

Original Article

Relationship between functional balance and walking ability in individuals with chronic stroke

MASUMEH HESSAM, PT, PhD candidate¹⁾, REZA SALEHI, PT, PhD^{1, 2)*},
MOHAMMAD JAFAR SHATERZADEH YAZDI, PT, PhD¹⁾, HOSSEIN NEGAHBAN, PT, PhD^{3, 4)},
SHAHRAM RAFIE⁵⁾, MOHAMMAD MEHRAVAR, MSc¹⁾

¹⁾ Musculoskeletal Rehabilitation Research Center, Ahvaz Jundishapur University of Medical Sciences, Iran: Golestan St, Ahvaz, 6135733133, Iran

²⁾ Rehabilitation Research Center, School of Rehabilitation Sciences, Iran University of Medical Sciences, Iran

³⁾ Department of Physical Therapy, School of Paramedical Sciences, Mashhad University of Medical Sciences, Iran

⁴⁾ Orthopedic Research Center, Mashhad University of Medical Sciences, Iran

⁵⁾ Department of Neurology, School of Medicine, Ahvaz Jundishapur University of Medical Sciences, Iran

Abstract. [Purpose] The objective of this cross sectional study was to investigate the validity of Functional Ambulation Category in evaluating functional balance and identifying the relationship between balance impairment and functional ambulation in individuals with chronic stroke. [Participants and Methods] A total of 31 chronic stroke patients with first ever ischemic middle cerebral artery strokes, with no cognitive deficits were recruited. Participants had a mean age of 54.84 (SD=7.05) years and a time after stroke of 22.74 (SD=27.13) months. Community ambulation was determined by Functional Ambulation Category and functional balance was assessed by Berg Balance Scale. [Results] The mean Berg Balance Scale and the Functional Ambulation Category scores were 47.38 (SD=7.54) and 3.8 (SD=0.79), respectively. Correlation analysis revealed that balance impairment and ambulatory function was significantly positively correlated with each other ($r=0.80$). [Conclusion] The results shows that the Functional Ambulation Category is a valid tool in evaluating functional balance and suggest that functional balance may be an important goal for rehabilitation to achieve improvement in walking ability in people with chronic stroke.

Key words: Walking, Stroke, Balance

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INTRODUCTION

Walking ability is associated with activities of daily living, participation in community and health-related quality of life. In stroke survivors, impairments such as weakness, spasticity and abnormal muscle activation pattern significantly limit walking ability, activity and participation in everyday life and decrease the quality of life¹⁾. Hence, the most frequent rehabilitation goal for this population is to regain walking and functional mobility^{2, 3)}.

Balance is one of the fundamental components of walking ability and knowledge about the association between balance and walking may be useful and provide a better guide to develop optimal intervention and more directed clinical decision making⁴⁾.

*Corresponding author. Reza Salehi (E-mail: salehi200@yahoo.com)

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Majority of studies have highlighted that balance contributes to ambulatory function in stroke participants and balance deficit has been associated with low level of ambulatory function. Previous researchers used gait speed tests, ten meter walk test, six-minute walk test, three hundred meter walk test and dynamic gait index as measuring tools for evaluating walking ability, which required some resources (time, space and information)^{1, 5-7}.

To plan an effective rehabilitation program, it is essential to evaluate the nature and severity of the patient's problem, requiring feasible, reliable, valid and responsive measurement tools^{3, 5}. Validity means the extent of the relationship that exists between an outcome measure to another, therefore clinicians can use one measure instead of others because it takes little time, easy to learn and administer and inexpensive⁸.

The Berg Balance Scale (BBS) has been identified as the most widely used clinical instrument for quantifying balance post-stroke. It has been shown to have excellent intra and inter-rater reliability, validity and a sensitive measure when applied to the stroke population. It takes 15–20 minutes to complete and may be too expensive in terms of time in inpatient and outpatient clinics^{3, 4, 9}.

On the other hand, for evaluating walking ability, laboratory gait assessment include three-dimensional kinematic and kinetic equipments which allow for comprehensive evaluation and represent the gold standard. However, high costs, time-demanding, difficulties in interpretation of the results and problems with availability in clinical practice, make laboratory gait analysis unsuitable for routine clinical use¹⁰. Thus observational gait analysis remains the most frequent method to provide an estimation of walking ability¹¹.

The common clinical gait assessment scales are the Timed Up and Go (TUG) test and the Functional Ambulation Category (FAC). The TUG is used to assess a person's mobility. It uses the time that a person takes to rises from a chair, walks three meters, turns around and walk back to the chair¹². This test does not provide information about the quality of walking. The FAC is designed to provide information about walking ability on the basis of the amount of physical support required by a participant to ambulate^{10, 13}. As the participant walks with self-paced and comfortable speed, the therapist assess walking ability and quality of walking. This instrument is a quick visual assessment tool, simple to administer in the clinical setting, straightforward to interpret and has been shown to be reliable, valid and sensitive to change in classifying hemiplegic gait^{5, 10}.

Therefore, as the BBS is time consuming and the FAC takes a few seconds to complete and does not require any additional tool to administer, the purpose of the present study was to determine the validity of FAC in evaluating balance and indicate the extent of the correlation between balance ability (measured by BBS) and walking performance (based on FAC) in a sample of individuals with chronic stroke.

On the basis of existing evidence from previous studies, the hypothesis was that the FAC is a usable tool in measuring balance performance and has a strong and positive correlation with the BBS.

PARTICIPANTS AND METHODS

This study was an observational cross-sectional study. Ethical approval was provided by the Ahvaz Jundishapur University of Medical Sciences, Ahvaz, Iran (PHT-9507). All participants received clear information prior to the study and signed informed consent forms.

Thirty one participants were recruited from local physical therapy clinics. To be eligible for this study patients with chronic stroke (the elapsed time from the onset of stroke was more than six months), had to meet the following criteria: 1) aged between 30–65 years. 2) First ever stroke involving the middle cerebral artery (MCA) territory, confirmed clinically with a CT scan or MRI. 3) No cognitive deficits as indicated by a score of 24 on the Mini-Mental State Examination (MMSE).

Participants were excluded from the sample if they had experienced more than one stroke, other concurrent neurological conditions or severe cardiopulmonary or musculoskeletal problems that limited walking ability.

Assessments were conducted in the Musculoskeletal Rehabilitation Research Center, Ahvaz, Iran by a physical therapist (M. Hessam) with 10 years of experience in neurological rehabilitation setting who was well aware of the clinical measures. All testing were performed in the same day and single session for each participants and 10 minutes of rests provided during the testing to avoid fatigue.

Ambulatory activity was quantified using the Functional Ambulation Category (FAC). This instrument is a reliable, valid and responsive assessment tool which distinguishes among 6 levels of walking ability, a score of 0 describes that the participant cannot walk. Scores of 1, 2 and 3 represent a dependent walker who requires support from another person in form of continuous manual contact (1), intermittent manual contact (2) and supervision (3). Scores of 4 and 5 denotes an independent walker who can walk only on level surface (4) or any surfaces including stairs (5)³.

Balancing ability for each participant was evaluated using the Berg Balance Scale (BBS). Which has been established as a valid, reliable tool in studies of balance in stroke populations. It consists of 14 tasks evaluating postural stability under a variety of functional activities such as sitting unsupported, standing to sitting transfer and vice versa, turning, transfer, standing with closed eyes, stepping, tandem stance, single leg stance and forward reach. Each item is scored from 0 to 4 with a maximum score of 56. Higher scores indicate better balance. It takes 15 to 20 minutes to complete^{1, 3}.

Data were analyzed using the IBM SPSS software version 20. Descriptive statistics (mean, standard deviation, percentage) were generated for all interval and ordinal variables. Normality of variables were assessed with Shapiro-Wilk's tests. Both BBS and FAC scores showed a non-normal distribution. The non-parametric Spearman's Rho correlation coefficient

was calculated to discern the strength of the association between the BBS and FAC Scores. The correlation coefficient of 0–0.25 indicated little correlation, 0.26–0.49 meant low correlation, 0.50–0.69 meant moderate, and 0.70–0.89 and 0.90–1.00 were indicators of high and very high correlation respectively¹⁴. The level of significance was set at $p < 0.05$ and a correlation coefficient of 0.7 or higher was considered to be acceptable.

RESULTS

Demographic and performance data (N=31) are presented in Table 1. 58.1% of participants were male, all participants have ischemic MCA stroke and 20 participants had right-sided brain damage, while 11 participants had left-sided brain damage. Significant positive bivariate correlation was found between BBS score and FAC ($r=0.80$, $p < 0.05$). In addition, the FAC only has a low but not significant correlation with item number 14 of BBS (single leg stance) ($r=0.47$, $p=0.03$) (Table 2).

DISCUSSION

The aim of the current study was to investigate the validity of FAC in evaluating balance performance and identifying the correlation between FAC and the BBS in participants with chronic stroke. The FAC showed significant positive and strong correlation coefficient ($r=0.8$, $p < 0.05$) with the BBS, which means that the high scores on BBS is associated with high scores on FAC. Higher scores on the BBS indicates better balance and low level of fall risk, with the results of current study, higher scores on the FAC also indicate better balance and low level of fall risk. Hence like the BBS, the FAC can identify the patients with risk of fall. But in this study, the cut of point value was not determined for the FAC. Further studies are suggested to determine this issue.

This finding implies that assessment of walking ability using the FAC may help to estimate balance abilities and vice versa. Since the FAC is easy to administer than the BBS and takes a few seconds to complete, the assessment of ambulatory function with this tool may help to understand patients' overall balance in both inpatient and outpatient clinics.

It is not surprising that balance control plays an important role in walking performance. Walking is an incredibly complex task. A majority of the gait cycle is spent in single leg stance and during this phase, the center of mass is traveled outside the margin of stability, thus making this phase inherently unstable. Therefore, balance recovery is critical to having a stable and safe ambulation. Following stroke, not only ambulation capacity is limited, but also due to weakness, spasticity and changes in muscle activation pattern, balance control is reduced^{15, 16}.

Consistent with the finding of the present study, other studies have also indicated that balance control (based on the BBS) is related to ambulatory function and has the ability to predict walking performance^{4, 16–20}. Although they have used different measuring tools for evaluating walking performance. Some determined walking ability by changing gait speed¹⁹, changes in Barthel index scores or Brunnstrom stage of motor recovery¹³. Makizako et al. also reported that the BBS can predict independent walking within 3 months of admission²¹.

The results of this study have potential clinical relevance. The clinician can use the FAC to estimate balance performance in chronic stroke patients and if there is any problem with that, they can suggest the BBS to obtain more information about balance ability. Also, the deficit in balance control may help to explain walking impairments post-stroke and this correlation suggests that recovery in balance is a potential goal for rehabilitation interventions for regaining gait in the stroke population.

The limitation of the current study was the case that only people with chronic ischemic stroke in MCA territory were recruited and also, other contributors to walking ability such as strength, endurance and cognitive function were not assessed. Further studies in a cohort design and on a larger sample size to provide a more accurate estimation of the relationship between balance control and walking ability are therefore recommended. The investigation of the effects of type of brain lesion on balance and walking ability in stroke population was also suggested.

Overall, the results of the current study show that the FAC is a valid tool in evaluating balance ability in participants with chronic stroke. Having an understanding of the relationship between balance and ambulatory function could help clinicians

Table 1. Sample characteristics (n=31)

Variable	Mean ± SD
Age (years)	54.87 ± 7.05
Gender (M:F)	18:13
BMI	27.19 ± 3.8
Side of hemisphere (right: left)	20:11
Time since stroke (months)	22.74 ± 27.12
MMSE (/30)	28.6 ± 1.81
BBS (/56)	47.38 ± 7.54
FAC (/6)	3.8 ± 0.79

Demographic and clinical data, Mean ± SD.

Table 2. Spearman's rho correlation coefficient between BBS and FAC (n=31)

	BBS	FAC
BBS	---	0.80*
FAC	0.80*	---

*Correlation is significant at the level of 0.01.

to design better rehabilitation strategies to improve gait in this population.

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Conflict of interest

The authors report no conflict of interest.

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