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Prosthetic use and functional and social outcome following major lower limb amputation

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Abstract
A total of 175 consecutive below and above-knee amputees sent to the prosthetic workshop in Helsinki for prosthetic fitting from 32 hospitals were reviewed to determine their functional ambulation and social adaptation. The average age of the patients was 62.2 years at the time of the prosthetic fitting. The mortality was 11% (19) during the first postoperative year. One-year postoperative information was obtained for 141 of the surviving patients (90%) by personal contact. At the time of the review, 68% of the amputees (96 patients) who had been fitted with a prosthesis made extensive and regular use of it. Half of all the above-knee amputees and 79% of the below-knee amputees used their prosthesis throughout the day or over seven hours a day. A total of 72% of the above-knee amputees (33/46) and 85% of the below-knee amputees (67/79) had useful ambulation, at least indoors. Of the 141 patients contacted, 124 (88%) lived in their own homes. The remaining 16 patients (11%) lived in apartment houses for the aged or old people's homes. A total of 48 amputees (34%) needed a regular home help.

Introduction

In Finland, there has been a clear increase in the number of lower limb amputations since the early 1970s (Solonen et al., 1973; Pohjolainen and Alaranta, 1988). The yearly incidence of major amputations has been 25 per 100,000 inhabitants. Amputation is often regarded as the final failure of orthopaedic or vascular treatment. However, amputation can often eliminate a painful limb, bring relief to the patient and also allow rehabilitation of the patient to the status of a functional prosthetic ambulator. The majority of amputations performed in the Western world are due to arterial insufficiency (Department of Health and Social Security, 1986; Helm et al., 1986; Ebskov, 1988).

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In amputation surgery and rehabilitation the most important outcome for the patient and the family is successful ambulation, with return to suitable accommodation and to previous social connections. The amputee frequently makes heavy demands upon the social services and the welfare workers of the hospital and the community. In addition to social adaptation, the rehabilitation process involves training the patient to walk with a prosthesis and to use ancillary aids.

The purpose of this study was to review the functional success of prosthetic ambulation according to different levels of amputation. In addition, a number of variables were analysed to assess their correlation with mobility. The return to society, whether ambulant or in a wheelchair, the living environment and the need for social services were also assessed.

Materials and methods

The patient base consisted of a total of 175 consecutive patients with major lower limb amputations sent to the Prosthetic Factory of Helsinki for prosthetic fitting by the operative units. The patients had been operated on between November 1985 and August 1988. The patients were examined by a physiatrist and a certified prosthetist. The medical records of the patients were also evaluated. Several variables such as cardiovascular, neurological and pulmonary diseases, operations and medication were defined. Out of all the original total of 175 patients, 19 (11%) died during the first postoperative year. The mortality at one year for vascular amputees was 11%, for tumour patients 12% and trauma patients 10%. Follow-up information for 141 (90%) of the surviving patients was obtained by personal contact after one postoperative year, with patients being interviewed and examined by the authors.

Patient sample

The sample consisted of 127 (73%) males and 48 (27%) females. The mean age was 62.2 years

Table 1. Distribution of patients according to diagnosis.

Diagnosis	Number of patients	
Vascular disease	142	(81.2%)
diabetes	88	
arteriosclerosis	52	
embolism	2	
Trauma	17	(9.7%)
Malignant tumour	10	(5.7%)
Frostbite	4	(2.3%)
Other	2	(1.1%)
Total	175	(100.0%)

with a range of 14 to 87 years. The proportion of the total sample in each age group increased progressively up to the 70-79 age group. The latter constituted the largest ten-year cohort, representing 31% of all the 175 amputees. The majority, 103 (59%), were between 60 and 79 years of age.

The distribution of patients according to diagnosis is shown in Table 1. The most prominent diagnosis was disease of vascular origin.

The distribution of patients by sex, type of amputation and age is shown in Table 2. There were 93 (53%) below-knee (BK), 62 (35%) above-knee (AK) and 20 (11%) bilateral amputees, of which 15 were bilateral BK, 3 bilateral AK and 2 BK/AK amputee patients. The mean age was 73.0 for female BK and 62.8 years for AK amputees, while the figures for men were 59.9 and 61.7 years, respectively.

Thirty-nine per cent of all the patients had undergone a previous vascular procedure or amputation. A reconstructive operation was the most common procedure (33%). The other procedures were sympathectomy (24%), amputation of the ipsilateral or contralateral limb (20%), endarterectomy (15%) and embolectomy (8%).

The patients had many additional concurrent disabilities: there was a 22% incidence of symptomatic ischaemic heart disease, while 14% of the 175 patients had experienced myocardial infarction and 49 (28%) had congestive cardiac failure. Eighteen (10%) had experienced a cerebrovascular accident.

Table 2. Distribution of 175 patients by sex, type of amputation performed and age.

Sex	Unilateral		Bilateral			Age (yrs)	
	BK	AK	BK/BK	BK/AK	AK/AK	$\bar{x}$	SD
Women	27	16	4	1	–	67.5	13.2
Men	66	46	11	2	2	60.2	16.2
Total	93	62	15	3	2	62.2	15.8

Classification of functional level

To summarize the information given in this section, the patients were classified into seven categories adapted from Narang et al. (1984):

Class I Ambulating with a prosthesis but without other walking aids.

Class II Independent at home, ambulating with a prosthesis but requiring one walking stick or crutch for outdoor activities.

Class III Independent indoors, ambulating with a prosthesis and one crutch, but requiring two crutches outdoors and occasionally a wheelchair.

Class IV Walking indoors with a prosthesis and two crutches or a walker, but requiring a wheelchair for outdoor activities.

Class V Walking indoors only short distances ambulating mostly with a wheelchair.

Class VI Walking with aids but without a prosthesis.

Class VII Nonambulatory except in a wheelchair.

Results

The average delay between the operation and the first permanent prosthesis was 16.4 weeks in all groups: 16 weeks for BK prostheses, 16.3 weeks for AK prostheses and 19.3 weeks for bilateral prostheses.

Table 3. Location of 141 surviving amputees.

Location	Below-knee	Above-knee	Bilateral	Total
At home				
alone	17 (21.5%)	16 (34.8%)	3 (18.8%)	36 (25.5%)
with spouse	43 (54.4%)	20 (43.5%)	8 (50.0%)	71 (50.3%)
with relatives	7 (8.9%)	7 (15.2%)	3 (18.8%)	17 (12.1%)
Apartment house for the aged	5 (6.3%)	3 (6.5%)	1 (6.2%)	9 (6.4%)
Old people's home	7 (8.9%)	–	–	7 (5.0%)
Hospital	–	–	1 (6.2%)	1 (0.7%)
Total	79 (100.0%)	46 (100.0%)	16 (100.0%)	141 (100.0%)

Table 4. Need for a home help among 141 amputees.

Home help	Below-knee	Above-knee	Bilateral	Total
No home help	53 (67.1%)	29 (63.1%)	11 (68.8%)	93 (66.0%)
1-3 hours/week	16 (20.3%)	7 (15.2%)	5 (31.2%)	28 (19.9%)
4-8 hours/week	10 (12.6%)	10 (21.7%)	–	20 (14.1%)
Total	79 (100.0%)	46 (100.0%)	16 (100.0%)	141 (100.0%)

Accommodation

At the time of the prosthetic fitting, 19 patients (11%) were in hospital. Their accommodation at the time of follow-up is summarized in Table 3. A total of 10 amputees (7%) removed into apartment houses for the aged after amputation. One amputee (1%) was in hospital at the time of the review. Of the 141 patients, 124 (88%) lived in their own homes. The remaining 16 patients (11%) lived in apartment houses for the aged or in old people's homes. Structural modifications to patient's homes such as the installation of ramps and rails, handrails in the toilet and bathroom etc. were required in the homes of 60 amputees (43%).

Home help

At the time of the follow-up, 48 amputees (34%) needed a regular home help (Table 4). Twenty-eight amputees (20%) needed a home help 1-3 hours per week and 20 amputees (14%) needed a home help 4-8 hours per week.

Employment

Of the 81 patients under 65 years of age at the time of amputation, 29 (36%) were in full or part-time employment, 4 (5%) were on sick leave, 2 (2%) were students and 46 (57%) were retired on a pension. Of the 72 patients aged under 65 at the time of the follow-up, 12 (17%) were working, 4 (5%) were on sick leave, 5 (7%) were students and 51 (71%) were retired.

Use of the prosthesis

The prosthesis was used for a mean daily total of 9.3 hours for women and 10.1 hours for men. At the time of the review, 68% of the amputees (96 patients) who had been fitted with a prosthesis made extensive and regular use of it, wearing it either all day (85 patients) or for a major part of the day (11 patients) (Table 5). A further 23 patients used it for about half of the day, while 7 patients used it for only a part of the day or occasionally, and 15 patients never used their prosthesis at all.

Only half (23/46) of the AK amputees used their prosthesis all day or over seven hours a day. The corresponding figure for the BK amputees was 79% (62/79).

Mobility

Table 6 shows the grades of mobility in the 141 patients who were followed up one year after amputation. At the time of the review, 85 amputees (60%) had useful ambulation indoors and outdoors (Classes I-III) and 111 (79%) were able to walk indoors (Classes I-IV). A further 15 amputees (11%) walked only short distances indoors (Class V) and 11 patients (8%) moved only in a wheelchair (Class VI). Of these 15 nonambulators (Classes VI-VII), 80% were over 60 years of age and 73% were AK amputees.

Of the AK amputees, 72% (33/46) were successful ambulators with their prosthesis, at least indoors (Classes I-IV). The corresponding figures for the BK amputees were 85% (67/79). Five per cent (4/79) of the BK amputees and 24% (11/46) of the AK amputees were nonambulators with their prosthesis. Of the bilateral amputees, 69% (11/16) walked with their prosthesis indoors (Classes I-IV) but the majority ambulated with a wheelchair when outdoors.

Table 5. Use of artificial limb by 141 major amputees.

Use of artificial limb	Below-knee	Above-knee	Bilateral	Total
No use	4 (5.1%)	11 (23.9%)	–	15 (10.6%)
1-3 hours/day	5 (6.3%)	2 (4.3%)	–	7 (5.0%)
4-6 hours/day	8 (10.1%)	10 (21.7%)	5 (31.2%)	23 (16.3%)
7-11 hours/day	6 (7.6%)	5 (10.9%)	–	11 (7.8%)
> 12 hours/day	56 (70.9%)	18 (39.1%)	11 (68.8%)	85 (60.3%)
Total	79 (100.0%)	46 (100.0%)	16 (100.0%)	141 (100.0%)

Table 6. Functional outcome of amputation.

Class	Below-knee	Above-knee	Bilateral	Total
Class I	17 (21.5%)	5 (10.9%)	1 (6.3%)	23 (16.3%)
Class II	26 (32.9%)	5 (10.9%)	3 (18.8%)	34 (24.1%)
Class III	13 (16.5%)	14 (30.4%)	1 (6.3%)	28 (19.9%)
Class IV	11 (13.9%)	9 (19.6%)	6 (37.5%)	26 (18.4%)
Class V	8 (10.1%)	2 (4.3%)	5 (31.3%)	15 (10.6%)
Class VI	4 (5.1%)	7 (15.2%)	–	11 (7.8%)
Class VII	–	4 (8.7%)	–	4 (2.8%)
Total	79 (100.0%)	46 (100.0%)	16 (100.0%)	141 (100.0%)

According to patients' reports, the mean walking distance was 360 metres for women and 830 metres for men. Among the follow-up amputees, 21 (15%) felt that they walked as much as non-amputees – for example they could walk outdoors for 2-3 hours – while 33 amputees (23%) could walk over one kilometre.

The main subjective symptom restricting walking in the amputees was ischaemic pain in the contralateral leg. The pain was mild in 19 amputees (14%), quite severe in 21 amputees (15%) and severe in two amputees (1%). Of the 141 amputees, 16 (11%) suffered from pain in the knees or hips and 9 (6%) from low back pain. Four patients (3%) had skin problems in their stump, 4 (3%) had symptomatic ischaemic heart disease and 3 (2%) had hemiplegia resulting in disability. In the complete group of 141 patients, 7 (5%) had some discomfort in the form of stump pain and 75 (53%) suffered from phantom pain. In one of these patients the stump pain was severe enough to limit walking.

Discussion

In most series concerning the rehabilitation of lower limb amputees, the patient base is consisted of the patients of one surgical unit (Helm et al., 1986; Cumming et al., 1987; Moore et al., 1989). The patients in this study came to the prosthetic workshop from 32 different hospitals for the prosthetic fitting. In general, only some of the amputees receive a prescription for a prosthesis at all. In Finland, the percentage of prosthetic fitting has been 62% for BK amputees and 27% for AK amputees (Pohjolainen et al., 1989).

The loss of a leg is a major disaster for patients, limiting both mobility and independence. Most patients with vascular disease are elderly with concomitant chronic illnesses. In this series, only 41% of the 175 patients had no other diseases. There was a considerable proportion of diabetics – 51%, which is similar to the proportion found in some other studies (Mooney et al., 1976; Rush et al., 1981; Tan et al., 1983). Other studies have also found similar high percentages for concurrent disabilities and concomitant chronic illnesses (Weaver and Marshall, 1973; Rush et al., 1981; Cumming et al., 1987). The disabilities resulting from cardiovascular disease, impaired vision and reduced learning capacity frequently impose extra problems in locomotion and in achieving independence.

The higher age at operation among the women is in agreement with previous observations (Mandrup-Poulsen and Jensen, 1982; Helm et al., 1986). It may reflect an earlier onset of arterio-sclerosis in men. In the present series men also had bilateral amputations performed more often than women, which is in accordance with the findings of Helm et al. (1986).

Early and better mobility can be facilitated by conservation of the knee joint with consequent retention of proprioception and a lower energy requirement (Waters et al., 1976; Huang et al., 1979). In the present study, there was evidence that retention of the knee joint influences the final degree of mobility, as 85% (67/79) unilateral BK amputees were mobile indoors with their prosthesis compared with 72% (33/46) where the knee joint was sacrificed. Of the patients in this study, 73% (11/15) of those in whom the prosthesis was unsuccessful were AK amputees. This is in accordance with the findings of Moore et al. (1989).

The use of a prosthesis indicates the state of rehabilitation and the benefit of the prosthetic fitting process in general. Of the 141 follow-up patients, 22 (16%) did not use their prosthesis or used it less than three hours per day, while 85 (60%) could ambulate with the prosthesis indoors and outdoors. Four patients (3%) ambulated only with a wheelchair while 69 (49%) needed the wheelchair occasionally or were able to get outside their home with the wheelchair. Many elderly patients cannot walk safely with crutches or a walker, especially outdoors.

The main symptom which restricted walking was ischaemic leg pain. Stump problems were very common but in only one of the patients was the stump pain severe enough to be a contributory

factor in limiting the use of the prosthesis. In the series of Weaver and Marshall (1973) there was a 23% incidence of stump or phantom pain and in 10% of these patients the discomfort was so severe that it either caused cessation of walking or limited the use of the prosthesis.

Chilvers and Browse (1974) stressed the difficulty of returning patients to their homes and 7 out of 20 of their cases were discharged to institutions. Of the 105 patients reported by Weaver and Marshall (1973), 18 were discharged to institutions. In the present study of 175 patients, 146 (83%) came from their home for prosthetic fitting and were also discharged home. A total of 29 patients (17%) came from institutions but at the time of follow-up only 17 patients (12%) were in institutional care. The successful return of 83% of surviving amputees to their homes would not have been possible without the involvement of medical social workers and home helps, or the structural alterations carried out in the homes of amputees.

The problem is also the time lag of 16.4 weeks between surgery and the fitting of the prosthesis, a delay observed in another Finnish study (Pohjolainen et al., 1989). Yet, although there have been delays in the prosthetic fitting, the percentages with an unsatisfactory outcome for prosthetic use (28% for AK and 15% for BK amputees) are not high compared with those in other reports (Jensen and Mandrup-Poulsen, 1983; Moore et al., 1989). By activating postoperative training, reducing the delay in the prosthetic fitting and organizing the regular follow-up of amputees the chance of a poor functional and social outcome may be minimized. There is also a need to assess several independent variables in order to determine the feasibility of prosthetic use and ambulation following major lower limb amputation, especially in elderly amputees.

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