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ORIGINAL RESEARCH

Muscle strength and locomotion ability in individuals with chronic stroke

Força muscular e habilidade de locomoção em indivíduos pós-acidente vascular encefálico crônico

Fuerza muscular y habilidad de locomoción en individuos post-accidente cerebrovascular crónico

Poliana do Amaral Benfica[1], Emiliane Aparecida Roza[2], Carla Silva Alves Lacerda[3], Janaíne Cunha Polese[4]

ABSTRACT | The objective of this study was to verify if there are differences in the lower-limb muscle strength (LL) and in the locomotion ability among post-stroke patients classified as community or non-community ambulators. A cross-sectional study was *conducted* in 60 post-chronic stroke subjects, divided into community (n=33) and non-community (n=27) ambulators by gait speed. The muscle strength of seven bilateral muscle groups of LL was evaluated through the modified sphygmomanometer test and locomotion ability through ABILOCO. Descriptive statistics were used to characterize the sample, and Student's t-test was used for independent samples to compare the two groups of post-stroke individuals. We observed that community ambulators had higher values of muscle strength for most muscle groups of LL (−0.973≥t≥3.189; p≤0.04), and in the locomotion ability (t=−2.841; p=0.006). Community ambulators showed higher LL muscle strength and better locomotion ability compared with non-community ambulators. Physiotherapeutic evaluation of post-stroke individuals should include, besides the measurement of LL muscle strength and its treatment, the measurement of the perception of locomotion ability to analyze the evolution of the patient and the efficacy of the therapeutic behavior.

Keywords | Stroke; Muscle Strength; Locomotion.

RESUMO | O objetivo do estudo foi verificar se existem diferenças na força muscular dos membros inferiores (MMII) e na habilidade de locomoção de indivíduos pós-acidente vascular encefálico (AVE) crônico, classificados como deambuladores comunitários ou não comunitários. Foi realizado um estudo transversal em 60 indivíduos pós-AVE crônico, divididos em deambuladores comunitários (n=33) e não comunitários (n=27) pela velocidade de marcha. A força muscular de sete grupos musculares bilaterais de MMII foi avaliada por meio do teste do esfigmomanômetro modificado e habilidade de locomoção pelo ABILOCO. Estatísticas descritivas foram utilizadas para caracterizar a amostra, e o teste t de Student para amostras independentes, a fim de comparar os dois grupos de indivíduos pós-AVE. Observou-se que os deambuladores comunitários apresentaram maiores valores de força muscular para a maioria dos grupos musculares de MMII (−0,973≥t≥−3,189; p≤0,04), e na habilidade de locomoção (t=−2,841; p=0,006). Os indivíduos pós-AVE crônico deambuladores comunitários possuem maior força muscular de MMII e mais habilidade de locomoção em comparação aos deambuladores não comunitários. Sugere-se que a avaliação fisioterapêutica de indivíduos pós-AVE inclua, além da mensuração da força muscular de MMII e seu tratamento, a mensuração da percepção da habilidade de locomoção, para análises da evolução do paciente e da eficácia da conduta terapêutica.

Descritores | Acidente Vascular Encefálico; Força Muscular; Locomoção.

Study developed in the Department of Physical Therapy of Faculdade Ciências Médicas de Minas Gerais (FCM-MG) – Belo Horizonte (MG), Brazil.

[1]Faculdade Ciências Médicas de Minas Gerais (FCM-MG) – Belo Horizonte (MG), Brazil. E-mail: poliana.benfica@gmail.com. Orcid: 0000-0003-4611-6386

[2]Faculdade Ciências Médicas de Minas Gerais (FCM-MG) – Belo Horizonte (MG), Brazil. E-mail: emilianeaproza@gmail.com. Orcid: 0000-0002-9294-6455

[3]Faculdade Ciências Médicas de Minas Gerais (FCM-MG) – Belo Horizonte (MG), Brazil. E-mail: carlaradiol1@gmail.com. Orcid: 0000-0002-2341-8325

[4]Faculdade Ciências Médicas de Minas Gerais (FCM-MG) – Belo Horizonte (MG), Brazil. E-mail: janainepolese@yahoo.com.br. Orcid: 0000-0003-3366-1545

Corresponding address: Janaíne Cunha Polese – Alameda Ezequiel Dias, 275 – Belo Horizonte (MG), Brazil – Zip Code: 30130-110 – Phone: (31) 99164-5246 – E-mail: janainepolese@yahoo.com.br – Financing source: Fundação de Amparo à Pesquisa do Estado de Minas Gerais – Conflict of interest: Nothing to declare – Presentation: Sept. 21st, 2018 – Accepted for publication: Feb. 20th, 2019 – Approved by the Research Ethics Committee of Faculdade Ciências Médicas de Minas Gerais under Protocol No. 1.720.245.

RESUMEN | El objetivo del estudio fue verificar si existen diferencias en la fuerza muscular de los miembros inferiores (MMII) y en la habilidad de locomoción de individuos post-accidente cerebrovascular encefálico (ACV) crónico, clasificados como deambuladores comunitarios o no comunitarios. Se realizó un estudio transversal en 60 individuos post-ACV crónico, divididos en deambuladores comunitarios (n=33) y no comunitarios (n=27) por la velocidad de marcha. La fuerza muscular de siete grupos musculares bilaterales de MMII fue evaluada por medio de la prueba del esfigmomanómetro modificado, y la habilidad de locomoción por el ABILOCO. Las estadísticas descriptivas se utilizaron para caracterizar la muestra, y la prueba t de Student para muestras independientes con el fin de comparar los dos grupos de sujetos post-ACV. Se observó que los deambuladores comunitarios presentaron mayores valores de fuerza muscular para la mayoría de los grupos musculares de MMII (−0,973≥t≥−3,189; p≤0,04), y en la habilidad de locomoción (t=−2,841; p=0,006). Los individuos post-ACV crónico deambuladores comunitarios poseen mayor fuerza muscular de MMII y más habilidad de locomoción en comparación a los deambuladores no comunitarios. Se sugiere que la evaluación fisioterapéutica de individuos post-ACV incluya, además de la medición de la fuerza muscular de MMII y su tratamiento, la medición de la percepción de la habilidad de locomoción, para análisis de la evolución del paciente y de la eficacia de la conducta terapéutica.
Palabras clave | Accidente Cerebrovascular; Fuerza Muscular; Locomoción.

INTRODUCTION

Although the ability to walk independently is among the most common goals in the rehabilitation of post-stroke victims[1], their recovery is often incomplete and insufficient for community ambulation[2]. Among the clinical criteria that measure community ambulation, speed is a measure capable of discriminating categories of this variable[3]: home ambulation (≤0.39m/s), limited community ambulation (0.4 to 0.79m/s) and full community ambulation (≥0.8m/s)[4].

Lower limb muscle strength is one of the factors that can influence the gait speed of post-stroke individuals[5,6] because it has a significant correlation with this construct[7] and is therefore related to community ambulation[8]. Another factor that needs to be considered and that can influence the gait speed and ambulation in the community of post-stroke individuals is their perception of locomotion. Self-perception measures are obtained by the individual's perception of their performance in the activities[9] and, even though they are considered susceptible to under or overestimation of the actual performance, they are able to capture an average performance in long periods of time[10,11].

Given this context, the objective of this study was to verify the ability of locomotion and LL muscle strength in chronic hemiparetic individuals stratified according to the level of functional performance determined by the gait speed, considering that muscle strength is one of the most relevant factors influencing the community ambulation but that the perception of the locomotion ability can also be important with better decision making in the clinical practice.

METHODOLOGY

Cross-sectional study conducted at the Department of Physical Therapy of Faculdade Ciências Médicas de Minas Gerais (FCM-MG) and approved by the Research Ethics Committee of FCM-MG (no. 1.720.245). The convenience sampling consisted of 60 post-chronic stroke individuals (33 community ambulators and 27 non-community ambulators). We included individuals aged over 18 years and time of evolution post-stroke of at least six months; and excluded those who presented cognitive alterations identified by the Mini-Mental State Examination[12]. The sample calculation was carried out a posteriori through the G* Power 3.0.10 Program. In this calculation, the significance level of 0.05 (α=0.05) and effect size of d=0.7 were considered. The sample included in this study had a power of 75%.

Before the tests were carried out, the participants were informed about the objectives of the study and signed the Informed Consent Form. Next, clinical-demographic information was collected to characterize the sample. Participants were classified as community and non-community ambulators through the 10 meter walk test, which presents adequate measurement properties for the post-stroke population[13,14]. The test was performed according to the criteria described by Salbach et al.[13], only one repetition was used[14], and the verbal commands

were standardized according to the recommendation of Nascimento et al.[15].

The perception of locomotion performance was measured by ABILOCO-Brasil[16,17], a questionnaire that assesses the perception of the locomotion performance of post-stroke individuals[18] and has adequate measurement properties for this population[17,18], in addition to a translated version adapted for Brazil[16,17]. The test was applied as an interview, in which individuals were asked to estimate their perceptions of difficulties according to the scale of responses ("Impossible"=0, and "Possible"=1)[18].

To evaluate the lower limb muscle strength, the modified sphygmomanometer test (MST)[19] was used, which provides objective measurements and has a low price[19,20]. In addition, it also presents adequate measurement properties for post-stroke individuals[20,21]. MST with pocket adaptation was used to measure the isometric muscle strength of seven muscle groups of the bilateral lower limbs (hip flexors, extensors and abductors, knee flexors and extensors, and ankle dorsiflexors and plantar flexors). A mobile aneroid sphygmomanometer of the brand Tycos (WelchAllyn Inc., NY, USA, model DS-44), already calibrated by the manufacturer, was used. The adaptation took place by the removal of the inflatable part from inside the cuff of the sphygmomanometer, which was folded in three parts and placed inside a bag of cotton cloth[19]. The positions were standardized and followed the descriptions of Souza et al[20]. After the familiarization, a maximum contraction of each muscle group was performed, with a duration of five seconds and a rest period of 20 seconds between the measurements, which were initiated by the non-paretic side and had verbal stimulation[22].

Descriptive statistics were performed to characterize the sample. The Student's t-test for independent samples was applied to compare the two groups and to verify if there are differences regarding the perception of the locomotion performance and the lower limb muscle strength. The statistical package used for all analyses was SPSS for the Windows version 18.0 (SPSS Inc., Chicago, IL, USA), considering the significance level of $\alpha=0.05$.

RESULTS

Sixty post-stroke subjects – 33 community ambulators and 27 non-community ambulators – were evaluated in the study. Table 1 shows the clinical-demographic characteristics of the total sample and the separate groups.

Table 1. Clinical and demographic characteristics of the participants (mean and standard deviation or absolute number and percentage)

Characteristics	Total Sample (n=60)	Groups	
		Community ambulators (n=33)	Non-community ambulators (n=27)
Sex			
Female	26 (43.3%)	11 (33.3%)	15 (55.5%)
Male	34 (56.7%)	22 (66.7%)	12 (44.5%)
Age (years)	59.0 (15.7)	54.4 (16.0)	64.4 (13.8)
Stroke evolution time (months)	62.2 (47.8)	49.3 (37.8)	77.9 (54.5)
Stroke Type			
Ischemic	41 (68.3%)	20 (68.9%)	21 (77.6%)
Hemorrhagic	11 (18.3%)	8 (27.5%)	3 (11.2%)
Both	4 (6.7%)	1 (3.6%)	3 (11.2%)

Table 2 shows the comparison between the groups of community and non-community ambulators in relation to the muscle strength assessed by MST and the locomotion ability evaluated by ABILOCO. The Student's t-test showed a statistically significant difference between the groups regarding the muscle strength of eight muscle groups – hip flexor and abductors, and knee flexors on both paretic and non-paretic sides; paretic knee extensors and plantar flexors – ($-0.973 \geq t \geq -3.189$; $p \leq 0.04$), and in the perception of locomotion performance ($t=-2.841$; $p=0.006$), with non-community ambulators presenting higher values in the muscle strength of these muscles and in the perception of locomotion performance.

Table 2. Comparison between the groups studied in relation to lower limb muscle strength assessed by MST and the perception of locomotion performance assessed by ABILOCO

Variables	Community ambulators (n=33) Mean (SD)	Non-community ambulators (n=27) Mean (SD)	*p*; t	Mean difference (95%CI)
P hip flexors	162.9 (53.0)	133.7 (36.4)	0.018; −2.427	−58.3 (−53.2 to −5.1)
NP hip flexors	206.3 (47.1)	162.7 (58.9)	0.002; −3.189	−87.2 (−71.0 to −16.2)
P hip extensors	211.27 (62.2)	184.2 (60.0)	0.094; −1.702	−54.1 (−58.9 to 4.8)
NP hip extensors	242.8 (49.5)	228.7 (56.5)	0.307; −1.030	−28.2 (−41.5 to 13.3)
P hip abductors	131.1 (48.4)	101.6 (30.0)	0.008; −2.762	−59.0 (−50.9 to −8.1)
NP hip abductors	154.4 (29.6)	135.4 (38.4)	0.035; −2.165	−38.0 (−36.6 to −1.4)
P knee flexors	157.7 (71.8)	112.7 (61.2%)	0.012; −2.581	−90.0 (−79.9 to −10.1)
NP knee flexors	227.7 (46.4)	197.7 (64.1)	0.040; −2.097	−59.9 (−58.6 to −1.3)
P knee extensors	236.7 (54.2)	194.0 (56.6)	0.004; −2.969	−85.2 (−71.3 to −13.9)
NP knee extensors	259.52 (42.6)	242.37 (51.4)	0.163; −1.413	−34.3 (−41.4 to 7.1)
P dorsiflexors	134.3 (78.8)	104.7 (47.5)	0.078; −1.795	−59.3 (62.7 to 3.4)
NP dorsiflexors	193.1 (46.9)	169.5 (60.2)	0.094; −1.705	−47.1 (−51.2 to 4.1)
P plantar flexors	153.7 (82.7)	105.0 (45.4)	0.006; −2.886	−97.2 (−82.4 to −14.8)
P plantar flexors	198.5 (53.6)	82.2 (72.4)	0.336; −0.973	v32.6 (−50.0 to 17.4)
ABILOCO	3.72 (2.06)	2.45 (1.38)	0.006; −2.841	−2.6 (−2.2 to −0.4)

95%CI: 95% confidence interval; SD: standard deviation; P: paretic; NP: non-paretic.

DISCUSSION

The relationship between lower limb muscle strength and gait speed is already well established in the literature[5-7], and, in this study, most muscle groups presented statistically higher values in the group of community ambulators compared with non-community ambulators. van de Port et al.[8] and Lee et al.[23] investigated the relationship between community ambulation and factors that determine the ambulation ability in post-chronic stroke individuals, considering the different categories of community ambulation through four levels of self-reported unsupervised mobility[3]. The results of these studies showed that the gait speed and the LL muscle strength were significantly related to the ambulation in the community[8,23], that is, even though not using the same classification of the community ambulation of this study, gait speed and muscle strength were evaluated and were positively related to community ambulation, corroborating with the results of this study.

Although most muscle groups showed differences between community and non-community ambulators, six muscle groups were not statistically different from each other. Aguiar et al.[21] and Souza et al.[20], who evaluated the MST measurement properties (test-retest and inter-rater validity and reliability) in the subacute and chronic post-stroke population, respectively, presented low correlation results for the non-paretic plantar flexors (test-retest[21] and inter-rater[20] reliability) and non-paretic dorsiflexors (test-retest[21] reliability). The authors explained this fact through problems that occurred during the evaluation, which may also have occurred in this study. For non-paretic plantar flexors, the difference in resistance provided by the rater during assessment, associated with the short lever arm of the foot and with the great strength exerted by the plantar flexors, may have required the rater to apply greater strength to maintain isometric contraction[24]. For dorsiflexors, the difficulty of stabilizing the equipment in a small area may have been an obstacle to a correct evaluation[21]. For the other muscle groups, a possible explanation would also be the problems that occurred during the assessment: for bilateral hip extensors and non-paretic knee extensors, the difficulty in stabilizing the limb in isometry during muscle strength assessment may have altered the measurements because they are muscle groups capable of generating a lot of strength[25].

Regarding the locomotion ability, community ambulators seem to have perceived a better locomotion performance than non-community ambulators. It seems obvious to think that individuals with higher gait speed have better performance in locomotion; however, no studies on the differences in the locomotion ability between these two groups were found. Despite this, it is very important to consider the self-perception measures, since they are capable of assessing the individual's actual performance[9], which is linked to what they accomplish

in their true life context[26]. In addition, it is important to consider customer-centric practice, which recognizes the role of the patient in clinical decision making[27]. Thus, the individual who can identify limitations on the performance of their locomotion may request the physical therapeutic behavior to be aimed at the improvement of this limitation.

This study presents some limitations. The convenience sampling provided results that cannot be generalized for individuals with characteristics different from those of the individuals evaluated. Moreover, due to the methodology and design used, it is not possible to establish cause and effect relationships with the presented results.

CONCLUSION

Community ambulators have greater muscle strength in most muscle groups of LL and better locomotion ability compared with non-community ambulators. In this way, physical therapeutic evaluation should include, besides the measurement of the LL muscle strength and its treatment, the quantification of the locomotion perception, which could help the analysis of the evolution of post-stroke patients and the efficacy of the therapeutic approach used to this end.

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