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RESEARCH PAPER

Claimed walking distance of lower limb amputees

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Abstract

Purpose: Walking ability in general and specifically for lower limb amputees is of major importance for social mobility and ADL independence. Walking determines prosthesis prescription. The aim of this study was to mathematically analyse factors influencing claimed walking distance of lower limb amputees of 500 m or more.

Method: A total of 437 patients returned two questionnaires: the Groningen Questionnaire Problems after Leg Amputation, in which walking distance was assessed, and the RAND 36.

Results: The chance of walking 500 m or more reduced when a transfemoral amputation was performed. The chance reduced even more when phantom pain or stump pains were present. If the amputation was performed because of vascular disease or because of vascular problems because of diabetes the chance reduced again. Independently of these factors, age reduced the chance of walking 500 m or more.

Conclusion: The chance of walking 500 m or more reduces with increase in age and a more proximal amputation. The chance reduces even further when the amputation is performed because of diabetes or a vascular disease and also if phantom pain and or stump pain is present.

Keywords: *Lower limb amputee, walking, phantom pain*

Introduction

Walking ability in general and specifically for amputees is of major importance for social mobility. Walking enables a simple and directly available means of transportation. Minor limitations in walking distance may limit social interactions partially if no other means of transportation are available. Larger limitations in walking distance may hinder shopping and recreational activities, and major limitations in walking distance may not only restrict outdoor activities but also indoor activities. In this respect, walking distance is an important factor in life: it enables ADL independence.

Walking distance is critical in lower limb amputees, especially in elderly amputees suffering from co-morbidity such as diabetes mellitus, osteoarthritis or

vascular disease. However, these elderly amputees with co-morbidity are the majority of the total group of amputees; about 80% of amputees are 60 years or older [1].

After lower limb amputation, adequate prostheses prescription is necessary to be able to walk, but only 48% of elderly amputees are fitted with a prosthesis [1]. Further, the ability to walk depends on the possibility of fitting a prosthesis, which in turn depends partially on co-morbidity [2,3]. Reciprocally, walking distance of a patient determines, amongst other things, the properties and components of the prosthesis prescribed. In the process of prescribing a prosthesis, a patient is usually asked for her or his ability to walk a distance. It is estimated that a walking distance of 500 m or more enables adequate ADL independence and is a positive

determinant with respect to quality of life in amputees [4]. With this distance of 500 m, shops in the neighbourhood can be visited either by walking or by walking from a parked car to the entrance of the shop and still being able to walk in the shop.

If the walking distance exceeds 500 m, the requirements of the prosthesis are more demanding: such as multiaxis ankle, dynamic foot and a multibar linkage knee [5,6]. If the walking distance is less than 500 m, the requirements of the prosthesis are less demanding and more focussed on stability. Thus, information given by the patient about his or her walking ability and walking distance is important for the requirements of the prosthesis. Further, prostheses prescription and thus also walking distance depend on the age and the profession of the amputee, the reason for amputation and the level of amputation, stump condition, comorbidity, stump pain and phantom pain [7–9]. The influences of the different variables on walking distance have been analysed univariately in different studies, but the cumulative effects of these variables on walking distance are seldom analysed.

The aim of this study was to analyse, mathematically, the walking distance claimed by lower limb amputees of 500 m or more. In the analysis, age, level of amputation, stump pain, phantom pain and reasons for amputation are included.

Patients and methods

Patients with a lower limb amputation were identified in the database of an orthopaedic manufacturing company (OIM Haren, The Netherlands). This database included patients who were referred by their physician (mostly medical specialists in Physical Medicine & Rehabilitation) to the orthopaedic manufacturer since 1 January 1993, for prosthesis fitting because of a major lower limb amputation. First, the manufacturer sent a letter to all patients who were registered in the database ($n = 1436$), in which they were informed about the study and in which they were invited to participate. In total, 536 (37%) patients returned positive replies. These patients were sent a questionnaire. Of this group, 437 (82%) patients returned the questionnaire. The questionnaire, the Groningen Questionnaire Problems after Leg Amputation (GQPLA) is a modified version of the questionnaire we used in an earlier study of upper limb amputees [4,10,11]. This questionnaire assesses reason and level of amputation, presence of phantom pain and stump pain, and walking distance (500 m or more). Demographic questions are also asked. To verify the answers concerning walking, the RAND-36 was also sent simultaneously [12]. The RAND-36 is a 36-item Health Survey and is similar to the MOS-36. The RAND-36 has nine subscales: physical functioning (walking, stair climbing, running, ADL), social

functioning (social contacts), role limitations (restriction of ADL due to physical problems), role limitations (restriction of ADL due to emotional problems), mental health, vitality, pain, general health perception and health change.

Stump pain was operationally defined as any painful sensation in the stump. Phantom pain was operationally defined as any sensation in the amputated part of the extremity that is so intense that it is experienced as painful [10,13].

Descriptive statistics, correlation between physical functioning of the RAND-36 and the claimed walking distance assessed in the GQPLA and multivariate logistic regression analyses were performed in SPSS version 9.0 for Windows. A multivariate logistic regression was used to analyse the relationship between two or more continuous or categorical explanatory variables and a single dichotomous response variable, in this study, the ability to walk 500 m or more. The ability to walk 500 m or more was predicted on the basis of presence or absence of the explanatory variables, age, and transfemoral or transtibial amputation, amputation due to vascular reasons or diabetes, phantom pain and stump pain. For a detailed example of the calculations the reader is referred to Dijkstra et al. [11].

From the results of the regression analysis, the chance of walking 500 m or more was calculated for different combinations of explanatory variables.

Results

Table I summarises the demographics of the amputees and amputation characteristics.

Phantom pain was present in 80% of the lower limb amputees. Of the subjects experiencing phantom pain, 70% experienced phantom pain at least a couple times per month. Stump pain was present in 68% of the amputees.

The correlation (Spearman's ρ) between physical functioning of the RAND-36 and the claimed walking distance assessed in the GQPLA was 0.73 ($P < 0.001$). For the regression analysis, only the patients with the transtibial and the transfemoral amputations were included, because these patients groups were the largest two groups. The regression coefficients are summarised in Table II. The regression model predicted 73% correctly.

Figure 1 presents the chance of walking 500 m or more for different age groups and different combinations of explanatory variables. For example, a transtibial amputee of 60 years and suffering from phantom pain or stump pain has a 78% chance of walking 500 m, and if the age of the same patient was 80 the chance would be reduced to 55%. However, for a transtibial amputee without phantom pain, these chances would be 88 and 73%, respectively.

Figure 1. TT, transtibial amputation; TF, transfemoral amputation; PP, phantom pain; SP, stump pain. The categories marked with V are the amputations are performed due to a vascular disease or diabetes mellitus. The other amputations were performed because of trauma, oncological disease or were congenital. Note the considerable reduction in the chance of walking 500 m or more with an increase in age for all combinations of explanatory variables. The difference in influence of transtibial amputation compared to transfemoral amputation is also large, and this difference increases with an increase in age. Because the regression coefficients for stump pain and phantom pain were about the same (Table II), the influence of stump pain and phantom pain on the chance of walking 500 m or more are not presented separately.

Table I. Reason for amputation, amputation type and age and duration of being amputated in lower limb amputees.

Patient characteristics	% (n)
Age, mean (SD)	65.2 (15.1)
Duration of being amputated (years), mean (SD)	17.9 (17.9)
Males	71 (302)
Females	29 (125)
<i>Reason for amputation</i>	
Vascular disease	28.8 (126)
Diabetes mellitus	20.6 (90)
Trauma	34.3 (150)
Cancer	8.7 (38)
Congenital	2.3 (10)
Other	4.3 (19)
<i>Amputation type</i>	
Pelvis	0.5 (2)
Hip	2.3 (10)
Transfemoral	28.1 (122)
Knee-exarticulation	7.8 (34)
Transtibial	57.1 (248)
Ankle	2.5 (11)
Others	1.6 (7)

Data do not add up to 437 because some data were missing.

Discussion

The chance of walking 500 m or more reduces with increase in age and a more proximal amputation. The chance reduces even further if the amputation was performed because diabetes or vascular disease is present, and also if phantom pain and or stump pain is present.

Table II. Regression coefficients.

Variables	β
Transfemoral (yes/no)	-0.859
Age (per year)	-0.054
Stump pain (yes/no)	-0.757
Phantom pain (yes/no)	-0.772
Amputation reason vascular or DM (yes/no)	-1.279
Constant (transtibial)	5.303

The regression coefficients of phantom pain and stump pain were almost identical. Therefore, the influence on walking distance of these variables is not presented separately because this would have resulted in largely overlapping lines. Further, we restricted the analysis to transfemoral and transtibial amputations for two reasons: these amputations were the largest groups. Moreover, energy expenditure for walking with a transfemoral or a transtibial amputation has been investigated extensively [14,15]. The energy expenditure is larger for the transfemoral amputation. There is even less known with regard to the energy use during walking for other types of amputation (pelvic, knee exarticulation) [16].

The results of our study can be used to predict the chance of walking 500 m or more for lower limb amputees. These data can be a helpful in prescription of prostheses [17]. In the provision of a prosthesis, the future of the amputee should be matched with the prosthetic components and the use of the whole

prosthesis. It is recommended that the functional ability (including walking distance) of the amputee forms the starting point in formulating the prescription of a lower limb prosthesis [18, 19]. Prescription of the specified components of the prosthesis depends on the age of the amputee, co-morbidity, mental condition, etc. In our calculations we used pain, age, level of amputation and co-morbidity (diabetes mellitus or vascular reason for amputation) as the explanatory variables.

A restriction of our study was that we did not actually measure the walking distance. However, in the process of prescribing a prosthesis, the patient is always asked to estimate their walking distance. Only during prescription of the first prosthesis is a physiotherapist counselled. To validate the claimed walking distance we also send the RAND-36 with the subscale 'physical functioning'. The RAND-36 is a short version of the RAND Health Insurance Study Questionnaire and it is similar to the MOS SF 36 [12]. The correlation between both was 0.73. This correlation supports the validity of the claimed walking distance considerably.

Another weakness of our study is the selection bias, only amputees who were referred to the orthopaedic manufacturer were included in the study. In our study group, we have a rather large percentage of traumatic amputees (34%) who are usually healthier than vascular patients, and thus are expected to walk a larger distance, as is found in the regression analysis with a larger chance.

Conclusions

The chance of walking 500 m or more reduces with increase in age and a more proximal amputation. The chance reduces even further when the amputation is performed because of diabetes or vascular disease, and also if phantom pain and or stump pain is present.

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