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Functional Outcome Assessment of Lower Limb Amputees and Prosthetic Users with a 2-Minute Walk Test

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A B S T R A C T

The aim of this study was to assess the functional outcome of a population of lower limb amputees supplied with prosthesis. The research was conducted from June to September of 2010 at the Center for Physical and Rehabilitation Medicine, of the Clinical Hospital Center Rijeka, Croatia. The study included 50 adult subjects of both genders with a unilateral transtibial or transfemoral lower limb amputations. The 2-minute walk test (2MWT) was used to assess the functional outcome of these individuals. Data were statistically analyzed. Subjects were divided into groups according to age. The best results were obtained by subjects between the age of 45 and 59 years. The difference between groups was statistically significant ($p<0.001$). Taking into account the cause of amputation, there was a statistically significant difference in the results of the 2 MWT between subjects in whom the cause of amputation was circulatory and those where the cause of the amputation was not due to circulatory problems. The best results were obtained in subjects in whom the cause of amputation was not circulatory ($p=0.009$). Considering the level of amputation there was a statistically significant difference in the results of the 2MWT between subjects with transtibial and those with transfemoral amputations. Better results were obtained in transtibial amputees ($p=0.039$). Considering the first prosthetic supply, better results were obtained in subjects using prosthetic devices over 9 years ($p=0.031$). Our research confirmed that age, gender, level and cause of amputation, including the time from the first prosthetic supply have an effect on the 2MWT results.

Key words: *amputation, prosthesis, assessment, walk*

Introduction

Amputation is the loss of a body part, most frequently of a limb. Amputation is not a tragic end of a treatment but the commencement of a new one, i.e., rehabilitation. The purpose of the rehabilitation process is to reduce the disability to a minimum and, if possible, return the individual to his/her family, community and the working environment. Prosthetic supply is very important for the amputees since it enables them to ambulate[1,2].

The success of rehabilitation and prosthetic supply is commonly evaluated by walking speed with prosthesis (10m/sec), time of prosthetic use in hours, autonomy in prosthetic fitting, use of other orthopedic walking aids, Functional Independent Measurement Index (FIM), Barthel Index, Prosthetics profile of the Amputee (PPA) and the Locomotor Capabilities Index (LCI). Some authors use the 2-minute walk test (2MWT)[3–10]. It consists of measuring a distance in meters walked in 2 minutes by a patient with prosthesis[11,12]. The 2-minute walk test is practical, quick, inexpensive and easy to administer. It gives us valid and reliable information about the patients¨ gait functioning with the prosthesis.

There is no registry of amputees in Croatia and as a result, no precise data on the number of persons with lower limb amputations are available. According to approximate data of some authors and the results of own investigation, in the County of Primorje and Gorski Kotar roughly 100–120 persons undergo lower limb amputations *per* year. Of those, 40% are supplied with prosthesis. The remaining of 60% use wheelchairs or are deceased due to main disease complications and comorbidity[13,14]. Of those who are supplied with prosthesis and wear it regularly, we assessed the functional ability of 50 subjects with the 2-minute walk test (2MWT)[14].

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Patients and Methods

This study included 50 adult subjects of both genders with unilateral transtibial or transfemoral lower limb amputations, irrelevant of the amputation cause. The research included subjects that underwent amputation and were supplied with prosthesis between three and eighteen years ago, and used the prosthesis on a daily basis.

The subjects were selected from the medical documentation of the Center of Physical and Rehabilitation Medicine, University Hospital Rijeka, Croatia, where they previously attended inpatient and outpatient prosthetic training and »walking school«. The same documentation provided us with data on age, gender, time from amputation, cause and level of amputation.

From June to September of 2010 measurements of 2-minute walk test (2MWT) were conducted during visits to outpatient services. The test was administered in a quiet uncarpeted corridor were subjects were asked to walk as far as they could in 2 minutes with the prosthesis and an elbow crutch. A physical therapist controlled the distance and time measurements with the meter measurement device and the stopwatch. The starting and finish point of the subjects walk were recorded. The distance walked was recorded in meters. Measurements were repeated three times and from the obtained data a mean value was generated.

The obtained data were statistically analyzed. The studied variable of the 2MWT was distributed in accordance with normal distribution, thus in analysis we used the methods of parametric statistics. When two samples were compared (by gender, distribution of amputation level and cause) we used the Student t-test, while for comparison of age groups the analysis of variance (ANOVA) was used. The forward stepwise solution in multivariate regression was used to analyze the influence of predictors on the dependent 2MWT variable. Statistical significance was set at $p \leq 0.05$, i.e., with a 95% confidence interval. For data analysis we used the Statistica, version 9.0 application program.

Results

Of the 50 subjects 41 (82%) were men and 9 (18%) were women. The significant difference in the results of the 2MWT according to age was first analyzed. The mean age of subjects of both genders was 69.4 (66.26–72.49 years, with a 95% CI) years, ranging from 45 to 89 years. The average age of men was 70.5 and women 64.0 years.

Subjects were divided into age groups. The results of the 2MWT presented in Table 1, show that the best results were achieved by younger subjects aged between 45 and 59 years. The table shows a significant difference between age groups within the 2MWT results ($p<0.001$). We analyzed each age group in relation to the distribution of amputation level, amputation cause, and gender. A significant difference was found in the distribution of amputation levels in the group over 74 years ($p=0.001$). The multiple partial correlation showed that of all the predictors influencing the 2MWT, there was a significant influence of age ($b=0.31$, $p=0.001$).

The Student's t-test was used to analyze the difference between genders within the 2MWT results. The results ($t=1.80$) and ($p=0.077$) demonstrate that there was no significant difference between men and women (Table 2).

The Student's t-test was used to analyze the difference between groups with regard to the level of amputation. The result of this statistical test was a t parameter ($t=2.11$) and p value ($p=0.039$). In our study there was a statistically significant difference with regard to the level of amputation in the results of the 2MWT. Significantly better results were obtained in subjects with transtibial amputations (Table 3).

The Student's t-test was also used to analyze the difference between groups with regard to the cause of amputation. The result of this statistical test was a t parameter ($t=2.69$) and p value ($p=0.009$). There was a significant difference between the results of the 2MWT with regard to the cause of amputation. The results of the

TABLE 2
RESULTS OF THE 2-MINUTE WALK TEST WITH REGARD TO SUBJECT GENDER

Gender	Walk test m	t	p
men	51.15	1.80	0.077
women	73.00		

Walk test = 2-minte walk test, m = meters

TABLE 1
RESULTS OF THE 2-MINUTE WALK TEST WITH REGARD TO SUBJECT AGE

Age (Y)	Number of subjects	Walk test results/m	P	Level of amputation			Gender			Cause of amputation		
45–59	11	94.27		T	96.7	p=0.79	M	85	p=0.21	C	92.5	p=0.88
				F	90		F	119		N	96.4	
60–74	19	60.07	<0.001	T	62.8	p=0.42	M	62.6	p=0.34	C	58.2	p=0.21
				F	52.4		F	53		N	76	
Over 74	20	28.8		T	37.8	p=0.01	M	28.5	p=0.62	C	28.8	p=0.94
				F	23.1		F	35		N	28	

T = tibial, F = femoral, C = circulatory, N = noncirculatory, Y = years, P = parameters

TABLE 3
RESULTS OF THE 2-MINUTE WALK TEST WITH REGARD TO THE LEVEL OF AMPUTATION

Level of amputation	Number of subjects	%	Walk test (m)	t	P
tibial	27	54	64.06	2.11	0.039
femural	23	46	44.56		

P, t = parameters, m = meters, Walk test = 2 – minute walk test

2MWT were statistically more significant in subjects in whom the cause of amputation was not vascular disease (Table 4).

All subjects were divided into three groups in relation to the time elapsed from the first prosthetic supply: the 3–5 years, 6–9 years and over 9 years group. Mean values, standard deviations and ANOVA test results are shown in Table 5. One-way ANOVA shows a significant difference between the studied groups (F=3.75, p=0.031). Post hoc analysis demonstrates a significant difference between the group using a prosthetic device from 3–5 years and that using prosthetics over 9 years (p=0.43) (Table 5).

Regression analysis was used to study the influence of predictors on the dependent variable of the 2MWT. We used age, gender, level of amputation, cause of amputation and the time of first prosthetic supply as predictors.

The multivariate regression forward stepwise solution shows that predictors affect the obtained 2MWT results.

The coefficient of multivariate regression R=0.841 indicates a close correlation of predictors and criteria variables. The coefficient of determination R^2 =0.707 demonstrates a regression efficacy of 71%.

TABLE 4
RESULTS OF THE 2-MINUTE WALK TEST WITH REGARD TO THE CAUSE OF AMPUTATION

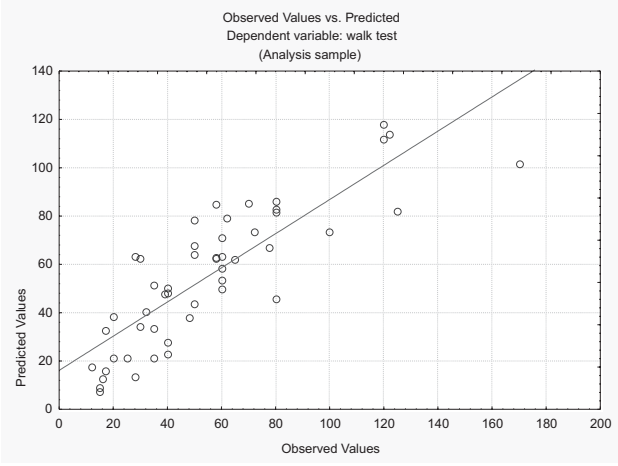
Cause of amputation	Number of subjects	%	Walk test (m)	t	P
circulatory	42	84	49.82	2.69	0.009
noncirculatory	8	16	82.75		

P, t = parameters, Walk test = 2 – minute walk test, m = meters

TABLE 5
RESULTS OF THE 2-MINUTE WALK TEST WITH REGARD TO THE TIME ELAPSED FROM THE FIRST PROSTHETICS SUPPLY

Time from the first prosthetics supply (y)	Number of subjects	Results of the walk test (m)	Standard deviation	P
3–5	23	42.61	25.63	0.031
6–9	19	61.76	34.94	
Over 9	8	75.13	37.00	

Y = year, P = parameters, Walk test = 2 – minute walk test, m = meters



Predictors = age, gender, level of amputation, cause of amputation, time elapsed from prostethic supply
Walk test = 2 – minute walk test

Fig 1. Regression efficiency presented as a relation between observed and predicted values (2 – minute walk test versus age, gender, level of amputation, cause of amputation, time elapsed from prostethic supply).

Correlation is significant (F=27.2, p<0.001). Multiple partial correlation of all predictors shows a significant influence of age (b=–0.31, p=0.021). Figure 1 illustrates the observed and expected values for the 2MWT variable.

Discussion

This study included fifty subjects who underwent unilateral lower limb amputations more than five years ago and were prosthetic users for a longer period of time, i.e., between three and eighteen years. The 2-minute walk test was used to evaluate their functional outcome. The mean age of the subjects was 71.5 years, which is compliant with data reported by other authors researching the amputee population[9,14,15].

The subjects were divided into age groups. The best 2MWT results were achieved by younger subjects in the age group of 45 to 59 years. Considering the results, the difference between groups was statistically significant (p<0.001), Table 1. According to the literature, amputees under the age of 65 have a higher probability of achieving autonomy and better mobility in relation to the elderly patients[15,16]. In older patients comorbidities that increase dependence are more frequent[16,17].

Our subjects were of both genders, however, the number of men 41 (82%) in relation to women 9 (18%) was higher. As known from the literature, lower limb amputations are two times, even three times more frequent in men than in women[16]. There was no statistically significant difference between genders in the 2MWT (t=1.80) and (p=0.077).

Furthermore, better results were achieved by subjects with transtibial in reference to those with transfemoral amputations (Table 3), which is consistent with reports of other authors[15,17], suggesting that the principal of a more distal amputation approach should be followed if it is possible[17,18].

The cause of lower limb amputations in 42 (84%) subjects was a peripheral vascular pathology, which is the most common complication of diabetes and atherosclerosis[14,15]. In only 8 (16%) subjects the cause was not circulatory but trauma and tumors. Better 2MWT results were obtained by subjects in whom other reasons and not circulatory were the cause of amputation, which was statistically significant (t=2.69, p=0.009). According to the literature, circulatory diseases developed as complications of diabetes and atherosclerosis are the cause of lower limb amputations in almost 85% of cases, arterial thromboembolism in about 6.6%, Buerger's disease in 5%, trauma in 2% to 20% and tumors in 2% to 5% of cases[15,16].

Walking test results were also compared in patients using prosthetic devices 3–5 years, 5–9 years, and over 9 years. Results showed that individuals using their prosthesis over 9 years, function better than those using prosthesis for 5 years, which was statistically significant (p=0.043), (Table 5). Better results were expected from these subjects due to longer prosthetic use and better adaptability.

Successful prosthetic supply that provides mobility and independence is of utmost importance for individuals with limb amputations. There is a dearth of validated outcome measures for patients with lower extremity amputation. The 2 minute test is practical, simple, quick and easy to administer and was responsive to physical functioning with the prosthesis when is correlated with patients age, gender, time from amputation, cause and level of amputation. Our research confirmed that age, gender, level and cause of amputation, including the time from the first prosthetic supply have an effect on the 2MWT results.

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PROCJENA FUNKCIONALNOSTI OSOBA S AMPUTACIJOM DONJEG UDA OPSKRBLJENIH PROTEZOM 2-MINUTNIM TESTOM HODA

SAŽETAK

Cilj rada je ocjena funkcionalnosti osoba s amputacijom donjeg uda, opskrbljenih protezom. Istraživanje je provedeno u Centru za fizikalnu i rehabilitacijsku medicinu, Kliničkog bolničkog centra Rijeka, od lipnja do rujna 2010. godine. U ovu studiju uključeno je 50 odraslih ispitanika, oba spola, s jednostranom amputacijom donjeg uda na razini potkoljenice ili natkoljenice. Za evaluaciju funkcijske osposobljenosti tih osoba, korišten je 2 – minutni test hoda (2MWT). Rezultati su statistički obrađeni. Prema dobi, ispitanici su svrstani u skupine, a najbolji rezultat postigle su osobe od 45–59 godina (p<0,001). Prema uzroku cirkulacijskih/necirkulacijskih amputacija, bolji rezultati dobiveni su u drugoj skupini bolesnika (p=0,009). Prema razini amputacije, nađena je statistički značajna razlika u rezultatima 2MWT između osoba s amputacijom potkoljenice i osoba s amputacijom natkoljenice, tj. bolje rezultate su postigle osobe s amputacijom potkoljenice (p=0,039). Obzirom na vrijeme od prve protetičke opskrbe, bolje rezultate postigli su oni, koji su pred više od 9 godina opskrbljeni protezom (p=0,031). Ovim istraživanjem smo ustanovili da dob, spol, razina, uzrok amputacije kao i vrijeme proteklo od prve protetičke opskrbe utječu na rezultate 2MTW.