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Investigating the relation between upper extremity function and trunk control, balance and functional mobility in individuals with stroke

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ABSTRACT

Aim: The purpose of our study was to examine the relation between upper extremity function and trunk control, balance and functional mobility and to compare trunk control, balance, and mobility with respect to upper extremity motor function level in individuals with stroke.

Material and Method: This study included a total of 39 stroke patients (age 63.87±9.03 years, post stroke 19.18±16.38 month). Upper extremity motor functions were evaluated with the upper extremity sub-scale of the Stroke Rehabilitation Assessment of Movement (STREAM) Scale and Brunnstrom stages of motor recovery; trunk control, balance, and functional mobility were evaluated with Trunk Impairment Scale (TIS), Berg Balance Scale (BBS), and Timed Up and Go Test (TUG) respectively.

Result: A moderate relation was determined between the trunk control, balance and functional mobility and upper extremity functions ($p<0.05$). When the trunk control, balance and mobility performances of the individuals were compared according to Brunnstrom arm stages, it was seen that those with worse upper extremity motor recovery had poor trunk control, balance and mobility ($p<0.05$)

Conclusion: As a result of our study, a relation was detected between upper extremity function and trunk control, balance and mobility. For this reason, it is important to focus on the upper extremity as well as trunk control to improve balance and mobility in physiotherapy and rehabilitation practices.

Keywords: Stroke, postural balance, upper extremity function

INTRODUCTION

Stroke is a central nervous system disease that has a great impact on public health as the cause of long-term disability. Upper Extremity dysfunction, which occurs after stroke, is one of the most common motor problems. Upper extremity problems greatly affect functional disability in approximately 80% of the patients (1). Many studies in the literature reported the importance of upper extremity disorder in people and the extent to which this affects the quality of performance in daily work activities (2,3).

As well as upper extremity problems, another important problem in individuals with stroke is the use of atypical body characterized by weakness and abnormal compensatory strategies. Trunk plays important roles as a central axis in stabilizing the proximal movements for functional movements of the extremities and smooth performance of distal movements. For this reason, trunk stability is important for motor performance, postural balance, and coordinated extremity use in daily functional activities in recovery process (4-6). For this reason, it is very important to acquire trunk control at an early stage in the rehabilitation process (7).

When the literature was reviewed, many studies (8,9) evaluating trunk control, balance, and lower extremity motor functions were detected; however, fewer studies were seen examining the effect of upper extremity functions on postural control and balance (10). As a matter of fact, decreased arm oscillations as a result of upper extremity problems affect postural balance negatively, and increase the risk of falls (11). Hyndman et al. (12) conducted a study, and reported worse upper extremity functions of

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individuals with a history of fall when they compared individuals with fall history and individuals without a history of fall. Arm movements help keep the center of gravity within the support surface during walking (13).

For this reason, it is very important to evaluate the upper extremity functions with trunk control and balance for the planning of an effective rehabilitation program in individuals with stroke. In addition, no study comparing trunk control and balance in stroke individuals with different upper extremity motor levels has been found in the literature. The purpose of our study was to examine the relation between upper extremity motor function and trunk control, balance and functional mobility in individuals with stroke and to compare trunk control, balance, and mobility with respect to upper extremity motor function level.

MATERIAL AND METHOD

Participants and Design

The study was conducted between January 2020 and November 2020. Individuals between the ages of 18-75 years who applied to Physiotherapy and Rehabilitation clinic of Kırıkkale University Faculty of Medicine, diagnosed with ischemic or hemorrhagic stroke, who had no communication problems and who could walk independently with or without an assistive device were included.

Aside from stroke, patients who had another brain tumor, multiple sclerosis, etc. neurological disease, or orthopedic problem, cardiopulmonary disease, agnosia or visual impairment, cooperative and communication problems that would affect functionality, balance, and upper extremity use were not included in the study. The study was approved by Non-Interventional Ethics Committee of University of Kırıkkale (decision no: 2019.11.09; date: 18.12.2019). Informed consent forms were obtained from all participating individuals.

Data Collection Tools

The socio-demographic characteristics of all individuals (age, height, body weight, body mass index, exercise and smoking habits, dominant side, lesion side, stroke type and onset, comorbid states, etc.) were recorded in the scope of the study. Upper extremity functions were evaluated with the upper extremity sub-scale of the Stroke Rehabilitation Assessment of Movement (STREAM) instrument; trunk control, balance, and functional mobility were evaluated with Trunk Impairment Scale (TIS), Berg Balance Scale (BBS), and Timed Up and Go Test (TUG) respectively. The upper extremity motor recovery level of the patients was clinically evaluated with the Brunnstrom stages of recovery.

Stroke Rehabilitation Assessment of Movement

It is used for clinical motor evaluation in stroke patients. The scale consists of a total of 3 parts as Upper Extremity (UE) voluntary act, lower extremity involuntary act, and basic mobility. Each part consists of 10 items, and is scored separately. The extremity movements are scored between 0 and 2 in a 3-point scale. The total score in STREAM UE is between 0 and 20. The scores are given according to the quality of the movement and the amount of doing it (14).

Trunk Impairment Scale

It was developed to evaluate the trunk balance (control) in patients who had neurological impairments. TIS consists of 17 parameters evaluating static (3 parameters, 7 points in total), and dynamic (10 parameters, 10 points in total) sitting balance, and trunk coordination (4 parameters, 6 points in total). TIS items are scored over 2 and 3 scores. The total score is 0-23. Higher scores indicate better performance (15,16).

Berg Balance Scale

It was designed to evaluate the static and dynamic balance, and identify the risk of falls. BBS consists of 14 items aimed to observe the protection of trunk balance during performance directly. Each item is scored between 0 and 4. The test measures the level of dependency and/or independency during positions like standing without sitting, standing with feet adjacent, standing in tandem position, balance on one leg, and the ability of the person to make position changes. According to the scores obtained from this test, individuals are divided into "high risk of falling (0-20 points)", "medium risk of falling (21-40 points)", "low risk of falling (41-56 points)", and the highest score of 56 is considered to show the best balance (17).

Timed Up and Go Test

It is applied to evaluate the risk of functional mobility and fall of patients. A standard chair is used for this test. Firstly, the patient is asked to sit on the chair. Then, the individual is asked to stand up from the chair, walk regularly at a distance of predetermined 3 meters, return at the end of 3 meters, and sit in the chair again. In the test, the patient's walking time is recorded in seconds with a stopwatch. The test is repeated 3 times, and the mean value is recorded (18).

Brunnstrom stages of motor recovery

Brunnstrom motor recovery evaluation consists of 6 stages. Higher Brunnstrom stages indicate better motor recovery (19).

Statistical Analysis

The SPSS 21.0 (SPSS Inc., Chicago, Illinois, USA) program was used for the analysis of the data. The agreement of the variables to normal distribution was checked with Shapiro-Wilk Test. The homogeneity of the group variables was checked with the Levine Test. $P<0.05$ level was considered to be statistically significant.

The descriptive statistics were given as mean±standard deviation (mean±SD). The Spearman Correlation Test was used in the relation measurements between the variables. Correlation coefficients were interpreted as 0-0.19=very low, 0.20-0.39=low, 0.40-0.69=moderate, 0.70-0.89=high, 0.90-1.0=very high correlation (20). The post-hoc power analysis with G*Power program (version 3.0.10 Universität Düsseldorf, Düsseldorf, Germany) was also used. In the post-hoc power analysis, when the statistical significance of alpha was found to be 5%, and the confidence interval was taken as 95%, the power (1-β) of the study was found to be 96%. The primary outcome was determined as TIS and STREAM upper extremity score. Effect size was calculated as 0.524.

RESULTS

This study included a total of 39 stroke patients (age 63.87±9.03 years, post stroke 19.18±16.38 month). The sociodemographic and clinical data of the individuals are given in **Table 1.**

Table 1. Socio-Demographic characteristics of the participants (N: 39)

	Participants
Gender	
Female, n (%)	11 (28.2)
Male, n (%)	28 (71.8)
Age, (years) median (minimum-maximum)	64 (41-81)
BMI, (kg/m^2) median (minimum-maximum)	26.57 (20.20-36.33)
Stroke duration (month) median (minimum-maximum)	12 (1-48)
Brunnstrom stage-arm, n (%)	
Brunnstrom-arm≤3	20 (51.3)
Brunnstrom-arm>3	19 (48.7)
Stroke type, n (%)	
Hemorrhagic	11 (28.2)
Ischemic	28 (71.8)
Dominant side, n (%)	
Right	35 (89.7)
Left	4 (10.3)
Affected side n (%)	
Right	14 (35.9)
Left	25 (64.1)
Falling history n (%)	
Nonfaller	28 (71.3)
Faller	11 (28.2)
Stream upper extremity score, median (minimum-maximum)	7 (0-20)
BBS score, median (minimum-maximum)	46 (7-56)
TUG (second), median (minimum-maximum)	19 (6.01-90)
TIS score, median (minimum-maximum)	14 (3-23)

BMI: Body mass index; STREAM: The stroke rehabilitation assessment of movement scale. BBS: Berg balance scale; TUG: Timed up and go test; TIS: Trunk impairment scale

A moderate relation was determined between the trunk control, balance and functional mobility and upper extremity functions (p<0.05, **Table 2**).

When the trunk control, balance and mobility performances of the individuals were compared according to Brunnstrom arm stages, it was seen that those with worse upper extremity motor recovery had poor trunk control, balance and mobility (p<0.05, **Table 3**).

Table 2. The correlations between upper extremity function, trunk control, balance and functional mobility in patients with stroke

	Stream-UE	TIS	BBS	TUG	
Stream-UE	-	-	-	-	-
TIS	r=0.803* p=0.001	-	-	-	-
BBS	r=0.524* p=0.001	r=0.672* p=0.001	-	-	-
TUG	r=0.394* p=0.013	r=0.499* p=0.001	r=-0.809* p=0.001	-	-

*p<0.05; STREAM-UE: The Stroke Rehabilitation Assessment of Movement Scale-Upper Extremity; TIS: Trunk Impairment Scale; BBS: Berg Balance Scale; TUG: Timed Up and Go Test

Table 3. Comparison of upper extremity motor functions, balance, trunk control and functional mobility according to the level of Brunnstrom stages in stroke individuals

	Brunnstrom-arm≤3 (n=20)	Brunnstrom-arm>3 (n=19)	p value
Stream-UE	4.78±3.90	13.15±6.34	0.001
TIS	10.90±4.17	16.94±4.46	0.001
BBS	34.25±15.45	45.31±10.72	0.007
TUG	41.35±29.09	19.90±15.69	0.011

*p<0.05; STREAM-UE: The Stroke Rehabilitation Assessment of Movement Scale-Upper Extremity; TIS: Trunk Impairment Scale; BBS: Berg Balance Scale; TUG: Timed Up and Go Test

DISCUSSION

As a result of our study, it was found that there is a relation between upper extremity functions and trunk control, balance, and mobility; and it was seen that patients with worse upper extremity functions had more disrupted trunk control, balance and mobility. Accordingly that upper extremity motor dysfunction as well as trunk control may be a factor adversely affecting the balance and mobility in individuals with stroke. When the literature was examined, the effect of lower extremity functions on mobility and balance was investigated (21), or the relations between upper extremity functions and trunk control, and the effects of trunk control on upper extremity performance were examined in current studies (22). The focus was also on the effect of shoulder sling or orthosis use on trunk control or on balance and gait in patients with upper extremity affected, or the effect of rehabilitation programs on upper extremity functions (23-26).

Wee et al. (27) investigated the relations between the restoration of upper extremity functions in the lower extremity function in stroke patients, and reported that the external trunk support in the lower extremity function had a significant effect on the upper extremity function. It was also reported that the recovery of upper extremity function developed in connection with the improvement of the trunk functions, and the trunk was decisive in the recovery of the upper extremity functions of the trunk in stroke patients.

For this reason, in our study, the effects of primarily upper extremity motor functions, but also trunk control, on balance and mobility in individuals with stroke were investigated.

The trunk is the most important dynamic stabilizer of the trunk, and is also the most important part of hemiplegia rehabilitation. The trunk muscles, which are active during sitting and standing, being affected after a stroke causes hemiplegic patients to experience activity limits (28).

Upper extremity function and posture are interconnected systems and are necessary to gain trunk control and improve the quality of upper extremity movements. In this sense, the development of postural control increases the function of upper extremities; and upper extremity movements are also important for the development of postural control, facilitating the trunk muscles. Ustinova et al. (29) conducted a study to determine how arm movements affect postural oscillation in hemiplegia patients, and found that while the center of pressure arm movement slid reverse in oscillation stage in healthy individuals, center of pressure and arms moved in the same direction in hemiplegic individuals. In other words, during the posture phase in healthy individuals, the trunk balanced the arm movements, the trunk moved with the affected arm in hemiplegic patients. As a result of the study, researchers concluded that stroke caused abnormal patterns in the interaction of the arm-trunk and center of gravity. Similarly, in another study, it was reported that there were highly positive relations between upper extremity functions and postural control (30). Ashburn et al. (31) evaluated individuals with stroke for the risk of falling after discharge, and reported that there were higher risks of falling in individuals with upper extremity dysfunction. For this reason, strategies to minimize the risk of falling in stroke individuals should also be given importance among the planned treatment approaches to improve upper extremity functions.

Actually, this is a vicious circle. Problems in both affect each other negatively. Based on these studies, although it is known how much trunk control affects the functional use of the upper extremity, the severity of upper extremity involvement is also important for trunk control, balance and mobility. In our study, when we compared the trunk control and balance levels of individuals with stroke according to the upper extremity Brunnstrom recovery stages, we found that individuals with better upper extremity functions had better balance and mobility of trunk control. For this reason, approaches to improve upper extremity functions should be considered among the treatment strategies planned in individuals with stroke. We believe that our study results can bring a different perspective to researchers.

Limitation

The limitation of our study was that the upper extremity functions are only considered with STREAM, there was no control group, and the affected side is not taken into account. STREAM evaluates only the quality of the movement. Fine and gross motor skills and functionality should also be evaluated in terms of upper extremity functions. Also, considering that the affected part may affect postural control, we recommend that these should be evaluated in future studies in detail.

CONCLUSION

As a result of our study, it was concluded that there is a relationship between upper extremity function and trunk control and balance and functional mobility, and those with poorer upper extremity functions and trunk control have worse balance. When we compared the trunk control, balance levels and mobility of individuals with stroke according to the upper extremity brunnstrom recovery stages, we found that individuals with better upper extremity functions had better balance, mobility and trunk control. Therefore, in physiotherapy and rehabilitation applications, it is important to focus on the upper extremity as well as trunk control to improve postural control, balance and mobility.

ETHICAL DECLARATIONS

Ethics Committee Approval: The study was approved by Non-Interventional Ethics Committee of University of Kırıkkale (decision no: 2019.11.09; date: 18.12.2019). Informed consent forms were obtained from all participating individuals.

Informed Consent: Written informed consent was obtained from all participants who participated in this study.

Conflict of Interest Statement: The authors have no conflicts of interest to declare.

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