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# Are femorodistal bypass grafts for acute limb ischemia worthwhile?

## *Vantagem associada ao uso de enxertos femorodistais para isquemia aguda de membros*

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### Abstract

**Background:** It has been shown that autogenous veins are associated with the best limb salvage rates for femorodistal bypass surgery. However, in emergency settings, when an autogenous vein is unavailable, use of synthetic graft material or amputation is a critical decision to make.

**Objective:** To assess the appropriateness of femorodistal bypass grafts for acute limb ischemia in emergency settings.

**Methods:** Patients who underwent emergent bypass and elective femorodistal bypass surgery between 1996 and 2006 were reviewed retrospectively in a single center.

**Results:** There were 147 patients of which 84 had elective and 63 had emergent bypass. The graft patency rates for elective admissions were 44 and 25% vs. 25 and 23% for admissions for acute femorodistal graft surgery at 2 and 4 years, respectively ( $p < 0.004$ ). Admissions for acute ischemia who were treated with prosthetic grafts had a primary patency of 24 vs. 27% for vein grafts at 2 years and 24 vs. 23% at 4 years ( $p = 0.33$ ). In the acute femorodistal grafts group, primary patency at 2 years for vein and prosthetic grafts was 27 and 24% as compared to 42 and 32% for electives. These values for cumulative limb salvage rates for elective bypasses were 73 and 63% as compared to 52% at both time points in the acute femorodistal graft group ( $p < 0.004$ ). In emergency settings, the limb salvage rate for acute femorodistal bypass with prosthetic grafts was 38%, and for vein grafts it was 62% at both time points ( $p = 0.08$ ).

**Conclusion:** The long term limb salvage rate of 38% suggests that emergent femorodistal revascularization is worthwhile.

**Keywords:** Mode of admission, femorodistal, bypass graft, vascular surgery.

### Introduction

Kunlin used greater saphenous vein for the first time as bypass graft for superficial femoral artery in 1951.<sup>1</sup> Campbell et al. introduced use of graft for femoral artery in 1979.<sup>2</sup> The prevalence of infrainguinal bypass surgery has

### Resumo

**Contexto:** Já foi mostrado que veias autógenas estão associadas às melhores taxas de salvamento de membros para a cirurgia de *bypass* femorodistal. No entanto, em cenários de emergência, quando não há uma veia autógena disponível, é crítica a decisão entre o uso de material de enxerto sintético ou a amputação.

**Objetivo:** Avaliar a adequação de enxertos femorodistais para isquemia aguda de membros em cenários de emergência.

**Métodos:** Pacientes submetidos a cirurgia de *bypass* de urgência e cirurgia de *bypass* femorodistal eletiva entre 1996 e 2006 foram retrospectivamente revisados em um único centro.

**Resultados:** Havia 147 pacientes, dentre os quais 84 haviam sido submetidos à cirurgia de *bypass* eletiva e 63 à cirurgia de *bypass* de urgência. As taxas de patência dos enxertos para internações eletivas foram 44 e 25% *versus* 25 e 23% para internações para cirurgia aguda de enxerto femorodistal a dois e quatro anos, respectivamente ( $p < 0,004$ ). Internações por isquemia aguda que foram tratadas com enxertos prostéticos tiveram patência primária de 24 *versus* 27% para enxertos venosos a 2 anos e 24 *versus* 23% a 4 anos ( $p = 0,33$ ). No grupo de enxertos femorodistais agudos, patência primária a 2 anos para enxertos venosos e prostéticos foi de 27 e 24%, comparado a 42 e 32% para eletivas. Esses valores para taxas de salvamento de membros em *bypasses* eletivos foram 73 e 63%, comparadas a 52% em ambos pontos no tempo para o grupo de enxerto femorodistal agudo ( $p < 0,004$ ). Em cenários de emergência, a taxa de salvamento de membros para *bypass* femorodistal com enxertos prostéticos foi de 38% e para enxertos venosos a taxa foi de 62% em ambos pontos no tempo ( $p = 0,08$ ).

**Conclusão:** A taxa de 38% para salvamento de membros a longo prazo indica que a revascularização femorodistal de urgência é vantajosa.

**Palavras-chave:** Modo de internação, femorodistal, enxerto de *bypass*, cirurgia vascular.

increased significantly since then.<sup>3</sup> Many studies have demonstrated the advantages of utilizing vein grafts, particularly, long saphenous vein, over prosthetic grafts for lower extremity revascularization.<sup>4-7</sup> Many factors have been shown to affect the outcomes of infrageniculate bypass

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grafts; these include diameter and quality of vein, quality of distal run off and diabetes mellitus.<sup>8-11</sup> Compared to supragenicular bypass surgery, infragenicular surgery is usually associated with a more severe atherosclerosis and outcome is less favorable.

Many patients requiring femorodistal bypass reconstruction are admitted on an emergency basis. Although there are numerous reports on the outcomes of infrageniculate bypass surgery in the literature,<sup>12-14</sup> the effect of mode of admission on these outcomes has not been ascertained. The aim of this study was to determine whether femorodistal revascularization for acute ischemia with prosthetic grafts is worthwhile.

### Materials and methods

Primary patency, limb salvage and mortality rates in an emergent and elective series with natural and prosthetic grafts were surveyed in a retrospective study. The outcomes of 147 consecutive femorodistal revascularization procedures performed between January 1996 and March 2006 were studied.

Patients were followed up for up to 48 months. Patients with elective admission were followed up for 30.7 months on average. All operations were performed by one of five consultants in the vascular surgery department. All patients were considered for a vein graft as a first-line measure. If a vein was not available a prosthetic graft was used.

Patency was assessed by clinical examination of the revascularized limb and measurement of arterial brachial pressure indexes (ABPIs) in all patients, with surveillance duplex scan referred for symptomatic patients. All patients were considered for percutaneous transluminal angioplasty after graft stenosis as the initial treatment. Primary graft patency was defined as uninterrupted patency with no procedures performed on the graft or its anastomoses.<sup>15</sup> Secondary patency referred to a status that flow was restored through most of the original graft, including at least one of its original anastomoses.<sup>15</sup> Patients were suffering from chronic limb ischemia. Emergent admissions for femorodistal revascularization for acute ischemia were defined as non-planned admissions that occurred in less than 96 hours from the outpatients visit.

The results of this study are reported according to the report of Society of Vascular Surgery and International

Society of Cardiovascular Surgery (SVS/ISCVS) ad hoc committee.<sup>15</sup>

Statistical analysis was performed by Stata statistical software (version 9.2). Survival functions were calculated using the log-rank test. Cox regression was used to investigate the effects of possibly confounding variables, with the proportional hazards assumption being checked using a graphical method (log-log plots). Significance was defined as a  $p < 0.05$ . All our patients are assessed in a multidisciplinary meeting (MDM) with interventional radiologists and surgeons and in the absence of a vein and the presence of ulceration we will generally opt for endovascular treatment in preference to surgery. These cases represent those in whom it was felt that endovascular therapy would not be possible or in whom the degree of ischemia and configuration of the disease was such that surgical treatment was felt to be the only option.

### Results

One hundred and forty seven patients who had undergone femorodistal bypass surgery were studied. 61.91% ( $n = 91$ ) of the patients were male and 38.1% ( $n = 56$ ) were female. Mean age for elective cases was  $76.1 \pm 9.5$  years (range: 44-104) and mean age for emergency cases was  $71.4 \pm 11.4$  years (range: 42-95). The follow-up range for emergency cases was virtually identical, with a mean follow-up of 30.2 months. All patients were on antiplatelet or anticoagulant after the operation. The characteristic and risk factors of patients are illustrated in Tables 1 and 2.

Eighty four patients had elective admissions and 63 cases were admissions for femorodistal grafts for acute ischemia. Prosthetic graft was utilized for 54% ( $n = 34/63$ ) of emergent admissions and 46% ( $n = 39/84$ ) of elective admissions. A detail of anastomotic sites is depicted in Table 3.

### Graft patency

#### Primary graft patency

Admissions with prosthetic grafts for acute ischemia had a primary patency of 24 vs. 27% for vein grafts at 2 years and 24 vs. 23% at 4 years ( $p = 0.33$ ) (Figure 1). However, this was not statistically significant ( $p = 0.32$ ).

Primary patency for all elective admissions was 44 vs. 25% for emergent cases at 2 years and 25 vs. 23% at 4 years ( $p < 0.004$ ) (Figure 2).

**Table 1** - Patient characteristics

Characteristic	Elective	Emergency	p*
Mean age, years (range)	76.1±9.48 (44-104)	71.4±11.4 (42-95)	0.003
Male, % (no.)	61 (51/84)	63.5 (40/63)	0.459
Risk factors, no. (%)			
Diabetes	33 (39.28)	34 (53.98)	0.357
Hypertension	34 (40.47)	37 (58.73)	0.028
Coronary artery disease	50 (59.52)	59 (93.65)	< 0.0001
Smoker	51 (60.81)	52 (82.53)	0.004
Cerebrovascular disease	13 (14.86)	9 (14.28)	0.841

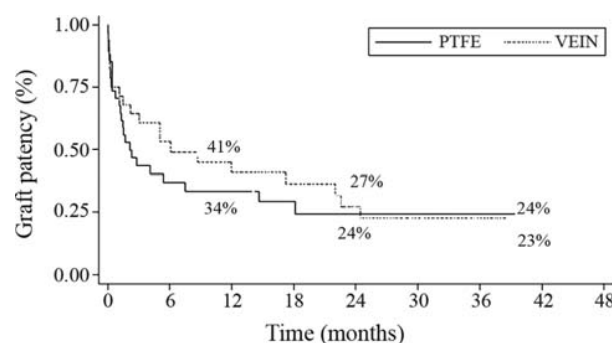
\* Differences between groups tested using two-sample t-test (age) and chi-square test (other variables).

**Table 2** - Rutherford stratification of participants

Characteristic	Elective, no. (%)	Emergency, no. (%)
Severe claudication (category 3, grade 1)	53 (63.09)	N/A
Ischemic rest pain (category 4, grade 2)	5 (5.95)	49 (77.77)
Tissue loss (category 5, grades 3 and 4)	26 (30.95)	14 (22.23)

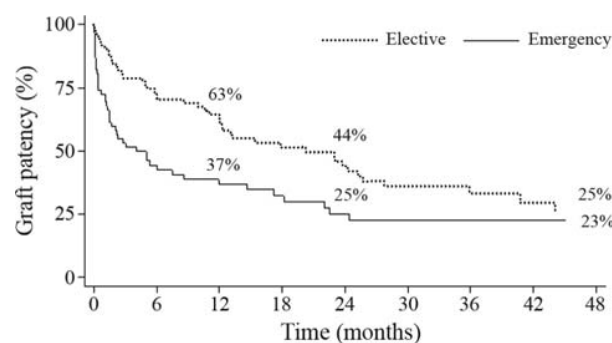
**Table 3** - Details of anastomotic sites

Sites of anastomosis	Vein, no. (%)	Prosthetic, no. (%)
Common femoroposterior tibial	40 (27)	36 (25)
Common femoroanterior tibial	20 (14)	28 (19)
Common femoroperoneal	6 (4)	6 (4)
Superficial femoroanterior tibial	2 (1)	2 (1)
Superficial femoroposterior tibial	2 (1)	0 (0)
Popliteo-posterior tibial artery	4 (3)	1 (1)

**Figure 1** - Primary patency of vein vs. prosthetic graft in emergency

### Secondary graft patency

Cumulative secondary patency rate at 2 years for elective cases was 47 vs. 29% for emergent cases. At 2 years, secondary patency for patients treated with prosthetic graft was 34 vs. 45% for vein grafts. Cox regression showed that mode of admission was a significant factor affecting outcomes of secondary patency ( $p = 0.01$ ). Two patients in the elective group vs. four patients in the emergency group received secondary intervention. Four thrombectomies and 2 percutaneous transluminal angioplasties (PTA) were performed.

**Figure 2** - Primary patency according to mode of admission

### Limb salvage

Patients undergoing elective admissions did significantly better than their femoropopliteal bypass grafts for acute ischemia group ( $p < 0.004$ ). Total elective limb salvage rate was 72 vs. 49% for emergent operations at 2 years and 60 vs. 49% at 4 years ( $p < 0.004$ ).

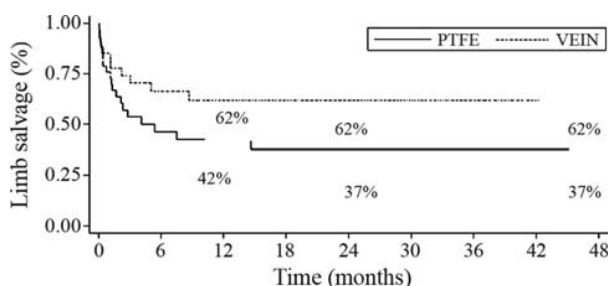
In emergency setting, patients treated with prosthetic grafts had less favorable outcomes vs. patients treated with vein grafts, having a limb salvage rate of 38 vs. 62% at 2 and 4 years. In a sub-analysis of the rate of limb salvage in admissions for femorodistal grafts for acute ischemia the rate of prosthetic grafts was 62 vs. 37% for vein grafts at both time points. Figure 3 illustrates a plot for limb salvage for prosthetic and vein grafts in patients with emergent admission. There was no statistically significant difference between the rate of limb salvage of vein and prosthetic grafts in emergent admissions ( $p = 0.84$ ).

### Survival rates

The 30-day mortality rate was 2.72% ( $n = 4$ ). Three were elective cases and one emergent admission. All four mortality cases had vein grafts. Fifty six (30%) patients died during follow up. The most common cause of death was myocardial infarction. There was no significant difference in mortality rates of the two groups ( $p = 0.838$ ). Table 4 summarizes the causes of death for both groups.

### Risk factors for graft failure and limb loss

Cox regression analysis was used for assessing simultaneous effects of several covariates, in a stratified analysis. Mode of admission was a significant factor for primary and secondary patencies ( $p = 0.01$ ), in a model which adjusted for age, sex, graft type and smoking and disease status. The adjusted hazard ratio (95% confidence interval, 95%CI) for salvage rate was 1.99 (95%CI 1.18-3.37). Ta-



**Figure 3** - Limb salvage in emergent admissions according to type of graft

**Table 4** - All causes of death (4 years)

All causes of death	Elective	Emergency
MI	15	9
Stroke	0	4
Cardiorespiratory failure	7	6
Chronic renal failure	4	1
Pneumonia	2	1
Other	3	3
Total	32	24

MI = myocardial infarction.

bles 5 and 6 illustrate the Cox models that primary patency and salvage rates are adjusted for the confounding factors.

### Discussion

Vein grafts are known to be superior to the prosthetic grafts.<sup>16</sup> However, coronary artery bypass grafts, varicose vein operations, and a poor quality vein deprive 15-30% of the patients from a vein graft.<sup>17-19</sup> This study aimed to justify whether emergent femorodistal revascularization with prosthetic grafts is worthwhile. In this study elective admissions had both higher patency and salvage rates ( $p < 0.004$ ). However, the type of graft did not lead in a significantly poorer outcomes for emergent operations ( $p = 0.084$ ).

This study was consistent with other studies showing the superiority of autogenous vein grafts over prosthetic grafts.<sup>20,21</sup>

Despite a lower patency rate with prosthetic grafts, 38% of the patients treated emergently maintained graft patency and limb salvage at 2 years. Therefore, the absence of a suitable vein should not mandate primary amputation. The type of graft did not affect outcome during emergency operations. Our results compare favorably to the primary and secondary patency rates reported in the literature (Table 7).

Whether to submit patients to a femorodistal bypass is a complex decision making process, weighing up life quality against mortality and morbidity of the procedure.<sup>27,28</sup> Patient's interest, availability of vein, patient's comorbidities with resources available need to be considered in decision making.<sup>29,30</sup> In a sense all femorodistal bypass procedures are urgent or emergent procedures. Non-emergent admission played an important role in defining the

**Table 5** - Cox models developed to assess the effect of potential confounding factors. Primary patency

Variable	Unadjusted hazard ratio (95%CI)	p	Adjusted hazard ratio (95%CI)	p
Age 65-79 (compared to < 65)	1.07 (0.60-1.91)	0.809	1.31 (0.69-2.51)	0.410
Age 80+ (compared to < 65)	0.95 (0.50-1.79)	0.869	1.22 (0.57-2.64)	0.605
Male (compared to female)	1.40 (0.92-2.15)	0.117	1.46 (0.91-2.34)	0.120
Admission (emergent compared to elective)	1.82 (1.22-2.73)	0.004	2.05 (1.20-3.49)	0.008
Graft type (prosthetic graft compared to vein)	1.43 (0.95-2.15)	0.089	1.37 (0.87-2.16)	0.180
Rutherford stratification 3.1 (compared to 5.3)	1.09 (0.67-1.75)	0.733	1.14 (0.69-1.89)	0.612
Rutherford stratification 4.2 (compared to 5.3)	1.18 (0.41-3.43)	0.762	2.09 (0.63-6.93)	0.229
Smoking	1.35 (0.84-2.19)	0.219	1.18 (0.68-2.07)	0.556
Diabetes	0.95 (0.63-1.44)	0.815	0.80 (0.51-1.25)	0.334
Hypertension	0.99 (0.66-1.50)	0.980	0.99 (0.63-1.56)	0.966
Ischemic heart disease	1.36 (0.83-2.21)	0.222	0.95 (0.51-1.78)	0.883
Stroke	0.81 (0.45-1.43)	0.459	0.84 (0.45-1.57)	0.588

95%CI = 95% confidence interval.

**Table 6** - Results of Cox proportional hazards modeling: confidence interval

Variable	Unadjusted hazard ratio (95%CI)	p	Adjusted hazard ratio (95%CI)	p
Primary patency				
Admission (emergent compared to elective)	1.82 (1.22-2.73)	0.004	2.05 (1.20-3.49)*	0.008
Graft type (prosthetic graft compared to vein)	1.43 (0.95-2.15)	0.089	1.37 (0.87-2.16) <sup>†</sup>	0.180
Secondary patency				
Admission (emergent compared to elective)	1.76 (1.18-2.63)	0.006	2.04 (1.19-3.52)*	0.010
Graft type (prosthetic graft compared to vein)	1.41 (0.94-2.13)	0.099	1.35 (0.85-2.14) <sup>†</sup>	0.205
Limb salvage				
Admission (emergent compared to elective)	2.17 (1.28-3.66)	0.004	2.89 (1.41-5.91)*	0.004
Graft type (prosthetic graft compared to vein)	2.09 (1.22-3.60)	0.008	2.47 (1.35-4.54) <sup>†</sup>	0.003

95%CI = 95% confidence interval.

\* Adjusted for graft type, age, sex, Rutherford stratification, smoking status, presence of diabetes, hypertension, coronary artery disease and stroke.

<sup>†</sup> Adjusted for admission mode, age, sex, Rutherford stratification, smoking status, presence of diabetes, hypertension, coronary artery disease and stroke.

outcomes of femorodistal bypass surgery in this study. Therefore, for suitable patients, surgery should be offered before reaching a critical point, needing emergent intervention. Patients should not be deterred from bypass surgery treatment on the basis of age or emergent admission.<sup>31,32</sup>

Ouriel et al. and Raviola et al. studies, however, have suggested that revascularization results are favorable compared to amputation, in the terms of efficacy of treatment and cost.<sup>20,21,28,31</sup> Revascularization has also been found to advance the quality of life by decreasing pain level and sleep problems and chances to avoid institutionalization.



**Table 7** - Primary and secondary patency in published series

Study	Cumulative primary patency (%)			Cumulative limb salvage (%)		
	1st year	2nd year	3rd year	1st year	2nd year	3rd year
<b>Vein graft</b>						
Panayiotopoulos et al. <sup>22</sup>	81.1	N/A	81.1	N/A	N/A	N/A
Feinglass et al. <sup>13</sup>	N/A	N/A	N/A	77	N/A	63
Murphy et al. <sup>23</sup>	12	4	N/A	22	10	N/A
<b>Prosthetic graft</b>						
Flinn et al. <sup>24</sup>	58	45	N/A	N/A	N/A	N/A
Whittemore et al. <sup>25</sup>	25	12	N/A	N/A	N/A	N/A
Panayiotopoulos et al. <sup>22</sup>	64.8	N/A	59.8	N/A	N/A	N/A
Griffiths et al. <sup>26</sup>	N/A	35	N/A	N/A	N/A	19

In conclusion, when there was no appropriate long saphenous vein, prosthetic graft was a reasonable substitute even in the emergency situations. Prosthetic grafts had a rather low rate of graft patency but acceptable long term limb salvage. This study illustrated that admitting patients on a planned basis will lead to better outcomes than waiting a crisis to develop (limb salvage  $p < 0.004$ ).

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