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Determinants of Balance Performance in Hemiparetic Stroke Survivors

Hemiparetik İnmeli Hastalarda Denge Performansı

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Summary

Objective: Balance dysfunctions in stroke survivors have significant impact on their functional independence. This study was designed to assess the balance performance of hemiparetic stroke survivors and to determine the effect of gender, type of stroke and laterality on balance performance.
Materials and Methods: The research was a cross-sectional study of 120 community-dwelling adults who had survived six months or more after a stroke. Balance performance was assessed using the Activities-specific Balance Confidence (ABC) scale and the Functional Reach Test (FRT).
Results: Eighty seven (72.5%) males and thirty three (27.5%) females with ages ranging from 31 to 83 years (mean 55.7±10.4) participated in this study. Sixty three (52.5%) had hemorrhagic stroke, while 57 (47.5%) had ischemic stroke. Seventy one (59.2%) had right-sided hemiparesis, while 49 (40.8%) had left-sided hemiparesis. Significant differences were found between balance performance (balance confidence and functional reach distance) of male and female stroke survivors with male stroke survivors having higher values; and between those of hemorrhagic and ischemic stroke survivors, with ischemic stroke survivors having higher values. In a multiple regression analysis, patients' characteristics (age, height, weight, body mass index, post stroke duration) were related to the balance performance, accounting for 5.1% and 7.4% of the variance in the ABC Scale scores and functional reach distance, respectively.
Conclusion: This study concluded that gender and stroke type had influence on balance performance of hemiparetic stroke survivors and should be considered as factors in balance assessment and retraining of hemiparetic stroke survivors. *Turk J Phys Med Rehab 2011;57:201-5.*
Key Words: Stroke, balance, hemiparesis, falls

Özet

Amaç: İnmeli hastalarda denge bozukluğunun fonksiyonel bağımsızlık üzerine önemli etkisi vardır. Bu çalışma hemiparetik inmeli hastalarda denge durumunu incelemek ve cinsiyet, inme tipi, taraf faktörünün denge performansı üzerindeki etkisini belirlemek amacı ile planlanmıştır.
Gereç ve Yöntem: Bu çalışmada altı ay ya da daha uzun süreli inme tanısı olan erişkin hastalar kesitsel olarak incelendi. Denge performansı Aktiviteye Özel Denge Güven Skalası (AÖD) ve Fonksiyonel Ulaşma Testi (FUT) ile değerlendirildi.
Bulgular: Yaşları 31-83 yıl arasında değişen 87 erkek (%72,5) ve 33 kadın (%27) çalışmaya alındı. Altmış üç hastada (%52,5) hemorajik, 57 hastada (%47,5) iskemik inme; 71 hastada (%59,2) sağ, 49 hastada (%40,8) sol hemiparezi vardı. Kadın ve erkek hastaların, ayrıca hemorajik ve iskemik inmeli hastaların denge performansları (denge güveni ve fonksiyonel uzanma mesafesi) arasında anlamlı farklılık bulundu. İnmeli erkek hastalarda kadınlara göre ve ayrıca iskemik inmeli hastalarda hemorajik inmeli hastalara göre değerler daha yüksek bulundu. Çoklu regresyon analizinde hasta özellikleri (yaş, boy, kilo, vücut kitle indeksi, inme başlangıcından itibaren geçen zaman) ile denge performansı arasında ilişki vardı ve bunların sırasıyla AÖD skorlarındaki varyansın %5,1'inden, fonksiyonel ulaşma mesafesindeki varyansın da %7,4'ünden sorumlu olduğu bulundu.
Sonuç: Bu çalışmaya göre hemiparetik inmeli hastalarda cinsiyet ve inme tipi denge üzerine etkili bulunmuştur ve bunlar hem dengenin değerlendirilmesinde, hem de denge eğitiminde etkili faktörler olarak ele alınmalıdır. *Türk Fiz Tıp Rehab Derg 2011;57:201-5.*
Anahtar Kelimeler: İnme, denge, hemiparezi, düşmeler

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Introduction

The World Health Organization (WHO) defines stroke as "rapidly developing clinical signs of focal (at times global) disturbance of cerebral function, lasting more than 24 hours or leading to death with no apparent cause other than that of vascular origin" (1). Sims and Muyderman (2) with consideration for survival simply defined stroke as a rapidly developing loss of brain function due to disturbance in blood supply to the brain resulting in range of neurological deficits that last longer than 24 hours.

The two broad categories of stroke are hemorrhagic and ischemic: hemorrhagic type is characterized by too much blood within the closed cranial cavity, while ischemic one is characterized by too little blood to supply an adequate amount of oxygen and nutrients to a part of the brain. Each of these categories can be divided into subtypes that have somewhat different causes, clinical pictures, clinical courses, outcomes, and treatment strategies. Brain ischemia can be due to thrombosis, embolism, or systemic hypoperfusion, while hamorrhage can be intracerebral or subarachnoid (3).

Sub-Saharan Africa is undergoing epidemiological transition and there are no systematic reviews of stroke mortality, prevalence, incidence, and case fatality (4). Although comprehensive stroke surveillance data for Africa are lacking, stroke has been found to account for 0.9-4% of hospital admissions and 2.8-4.5% of total deaths (5). Osuntokun (6) reported a mortality rate of 4-9% for Africa.

Balance dysfunctions, common in stroke victims, have significant impact on functional independence and overall recovery of the patient. Patients who have suffered a stroke present with abnormal and delayed postural responses in the extremity muscles during standing displacements and distorted proprioception. These could result in clinical presentations such as loss of static and dynamic stability and reduced functional abilities (7).

Stroke has been identified as the most prevalent cause of falls in adults. Balance is diminished in people with hemiplegia and hemiparesis. Hemiplegia can cause a reduction in patients' limits of stability, which is defined as the maximal distance that an individual can shift his or her weight in any direction without loss of balance (8).

Balance problems are thought to be common after stroke, and they have been implicated in the poor recovery of Activities of Daily Living (ADL) and mobility as well as in the increased risk of falls (9,10). Most studies have measured balance impairments (such as postural sway, weight distribution, or related parameters) rather than balance disability (the type of balance task that a subject can perform while maintaining an upright position, such as static or dynamic sitting or standing balance) (11).

Measures of balance confidence were developed to provide a sensitive measure of fear of falling. Earlier approaches simply consisted of asking whether someone was afraid of falling. Balance confidence, which is based on Bandura's theory of self-efficacy (12), is defined as the belief that the individual has the capability to perform an activity or action. Rehabilitation efforts for persons with stroke focus primarily on enhancing physical function with less attention paid to mental functions such as self-efficacy. Self-efficacy, defined as a judgment of one's ability to organize and execute given types of performances, is considered as important as physical ability in influencing decisions to engage in various activities (13).

The Functional Reach Test (FRT) developed by Duncan et al. (14) is a well-known clinical measure of dynamic standing balance, and tested for both validity and reliability. FRT measures the distance between the length of the arm and a maximal forward reach in the standing position while maintaining a fixed base of support. It was developed as a dynamic measure of balance with no attempt to control for the movement strategy (15).

These tests are simple and easy to administer and score, but few studies have used it for stroke patients now that the incidence is increasing in this environment because of the increasing risk factors. This study was designed to assess the balance performance of hemiparetic stroke survivors and to determine the effects of gender, type of stroke and laterality on balance performance.

Materials and Methods

Participants

The study population consisted of a total of 120 stroke survivors in the outpatient physiotherapy departments of Obafemi Awolowo University Teaching Hospitals Complex (Ile-ife and Ilesha units), Osun state, Nigeria and Ladoke Akintola University Teaching Hospital, Osogbo, Nigeria.

Patients were included as they met the following criteria: (a) they experienced first episode of unilateral stroke with hemiparesis; (b) they were able to walk without the physical assistance of a therapist or carer on assessment; this criterion corresponds to Functional Ambulation Categories (FAC) level 3 (16); (c) they had no complicating medical history such as cardiopulmonary or orthopaedic disorders; (d) they were able to understand and follow simple verbal instructions, and (e) they had provided written or verbal informed consent to participate.

Procedure

The protocol was approved by the Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife Ethics and Research Committee. All the participants received an explanation of the procedure of the study prior to enrollment for assessment and data collection. Demographic (age, gender) and clinical (duration of stroke, side of affectation) information were obtained from the participants and from their case records. From physicians' diagnosis and clinical findings, patients' strokes were classified as hemorrhagic or ischemic.

Anthropometric (height and body weight) data were measured using standard procedures. Body Mass Index (BMI) of the participants used as a measure of relative body weight was calculated by using the Quetelet's BMI formula;

$BMI = \text{weight (kg)}/\text{height (m)}^2$ (17)

Perceived balance self-efficacy was assessed with the Activities-specific Balance Confidence (ABC) scale. This scale consists of 16 functional activities, and the rating is based on an 11-point scale ranging from 0% ("no confidence at all") to 100% ("completely confident"). The participants were asked to rate their self-perceived balance confidence level from 0 (no confidence at all) to 100 (full confidence) for completing 16 activities of daily living. A total score out of 100 was computed by taking the average of the item scores. The higher the score, the better the level of balance confidence.

The FRT was used to assess dynamic standing balance by measuring the maximum distance that participants could reach forward horizontally beyond arm's length while maintaining a fixed base of support in standing with comfortable stance width. The participants were not allowed to use any assistive device. Using a

yardstick calibrated in centimeters, mounted on the wall at shoulder height, each participant was asked to position the body close to but not touching the wall, with feet at a comfortable distance apart, the nonparetic arm outstretched and hand fisted. The starting position was noted by determining what number of the metacarpophalangeal (MCP) joints line up with on the rule. The participant was asked to reach as far forward as possible without losing his or her balance or taking a step. The start and end measurements were recorded. The functional reach distance was the difference between the two measurements. Each participant was given two practice trials; then, the performance on an additional three trials was recorded and averaged. The participants were guided in case of loss of balance (14).

Data Analysis

The statistical analyses were carried out using the Statistical Package for Social Sciences (SPSS) 16.0 for Windows (SPSS Inc. Chicago, USA). Data were analyzed using both inferential and descriptive statistics. Descriptive statistics of mean, standard deviation and range were calculated for characteristics of hemiparetic stroke survivors. Independent samples t-test was used to determine the differences between the anthropometric, demographic and clinical characteristics, as well as balance performance in male and female hemiparetic stroke survivors, in hemorrhagic and ischemic stroke survivors, and in stroke survivors with right-sided or left-sided hemiparesis.

Pearson's product-moment coefficient of correlation was used to determine the relationship between balance performance and the selected variables. To analyze the determinants of balance confidence, a stepwise multiple regression analysis was performed with ABC scale score as the dependent variable. The regression model used the FRT distance and the participants' characteristics as independent variables. Determinants of dynamic standing balance were also analyzed with the FRT distance as the dependent variable, while ABC scale score and participants' characteristics as independent variables. Independent t-tests were used to compare ABC scale scores and functional reach distances of stroke survivors grouped according to gender, stroke type and laterality. Results were considered significant if $p<0.05$.

Table 1. Comparison of characteristics of participants.

	All participants (n= 120)	Male (n= 87)	Female (n= 33)	p-value
Age (Years)	55.70±10.38	57.33±10.58	51.39±8.58	0.005*
Height (m)	1.65±0.09	1.68±0.09	1.58±0.07	0.001*
Weight (Kg)	66.93±10.39	67.31±9.78	65.91±11.96	0.512
Body mass index (Kg/m^2)	24.72±3.40	24.04±3.28	26.50±5.08	0.002*
Stroke duration (Months)	18.92±7.51	19.33±7.78	17.81±7.12	0.674

Results

Eighty seven (72.5%) males and 33 (27.5%) females with age range of 31 to 83 years (mean 55.7±10.4 years) participated in this study. Sixty three (52.5%) had hemorrhagic stroke, while 57 (47.5%) had ischemic stroke. Seventy one (59.2%) had right-sided hemiparesis, while 49 (40.8%) had left-sided hemiparesis. The mean ABC scale score for all the stroke survivors was 64.60±18.81, while the mean FRT distance was 25.17±8.75 cm. Table 1 shows the characteristics of the participants.

Significant differences were found between balance confidence and dynamic standing balance of male and female stroke survivors with male stroke survivors having higher values; and between those of hemorrhagic and ischemic stroke survivors, with ischemic stroke survivors having higher values. Independent t-tests revealed that the ABC scale scores and functional reach distance were higher for male participants than female participants. ABC scale scores were higher for hemorrhagic stroke survivors than ischemic stroke survivors, and functional reach distance was higher for ischemic stroke survivors than hemorrhagic stroke survivors (Table 2). No statistically significant relationship was found between ABC scale sores and functional reach distance.

Multiple regression analysis (performed to determine the extent to which participants' characteristics could explain balance confidence) revealed that the characteristics accounted for 5.1% of the variance in ABC scale scores. Regression analysis, performed to determine the extent to which participant characteristics could explain dynamic standing balance, revealed that the characteristics accounted for 7.4% of the variance in functional reach distance (Table 3).

Discussion

The result of this study shows that stroke type and gender are factors of balance performance (balance confidence and dynamic standing balance) in stroke survivors. Ischemic stroke survivors had higher balance confidence and performed better in the FRT than hemorrhagic stroke survivors. Male stroke survivors had higher balance confidence and FRT values than female stroke survivors. These findings suggest that the type of stroke and gender affect balance performance in stroke survivors.

Table 2. Comparison of balance performance according to gender, stroke type and laterality using t-test.

		n (%)	ABC (%) Mean±SD	p value	FRT (cm) Mean±SD	p value
Gender	Male	87 (72.5)	67.84±18.71	0.016*	26.56±8.51	0.005*
	Female	33 (27.5)	57.53±18.09		21.55±8.45	
Stroke type	Hemorrhagic	63 (52.5)	60.29±20.95	0.008*	22.91±8.01	0.003*
	Ischemic	57 (47.5)	69.36±14.90		27.66±8.93	
Laterality	Right	71 (59.2)	63.97±19.34	0.661	24.18±8.50	0.137
	Left	49 (40.8)	65.51±18.18		26.60±9.01	

ABC- Activities-specific Balance Confidence scale score, FRT-Functional Reach Test distance

The result of this study showed that the mean ABC scale score for stroke survivors was 64.60±18.81. This is similar to the findings in a study of people living in the community after stroke by Miller and Yiu (18) - the mean balance confidence for the mostly male (71%), older adult sample (mean age 67.7±10 years) was 62±24. They found balance confidence to be an independent predictor of physical function, participation and stroke recovery.

The result of this study is also in agreement with that of another study by Salbach and colleagues (13) who reported that subjects living in the community after stroke experience impaired balance self-efficacy. In their study, average balance self-efficacy was 59 out of 100 points on the ABC scale which is less than that of this study. The reason for these discrepancies may be because the participants in their study (mean age 72 years) were older than those in our study (mean age 55.7 years) They reported that gait training enhances falls and balance self-efficacy and that depression, age, sex, comorbidity, time post stroke, and functional mobility predict self-efficacy improvement. They suggested that enhancing balance self-efficacy in addition to functional walking capacity may lead to greater improvement, primarily in perceived health.

Self-efficacy, a concept in the field of psychology, refers to an individual's perceived capacity within a specific domain of activities. Assessing balance confidence or self-efficacy in performing specific activities or tasks, rather than global fear of falling should reveal the extent to which a person believes he/she is able to participate in specific activities without falling (19). The ABC scale (20) which has been shown to be valid and reliable for people with stroke, is a self-efficacy scale that evaluates confidence in 16 mobility tasks, 9 of them outside (21). Improvement in falls self-efficacy, initially impaired after stroke, has been observed during inpatient rehabilitation and is associated with gains in balance, motor function, and walking capacity (13).

Falls remain a common feature in the life of people with stroke after discharge from hospital. Approximately 40% of people fall within the first year of a stroke (10). Lajoie and Gallagher (22) have suggested that an ABC scale cut-off score of 67% can be used to accurately classify people who fall 84% of the time. The FRT has also been associated with an increased risk of fall and frailty in elderly people who are unable to reach more than 15 cm (15). Using these classifications, the non-fallers in the study with ABC scores were 66 (55%), and using the FRT distance, the non-fallers were 99 (82.5%).

The findings in this study are lower than reported ABC scores of healthy community-dwelling elderly people. Hatch et al. (23) in a study of community-dwelling elderly people in the United States of America (USA) found the ABC score to be 78.87. People with reduced balance confidence may avoid falls, despite having impaired balance or being at risk for falls, by limiting their participation in activities. Their study is in disagreement with Myers et al. (24) who reported a relationship between balance confidence and instrumented measures of balance performance.

Table 3. Regression analysis of balance performance and participants' characteristics.

Dependent variable	SE	R2
Balance Confidence	18.725	0.051
Dynamic Balance	1.546	0.074

Predictors- Age, weight, height, body mass index, stroke duration
B= Unstandardized regression coefficient, SE= Standard error.

Myers et al. (25) reported that physically active elderly people in good health had a total mean balance confidence score greater than 88 on the ABC scale. Self-assessed balance confidence was also associated with recurrent falls. In other studies, the association between balance confidence and falls has varied in magnitude (26). Also Lajoie and Gallagher (22) reported that fallers had significantly lower scores in ABC scale compared to non-fallers. Conversely, Cho et al. (27) reported that there was no significant relationship between balance confidence (measured by ABC scale) and frequent falling in balance-impaired older adults. They have reported that among older people with history of falls, the mean score of balance confidence ranges between 48 and 54 and in healthy older adults between 68 and 88.

The FRT distance for the stroke survivors that participated in this study was 25.17±8.75 cm. This is higher than the findings in a study of stroke survivors by Takatori et al. (28). The functional reach distance was 22.3 cm for all their participants including fallers and non-fallers. The reason for the difference in the findings of this present study and that of Takatori et al. (28) may be because their patients were either 2 months of onset or required intensive rehabilitation and the stroke survivors that participated in this present study were community-dwelling stroke survivors who were 6-24 months of onset and were not receiving intensive rehabilitation.

This study found significant difference between balance performance in hemorrhagic and ischemic hemiparetic stroke survivors. This finding is contrary to the findings in the study by Salbach et al. (13) who reported that balance self-efficacy was unrelated to stroke characteristics, such as the type of stroke and the number of strokes sustained. Their average ratings were 59 and 60 points on the ABC scale in persons with ischemic and hemorrhagic stroke, respectively. But in agreement with their study, this study found balance confidence to be unrelated to side of stroke.

This study found no significant difference between stroke survivors with right-sided affectation and those with left-sided affectation. This finding is in agreement with Andrew and colleagues (29) who found no association between functional outcome and laterality in patients with stroke. Di Legge et al. (30) found significant differences between the stroke outcome of patients with left hemispheric strokes and those with right hemispheric strokes. The reason for the difference in the results may be because stroke characteristics of the participants were different.

Although participants with left hemiparesis had higher values of ABC scale scores and FRT distance, this present study found that laterality had no significant effect on balance performance in stroke survivors. These findings are contrary to the findings by Laufer et al. (31) in a study to determine the effects of the side of brain lesion on recovery of functional abilities and balance control among participants following a stroke. They reported that the side of brain lesion seems to affect recovery of independent stance with an advantage to patients with right hemiparesis. However, there was no difference between balance control of individuals with left versus right hemiparesis. Contrary to their findings, the result of this study showed that stroke survivors with left-sided hemiparesis scored higher than those with right-sided hemiparesis. Also, Salbach et al. (13) reported that persons with left- as opposed to right-sided hemiparesis scored an average of 57 and 61 points, respectively, on the ABC scale. Balance confidence

is a remedial condition; however, it is seldom if ever addressed in rehabilitation (18).

Without prejudice to the (possible) contribution of other factors like paretic side, lower limb muscle strength and degree of spasticity, we conclude that gender and type of stroke are significant factors that affect balance performance of hemiparetic stroke survivors. This finding should be taken into consideration in setting rehabilitation goals for stroke survivors. Further studies may investigate the contribution of the mentioned factors along with laterality on balance performance in stroke survivors.

Conflict of Interest:

Authors reported no conflicts of interest.

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