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HEALTHY AGING RESEARCH

Association between dual-task performance and balance during gait in community-dwelling elderly people after stroke

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Abstract

Introduction: Age-related physiological changes coupled with impairments that are secondary to stroke can compromise balance performance, thus affecting mobility and independence. The aim of this study was to identify factors related to balance performance during gait in elderly persons after stroke.

Methods: This study evaluated 60 old adults (mean age 68.7±7.06 years) living in the community after having suffered a stroke. Sociodemographic, clinical and functional data were collected and the following scales/tests were applied: National Institutes of Health Stroke Scale (NIHSS), Mini Mental State Exam (MMSE), Timed Up and Go with cognitive task (TUGcog), and the Dynamic Gait Index (DGI). After univariate analysis, variables were included in a multivariate logistic regression model. Patients were divided into two groups based on the DGI cut-off point.

Results: Individuals in the group performing worst on the DGI scale (≤19) were those who had suffered more serious stroke events according to NIHSS ($p<0.001$); they also had poorer cognitive function, as evaluated by MMSE ($p<0.006$), and the worst dual-task performance, according to TUGcog ($p<0.001$). In multivariate analysis, stroke severity ($p<0.042$) and dual-task performance ($p<0.007$) remained significantly associated with balance during gait. Elderly persons with a DGI score ≤19 had lower average scores in tasks assessing gait with horizontal movements of the head, turning on own body axis, and ability to use stairs, whereas those with a DGI >19 had lower average scores in tasks assessing gait with horizontal and vertical movements of the head.

Conclusions: Elderly persons' ability to perform dual-tasks, and stroke severity, were factors associated with balance performance during gait. This highlights the importance of these aspects in the evaluation of balance in community-dwelling elderly persons after stroke.

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Introduction

Physiological changes resulting from the aging process, coupled with multiple impairments that are secondary to stroke, such as cognitive, sensory, perceptual and motor deficits, affect the mobility and independence of the elderly population and increase their need for care [1, 2]. Among those deficits, gait impairments arguably result in a stronger impact on functional capacity, and must be better understood [3].

Difficulties in dealing with the attentional demands of a given task, and the environment in which it is carried out – especially in dual-task situations – favor

a gait pattern with more cognitive than automatic control. This may interfere with balance performance during walking and predispose an elderly person to falls [4]. These are common events in the elderly population, and are also frequent in individuals with neurological diseases [5]. In addition, to compromise the performance of basic and instrumental daily living activities, falls may restrict social participation [6], and generate direct and indirect costs for the family and Brazil's Unified Health System (SUS) [7].

Several tools are used to functionally evaluate balance and gait in patients after stroke; among them is the Dynamic Gait Index (DGI) [3]. Shumway-Cook et al. originally designed this index in 1997 in order to assess and document the capacity of elderly persons with balance disorders, to modify the gait, and meet the demands of the task [8, 9]. It was culturally adapted into Brazilian Portuguese [9] and validated for patients living after stroke [8]. The DGI contains tasks allowing assessment of the ability to walk on a flat surface, temporal aspects, postural control to perform dual-tasks and change direction, response to changes in terrain, and ability to go across and around obstacles [8, 9, 10]. This study aims to identify factors related to balance performance during gait assessment in an elderly population after stroke.

Methods

This cross-sectional study included patients recruited from the Stroke Clinic of the Federal University of Bahia meeting the following criteria: one or more episodes of stroke, aged over 60 years, able to walk at least 6 meters with or without auxiliary gait and without assistance, with enough vision and hearing to complete the required tasks, and ability to understand verbal instructions. Exclusion criteria were those with pre-existing neurological disorders, orthopedic conditions that would compromise the natural gait, and peripheral vestibular dysfunction.

Data were collected by three physical therapists who had been previously trained and had full knowledge of the evaluation processes. A semi-structured questionnaire to collect sociodemographic and clinical data (prepared by the authors) was used, and the following scales and tests were applied: the Mini Mental State Examination (MMSE) [11], the National Institutes of Health Stroke Scale (NIHSS) [12], Modified Barthel Index (MBI) [12], Timed up and Go test with cognitive task (TUGcog) [13] and the DGI [8, 9]. Data related to injury were noted from patients' medical records, as were incidences of polypharmacy (patient taking five or more medications).

A validated version of the MMSE taking education level into account was applied to identify the presence or absence of cognitive impairment [11]. The cut-off point for individuals with no formal education was 13, 18 for individuals with elementary and middle-schooling, and 26 for subjects with a high level of education. Stroke severity was assessed by the NIHSS; the higher the score, the more serious the event, with a range from 0 to 42 [12]. The MBI was applied in order to evaluate functional capacity, with scores as follows: 50, total independence; 46–49, slight dependence; 31–46, moderate dependence; 11–30, severe dependence; and 10, total dependence [12]. The TUGcog test was used to verify patients' ability to perform dual tasks. Patients were instructed to get up from a standard chair and walk, using his/her usual gait (with or without an orthosis), for a distance of three meters, before return to the starting position, while simultaneously recalling animal names [13].

DGI evaluates gait balance in the following tasks: walking on a flat surface with changing speed, horizontal head movements and vertical head movements; turning around his/her own body axis; going across and around obstacles; and going up and down steps [8, 9]. Each task can be scored from 0 to 3, where 0 is considered the worst performance and 3 the best. The cut-off point for risk of falls is 19; this has already been validated in the elderly population [9].

In this study the evaluated elderly population was divided into two groups: one group of patients with a DGI score higher than 19, and the other comprising individuals with a score equal to or lower than 19.

A Mann-Whitney test was used for data analysis, and the Chi-square test was applied to compare the performance of elderly stroke patients between groups. A value of $p \leq 0.05$ was considered statistically significant. Logistic regression, according to the ENTER model, was used for multivariate analysis. Analyses were conducted in SPSS 17.0 for Windows.

The Professor Edgar Santos University Hospital Ethics Committee approved the project, according to protocol 09/2010. All participants signed a form indicating informed consent to participate in the study, in accordance with the Brazilian National Health Council's Resolution 196/96 on research involving human subjects.

Results

Sixty old adults who had previously suffered a stroke were evaluated between August 2011 and August 2013. The average age of participants was 68.7 (±7.06) years; 56.7% were women and 56.7% had not completed elementary school. Ischemic events were predominant (90%) and 83.3% had had a single stroke. Median time since the last stroke was 15 (range: 1–183) months. A median stroke severity of 1 point (range: 0–8) was observed, as assessed by the NIHSS. Among the subjects, only 20% used a walking aid device. According to MMSE scores, the sample had no cognitive impairments (mean: 22.07 ±4.82), and 48.3% were classified as slightly dependent, with an IBM score of 49 (range: 32–50). The median to complete the TUGcog test was 18.52 (range: 9.72–68.15) seconds, and the median DGI score was 19.5 (range: 7–24). Falls in the previous 12 months were reported by 23.3% of the patients.

Table 1 shows the most relevant sociodemographic, clinical and functional characteristics in both groups. In univariate analysis, gender, age and use of polypharmacy were similar between groups. However, the group with the worst DGI performance (≤19) was composed of individuals who suffered more serious events (according to the NIHSS scale; $p<0.001$), had poorer cognitive function (as evaluated by MMSE; $p<0.006$), and had the worst dual-task performance (according to TUGcog; $p<0.001$).

Table 2 presents the results of our multivariate analysis. Only stroke severity ($p<0.042$) and dual-task performance ($p<0.007$) remained significantly associated with balance during gait in elderly stroke patients. According to the odds ratio, for every one point increase on the NIHSS, patients have a 78.9% chance of performing more poorly in the DGI, and for each increase of one second in time to complete the TUGcog test, elderly persons have a 19.9% chance of obtaining a lower performance DGI score.

Figure 1 shows the performance DGI score for each task in both groups. We observed that, in general, those with a DGI ≤19 had a worse performance in all tasks. Those with a DGI score >19 had lower average scores in Tasks 3 (gait with horizontal movements of the head) and 4 (gait with vertical movements of the head).

Table 1. Demographic, clinical and functional data from 60 elderly patients after stroke

Variables	Total (*n*=60)	DGI >19 (*n*=30)	DGI ≤19 (*n*=30)	*p* value
Age in years, mean (SD)*	68.70 (7.06)	68.00 (7.29)	69.50 (6.85)	0.270
Female, *n* (%)**	34 (56.7%)	14 (46.7%)	20 (66.7%)	0.193
Polypharmacy, *n* (%)**	34 (56.7%)	13 (43.3%)	21 (70.0%)	0.088
Severity of stroke (NIHSS), median (range)*	1 (0-8)	1 (0-5)	2 (0-8)	0.000
Cognitive function (MMSE), mean (SD)	22.07 (4.82)	23.67 (4.38)	20.47 (4.78)	0.006
TUGcog seconds, median (range)*	18.52 (9.72-68.15)	16.52 (9.72-36.40)	25.05 (15-68.15)	0.000
DGI, median (range)*	19.5 (7-24)	23 (20-24)	15.5 (7-19)	0.000

NIHSS: National Institutes of Health Stroke Scale; MMSE: Mini Mental State Examination; TUGcog: Timed up and Go test with cognitive task. *Mann Whitney Test **Pearson Test

Table 2. Multivariate logistic regression analysis for factors associated with balance during gait

Variable	Odds Ratio	Confidence Interval (95%)	*p* value
NIHSS*	1.789	1.022-3.131	0.042
MMSE	0.959	0.816-1.127	0.611
TUGcog**	1.199	1.052-1.367	0.007

NIHSS: National Institutes of Health Stroke Scale; MMSE: Mini Mental State Examination; TUGcog: Timed up and Go test with cognitive task; NIHSS* to each increase of one point; TUGcog** to each increase of one second; MMSE to each increase of one point.

Patients with a DGI score ≤19 had even smaller average scores in Task 3 (as above), 5 (turning around own body axis) and 8 (up and down steps).

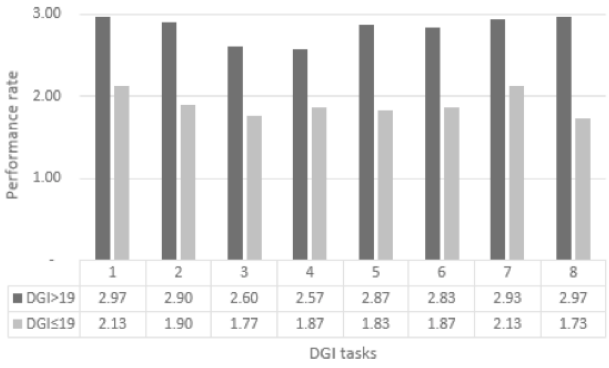

Figure 1. Performance of elderly patients living in the community after suffering a stroke on the following Dynamic Gait Index items

(1) gait on level surface, (2) gait with speed changes, (3) gait with horizontal head turns, (4) gait with vertical head turns, (5) Pivot turn, (6) Over obstacle, (7) Around obstacles and (8) Steps.

Discussion

In this study, the ability to perform dual tasks was identified as an important factor associated with balance during gait in elderly patients living in the community after a stroke. The ability to perform tasks simultaneously can be evaluated from the concurrent use of TUG and another motor or cognitive task [14]. This capacity is reduced due to age and the presence of neurological diseases that negatively impact on the allocation of attentional resources to perform tasks [15–17]. Studies have shown that the more complex the associated task, the greater the interference with the performance of the primary task [18], for example, talking while walking reduces gait speed [19].

In the elderly population, it has been shown that the inability to perform dual tasks affects gait balance [20], and thus may further increase the risk of falls [19, 21, 22]. After brain injury, individuals may also be susceptible to this risk since cortical and subcortical areas are required to implement multi-tasking [23]. After stroke, disorders of executive function, attention and memory are among the most common impairments [24, 25]; therefore both aging and brain injury are factors that favor body imbalance in these individuals in situations of cognitive demand.

After multivariate analysis, cognitive function, separately assessed by MMSE, did not remain a factor associated with balance during gait in this sample. However, the motor-cognitive task was an independent predictor of worse performance; this highlights the importance of including this task in the gait balance test for walkers who have suffered stroke [26]. The development of studies to identify the impact of motor-cognitive interference in the gait of this population has been identified as a relevant area for future research [26].

Previous studies, including patients both in the acute and chronic phase after stroke, have already related the severity of the event with the compromise of functional status and the occurrence of falls [6, 27]. Although a lower NIHSS median score was found in those studies, the findings of this study suggest that the severity of injury is an important factor to be considered, regardless of the injury time.

Despite the evidence that individual and multifactorial interventions can reduce falls in elderly people, this issue remains relatively unexplored in stroke survivors. Results to date do not support the applicability of these interventions in stroke survivors who are living in the community [28, 29]. While it is likely that some of the approaches proven to reduce falls in the elderly may, in general, also be effective in individuals who have suffered stroke, there are

specific risk factors, such as inattention or neglect, which can influence adherence and effectiveness of interventions in this population [30].

Although it has been previously reported by other authors, factors such as age, gender and polypharmacy, which are often associated with the risk of falls in both healthy elderly and patients with stroke [31-35], were not significant predictors in this study.

After a stroke, patients may present with various deficits such as changes in motor control, central sensorimotor processing, cognition and hemiparesis [1, 2]. Regarding the impairment of balance, it has been observed that muscle weakness and decreased sensory information from the affected hemisphere associated with compensations are directly related, generating displacement of the center of gravity, asymmetrical weight shift, and postural instability [36–38]. Difficulty in adapting postural movements to a change of task and/or external environmental demands has also been observed [21].

Individuals with a DGI score ≤19 experienced greater difficulty during tasks involving going up and down steps, and in performing gait with horizontal movements of the head. Corroborating this finding, a study by Chiu et al. (2006) [39], which observed a population of elderly persons without neurological deficits, found that gait associated with horizontal movements of the head and going up and down steps were considered the most difficult tasks. It is known that walking while making horizontal head movements involves a dual task, in which case the patient tends to assume a gait pattern with more cognitive control than automatic, and finds it difficult to maintain postural control [4]. Going up and down steps likewise represents a major challenge for the musculoskeletal system [39], an aspect that in elderly stroke patients may be compromised both by the physiological aging process [40], and the secondary musculoskeletal changes due to stroke [41].

Conclusions

This study found that the ability to perform dual tasks, and stroke severity, were factors associated with balance performance during gait assessment. This highlights the importance of these aspects in the evaluation of balance in elderly patients living in the community after suffering a stroke.

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