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Rehabilitation after amputation for vascular disease: a follow-up study

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Abstract

Rehabilitation of one hundred and twenty eight patients with lower limb amputation performed for vascular disease from 1979 to 1987 was assessed. Arteriosclerotic occlusive disease was the most frequent cause of amputation (85.9%). Sixty seven patients (52.3%) were diabetic. Early and late results were analysed. For long-term follow-up evaluation, Univariate method of Kaplan-Meyer product limit was employed. Multifactorial analysis was used to assess factors influencing mortality. On immediate evaluation of rehabilitation with a prosthesis 85.2% of patients were successfully fitted. On long term evaluation 47.8% of below-knee and 22.1% of above-knee amputees were alive and using the prosthesis full time at five years of follow-up (p=0.0026). Opposite limb preservation at five years was 69.5% for diabetics and 90.2% for non-diabetics, respectively (p=0.0013). Survival rate at five years was 42.4% for diabetics, and 85.0% for non-diabetics (p=0.0002). On multifactorial analysis diabetic patients showed a risk of late mortality six times greater than non-diabetics. In conclusion rehabilitation after vascular amputation is feasible in a large number of patients, despite a limited life span. Diabetes represents a major risk factor both for life and for the opposite limb. Knee preservation is an important factor for better rehabilitation.

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Introduction

Rehabilitation after amputation due to vascular disease presents special features that make this group of patients particular. Advanced age, associated diseases, and vascular involvement of the opposite limb are examples of these peculiar conditions. The fate after vascular amputation is not well known in terms of rehabilitation possibilities and life span of this population (Chilvers and Browse, 1971; Weaver and Marshall, 1973; Harris *et al.*, 1974; Jamieson and Hill, 1976; Finch *et al.*, 1980).

The objective of this study is to assess rehabilitation in respect of walking capability, when using a prosthesis, according to the level of amputation, as well as to analyse the influence of diabetes mellitus in long term patient survival and contralateral limb preservation.

Patients and methods

From August 1979 to August 1987, 128 consecutive patients with lower limb amputation due to peripheral vascular disease were evaluated. Ninety nine were male (77.3%) and 29 female (22.7%). The age distribution is shown in Table 1. The median age was 62 years. Sixty seven patients (52.3%) were diabetic. Arteriosclerotic occlusive disease was the most frequent cause of amputation (85.9%).

One hundred and seventeen patients were unilateral amputees (91.4%), and 11 were bilateral (8,6%). Of the unilateral patients, 65

Work done at the Limb Preservation and Fitting Centre of São Paulo, São Paulo, Brazil.

Table 1. Age and sex distribution

Age	Sex		Total	(%)
	M	F		
0–9	1	0	1	0.8
10–19	2	0	2	1.6
20–29	2	1	3	2.3
30–39	4	2	6	4.7
40–49	9	2	11	8.6
50–59	23	3	26	20.3
60–69	35	14	49	28.3
70–79	20	7	27	21.1
80–89	3	0	3	2.3
Total	99	29	128	100.0%

(55.5%) had amputation below the knee, 40 (34%) above the knee, 10 (8.5%) through the knee, 1 had a Syme and 1 a Chopart amputation (0.8%). Among patients with both limbs amputated 5 (45%) were bilateral below-knee (BK), 2 (18%) were BK on one side and above-knee (AK) on the other, 2 (18%) were bilateral AK, 1 (9%) had Syme bilaterally and 1 (9%) was BK on one side and transmetatarsal on the other (Table 2).

Distribution according to age group (Table 3) and amputation level showed correlation with diabetes (Table 4).

Patients were referred to the rehabilitation centre only after amputation for initial evaluation. No patient had ever used a prosthesis before. Prosthetic fitting was attempted after medical and physiotherapeutic treatment in all the 128 cases. This was done in the specialised centre in a team approach, including one vascular surgeon, one orthopaedic surgeon, physical therapists, co-ordinating nurse and prosthetic technicians.

Immediate results were analysed in terms of restoration of bipedal gait. Outcome was assessed by personal interview with patients or by relatives' information in case of death. No patient was lost to follow-up. At the last consultation (average follow-up of 24.6 months) patients were classified according to the use of a prosthesis in three categories: non-wearers, partial wearers and fulltime wearers.

Table 2. Distribution according to amputation level.

Level	Frequency	Percentage
Below-knee	65	50.8%
Above-knee	40	31.3%
Through-knee	10	7.8%
Syme	1	0.8%
Chopart	1	0.8%
Bilateral	11	8.6%
Total	128	100.0%

Table 3. Diabetes related to age group.

	Diabetes		
Age group	No	Yes	Total
<50 years	20 (74.1%)	7 (25.9%)	27 (21.1%)
>50 years	41 (40.6%)	60 (59.4%)	101 (78.9%)
Total	61 (47.7%)	67 (52.3%)	128 (100%)

X^2_c=8.27819; p=0.004

Table 4. Level of amputation related to diabetes.

	Diabetes		
Level	No	Yes	Total
Below-knee	29 (39.2%)	45 (60.8%)	74 (57.8%)
Above-knee	32 (59.3%)	22 (40.7%)	54 (42.2%)
Total	61 (47.7%)	67 (52.3%)	128 (100%)

X^2_c=4.26867; p=0.0388

The Kaplan-Meyer product limit test was used for univariate analyses (Campos-Filho and Franco, 1988). Survival prognostic risk factors were investigated by multivariated analysis (Campos-Filho and Franco, 1990). For cross-tabulations the chi-square method was used.

BK (65 patients) and AK (40 patients) amputees were compared regarding prosthetic use on long term evaluation using the Kaplan-Meyer life table method. For this functional evaluation a successful event was defined as being if patients were alive and using a prosthesis full time (Table 6) or alive and using a prosthesis partial time (Table 7) at time of last follow-up.

Table 5. Immediate results of rehabilitation.

	Prostheses fitted		
Level	No	Yes	Total
Below-knee	6 (8.9%)	61 (91.1%)	67 (52.3%)
Above-knee	8 (20.0%)	32 (80.0%)	40 (31.3%)
Through-knee	1 (10.0%)	9 (90.0%)	10 (7.8%)
Bilateral	4 (36.4%)	7 (63.6%)	11 (8.6%)
Total	19 (14.8%)	109 (85.2%)	128 (100%)

Table 6. Summary of survival and prosthetic use full and partial time of below-knee and above-knee amputees.*

variable	categories	number of patients	mean time on use of prosthesis (months)	proportion using prosthesis 3 years	proportion using prosthesis 5 years
level	BK	65(61.9%)	60.1± 4.9	77.4	58.0
	AK	40(38.1%)	45.5± 5.9	55.4	38.6

*Kaplan-Meyer product-limit estimates.

Table 7. Summary of survival and prosthetic use full time of below-knee and above-knee amputees.*

variable	categories	number of patients	mean time on use of prosthesis (months)	proportion using prosthesis 3 years	proportion using prosthesis 5 years
level	BK	65(61.9%)	52.2± 4.9	63.7	47.8
	AK	40(38.1%)	32.0± 4.5	41.3	22.1

*Kaplan-Meyer product-limit estimates.

Table 8. Summary of survival data* for 128 patients with lower limb amputation caused by peripheral vascular disease observed between 1979 and 1987.

variable	categories	number of patients	mean survival time (months)	proportion surviving (%) 3 years	proportion surviving (%) 5 years
sex	male	99(77.3%)	93.5± 12.6	73.5	61.3
	female	29(22.7%)	95.4± 22.1	80.2	67.3
age	<50	26(20.3%)	100.4± 5.4	93.3	93.3
	50–65	54(42.2%)	66.9± 6.4	68.0	60.5
	>65	48(37.5%)	61.8± 6.6	73.4	51.3
associated disease	diabetes	67(52.4%)	55.6± 5.5	61.8	42.4
	others	61(47.6%)	86.4± 4.5	89.4	85.5

*Kaplan-Meyer product-limit estimates.

Results

Ambulation with a prosthesis was initially achieved by 85.2% (109/128) of all patients. These rates for unilateral amputees were: 91.1% (61/67) for BK (including one Chopart and one Syme amputation), 80% (32/40) for AK and 90% (9/10) for through-knee. Bilateral amputees were initially successful in wearing a prosthesis in 63.6% (7/11). These patients were: 1 with Syme's amputation bilaterally, 1 with transmetatarsal on one side and BK on the other, 4 with BK bilaterally, and 1 with AK bilaterally. These results are summarised in Table 5.

Table 9. Cox regression model data for death risk estimation on diabetics and non-diabetics.

Parameters	Model unifactorial	Model multifactorial
Regression Coefficient	1.5351	1.5950
Standard Error	0.3938	0.4275
Likelihood Ratio	18.456	38.248
Score	1	6

Survival and prosthetic use rated as full time or partial time at 5 years was 58.0% for BK and 38.6% for AK ($p=0.045$), as shown in Table 6.

Survival and prosthetic use rated as full time at 5 years was 47.8% for BK and 22.1% for AK ($p=0.0026$), as shown in Table 7 (Fig. 1).

General survival rate at the end of five years was 42.4% for diabetics, and 85.5% for non-diabetics ($p=0.0002$) (Table 8). On multifactorial analysis diabetic patients showed a risk of late mortality six times greater than non-diabetics (Table 9). Opposite limb amputation occurred in 9% (11/117) of patients with unilateral amputation. This incidence was

Table 10. Summary of opposite limb preservation* for 117 patients with unilateral amputation observed between 1979 and 1987.

variable	categories	number of patients	opposite limb permanence (months)	patients with opposite limb preservation (%)	
				3 years	5 years
associated disease	diabetes	67(52.4%)	67.5± 6.7	78.2	69.5
	others	61(47.6%)	87.1± 3.9	100.0	90.2

*Kaplan-Meyer product-limit estimates.

higher in the diabetic group (p=0.0013) (Table 10).

Discussion

Peripheral vascular disease is the leading cause of amputation in many western countries (Mooney *et al.*, 1976; Christensen, 1976; Fleurant and Alexander, 1980; Liedberg and Persson, 1983). Elderly, atherosclerotic patients usually with associated diabetes is the pattern frequently observed (Cameron *et al.*, 1964; Steer *et al.*, 1983; Most and Sinnock, 1983; Liedberg and Persson, 1983; Falkel, 1983). Despite the fact that in some series (Mooney *et al.*, 1976) diabetes has been related to amputation in younger age, in this study it was prevalent over the age of 50 (Table 3). Furthermore, due to the more distal arterial involvement, it has been observed that the level of amputation may be lower in the diabetic population (Kihn *et al.*, 1972; Burgess and Marsden, 1974; Kacy *et al.*, 1982). This was also observed in this series, as is seen in Table 4.

Rehabilitation has been studied in terms of immediate and late results. For immediate results, success was considered as being

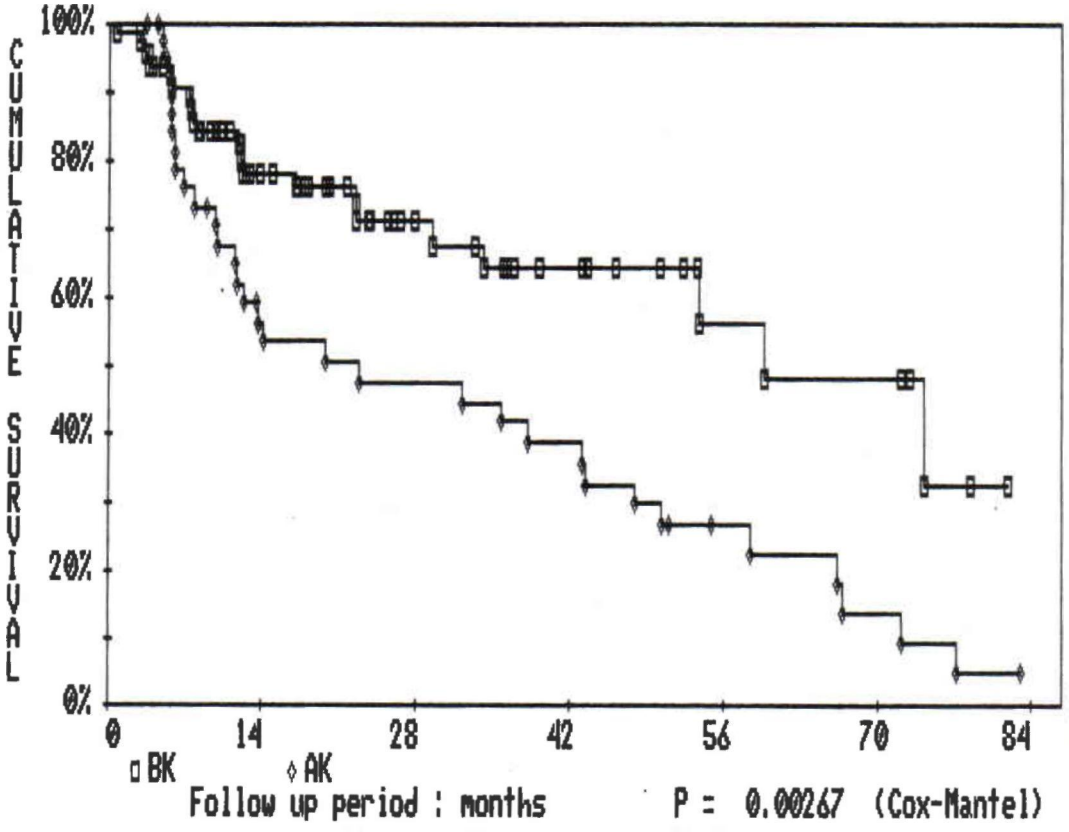

Fig. 1. Survival and prosthetic use/level.

achieved when a prosthesis was fitted, and a patient attained an independent gait at the end of initial treatment. By this measure 85.2% of all patients reached this condition (Table 5).

Late evaluation comparing BK and AK amputees, the most significant groups, showed better results on survival and prosthetic use full or partial time for BK amputees (Table 6). This difference was emphasised when only full prosthetic use was considered (Table 7), pointing out the limitations imposed on AK amputees and the importance of knee preservation.

Survival comparison between the diabetic and non-diabetic populations showed a significant statistical difference ($p=0.0002$) highlighting diabetes as a risk factor. This observation prompted also a multifactorial analysis, relating diabetes with a six times higher mortality risk (Table 9).

Applying the same cumulative survival method for the preservation of the opposite limb of unilateral amputees, diabetic patients also had more contralateral limb amputation. This has also been reported by others (Bodily and Burgess, 1983).

In conclusion, rehabilitation after amputation for vascular disease is associated with limited life span, but it is feasible and rewarding in a large number of patients. Diabetes is a major risk factor for both survival and limb preservation. Prosthetic fitting is frequently achieved, restoring the gait and mobility conditions essential for normal living. Knee preservation is an important factor for better rehabilitation.

REFERENCES

Burgess EM, Marsden FW (1974). Major lower extremity amputations following arterial reconstruction. *Arch Surg* **108,** 655–660.

Bodily K, Burgess EM (1983). Contralateral limb and patient survival after leg amputation. *Am J Surg* **146,** 280–282.

Cameron HC, Lennard-Jones JE, Robinson MP (1964). Amputations in the diabetic:outcome and survival. *Lancet* **2,** 605–607.

Campos NF, Franco ELF (1988). Micro-computer assisted univariate survival data analysis using Kaplan-Meier life table estimators. *Comput Methods Programs Biomed* **27,** 223–228.

Campos NF, Franco ELF (1990). Micro-computer assisted multivariated survival data analysis using Cox's proportional hazard regression model. *Comput Methods Programs Biomed* **31,** 81–87.

Chilvers AS, Browse NL (1971). The social fate of the amputee. *Lancet* **2,** 1192–1193.

Christensen S (1976). Lower extremity amputations in the county of Aalborg 1961–1971. *Acta Orthop Scand* **47,** 329–334.

Falkel JE (1983). Amputations as a consequence of diabetes melitus: an epidemiological review. *Phys Ther* **63,** 960–964.

Finch DRA, MacDougal M, Tibbs DJ, Morris PJ (1980). Amputation for vascular disease: the experience of a peripheral vascular unit. *Br J Surg* **67,** 233–237.

Fleurant FW, Alexander J (1980). Below-knee amputation and rehabilitation of amputees. *Surg Gynecol Obstet* **151,** 41–44.

Harris PL, Read F, Eardley A, Charlesworth D, Wakefield J, Sellwood RA (1974). The fate of elderly amputees. *Br J Surg* **61,** 665–668.

Jamieson CW, Hill D (1976). Amputation for vascular disease. *Br J Surg* **63,** 683–690.

Kacy SS, Wolma FJ, Flye MW (1982). Factors affecting the results of below-knee amputation in patients with and without diabetes. *Surg Gynecol Obstet* **155,** 513–518.

Kihn RB, Warren R, Beebe GW (1972). The "geriatric" amputee. *Ann Surg* **176,** 305–314.

Liedberg E, Persson BM (1983). Age, diabetes and smoking in lower limb amputation for arterial occlusive disease *Acta Orthop Scand* **54,** 383–388.

Liedberg E, Persson BM (1983). Increased incidence of lower limb amputation for arterial occlusive disease. *Acta Orthop Scand* **54,** 230–234.

Mooney V, Wagner W, Waddell J, Ackerson T (1976). The below-the-knee amputation for vascular disease. *J Bone Joint Surg* **58A,** 365–368.

Most R, Sinnock P (1983). The epidemiology of lower extremity amputations in diabetic individuals. *Diabetes Care* **6,** 87–91.

Steer HW, Cuckle HS, Franklin PM, Morris PJ (1983). The influence of diabetes mellitus upon peripheral vascular disease. *Surg Gynecol Obstet* **157,** 64–72.

Weaver PC, Marshall SA (1973). A functional and social review of lower-limb amputees. *Br J Surg* **60,** 732–737.