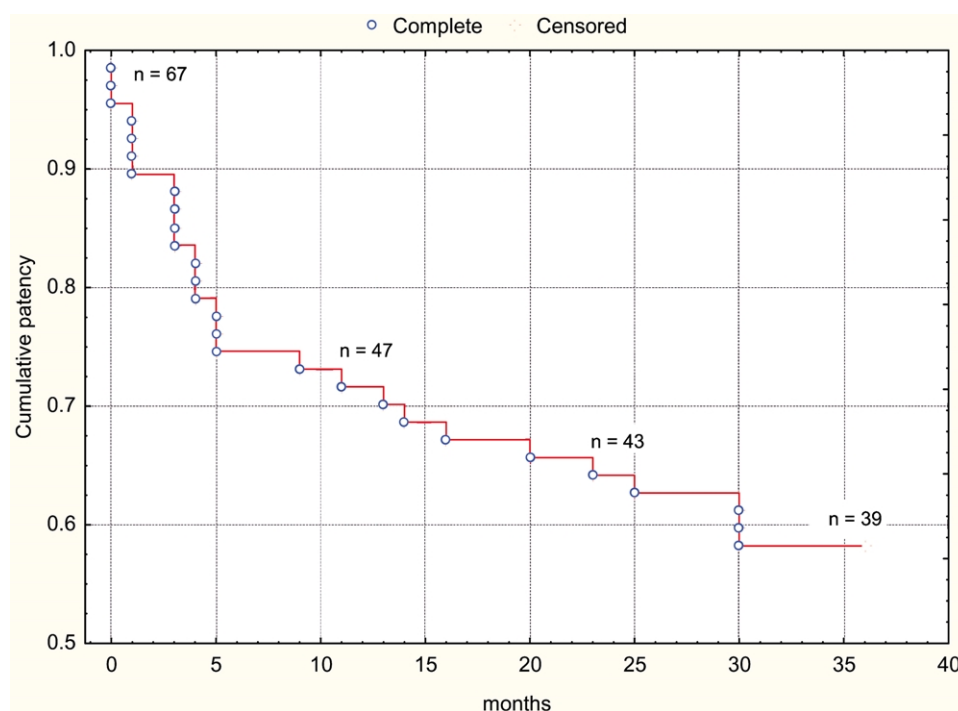


Fig. 1. Cumulated primary bypass patency according to the Kaplan–Meier method. *n*, number of bypasses remaining under observation at various time points.

identified as significant according to the multivariable method of Cox.

The cumulative limb survival rate was $78 \pm 5\%$ at 12 months, $76 \pm 5\%$ at 24 months and $73 \pm 5\%$ at 36 months (Fig. 2). Again, none of the factors analyzed influenced limb survival; neither when analyzed individually nor using the multivariable method of Cox.

Although no difference was found between primary and secondary patency ($p = 0.72$ and $p = 0.8$), or limb salvage ($p = 0.24$) in the two groups treated with a vein cuff with or without an associated distal arteriovenous fistula, when we compared specific factors in the two groups there was no difference in the number of vascular risk factors ($p = 0.58$), Leriche and Fontaine clinical classification ($p = 0.65$), previous arterial reconstruction ($p = 0.37$), or distance of distal implantation ($p = 0.1$). The only criterion that differed significantly in the two groups was the number of distal residual arteries ($p = 0.001$) (Table 2).

The cumulative survival rate was $72 \pm 5.1\%$ at 12 months, $66 \pm 6\%$ at 24 months and $63 \pm 6\%$ at 36 months (Fig. 3). Most of the possible factors analyzed had no influence on global survival, but in a multivariate Cox analysis three variables were found to have significant impact on patient survival: extensive vascular disease ($p = 0.027$), previous arterial recon-

struction ($p = 0.009$) and the number of distal arteries ($p = 0.028$).

Discussion

In this series of patients with chronic critical leg ischemia, our finding that each leg had on average only 1.75 distal residual arteries implied that more than half of the normal distal arteries had been destroyed. In patients with distal atheromatous disease the artery most often preserved was the peroneal artery. This artery was present in 79% of our patients and when only one artery was preserved, in 67% of the cases it was the peroneal artery. The absence of direct arterial connections with the plantar or dorsal arcades and the presumed difficulty in exposing the peroneal artery make peroneal bypasses rare.⁷ In our series, we overcame technical difficulties and successfully used peroneal bypasses for distal implantation in 32 of the 65 patients, by using an external approach to resect a peroneal bone segment.

Despite the initial optimism,⁵ many series using adjuvant techniques, including vein cuff and arteriovenous fistula alone or associated, have reported non-comparable patency rates.^{7–18} Our results from this large homogenous series of patients who had the same clinical status and distal arterial indication, treated

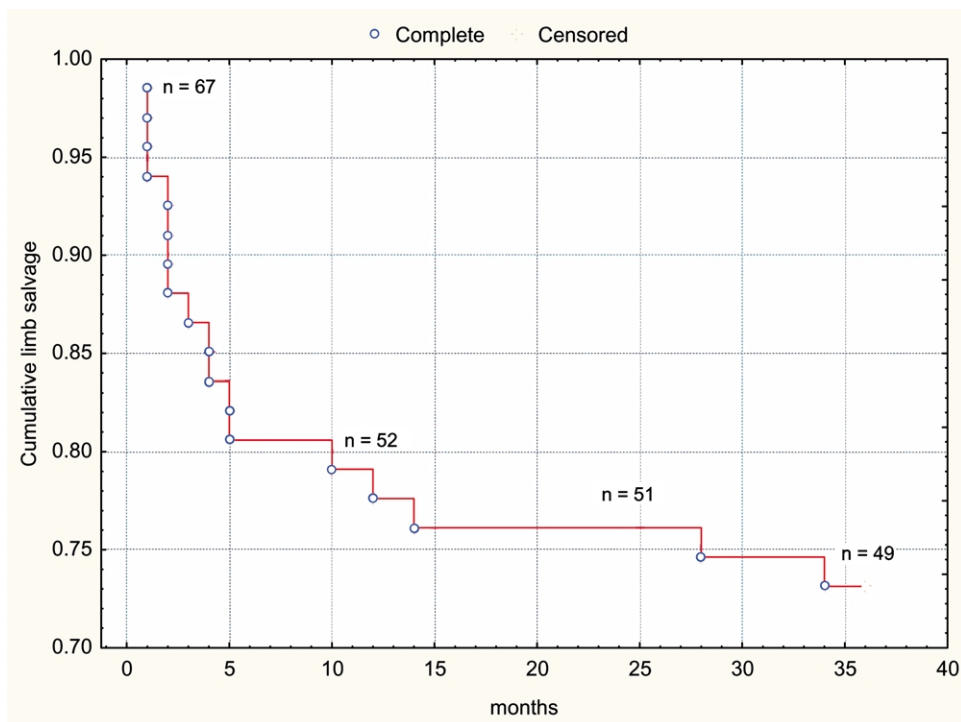


Fig. 2. Cumulated limb survival according to the Kaplan–Meier method. *n*, number of limbs remaining under observation at various time points.

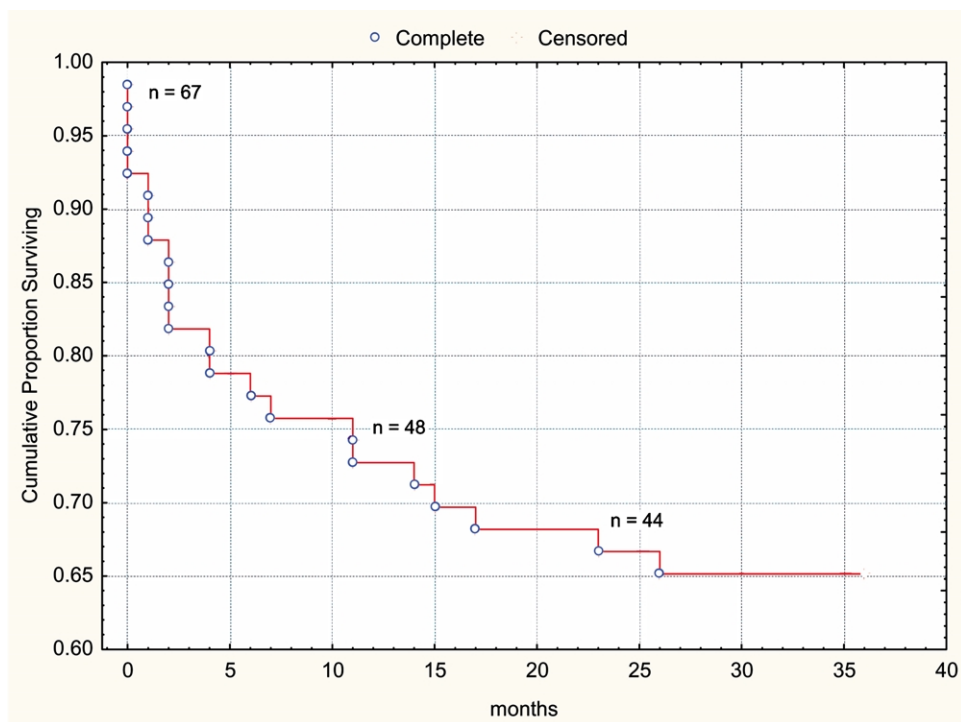


Fig. 3. Probability of overall survival according to the Kaplan–Meier method. *n*, number of patients remaining under observation at various time points.

with 67 distal prosthetic bypasses constructed with the same adjuvant operative techniques, strengthen the growing evidence that adjunctive techniques do not improve patency rates.^{12,14,16,19} The disappointing actuarial rates for primary and secondary patency in our series (53 and 64% at two years) match those in a prospective randomized series conducted by Nevelsteen *et al.*¹⁴ who found no statistical benefit for the use of adjuvant techniques. Considering the adjunction of an arteriovenous fistula to a vein cuff for a certain number of bypasses, our overall results also match those reported by Wijesinghe *et al.*¹⁶ (64% patency at one year and 51% at two years). They reported that adding an arteriovenous fistula to a vein cuff did not benefit patency outcome. Although we did not compare the impact on patency of bypasses constructed with adjunctive procedures or bypasses constructed directly on the artery, our findings again suggest that the adjunction of specific techniques confers no real benefits for patency.

Despite the poor patency rates, the most interesting finding in this series was the satisfactory limb salvage rates (78% at 12 months, 76% at 24 months and 73% at 36 months). Two thirds of the patients had their ischemic lower limb preserved at three years. Although these rates are lower than those reported for limb salvage after venous bypasses,²⁰ they are acceptable in patients who present with chronic, critical lower-limb ischemia. Ours results are in line with benefits of limb salvage in patients treated with adjuvant techniques (vein cuff) reported by Stonebridge *et al.*¹⁸ The use of adjuvant techniques yield distinctly different rates for patency and limb salvage, as the study reported by Eagleton in 1999 clearly illustrates.¹⁷ For example, Kreienberg *et al.* report an 85% limb salvage rate at 24 months and primary patency of 49%.¹² Our series, like the currently published data and randomized series,¹⁸ also yields higher limb salvage rates than those currently reported for prosthetic bypasses directly anastomosed on arteries without adjunctive techniques.²¹

Rather than preventing hyperplasia, as initially supposed,²²⁻²⁴ the vein cuff merely redistributes it within the anastomosis.^{25,26} In previous experiments in an animal model we confirmed data showing that hyperplasia reaches maximum within the vein cuff.^{26,27} The vein cuff, therefore, preserves the artery receiving the prosthetic bypass better than a direct anastomosis. This mechanism presumably explains the higher rates for limb salvage than for patency. After surgery using adjuvant techniques, if thrombosis occludes the prosthesis, in many cases the artery can remain patent, thus explaining why the limb can be salvaged even though the bypass fails. In our series, of

the 21 adjacent arteries examined by angiography or echo-Doppler, after thrombosis of the bypass 9 remained patent (43%). The only report on this event comes from a series conducted by Raptis *et al.* in 1995²⁸ who described 51% patency for the cuffed anastomosed artery after thrombosis of the bypass. No epidemiological studies have yet confirmed this datum.

Whereas a vein cuff demonstrably benefits limb salvage, whether an adjunctive arteriovenous fistula to a vein cuff benefits limb salvage remains unclear. When we compared the two groups (with or without adjunctive arteriovenous fistula) the only factor that differed significantly was the number of residual distal arteries. Adjunctive arteriovenous fistulas were used preferentially for patients with the most degraded distal arterial network. Hence, the matching rates for patency and limb salvage despite the distinctly different quality of the distal arteries, in contrast to preceding reports,²² suggest an adjunctive arteriovenous fistula as an appropriate option for patients with the most severe distal arterial degradation.

In conclusion, our findings in this homogeneous series of patients with chronic arterial ischemia suggest that the adjunction of specific techniques (interposition vein cuff and arteriovenous fistula) to prosthetic distal bypasses confer no real benefits for patency. But despite the prosthetic graft failure related to thrombosis in many cases the vein cuff preserves the recipient artery thus allowing a satisfactory rate of limb salvage. In patients with poor distal vascularization, adding an arteriovenous fistula to a vein cuff may improve rates for limb salvage and patency.

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