

Falls in Unilateral Lower Limb Amputees Living in the Community: A Portuguese Study

Queda na Comunidade em Amputados Unilaterais do Membro Inferior: Um Estudo Português



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ABSTRACT

Introduction: Lower limb amputees present a high risk of falling. This study aims to characterise fall history in unilateral lower limb amputees that are autonomous in the community, identifying differences between transfemoral and transtibial amputees and assessing fear of falling between fallers and non-fallers.

Material and Methods: Descriptive, cross-sectional study of consecutive community-dwelling unilateral lower limb adult amputees of any aetiology, attending outpatient consultation in a Portuguese Physical and Rehabilitation Medicine central and university hospital department. Inclusion criteria: a prior 12 week individualised rehabilitation program for prosthesis training; regular prosthesis use for more than one year with autonomous gait; and a Functional Independence Measure[®] score equal to or greater than 100. Injury severity was classified according to the National Database of Nursing Quality Indicators[®] injury falls measure. In order to assess walking performance over short distances and fear of falling we used the 10-meter walk test and the Falls Efficacy Scale, respectively.

Results: In a sample of 52 lower limb amputees, mainly men (80.8%) and of traumatic aetiology (63.5%), with a mean age of 57.21 ± 11.55 years, 36.5% reported at least one fall in the previous 12 months, all classified as minor injuries. Transfemoral amputees (n = 23) presented a higher number of falls (2.22 ± 3.23, p = 0.025) and lower gait velocity (0.77 ± 0.26 m per second, p < 0.001). Regarding fear of falling, we found no significant differences between fallers and non-fallers.

Discussion: The prevalence of falls was low and of minor severity. Transfemoral amputees fell more often and were slower. There were no reported differences in fear of falling between groups.

Conclusion: This paper contributes information about Portuguese lower limb amputees, whose studies are scarce and are rarely dedicated to falling.

Keywords: Accidental Falls; Amputation/rehabilitation; Amputees/rehabilitation; Lower Extremity

RESUMO

Introdução: Amputados do membro inferior apresentam um elevado risco de queda. Neste estudo pretende-se caracterizar a história de queda em amputados unilaterais de membros inferiores, autónomos da comunidade, identificar diferenças entre transfemorais e transtibiais e avaliar diferenças no medo de cair entre os que caíram e os que não caíram.

Material e Métodos: Estudo descritivo, transversal, de amputados unilaterais de membros inferiores, adultos, residentes na comunidade, de qualquer etiologia, consecutivamente recrutados da consulta do serviço de Medicina Física e de Reabilitação de um hospital central e universitário de Portugal. Critérios de inclusão: reabilitação de 12 semanas para treino protético; uso regular de prótese superior a um ano, marcha autónoma e Medida de Independência Funcional[®] igual ou superior a 100. A gravidade de queda foi classificada recorrendo à *National Database of Nursing Quality Indicators[®] injury falls measure* e a capacidade de andar e medo de cair com, respetivamente, o *10-meter walk test* e a *Falls Efficacy Scale*.

Resultados: Foi analisado um total de 52 amputados, maioritariamente homens (80,8%) e de etiologia traumática (63,5%) e com idade média 57,21 ± 11,55 anos, dos quais 36,5% relataram pelo menos uma queda, todas de baixa gravidade. Os transfemorais (n = 23) apresentaram mais quedas (2,22 ± 3,23, p = 0,025) e menor velocidade de marcha (0,77 ± 0,26 m por segundo, p < 0,001). Relativamente ao medo de cair, não encontramos diferenças significativas entre doentes amputados com e sem história de quedas.

Discussão: A prevalência e gravidade de queda foi baixa. Amputados transfemorais apresentaram mais quedas e menor velocidade de marcha. Não existiram diferenças no medo de cair em função da história de queda.

Conclusão: Este trabalho acrescenta informação acerca dos amputados do membro inferior portugueses, cujos estudos são escassos e raramente dedicados a queda.

Palavras-chave: Amputação/reabilitação; Amputados/reabilitação; Extremidade Inferior; Quedas Acidentais

INTRODUCTION

Lower limb amputation is a disabling clinical condition usually related to restriction in social participation.^{1,2} This is a highly prevalent condition and it is estimated that the number of people living with lower limb amputation may double in the next three decades.³ An English study estimates the prevalence rate of amputations to be 26.3/100 000,⁴ for

those aged of 50 – 84 years old. In Portugal, national data on lower limb amputation is yet to be published.

Falls represent a significant health risk and are usually related to having less mobility, loss of balance, loss of confidence and self-imposed restriction on participation.^{5,6} It is estimated that up to 30% of older people living in the

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community will fall every year.⁷ Unilateral lower limb amputees are more prone to falling when compared to able-bodied individuals, with a reported incidence of 52.4%⁵ to 58%⁸ among community-dwelling amputees.⁹ According to one study, 12% of falls were related to prosthetic conditions, 22% to the environment, and 48% were due to a combination of various intrinsic factors.⁸ Severe falls occur in 26.8%¹⁰ to 40.4%⁵ of the community-dwelling adult lower limb amputee population.⁹ The fall risk seems to be present from the moment of amputation until several years after the prosthetisation, probably due to progressive deterioration of balance.^{9,11,12} Transfemoral amputation, lumbar and joint pain and several problems with stump or prosthesis were associated with an increased fall risk among lower limb amputees.^{5,6}

The ability to walk and perform independent activities of daily living (ADL) while wearing a prosthesis is usually associated with a better function. Conversely, fear of falls and deterioration of functionality can be strongly disabling.^{6,13,14} The Falls Efficacy Scale (FES) and the 10-meter walk test (10MWT) are two instruments used to characterise the functionality of lower limb amputees.¹⁵⁻¹⁷ FES measures fear of falls and 10MWT assesses walking speed over short distances. The level of functional performance is relevant to detect fall risk. Early identification^{8,9,19} and the ability to promote a rehabilitation program can decrease the number and lower the severity of falls in this population.²⁰⁻²²

The aims of this study were to characterize the fall history of Portuguese community-dwelling unilateral lower limb amputees with autonomous gait, to identify the main clinical differences between transfemoral and transtibial amputees and to assess the fear of falls between fallers and non-fallers.

MATERIAL AND METHODS

A descriptive and cross-sectional study was carried out by recruiting consecutive community-dwelling unilateral lower limb amputees, of any etiology, attending the amputee outpatient consultation of the Physical and Rehabilitation Medicine (PRM) department of Centro Hospitalar e Universitário de Coimbra (CHUC), Portugal, between October and December 2017.

The inclusion criteria were: age over 18; a prior 12 week individualised rehabilitation program for prosthesis training; regular prosthesis use (over eight hours daily) for more than one year with autonomous gait (with or without assistive technologies); and a Functional Independence Measure® (FIM®) score equal to or greater than 100.

The exclusion criteria were: various comorbidities (uncontrolled cardiovascular disorders, neurological, and vestibular or visual disorders), inability to fill in questionnaires; cognitive deterioration; inability to understand the Portuguese language.

The 12-week rehabilitation program focused on muscle strengthening, balance and gait kinematics training, assistive devices usage, and on promoting aerobic conditioning in ADL. It was designed by an experienced PRM medical

team and implemented by qualified physiotherapists and rehabilitation nurses at the department of PRM.

Ethics committee approval was granted by the Ethics Committee of CHUC and written informed consent was obtained from each participant.

Measures

Every eligible patient replied to a questionnaire that included demographic (age and gender), clinical (amputation level, amputation etiology, years of prosthetisation and assistive walking device usage) and falls (number and severity of falls in the previous year) related questions.

FIM® assesses 18 basic ADL divided into 6 main areas: self-care, sphincter control, transfers and locomotion; communication and social cognition. Each task is ranked on a 7-point ordinal scale ranging from 1 ('total assistance') to 7 ('complete independence') resulting in a total score of 18 - 126 points.^{23,24} We used FIM® as an inclusion criterion to guarantee that only the amputees with high ADL independence were selected, thus ensuring a more homogenous sample concerning functionality. To the best of our knowledge, since the existing literature lacks any cut-off that indicates significantly greater independence regarding amputee patients, in this study it was defined as a minimum of 100 points to ensure that, on average, any eligible subject scored between 5 ('supervision or setup') and 6 ('modified independence').

In order to assess walking speed, we performed the 10MWT,^{15,17} which is a simple method of measuring walking speed in meters per second over a short duration. Subjects were instructed to walk a 10 m straight path distance at their preferred walking pace. Speed was calculated over the middle 6 m to allow for acceleration and deceleration at either end. We conducted three repetitions to calculate the average speed of each amputee. Participants who usually used walking aids (cane, crutches, or walker) performed the test with them.

In order to measure fear of falling we applied FES,^{16,18,25} which is based on the definition of fear as "a low perceived self-efficacy at avoiding falls during essential, non-hazardous activities of daily living". Self-efficacy is the personal judgment of an individual's capabilities within a particular domain of activities. Efficacy may be linked to functional decline since people with low perceived efficacy in an activity tend to avoid the activity.^{25,26} Thus, higher fall self-efficacy indicates less fear of falling. FES is composed of 10 items corresponding to tasks of various degrees of difficulty; the total score ranges from 10 to 100 with higher scores indicating less fear of falling.¹⁸

We classified fall-related injury severity according to the National Database of Nursing Quality Indicators® (NDNQI®) Injury Falls Measure (none, minor, moderate, major, or death).²⁷

All variables were compiled for descriptive analysis. Frequency tables, measures of central tendency (mean, median), and dispersion measures (standard deviation) were used. Normality of distributions was assessed using the

Kolmogorov-Smirnov test.

We then divided eligible patients into groups for further analysis according to the amputation level (transfemoral and transtibial) and the fall history in the previous year (fallers and non-fallers). Fallers were patients reporting at least one fall in the previous year regardless of its severity, and the non-fallers had no reported falls in the same period. Pearson's chi-square and student's *t*-test were used where applicable.

P-values < 0.05 were considered significant with 95% of confidence interval (CI₉₅). Analysis was performed using IBM® SPSS Statistics version 23 for Windows®.

RESULTS

In Table 1 we present the sample characterization and the differences between transfemoral and transtibial amputees, and between fallers and non-fallers.

From the 138 amputees scheduled for outpatient consultation between October and December 2017, 52 partici-

pants met the criteria, completed all assessments and were therefore included in the study and data analysis. From the 86 patients excluded, 42 amputees never attended the consultation and 44 did not meet the criteria. From the 52 study subjects, 42 were men (80.8%). The mean age was 57.21 ± 11.55 years. Concerning the level of amputation, 29 (55.8%) amputees were transtibial and 23 (44.2%) were transfemoral. The most frequent cause of amputation was trauma (63.5%), followed by vascular (25.0%), and all patients had worn their current prosthetic leg for more than 12 months (range 1 to 5 years). Twenty four amputees (46.1%) reported using walking aids on a daily basis. Regarding the history of falls, 19 (36.5%) patients recalled at least one fall in the previous year. The number of falls varied from 1 to 11 (mean 1.27 ± 2.48). Six out of 52 (11.5%) patients had experienced only one fall and 13/52 (25.0%) had recurrent falls. Only 6/52 (11.5%) patients experienced any fall-related adverse events, all reported as minor injuries according to the NDNQI® Injury Falls Measure. The FIM® score, an

Table 1 – Sample characterization and comparison between transfemoral and transtibial amputees and between fallers and non-fallers

	Transfemoral (n = 23)	Transtibial (n = 29)	Non-fallers (n = 33)	Fallers (n = 19)	Total (n = 52)
Gender [n (%)]					
Female	5 (21.7)	5 (17.2)	6 (18.2)	4 (21.1)	10 (19.2)
Male	18 (78.3)	24 (82.8)	27 (81.8)	15 (78.9)	42 (80.8)
Age/years [mean ± SD]	59.48 ± 11.56	55.41 ± 11.41	55.21 ± 11.91	60.68 ± 10.27	57.21 ± 11.55
Level of Amputation [n (%)]					
Transtibial	N/A	N/A	23 (69.7)	6 (31.6)	29 (55.8)
Transfemoral			10 (30.3)	13 (68.4)	23 (44.2)
Aetiology of amputation [n (%)]					
Vascular	7 (30.4)	6 (20.7)	7 (21.2)	6 (31.6)	13 (25.0)
Traumatic	13 (56.5)	20 (69.0)	21 (63.3)	12 (63.2)	33 (63.5)
Tumor	2 (8.7)	3 (10.3)	4 (12.1)	1 (5.3)	5 (9.6)
Other	1 (4.3)	0	1 (3.0)	0	1 (1.9)
Walking assistive devices [n (%)][‡]					
Yes	17 (73.9)	7 (24.1)	14 (42.4)	10 (52.4)	24 (46.1)
No	6 (26.1)	22 (75.9)	19 (57.6)	9 (47.4)	28 (53.9)
Any fall in the previous year [n (%)]					
Yes	13 (56.5)	6 (20.7)	N/A	N/A	19 (36.5)
No	10 (43.5)	23 (79.3)			33 (63.5)
Fall categories [n (%)]					
Non-fallers	10 (43.5)	23 (79.3)	N/A	N/A	33 (63.5)
Single fallers	4 (17.4)	2 (6.9)		6 (31.6)	6 (11.5)
Recurrent fallers	9 (39.1)	4 (13.8)		13 (68.4)	13 (25.0)
Number of falls [mean ± SD][‡]	2.22 ± 3.23	0.52 ± 1.30	0	1.27 ± 2.48	1.27 ± 2.48
Fall severity [n (%)]					
Death	0	0		0	0
Major injury	0	0	N/A	0	0
Moderate injury	0	0		0	0
Minor injury	4 (17.4)	2 (6.9)		6 (31.6)	6 (11.5)
None	19 (82.6)	27 (93.1)		13 (68.4)	46 (88.5)
FES score [mean ± SD]	81.87 ± 19.57	86.83 ± 18.62	82.94 ± 21.47	87.58 ± 13.83	84.63 ± 19.02
Walking speed/meters per seconds [mean ± SD][‡]	0.77 ± 0.26	1.05 ± 0.26	0.96 ± 0.31	0.85 ± 0.25	0.92 ± 0.29

N/A: non-applicable; SD: standard-deviation; FES: Falls Efficacy Scale;

Fall categories: non-fallers: no reported falls in the previous year; single fallers: only one fall reported in the previous year, regardless severity; recurrent fallers: ≥ 2 falls reported in the previous year, regardless severity.

[‡] Significant difference between transfemoral and transtibial amputees with *p*-value < 0.001;

* Significant difference between transfemoral and transtibial amputees with *p*-value 0.025

inclusion criterion, was 121.06 ± 5.53 points.

The transfemoral group used more walking aids ($p < 0.001$) and presented a higher number of falls [$p = 0.025$, mean difference = 1.70, CI_{95} (0.23; 3.17)] and lower walking speed [$p < 0.001$, mean difference = -0.28 m/s, CI_{95} (-0.43; -0.14)]. No significant differences were found in age and FES scores.

Non-fallers did not differ significantly from fallers, namely in mean age and mean FES score (Table 1).

DISCUSSION

The amputee outpatient consultation at the department of PRM department has an average of 150 amputees every three months, mainly of geriatric age and of vascular etiology. This study included 52 community-dwelling, middle-aged amputees, mostly of traumatic etiology. Therefore, the sample is not representative of amputees treated in our department, since in the 21st century, geriatric age and vascular etiology prevail in all European rehabilitation departments.^{9,21,28}

In our study, the prevalence of falls (36.5%) was found to be lower than that described by other authors, where percentages above 50% have been reported.^{5,8,9} Age and functional pattern of the amputees may justify this lower value. Furthermore, the amputees completed a 12-week functional rehabilitation program focusing on kinetic performances and ADL.

Therapeutic programs implemented after amputation are usually effective in reducing the number and severity of falls.^{19,21,22} In this study, fall severity was described in all cases as minor injury. Injurious falls occurred only in 11.5% of the patients, clearly less than what was previously reported (26.8% to 40.4%) in studies mainly focusing on vascular and geriatric amputees.^{5,10} Wong *et al* concluded that the higher the number of falls, the greater their severity.¹⁰ Fall prevention programs and home intervention may limit this risk, particularly in geriatric amputees.^{29,30}

In agreement with the literature,^{5,6,31,32} transfemoral amputees presented higher prevalence of falls and lower walking speed, even when using more walking assistive devices. Different impairments in mobility (muscle strength, balance, etc.), energetic demands imposed by the type of prosthesis, and cardiorespiratory performance may justify these findings. Thus, transfemoral amputees are clearly in need of specific interventions, focused on posture control, prosthesis management, aerobic conditioning, and gait training.

Different interventions aim to demonstrate their effectiveness in improving quality and speed of gait.²⁹ However, electrotactile and auditory error-based feedback in upper-leg prostheses do not have proven efficacy.³³ Mirror-reflected body image training seems to improve the upright stance control during quiet standing³⁴ and vibration technics could partially correct posture asymmetries.³⁵ In any case, feedback techniques can contribute to reduce the risk of falling in transfemoral amputees. Smartphone applications for fall detection can also provide real-time warning for gait dis-

turbances that suggest a greater risk of falling.³⁰ However, there is insufficient evidence that increasing walking speed may reduce the risk of falls in transfemoral amputees.

The self-perception of fear of falling, measured by the FES score, was not significantly different between fallers and non-fallers. Fear of falling, assessed by using a simple yes or no question, was already found not to be related to fall history in a previous study.⁵ As mentioned before, FES intends to identify "low perceived self-efficacy at avoiding falls during essential, non-hazardous activities of daily living".^{16,18,25} Therefore, we justify this result with the fact that the amputees included in the study have FIM[®] scores equal to or greater than 100, suggesting high participation capacity based on a reduced fear of falling. Thus, in a community-dwelling amputee population, the FES score does not seem to be useful in clinical practice. Other populations of amputees as well as other fear of falling measures, such as the Activities-Specific Balance Confidence (ABC) scale,^{12,36} should be addressed in the future.

Strengths

Our study is one of the few Portuguese studies on lower limb amputees published to date,²⁸ and to the best of our knowledge, the very first study comparing transfemoral and transtibial amputees, thus adding an important contribution to better understand the needs of these individuals in our community. We also test the fear of falling using FES, a relatively unexplored instrument for evaluating lower limb amputees.¹⁶

Limitations

We only included community-dwelling amputees that reported wearing prosthesis on a daily basis, and who had a FIM[®] score equal to or greater than 100 to ensure functionality in such a vulnerable population. This excluded almost as many amputees ($n = 44$) as the ones included ($n = 52$), which means that the scenario depicted in this study does not generalize to patients followed in an amputee outpatient consultation. Second, the cross-sectional study design means there was neither prior assessment nor follow-up of the amputees. The sample size is also limited, thus not allowing for comparison between some of the studied parameters, such as the etiology of the amputation, which may be of clinical interest. Finally, there is also the possibility of under-reporting of falls due to the recall bias of retrospective studies.³⁷

CONCLUSION

This paper contributes information about Portuguese lower limb amputees to the existing body of research. Studies on Portuguese lower limb amputees are scarce and are rarely related to falls. The incidence of falls in community-dwelling lower limb Portuguese amputees with autonomous gait and a FIM[®] score equal to or greater than 100 is low and associated with minor injury. However, transfemoral amputee patients have higher fall occurrence, slower walking speed, and increased need for walking aids compared

to transtibial amputees. There is a low level of interest in using FES to identify fear of falling in this high FIM® population.

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PROTECTION OF HUMANS AND ANIMALS

The authors declare that the procedures were followed according to the regulations established by the Clinical Research and Ethics Committee and to the 2013 Helsinki Declaration of the World Medical Association.

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DATA CONFIDENTIALITY

The authors declare having followed the protocols in use at their working center regarding patients' data publication.

CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

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