REVIEW ARTICLE

Functional assessment after lower limb amputation

Avaliação funcional em pacientes amputados de membros inferiores

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ABSTRACT

The functional assessment of the amputated patient is of great importance, as the main rehabilitation goals in this group of individuals are mobility and independence. The objective of this study was to search in the specialized literature for existing instruments to help assess the degree of mobility in lower limb amputees and also to carry out a critical analysis of the selected articles. A total of 52 articles were included, which were published in English, Portuguese, Spanish and French from 1985 to 2005, using the following databases: Lilacs, Medline, Pubmed and Cochrane. Other non-online sources were also considered. This study has shown that several evaluation methods are used to assess functionality in lower limb amputees, but that a gold standard is yet to be acknowledged and that generic instruments, which are not amputee-specific methods to evaluate function, are inappropriate for use in this group of patients.

KEYWORDS

evaluation, amputation, lower extremity, prostheses and implants, rehabilitation

RESUMO

A avaliação funcional possui grande importância para os amputados, uma vez que a reabilitação deste grupo de pacientes visa melhorar a mobilidade e a independência pessoal. O objetivo deste estudo foi buscar na literatura instrumentos existentes para se avaliar a função em pacientes amputados de membros inferiores e realizar uma análise crítica dos textos selecionados. Foram incluídos 52 artigos publicados no período entre 1985 a 2005, nos idiomas inglês, português, espanhol e francês, nas bases de dados Lilacs, Medline, Pubmed, Cochrane e por meio de busca não eletrônica, a partir das referências dos artigos selecionados. Este estudo demonstrou que existem diversos instrumentos usados para avaliar a função em pacientes amputados, porém não há um considerado padrão-ouro e que instrumentos genéricos não específicos para medir função de amputados são inapropriados para uso com este grupo de pacientes.

PALAVRAS-CHAVE

avaliação, amputação, extremidade inferior, próteses e implantes, reabilitação

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INTRODUCTION

The functional evaluation defines the residual and potential capacities based on which the means, goals and parameters of follow-up will be established for the patients' rehabilitation process. Due to the large number of variables that can comprise a functional assessment, there is the necessity to define some instruments that can more efficiently serve our needs during the rehabilitation process of an amputated patient.

Calmels and cols., in 2001, published a review study of the assessment tools used to evaluate function of lower-limb amputees using the following key words: lower-limb amputees or amputation, functional assessment or evaluation instruments and activities of daily living. They presented the results of 26 publications, subdivided in Clinical and Instrumental Assessment, Functional Assessment of the Activities of Daily Living (ADL) and Evaluation of the Performance and Quality of Life.[1]

Geertzen, Martina and Rietman, also in 2001, published a review study carried out from 1990 to 2000, using the following key words: lower limb, amputation, humans and rehabilitation. A total of 104 studies were found and 24 of them were selected; of these, 6 reported on the general aspects, 9 on the functional aspects, 6 on predictive factors, 2 on phantom pain and 1 on skin disorders.[2]

Deathe, Miller and Speechley,[3] in 2002, carried out a study in Canada to describe how the amputee care centers assessed their programs and their treatment outcomes. They concluded that most of the services used non-standardized and informal functional independence measures, which made it difficult to compare the obtained results.

We observed that several authors described tools for the analysis of function in amputated patients in the literature,[1-3] but there is no consensus on which of them should be used and many are limited to a universal use by restricting age, phase of rehabilitation, presence of comorbidities or other individual aspects.

OBJECTIVE

Based on these considerations, the authors carried out this review with the objective of identifying and selecting in the literature the existing tools for the functional evaluation of lower-limb amputees and perform a critical analysis.

METHODS

The underlined articles:
1. were related to the tools used to evaluate function of uni or bilateral lower-limb amputees, concerning the aspects of mobility, transferences, ADL and practice, gait with or without prosthesis;
2. were published in the period between 1985 and 2005, in the English, Portuguese, Spanish and French languages, at the Lilacs, Medline, Pubmed and Cochrane databases and through non-electronic search tools, based on the references of the selected articles;
3. had the following key words: amputados, amputees, amputaçoes, amputations, membros inferiores, lower limb, funcao, function, resultados, outcome, reabilitacao, rehabilitation.

The excluded articles:
1. referred, exclusively, to the social function assessment, to the aspects of quality of life or personal satisfaction or even school, professional or sports inclusion;
2. had samples with fewer than 20 patients.

RESULTS

After reading 252 abstracts and 86 full texts, the authors selected 52 articles and created a table to demonstrate the results. Table 1 shows the surname of the first author, country of origin and year of publication of the article, objective, study type, sample size and tools used for the analysis.

The tools used to perform the functional assessments will be described according to the order in which they appear in Table 1.

The Barthel Index[6] consists in a self-applicable assessment tool, about 10 measures on self-care and mobility, as follows: feeding, transferences from the wheelchair to the bed and vice-versa, personal hygiene (wash hands and face, brush the teeth, shave), use the bathroom, take a shower/bath, ambulation of at least 45.72 meters, wheelchair propelling, going up and downstairs, get dressed and undressed, urinary and fecal continence. Its score varies from 0 to 100, with the highest scores demonstrating higher functional independence.

The ESCROW Scale[7] incorporates six factors, evaluated and scored independently, from 1 to 4, with 1 being more independent or better and 4 being more dependent or worse. It investigates adaptation to the environment, resources or financial situation, social support, family and community life, decision-making capacity and study or work status. The sum of the scores varies from 6 (better) to 24 (worse).

PULSES Profile[8] is a scale with six components and reflects life independence. It evaluates the physical condition, upper limb function, lower limb function, sensory component, sphincter control and intellectual, emotional, family, social and financial support. Its scores vary from 6 to 24 and the lower they are, the higher the independence.

Physical Function[10] evaluates four functional levels that include: 1- wears prosthesis daily, alone, out of the house, can use crutches, does not use a wheelchair; 2- wear prosthesis daily, walks alone with a single crutch inside the house and with a pair of crutches outside the house, sometimes uses a wheelchair; 3- wears prosthesis part of the day, uses crutches or walker, walks alone in the house, but not outside the house, needing a wheelchair; 4- patient does not wear prosthesis or wears it for cosmetic use only.

Social Dependence[11] originally described for six functional levels, was used here in its adapted version with four levels of independence, scored 1 to 4, with 1 being – the independent individual, who takes care of the house and does not need help; 2, being the slightly dependent individual, who needs domestic help 1 to 4 hours

per week and/or incapable of performing housework; 3, being the moderately dependent individual, who needs help with housework for at least 5 hours per week and/or is incapable to perform personal hygiene and 4, the totally dependent individual, who need to be cared by a nurse or caregiver.

Katz Activities of Living Scale (KATZ)[14] was developed to study the treatment outcome and prognosis of the elderly and individuals with chronic diseases. It evaluates the index of independence in the activities of daily living (ADL), i.e., bath/shower, transferences, getting dressed, continence, bathroom use, feeding oneself, at eight different functional levels that vary from A to G and another classified as Other.

Affect Balance Scale (ABS)[15] evaluates, subjectively, how positive feelings about life can help overcome negative feelings.

Volpicelli Mobility Scale18 is a scale that evaluates mobility and is subdivided in 7 grades, from six to zero, with six corresponding to the unlimited community ambulator and zero corresponding to the bedridden individual. The highest scores indicate more autonomy and gait independence.

Frenchay Activities Index (FAI)[19] originally described for patients who suffered a cerebrovascular accident, was developed to measure general activities, such as personal care and social function. It consists of 15 items, analyzes tasks that involve the patient's decision and organization carried out in the last 3 and 6 months, inside and outside the house. The scores vary from 0 (inactive patient) to 45 (highly active patient).

Functional Independence Measure (FIM)[24] is a scale to quantitatively evaluate the load of care required by one individual to perform the 18 motor and cognitive tasks of daily living. The assessed activities are divided in seven domains: Motor: self-care, transferences (bed, chair or wheelchair), mobility (gait/wheelchair and go up and downstairs) and sphincter control; Cognitive: communication (understanding and expression), social cognition (social integration, problem-solving and memory). Each function level is scored from 1 (total assistance) to 7 (total independence). Its score varies from 18 to 126 and the higher the score, the higher the functional independence.

Reintegration to Normal Living Index (RNL)[26] was developed for the individual's self-evaluation of the life adjustment caused by disabling diseases. It evaluates 8 areas regarding the ADL, such as mobility inside an environment, mobility in the community, mobility outside the town, personal care, the performance of daily activities and tasks, leisure activities and relationship with the family. It also measures three areas related to self-perception: personal relations, self-presentation and coping strategies. The tool has 11 questions, which are concise and easy to understand and administrate by telephone. Five answers are possible: I strongly agree, I agree, No opinion, I disagree and I strongly disagree.

Prosthetic Profile of the Amputee (PPA)[30] is a qualitative questionnaire that has six domains: current physical condition, prosthesis satisfaction and adaptation, use of prosthesis at home or in the community, leisure and socioeconomic conditions. It aims at evaluating and determining the factors that are potentially related to the prosthesis use after the discharge from the Rehabilitation Cen-

ter. It can only be used in the assessment of patients older than 18 years, with unilateral amputations of lower limbs and prosthetized.

Locomotor Capabilities Index (LCI)[30] was based on the classification of mobility disabilities of the World Health Organization and is part of the Prosthetic Profile of the Amputee (PPA). It can be used independently and measures the capacity of an amputated patient to walk with the prosthesis during and after the rehabilitation. It consists of 14 items and 2 sub-scales: basic and advanced. Each item can be scored from zero (no capacity) to three (capable without help) and the maximum score is 42 points, showing the maximum mobility capacity.

Sickness Impact Profile (SIP)[36] comprehends 136 health-related points, in 12 distinct areas of activity (sleep and rest, eat, work, take care of the house, leisure, ambulation, mobility, care with the body and movements, social interaction, capacity to make decisions and emotional behavior) and the patient classifies each area from 0 to 100%. This is a very useful and practical questionnaire, as it can be used in the comparison with other patients.

International Classification of Impairments, Disabilities and Handicaps (ICIDH)[37] evaluates patients through a scale that varies from 0 to 3 points, with 0 (zero) corresponding to the individual who is capable of performing activities without difficulties on his or her own, with or without help; 1, when the person is capable of performing tasks with some difficulty on his or her own, with or without help; 2, when the person is capable of performing tasks with a high degree of difficulty on his or her own or with help and 3, when the individual cannot perform any task without help.

Houghton Scale[39] evaluates the daily use of prosthesis by the patient. It consists of 4 questions on the evaluation of the frequency of use in different activities. The total score varies from 0 (minimum) to 12 (maximum). A score ≥ 9 defines the success and a score < 9 shows prosthetic rehabilitation failure.

Gait performance according to Steinberg[42] - This classification was proposed to evaluate the functional level of gait with prosthesis and subdivides patients in three groups: 1- Functional users: walk with the prosthesis during the whole day, with or without gait aids; 2- Partial users: use the prosthesis for only a period of the day, for instance, to stay at home, depending on the wheelchair for moderate and long distances; 3- Non-users: do not use their prosthesis or only use them for cosmetic reasons.

Functional Reach Test (FRT)[44] is an tool-based test that used a power platform to evaluate the displacement of the patient's pressure center. It is a measurement of balance assessed through the measurement of the maximum distance walked forward that exceeds an arm span of distance by a patient while the fixed support base is maintained in the standing position.

Physical Performance Test (PPT)[45] consists in the evaluation of the performance to carry out 8 tasks: write a sentence, to simulate eating, raising a book to put it on a shelf, put a jacket on and take it off, pick a coin up from the ground, turn 360 degrees, walk 15.2 meters and go up 12 steps. The time spent in minutes or seconds is converted into scores, except for turning 360 degrees.

Howard Rusk[50] This scale classifies the function of amputated patients in six Grades: Grade 1: complete recovery of the previous

Table 1
First author's Surname*, Country of origin, Year of publication, Objective, Study Type, Sample size and Used tools.

Author*, Country, Year	Objective	Study/sample	Used tools
De Luccia[4] Brazil / 1985	To evaluate patients at late follow-up for 24 months.	Case series / 51	Questionnaires proposed by the authors on the use of prosthesis and life independence.
O'Toole[5] USA / 1985	To evaluate the functional changes at hospital admission and six months after rehabilitation discharge	Case series / 60	Barthel Index[6] ESCROW Scale[7] PULSES Profile[8]
Helm[9] Denmark / 1986	To evaluate the functional capacity, social dependence and pain.	Case series / 257	Physical function[10] Social dependence [11] Pain (proposed by the authors)
Chan[12] Singapoure / 1990	To evaluate the functional independence with prosthesis in elderly patients.	Prospective 47	Questionnaire proposed by the authors on the frequency of prosthesis use, modified Barthel Index[6].
Weiss[13] USA / 1990	To identify the variables to predict rehabilitation after amputation	Case series / 97	Katz Activities of Living Scale[14] Affect Balance Scale (ABS)[15]
Pohjolainen[16] Finlândia / 1991	To evaluate prosthesis use, mobility and accommodation one year after amputation.	Transversal 125	Questionnaire proposed by the authors on the functional use of prosthesis and type of accommodation
Datta[17] England / 1992	To evaluate the functional results of bilateral amputees admitted at rehabilitation.	Case series / 41	Ambulation Scale of Volpicelli[18] Frenchay Activities Index (FAI)19 Questionnaire proposed by the authors for Activities of Daily Living (ADL)
De Luccia[20] Brazil / 1992	To evaluate the results of rehabilitation in relation to the gait capacity with prosthesis in patients with vasculopathies	Prospective 128	Questionnaire proposed by the authors on the functional use of the prosthesis
Diogo[21] Brazil / 1992	To verify ADL alterations in two groups of elderly individuals	Transversal 25	Questionnaire proposed by the authors on the ADL and use of gait aids
Houghton[22] England / 1992	To evaluate prosthesis adaptation	Case series / 440	Questionnaire proposed by the authors on the number of hours of use/day, use of community or home gait aids.
Muecke[23] USA / 1992	To evaluate functional capacity.	Transversal / 68	Katz Activities of Living Scale[14] Functional Independence Measure (FIM)[24]
Nissen[25] USA /1992	To identify the factors that influence the reintegration to normal living.	Transversal / 42	Reintegration to Normal Living (RNL)26
Jones[27] Australia / 1993	To evaluate the function after at least one year of discharge.	Prospective Cohort / 65	Questionnaire proposed by the authors on the use of prosthesis, independence at ADL, use of automobile or public transportation and return to work.
Pinzur[28] USA / 1993	To evaluate functional outcome.	Retrospective Cohort / 299	Ambulation Scale of Volpicelli[18]
Stewart[29] Scotland / 1993	To revise 25 years of the Dundee Limb Fitting Centre	Retrospective / 1,846	Prosthetization Index and time of prosthesis use/day
Grisé[30] Canada / 1993	Describe the phases of questionnaire construction to evaluate and determine the factors related to prosthesis use.	Retrospective Cohort / 26	Prosthetic Profile of the Amputee (PPA)
Gauthier-Gagnon[31] Canada / 1994	To evaluate the validity and reliability of the Prosthetic Profile of the Amputee	Transversal / 89	Reintegration to Normal Living (RNL)[26] Prosthetic Profile of the Amputee (PPA)[30]
McWhinnie[32] USA / 1994	To evaluate the outcome of prosthesis rehabilitation after 5 years of follow-up.	Prospective Cohort / 96	Annual interview on the use of prosthesis, analysis of survival.
Walker[33] England / 1994	To evaluate the patient's perception in relation to functional outcome in trauma amputations.	Transversal / 87	Questionnaire proposed by the authors to investigate stump problems, prosthesis use, mobility, sports practice, work, perception and satisfaction.
Christensen[34] Denmark / 1995	To determine the outcome of prosthetic rehabilitation.	Transversal / 29	Questionnaire proposed by the authors to evaluate the socioeconomic conditions of the family and of the house, prosthesis use and patient's opinion.
Greive[35] Holland / 1996	To describe the functional outcome 5 months after the amputation in comparison with the preoperative functional capacity.	Prospective Cohort / 26	Sickness Impact Profile (SIP)[36] International Classification of Impairments Disabilities and Handicaps (ICIDH)[37]
Leung[38] Canada / 1996	To determine the values of the Functional Independence Measure to indicate prognosis of prosthesis use.	Prospective Cohort / 41	Functional Independence Measure (FIM)[24] Houghton Scale[39]
Rommers[40] Holland / 1996	To determine the outcome after rehabilitation.	Retrospective Cohort / 183	Prosthesis use
Chamlian[41] Brazil / 1997	To evaluate the outcome obtained with the prosthetization of patients through gait performance.	Prospective Cohort / 81	Gait performance according to Steinberg[42]
Mueller[43] USA / 1997	To compare the function of diabetic patients with transmetatarsal amputations and a normal control group.	Controlled Clinical Trial / 30	Sickness Impact Profile (SIP)[36] Functional Reach Test (FRT)[44] Physical Performance Test (PPT)[45] Gait velocity

Table 1
First author's Surname*, Country of origin, Year of publication, Objective, Study Type, Sample size and Used tools.

Frykberg[46] USA / 1998	To evaluate mortality and the functional results in patients older than 80 years.	Retrospective Cohort / 41	Questionnaire proposed by the authors to evaluate the functional independence and residential status.
Gauthier-Gagnon[47] Canada / 1998	To validate the consistency of the analysis factors used in the Locomotor Capabilities Index.	Prospective Cohort / 70	Locomotor Capabilities Index (LCI)[30]
Gauthier-Gagnon[48] Canada / 1998	To evaluate the factors that predispose to prosthesis use of in unilateral amputees.	Prospective Cohort / 396	Prosthetic Profile of the Amputee (PPA)[30]
Monzón[49] Venezuela /1998	To compare the patients when the prosthesis laboratory was functioning and when it was not.	Retrospective Longitudinal / 446	Functional Recovery Scale of Howard Rusk[50]
Traballessi[51] Itália / 1998	To predict the rehabilitation potential and the prognostic factors in amputees due to vascular diseases.	Prospective Cohort / 144	Barthel Index[6] Rivermed Mobility Index[52]
Treweek[53] Escócia / 1998	To measure functional activities.	Transversal 938	Barthel Index[6] Locomotor Capabilities Index (LCI)[30] Russek's classification[54]
Gauthier-Gagnon[55] Canada / 1999	To evaluate the frequency and use of prosthesis and identify factors that promote its use.	Prospective Cohort / 396	Prosthetic Profile of the Amputee (PPA)[30]
Schoppen[56] Holland / 1999	To determine the reliability of and to validate the Timed Up and Go test in elderly patients.	Prospective Cohort / 32	Sickness Impact Profile (SIP)[36] Timed Up and Go (TUG)[57] Groningen Activity Restriction Scale (GARS)[58]
Brooks[59] Canada / 2001	To determine the validity of construction and sensitivity of the Two-Minute Walk Test	Retrospective / 290	36-Item Short-Form Heath Survey (SF 36)[60] Hougton Scale[39]
Buzato[61] Brazil / 2001	To determine the functional situation at least two years after the amputation.	Retrospective Cohort / 48	Questionnaire proposed by the authors on the actual functional rehabilitation and the pre-amputation one.
Dillingham[62] USA / 2001	To document and examine the use, satisfaction and problems with prostheses in post-trauma amputees.	Retrospective Cohort / 146	Injury Severity Score (ISS)[63] Phantom pain.
Miller[64] Canada / 2001	To evaluate the association between falling, fear of falling and prosthesis reliability, mobility and social activities 12 months after the amputation.	Case series / 435	Frenchay Activities Index[19] Hougton Scale[39] Prosthesis Evaluation Questionnaire (PEQ)[65]
Miller[66] Canada / 2001	To evaluate and compare the reliability among three scales of mobility assessment.	Retrospective Cohort / 329	Prosthetic Profile of the Amputee (PPA)[30] Hougton Scale[39] Prosthesis Evaluation Questionnaire (PEQ)[65]
Brooks[67] Canada / 2002	To evaluate the reliability of the Two-Minute Walk Test.	Prospective Cohort / 33	Two Minute Walk Test[68]
Gailey[69] USA / 2002	To describe the development of the Amputee Mobility Predictor to evaluate the gait potential with and without prosthesis.	Prospective Cohort / 191	Six Minute Walk Test[70] Amputee Activity Survey (AAS)[71] Melchiorre Comorbidity Index[72]
Hoffman[73] USA / 2002	To determine the results of patients that survived transfemoral amputation due to malignant tumor.	Retrospective Case Control / 35	Musculoskeletal Function Assessment (MFA)[74] Short Form-12 General Health Status Survey (SF-12)[75]
Meikle[76] USA / 2002	To determine the frequency of rehabilitation interruptions of inpatients and identify causes, risks and consequences.	Retrospective Cohort / 254	36-Item Short-Form Health Survey (SF-36)[60] Houghton Scale[39] Two Minute Walk Test[68]
Davies[77] England / 2003	To investigate the mobility one year after the amputation.	Prospective Cohort / 281	Harold Wood-Stanmore Mobility Grade[78]
Diogo[79] Brazil / 2003	To evaluate the level of functional independence in elderly patients.	Transversal 40	Barthel Index[6]
Diogo[80] Brazil / 2003	To identify the association between general satisfaction with life and functional capacity in the elderly.	Transversal 40	Barthel Index[6], Modelo de Cantrill[81]
Miller[82] Canada / 2003	To evaluate the reliability and validity of the Activities-specific Balance Confidence Scale.	Experimental / 329	Timed Up and Go (TUG)[57] Two Minute Walk Test[68] Activities-specific Balance Confidence Scale (ABC)[83]
Ryall[84] Ireland / 2003	To develop an evaluation tool for the mobility in amputees (SIGAM) to use in daily clinical routine, also monitoring functional changes.	Transversal 210	Rivermed Mobility Index[53] Timed Walking Test (TWT)[85]
Schoppen[86] Holland / 2003	To study the physical, mental and social characteristics as predictors of the functional outcome in the elderly 2 and 6 weeks after the amputation.	Prospective Cohort / 46	Sickness Impact Profile (SIP)[36] Timed Up and Go Test (TUG)[57] Groningen Activity Restriction Scale (GARS)[58] Uso da prótese.
Burger[87] Slovenia / 2004	To determine differences in the functional status among 3 different ethnic groups.	Case series / 671	Walked distance /day Prosthesis functionality.
Devlin[88] Canada / 2004	To evaluate the reliability, validity and sensitivity to the changes in Hougton's scale.	Prospective Cohort / 125	36-Item Short-Form Health Survey (SF-36)[60] Hougton Scale[39] Two Minute Walk Test[68]
Cassefo[89] Brazil / 2005	To evaluate prosthesis function and satisfaction in unilateral amputees.	Transversal 24	Prosthetic Profile of the Amputee (PPA)[30]
Geertzen[90] Holland / 2005	To mathematically analyze the factors that influence the demand that amputees should walk 500 meters or more.	Transversal 437	Groningen Questionnaire Problems after Leg Amputation (GQPLA)[91] RAND 36[92]

function at work, sports and social life; Grade 2: partial recovery of previous function, with alterations at work, sports and social life; Grade 3: more independence and autonomy for ADL; work in activities that do not demand walking or standing; cannot dance, or walk long distances; Grade 4: less autonomy, use the prosthesis rarely, need help with ADL, use the prosthesis socially; Grade 5: use the prosthesis for cosmetic reasons only, need help with ADL; Grade 6: the patients are not eligible for prosthesis use.

Rivermead Mobility Index (RMI)[52] is a test that evaluates mobility by verifying the patients' capacity in performing 15 common daily movements. Its score varies from zero (completely incapable) to 15 and the lowest scores are associated to the worst results. Although it was originally developed for neurological diseases, it has been used to evaluate changes after rehabilitation treatment of amputated patients.

Russek's Classification[54] is a scale that evaluates the functional capacity of amputated patients with prosthesis. Its score varies from 1 to 6 and 1 (impossible) means that the prosthesis has no advantages for the patient; 2 (additional cosmesis) indicates that the patient performs at-home gait for short distances, with insecurity or discomfort; 3 (minimum self-care) indicates that the patient needs help in different degrees and feels fatigued; 4 (additional self-care) indicates that the patient has complete independence, might need changes at work and performs regular activities; 5 (partial recovery) indicates that the patient has restrictions only for certain activities, such as dancing, practicing sports, etc; and 6 (complete recovery) indicates that the patient does not have any incapacity.

Timed Up and Go Test (TUG)[57] was developed to quantify the physical mobility of the elderly. It is based on the observation and measurement of the time spent, in seconds, by a patient to get up from an armchair, walk 3 meters at a safe and comfortable velocity and return to the chair.

Groningen Activity Restriction Scale (GARS)[58] is a short questionnaire with 18 items that evaluate the capacity during ADL, including mobility and the instrumental activities of daily living (IADL). It has four categories of responses: 1- capable of performing the activity without any difficulty; 2- capable of performing the activity with some difficulty; 3- capable of performing the activity with much difficulty and 4- incapable of performing the activity independently. The score varies from 18 to 72 and the lowest scores are associated with the best results.

36 – Item Short Form Health Survey (SF 36)[60] is a generic tool to evaluate quality of life, easy to apply and understand, as it was developed to be self-applied in 10 to 12 minutes. It is multidimensional and consists of 36 items, divided in 8 scales or components: 1- Physical, comprehending functional capacity, physical aspects, pain and general health status and 2- Mental, which refers to mental health, emotional aspects, social aspects and vitality. It presents a final score of 0 (zero) to 100, in which 0 corresponds to the worst general health status and 100 to the best general health status.

Injury Severity Score (ISS)[63] is a numerical method to measure the severity of a traumatic lesion in different parts of the body. Its score varies from 1 to 75 and it is calculated by the sum of the means of the highest score of the Abbreviated Injury Scale in the three most affected regions.

Prosthesis Evaluation Questionnaire (PEQ)[65] is a specific tool to assess quality of life, which consists of nine validated scales, with each one of them encompassing multiple questions and an additional number of individual questions on: satisfaction, pain, transferences, prosthesis care, self-efficiency and importance. The assessed scales are: Usefulness, Appearance, Sounds and Health of the Residual Limb; Mobility and Transference and Ambulation; Frustration, Perceived Response and Social Weight; Well-being.

The answers are filled out according to the Visual Analog Scale, which is a 100-mm long line, scored as a continuous numerical variable, always measured from left to right (0-100). The higher the number of the answer (towards the right side), the more positive the answer will be. The patient must always answer the questions regarding the four last weeks, with options that vary from very much to not at all.

Two Minute Walk Test[68] and Six Minute Walk Test[70] are quantitative tests to asses the functional capacity to perform exercises, based on the time spent to perform them and their results can be expressed in distance or velocity.

Amputee Mobility Predictor (AMP)[69] is a test developed to verify the gait potential with prosthesis and can be used as a tool to evaluate function during and after the rehabilitation treatment. It consists of six domains containing 21 items in total: balance in the sitting position, transference, balance in the standing position, gait, go up and downstairs and using gait aids. The scores vary from zero (worst) to 42 (best).

Amputee Activity Score (AAS)[71] is a multiple-choice questionnaire applied by the interviewer in approximately 15 minutes. It is used in amputated and prosthetized outpatients. It has eight subscales and 20 items and evaluates the capacity to put the prosthesis on and take it off, time of prosthesis use, go upstairs, working details, use of gait aids, domestic responsibilities, regular gait habits and social activities. The scores are subdivided in five levels of activity (inactive, restricted, moderate, high, very high) and vary from -70 to +50.

Melchiorre Comorbidity Index[72] is a version of the Charlson Comorbidity Scale for amputated patients.

Musculoskeletal Function Assessment (MFA)[74] is a questionnaire that evaluates the patient's health status, designed to detect small functional differences among patients with musculoskeletal disorders of the extremities. It has 100 items and it takes around 15 minutes to be completed. Its scores vary from 0 to 100 and the lowest scores are associated with the lower dysfunctions.

Short Form-12 General Health Status Survey (SF-12)[75] is a generic multidimensional tool of quality of life assessment that consists of 12 items, comprehending 8 scales or components: 1- Physical, comprehending functional capacity, physical aspects, pain and general health status and 2- Mental, referring to mental health, emotional aspects, social aspects and vitality. It has a final score of 0 to 100, in which 0 corresponds to the worst and 100 to the best health status.

Harold Wood-Stanmore Mobility Grade[78] is a scale that evaluates home and community mobility. Its scores vary from 1 to

6 and refer to: 1- prosthesis rejection or cosmetic use only; 2- uses the prosthesis for transferences or to help with self-care. Walks only with the therapist or caregiver; 3- walks at home with the help of gait aids. Out of the home needs help from others; 4- Walks at home and in the community with gait aids; 5- walks independently inside and outside the home without the need for gait aids or only exceptionally, uses them for safety on irregular ground or during bad weather; 6- Normal or near-normal gait.

Cantrill Model [81] is a tool developed to evaluate the general satisfaction with life. It consists of an ascending scale of 1 to 10, represented schematically by steps, in which the lowest value represents the worst life and the highest value, the best life.

Activities-specific Balance Confidence Scale (ABC) [83] is used to determine the balance confidence. The individuals must self-evaluate their confidence in scores that vary from 0 to 100%, during activities such as going upstairs, read above one's head or walk on irregular surfaces.

The Special Interest Group in Amputee Medicine (SIGAM) [84] developed this tool to evaluate mobility with a functional or cosmetic prosthesis. It includes a 50-m gait test and uses a questionnaire with an algorithm.

Timed Walking Test (TWT) [85] is a test used to measure mobility; its results can be expressed by the time spent to perform the task in seconds or gait velocity in meters per second or by the walked distance in meters.

Groningen Questionnaire Problems after Leg Amputation (GQPLA) [91] - this questionnaire contains, in addition to the demographic aspects, questions that evaluate the presence or absence of phantom pain or sensation at the stump and the gait distance (500 meters or more) with prosthesis.

RAND-DLV 36 [92] is the German version of the SF 36 and consists of a questionnaire with 36 items of health assessment. It has 9 subscales: physical function (walking, going upstairs, running, ADL), social function (social contact), real limitations (restrictions in ADL due to physical or emotional problems), mental health, vitality, pain, general health perception and changes in health.

DISCUSSION

The inclusion of seven key words is justified by the large number of variables that can be understood as functional assessment. The functional status of an individual can be evaluated through clinical and laboratory tests, as well as physical tests such as the assessment of flexibility, muscular strength, velocity, resistance to fatigue, oxygen consumption, balance, coordination, dexterity, among other types of assessment. In rehabilitation, and especially concerning the amputated patient, in addition to all aforementioned modalities, we also must observe how the postural changes are attained, as well as transferences, ADL and practical living, orthostatism, wheelchair mobility, gait with or without prosthesis, presence of pain, level of personal satisfaction and quality of life, social dependence, return to sports practice and work.[1]

Of the 52 articles that compose Table 1, 24 (46.2%) were published in North America, 17 (32.7%) in European countries, 2 (3.8%) in Asia, 9 (17.3%) in South America, with 8 (15.4%) having been published in Brazil, demonstrating the increasing interest in this area in our country.[4, 20, 21, 41, 61, 79, 80, 89]

Although the German language was not included in our search, we maintained the original references of the studies that published the tools for the first time.[10,92]

The types of studies that were carried out were very distinct and the way the authors described them also raised questions when classifying them and including them in the Table. For instance, to apply a certain questionnaire at a definite time of the follow-up was sometimes classified as a transversal study and sometimes classified as case series or prospective study. The classification between observational (case series, case-control, cohort) and experimental studies (randomized clinical trial) would be the adequate way to classify them to make the information homogeneous.

The research strategies were wide-ranging, which included from self-applicable questionnaires sent by mail, phone interviews, evaluations carried out during hospitalization and routine assessments after rehabilitation discharge to specific test requests and home visits.

In thirteen articles (25%), the authors used some type of questionnaire or classification proposed by them, which had not been published previously. The use of non-validated and non-standardized tools prevents the comparison of the results, puts the reliability of the research at risk and impairs the study reproducibility.

We identified 41 different tools that were used in the amputated patients, with 36 of them dealing with the functional aspects included in this research (mobility and physical function).

The questionnaires on quality of life were included only when used together with another functional assessment tool. The generic tools Sickness Impact Profile (SIP),[36] Short Form [36] (SF-36)[60] and Short Form [12] (SF-12)[75] have not had their psychometric properties tested with amputees and are not adequate for this group of patients. The specific tool Prosthesis Evaluation Questionnaire (PEQ)[65] has good reproducibility and excellent construct validity.[65] Its translation and validation into Brazilian Portuguese is about to be published and can be a valuable tool to be used in our country.

Of the generic function tools, the Barthel Index (BI)[6] shows to be standardized, valid and reproducible, but it is not sensitive to demonstrate changes, being considered inappropriate to be used with amputees. The Functional Independence Measure (FIM)[24] is not adequate either for this group of patients due to the responsiveness failures and effects of maximum score in some domains.[54]

Of the generic measurements of mobility, the following are frequently employed and have shown to be valid, reproducible and easy to use in a clinical setting: the Timed Up and Go (TUG)[57] is well indicated for the elderly, as it includes balance assessment and the Timed Walking Test (TWT)[86] could be recommended as the gold standard to be used with amputees.

As an specific tool of amputated patients' function, the Prosthetic Profile of the Amputee (PPA)[30] shows good psychometric properties, but it is long, difficult to be interpreted by the patient and requires a computer for its analysis. The analysis of the data of the Amputee Activity Score (AAS)[71] is complex and requires

a guide, but its psychometric properties seem to be adequate. The Houghton Scale[39] has been recommended for use with amputees, as most of its tested psychometric properties is adequate.

Of the specific measures of amputee mobility, the Locomotor Capabilities Index (LCI)[30] that integrates the PPA is simple, easy to use, has good clinical acceptance and their adequate psychometric properties have suggested its use in researches. The Amputee Mobility Predictor (AMP)[69] of the patient with prosthesis is a promising tool that needs to be tested in larger populations.

Of the non-generic and non-specific tools of functional assessment for amputees, the Rivermead Mobility Index (RMI)[52] evaluates mobility and have shown to be reliable and responsive to changes with rehabilitation, but needs further testing. The Frenchay Activities Index (FAI)[19] presents internal homogeneity and test-retest reproducibility, but it has low construct validity to be used with amputees.[65]

There is still great need of studies on the functional assessment of lower-limb amputees to allow further assurance when choosing a test or a questionnaire to carry out a study. There is little or no consensus among the researchers mentioned in this review. In spite of that, there is no justification to create new tools for this group of patients, until the currently used ones are discarded or approved.

The authors expect that the present study will help the search for the mentioned articles and will stimulate the researchers interested in this issue to further investigate this matter.

CONCLUSION

There are many functional assessment tools currently being used, but none of them is considered to be the gold-standard.

Non-specific generic tools for amputees are inadequate to be used with this group of patients.

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