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Relationship of Cognitive Functions and Physical Activities in Persons with Chronic Stroke

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ABSTRACT

Purpose : The purpose of this study was to evaluate the relationship between physical performance, such as gait and postural control, and cognition on as assessed by clinical tools in individuals with chronic hemiparetic stroke.

Methods : Twenty-six patients who had hemiparetic stroke participated in this study, and were evaluated four common clinical measurements, including the Berg balance scale (BBS), 10 meter walk test (10MWT), 6 minute walking test (6MWT), and Montreal cognitive assessment (MoCA). Multiple regression analysis was used BBS score, 10MWT, and 6MWT as the dependent variables; MoCA score, post-stroke duration, age, and affected side as independent variables.

Results : In the regression equation of the BBS score, the correlation coefficient (r) was 0.875, the coefficient of determination (R2) was 0.786, and the MoCA score was the most important variable for determining the BBS score. In the regression equation for the 10MWT, ther was 0.888, the R2 was 0.999, and the MoCA score was the most important variable for determining 10MWT. Finally, the r was 0.777, the R2 was 0.998, and the MoCA score was the most important variable for determining 6MWT in the regression equation of the 6MWT.

Conclusion : The results show that cognitive abilities affect gait proficiencies in individuals with chronic hemiparetic stroke. Therefore, these results suggest that cognitive tests are necessary for examining and evaluating the abilities of postural control and gait performance for chronic stroke patients in research and clinical environments.

Key Words : Cognitive functions, Physical activities, Chronic stroke

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I. Introduction

Stroke is one of the primary causes of permanent physical disabilities in adulthood. Mobility impairments associated with sensory, motor, and visual deficits commonly affect basic and instrumental activities of daily living and ultimately limit participation in community-based activities and social activities. Cognitive impairment is also a major consequence following stroke, with about 64% of survivors having some degree of cognitive impairment following stroke and approximately 35% of stroke patients reporting significant cognitive deficits. Persons with cognitive impairment of ten require assistance by caregivers and the society, because cognitive impairment after a stroke reduces functional independence and the performance of the basic and instrumental activities of daily living. Therefore, physical activities, recovering cognitive abilities, and reducing cognitive disabilities to maintain normal activities in persons after stroke are important in clinical and research settings.

Examination using clinical measures is necessary to understand how the pathology and identified impairments are associated with functional disabilities following stroke and to provide meaningful data for establishing a functionally relevant treatment plan and goals for stroke patients., An effective plan of care and goals would provide more effective physical therapy interventions for reducing movement dysfunction. Therefore, physical therapists should gather sufficient information about the patient's existing or potential motor and cognitive dysfunctions to formulate a diagnosis and prognosis and to determine whether the difficulties of stroke patients can be improved to a more normal level by physical therapy interventions., Cognitive function is often compromised after stroke and whether cognition affects the rehabilitation process is a controversial issue and that is largely uninformed by empirical evidence; however, cognitive impairment is rarely assessed in research and clinical trials. The purpose of this study was to evaluate the relationship between physical performance tasks, such as gait and postural control, and cognition as assessed by clinical tools in individuals with chronic hemiparetic stroke.

II. Methods

This study included 26 subjects who had experienced chronic hemiparetic stroke and who were recruited on a voluntary basis from the local rehabilitation. The inclusion criteria were as follows: (1) first-time stroke, (2) 6 months or more after stroke onset, (3) no neurological disorder except stroke, (4) no orthopedic problems, (5) the ability to walk independently over ground for at least 10 m with or without the use of an ankle-foot orthosis or assistive device, and (6) the ability to understand verbal instructions. The subjects' general characteristics are listed in Table 1. All participants provided informed consent after receiving a detailed explanation of the study.

This study used 4 common clinical tools, the 10MWT, 6MWT, BBS, and MoCA, to evaluate the relationship between cognitive and physical functions for chronic stroke patients. Those tools were used in randomized order by 2 physical therapists and 1 occupational therapist. All examiners had more than 10 years of experience in evaluating patients with neurological problems and were not

aware of the purpose of this study. The tests were performed in a quiet and well-organized therapy room and subjects were given the standard verbal instructions of the BBS and MoCA. Although the verbal instructions were given only once, they were repeated if required by the participants. Participants were allowed a rest period between each test, and they used their normal shoes during the assessments.

The 6MWT is a performance-based test that measures the distance in meters walked in 6 min. A greater distance indicates a better performance. The test showed an excellent correlation with balance function (r = 0.78 to 0.80) among stroke patients, and the score for the test-retest reliability was high., The 10MWT examines gait speed to confirm safe community mobility. This study measured the 10MWT calculated in meter/second units at the maximal speed. To avoid recording the increase and decrease in speed that occurs at the beginning or end of the walking test, each subject was asked to walk a 14-m distance and the speed of the 10-m distance was measured in the mid-range. The inter-rater and intra-rater reliability was high., The BBS test is widely used to examine postural control while sitting and standing in individuals with neurological disorders. The scale consists of 14 items and has a maximum possible score of 56 points; a cutoff score of 45 points is used for fall prediction. The reliability and validity of the BBS have been demonstrated in stroke patients.

The MoCA is a rapid screening instrument for mild cognitive dysfunction. The MoCA measures 8 cognitive items, including attention and concentration, executive functions, memory, language, visuoconstructional skills, conceptual thinking, calculations, and orientation, by using rapid, sensitive, and easy-to-administer cognitive tasks. The total possible score is 30 points and a score of 26 or above is considered normal. The MoCA showed high sensitivity and reliability in stroke patients.

This study used descriptive analyses to describe common characteristics and clinical measurement scores. Spearman's correlation coefficients were calculated to determine the correlation among the total scores of 6MWT, 10MWT, BBS, and MoCA. Multiple regression analysis was used subsequently to determine the relationships between cognitive and physical functions in the context of the outcome measures. Significance was accepted at $a < 0.05$. Data analyses were performed by using PASW version 18.0.

Table 1. General characteristics of the participants in this study (N=25)

Characteristics	Mean±SD
Age (yr)	53.6±10.9
Sex (Male /Female) (number)	15/10
Affected Side (Left/Right) (number)	11/14
Post-stroke duration (month)	36.6±18.1
Montreal cognitive assessment	24.7±4.5
10 meter walk test (second)	0.9±0.4
6 minute walking test (meter)	336.7±91.3
Berg balance scale (scores)	47.2±5.6

III. Results

The mean 6MWT, 10MWT, BBS, and MoCA score are shown in Table 1. A floor or ceiling effect was not noted for any of the evaluation scales. The relationships between the MoCA and the 6MWT, 10MWT, and BBS are shown in Table 2. The MoCA was significantly correlated with the 6MWT (r = 0.852), 10MWT (r = 0.813), and BBS (r = 0.920).

For the regression equation for the 10MWT, the correlation coefficient (r) was 0.695, the coefficient of determination (R^2) was 0.483, the regression constant was -0.686, and the regression coefficient for the MoCA score was 0.066. For the regression equation for the 6MWT, the r was 0.803, the R^2 was 0.645, the regression constant was -62.068, and the regression coefficient for the MoCA score was 16.133. For the regression equation for the BBS, the r was 0.913, the R^2 was 0.833, the regression constant was 19.242, and the regression coefficient for the MoCA score was 1.133. The MoCA score was the most important variable for determining the 10MWT, 6MWT, and BBS(Table4).

Table 2. The correlation analysis of the Montreal cognitive assessment with other measure (N=25)

Parameters	MoCA	10MWT	6MWT	BBS
MoCA		0.813**	0.797**	0.920**
10MWT	0.813**		0.916**	0.926**
6MWT	0.797**	0.916**		0.797**
BBS	0.920**	0.926**	0.920**	

MoCA, Monstreal cognitive assessment; 10MWT, 10 meter walk test; 6MWT, 6 minute walk test; BBS, Berg balance scale. **p<0.01

Table 3. The equations for MoCA on the 10MWT, 6MWT and BBS by multiple regression analysis (N=25)

Outcome Measures	Regression equation	r	R^2
10 meter walk test	(-0.686)+(0.066×MoCA)*	0.695	0.483
6 minute walking test	(-62.068)+(16.133×MoCA)*	0.803	0.645
Berg balance scale	(19.242)+(1.133×BBS)*	0.913	0.833

MoCA, Monstreal cognitive assessment; 10MWT, 10 meter walk test; 6MWT, 6 minute walk test; BBS, Berg balance scale.
* p<0.05

Table 4. Output for multiple regression analyses for the prediction of the 10MWT, 6MWT, and BBS from the MoCA (N=25)

10MWT	Standardized coefficient(β)	6MWT	Standardized coefficient(β)	BBS	Standardized coefficient(β)
WR2=0.483***		R2=0.645***		R2=0.833***	
MoCA***	0.014	MoCA***	2.498	MoCA***	1.133

MoCA, Monstreal cognitive assessment; 10MWT, 10 meter walk test; 6MWT, 6 minute walk test; BBS, Berg balance scale.
***p<0.001

IV. Discussion

The purpose of this study was to predict and analyze the relationship between cognitive and physical functions among chronic stroke patients. This study had several main findings. First, MoCA had a good correlation with 6MWT, 10MWT, and BBS. Second, in persons with chronic stroke, the MoCA score had a predictive ability of 48% for the 10MWT, a predictive ability of 65% for the 6MWT, and a predictive ability of 83% for the BBS score.

A fundamental issue in any clinical setting is how the functional activity levels are measured in patients, and stroke is no exception. Most studies that examined stroke patients focused on physical consequences for evaluating the effectiveness and determining the appropriateness of physical therapy intervention, whereas few studies have examined the cognitive or perceptual deficits. However, the most important aspects for examination following stroke are cognitive impairments, because these deficits affect the performance of the basic and instrumental activities of daily living and independent integration into the community and social surroundings.

The mini-mental state examination (MMSE) is a common clinical measure for evaluating cognitive deficits in persons with neurological disorders. However, the MMSE is not a clinically acceptable method for measuring the degree of cognitive impairments exhibited by patients with neurological disorders, particularly those with mild cognitive impairments. Several previous studies reported that the widely used MMSE has a lower sensitivity for measuring vascular cognitive impairment following stroke compared to Alzheimer's disease. The MoCA scale was developed as a screening tool that promised greater sensitivity for deficits arising from stroke and vascular cognitive impairment compared with the MMSE. However, Godefroy and coworkers reported that the MoCA and MMSE screening tests are moderately sensitive to acute post-stroke cognitive impairment. The participants of this study were chronic stroke patients and the significant finding of this study was that the MoCA has a good ability to predict the 10MWT, 6MWT, and BBS scores. Therefore, this study revealed the strong predictive ability of the MoCA for physical activities such as gait velocity, gait endurance, and postural control as assessed by the 10MWT, 6MWT, and BBS, comprehensive neuromusclular and musculoskeletal systems.

In conclusion, this study provides evidence for the necessity of examining and evaluating cognitive and physical impairments following stroke in research and clinical settings because the results suggest that cognitive deficits are a good predictor of physical performance in chronic stroke patients. The measurement of cognitive deficits may improve the evaluation, diagnosis, and prognosis of chronic stroke patients. However, these results cannot be generalized to the rehabilitation of acute or subacute stage stroke patients because the individuals who participated in this study were chronic patients.

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