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CAN TRUNK IMPAIRMENT LEVEL AND UPPER EXTREMITY FUNCTIONAL CAPACITY IN STROKE SURVIVORS IN THE ACUTE PERIOD PREDICT TRUNK RECOVERY IN THE SUBACUTE PERIOD?

ABSTRACT

Purpose: One of the most common motor problems after stroke is trunk motor impairment. In general, maximal recovery of the trunk occurs within the first three months. For this reason, it is essential to investigate models that can affect trunk recovery in the early period. This study aimed to examine the usability of patients' trunk impairment levels and upper extremity motor functions in the early period after stroke to predict trunk gains one month later.

Methods: Fifty-five patients with stroke diagnoses between the ages of 30-80 were included in the study. The trunk impairments and upper extremity motor functions of the patients were assessed with the trunk impairment scale (TIS) and Wolf motor function test (WMFT), respectively. While TIS and WMFT were used in the initial evaluation, TIS tool was also used in the follow-up examination one month later.

Results: While there was a positive, very strong correlation between the patients' $TIS_{baseline}$ and $WMFT_{baseline}$ assessments ($r=0.818$; $p<0.001$); a strong correlation was detected between the $TIS_{baseline}$ and $TIS_{1\text{-}month}$ variables ($r=0.725$; $p<0.001$). According to the results of multiple regression analysis, the predictive effect of the $TIS_{baseline}$ and $WMFT_{baseline}$ variables on $TIS_{1\text{-}month}$ was determined as 51.60%. The WMFT variable did not directly affect the model ($p=0.339$).

Discussion: According to the study results, trunk involvement and upper extremity motor function after stroke are usable tools to predict future trunk gains. Although the upper extremity motor function test does not contribute significantly to the model, the strong relationship between it and trunk functions may have contributed to the model.

Keywords: Motor function, Stroke, Trunk impairment, Upper extremity

İNME HASTALARINDA AKUT DÖNEMDEKİ GÖVDE ETKİLENİM DÜZEYİ VE ÜST EKSTREMİTE FONKSİYONEL KAPASİTESİ, SUBAKUT DÖNEMDEKİ GÖVDE İYİLEŞMESİNİ ÖNGÖREBİLİR Mİ?

ÖZ

Amaç: İnme sonrası en sık görülen motor problemlerden biri gövdenin motor etkilenimidir. Genel olarak gövdeye ait maksimal düzeydeki geri kazanımlar ilk üç ay içerisinde gerçekleşmektedir. Bu sebeple erken dönemde gövdenin iyileşmesini etkileyebilecek modellerin geliştirilmesi önemlidir. Bu çalışma ile hastaların inme sonrası erken dönem gövde etkilenim seviyesi ile üst ekstremite motor fonksiyonlarının bir ay sonraki gövde kazanımlarını öngörmede kullanılabilirliklerinin incelenmesi amaçlandı.

Yöntem: Çalışmaya 30-80 yaş aralığındaki 55 inme tanılı hasta dahil edildi. Hastaların gövde etkilenim seviyeleri ve üst ekstremite motor fonksiyonları sırasıyla gövde etkilenim ölçeği (TIS) ve Wolf motor fonksiyon skalası (WMFT) ile değerlendirildi. Başlangıç değerlendirmesinde TIS ve WMFT kullanılırken, bir ay sonraki kontrol muayenesinde yalnızca TIS aracı ile değerlendirme gerçekleştirildi.

Bulgular: Hastaların $TIS_{başlangıç}$ ve $WMFT_{başlangıç}$ değerlendirmeleri arasında pozitif yönlü tam bir ilişki söz konusu iken ($r=0,818$; $p<0,001$); $TIS_{başlangıç}$ ve $TIS_{1.\ ay}$ değişkenleri arasında güçlü bir ilişki vardı ($r=0,725$; $p<0,001$). Çoklu regresyon analizi sonuçlarına göre ise; $TIS_{başlangıç}$ ve $WMFT_{başlangıç}$ değişkenlerinin $TIS_{1.\ ay}$ üzerine yordayıcı etkisi %51,60 olarak tespit edildi. Modele WMFT değişkenin doğrudan anlamlı bir etkisi yoktu ($p=0,339$).

Sonuç: Çalışmanın sonucuna göre; inme sonrası gövde etkilenimi ve üst ekstremite motor fonksiyonu gelecekteki gövde kazanımlarını tahmin etmede kullanılabilir araçlardır. Model de üst ekstremite motor fonksiyon testinin anlamlı bir katkısı yokmuş gibi görünse de gövde fonksiyonları ile arasındaki güçlü ilişki modele katkı sağlamasına neden olmuş olabilir.

Anahtar Kelimeler: Motor fonksiyon, İnme, Gövde etkilenimi, Üst ekstremite

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INTRODUCTION

The World Health Organization defines stroke as a clinical finding of focal or global cerebral dysfunction that develops rapidly without a precise cause other than vascular origin, has symptoms that last more than 24 hours, and can lead to death (1). The most fundamental cause of functional limitation is the loss of motor function in the trunk and extremities that results from impaired cerebral circulation. Approximately 80% of patients experience moderate to severe upper extremity involvement, while two-thirds experience lower extremity involvement in the acute phase, especially (2,3). Trunk impairment negatively affects patients' lives from the onset of the disease to the sixth month, with mild to moderate severity (4). However, current knowledge indicates that recovery in the trunk occurs earlier than in the extremities, with visible improvements occurring within an average of three weeks (5). This recovery also affects functional recovery after stroke by 45% to 71% (6). Trunk involvement that is not detected or treated in the early period directly negatively affects extremity functions and Activity of Daily Living activities in the later stages of recovery (7).

Trunk control occupies a distinctive position in the context of stroke rehabilitation. In particular, as it directly affects numerous motor functions of the lower and upper extremities, including balance, mobility, upper extremity functional outputs, and grip strength, it is clinically meaningful to investigate the factors contributing to the recovery of the trunk and trunk control (8,9). Task-oriented daily living activities and maintenance of upper extremities motor functions are closely related to trunk control mechanisms (10). By facilitating active movement, stroke patients with limited arm use can be empowered to achieve their goals and perform the requisite daily living activities (11). On the other hand, although compensatory trunk movements allow the performance of upper extremity movements, it has been reported that they cause functional limitations in the chronic periods of stroke (11,12). Therefore, ensuring proper trunk control from the earliest stages of rehabilitation is critical. This not only supports extremity recovery but also provides valuable information for planning the rehabilitation process.

Most previous studies have examined trunk impairment primarily as a predictor of upper extremity function. However, no studies to date have explored whether the level of early trunk involvement and upper extremity motor function could influence subsequent recovery of the trunk itself. This represents an important gap in the literature. Therefore, the aim of this study was to investigate whether early trunk control and upper extremity motor skills in stroke patients could serve as predictive indicators of future improvements in trunk function.

METHOD

Population, Power, and Ethics

The universe of the study consisted of patients diagnosed with stroke in İstanbul. Patients who applied to University of Health Sciences Türkiye, Bağcılar Training and Research Hospital due to acute stroke constituted the sample of the study. A total of 55 patients' data were analyzed as the sample.

G*Power 3.1. 9.7 software was used in the post-hoc power analysis calculation. The adjusted R^2 value (0.516) was the reference for the effect size (1.06) calculation. When the alpha error was entered as 5%, the total sample size was 55, and the number of model predictors was 2, the power of the study was calculated as 99%.

Ethical approval for the study was received from the Karadeniz Technical University Health Sciences Scientific Research Ethics Committee (file number: 2024/76, date: 01.07.2024). The study was conducted in accordance with the principles of the Declaration of Helsinki, and written informed consent was obtained from the patients.

Participants

Patients aged between 30 and 80 years who had an ischemic or hemorrhagic stroke were included in the study. Those with a secondary orthopedic and/or neurological disease, a lumbosacral injury, impaired consciousness, neglect in either half of the body, a recurrent stroke, and a mini-mental state assessment score <24 were excluded from the study.

Assessments

The initial evaluation was conducted by the same assessor with patients who had been hospitalized in the neurology ward following a cerebrovascular event, diagnosed with a stroke and were clinically stable. The same assessor performed the second assessment during the post-discharge follow-up examination. Information regarding the assessments is as follows.

Sociodemographic Data Form: This form was developed by the researchers and had age, gender, lesion type, affected side, and dominant extremity information.

Trunk Impairment Scale (TIS): Three items of the scale assess static sitting balance, ten assess dynamic sitting balance, and four assess trunk coordination. The maximum score that can be obtained from these three sections is 23 points. The trunk coordination section was not assessed within the scope of this study. Static and dynamic sitting balance are scored between 0 and 17 in total. A higher score defines better sitting performance. The scale's test-retest and inter-rater reliability coefficients were calculated as 0.85-0.99 (13). This scale was applied twice in the neurological ward after the first 24 hours in

the intensive care unit discharging and during the first month's control examination.

Wolf Motor Function Test (WMFT): The test is a performance tool consisting of seventeen items designed to evaluate the motor skills of the upper extremity. While fifteen items assess functional skills, two items determine muscle strength. Muscle strength was not used in this study. A total score was calculated for the patients' functional skills. The test is scored between 0-5, and the total score varies between 0-75 points for this study (14). This test was performed after spending 24 hours in the intensive care unit discharging.

Statistical Analysis

Statistical Package for the Social Sciences (SPSS v11) was used for all analyses, and the reference value for significance was accepted as $p<0.05$. Since the data showed a normal distribution, Pearson correlation analysis was performed for correlation. Multiple linear regression analysis was used as the appropriate statistical method for the research model. The acceptance conditions for regression analysis were a linear relationship between variables and normal distribution, the absence of multiple linearity, the provision of homoscedasticity, and the lack of extreme values. All conditions except the absence of extreme values were met. As a result of the analyses, it was seen that three patients had extreme values, and these data were removed from the study, and all analyses were repeated. Thus, all prerequisites for regression analysis were met.

RESULTS

A total of fifty-five patients were included in the study. The mean age of the patients was 64.83±11.26 years. The female/male ratio was 0.83. Most patients (92.70%) had an ischemic-type lesion, while the left side of the body was affected (54.60%). The mean TIS score of the patients at the initial assessment was 13.41±5.13 points, and it was seen that the TIS scores increased to 16.65±0.72 points at the control examination after one month. The $WMFT_{baseline}$ test results were 50.72±26.24 points. Characteristics of the participants are given in Table 1.

According to the Pearson correlation analysis results, a positive and strong relationship was found between the $TIS_{baseline}$ and the $TIS_{1\text{-month}}$ results ($r=0.726$; $p<0.001$). While there was a very strong positive relationship between the initial TIS and WMFT scores ($r=0.818$; $p<0.001$), a strong positive relationship was found between the first month TIS and WMFT scores ($r=0.645$; $p<0.001$) (Table 2).

A multiple linear regression model with a 95% confidence interval was applied to analyze our hypothesis. The success of the early post-stroke trunk and upper extremity functional status in predicting trunk involvement in the first month after discharge was examined in the model. The analysis results showed a good model fit, and it was seen that the independent variables $TIS_{baseline}$ and $WMFT_{baseline}$ could predict the change in the $TIS_{1\text{-month}}$ variable by 51.60% (adjusted $R^2= 0.516$ and $p<0.001$). The early post-intensive care trunk impairment level had a positive and beneficial effect on the trunk gains in the first month ($B=0.595$, $t=3.618$, and $p<0.001$). It was seen that the early post-intensive care arm functions did not have a significant effect on the model in predicting the trunk impairment levels one month later ($B=0.159$, $t=0.966$, $p=0.339$). The study's value inflation factor (VIF) also showed no evidence of multi-collinearity in the data set (VIF: 3.017) (Table 3).

DISCUSSION

The main starting point of the study was to examine whether the early trunk control levels and upper extremity motor skill levels of stroke patients could be used as a tool to predict trunk functions after discharge by modeling them together. When the correlation results were examined before the regression

Table 1. Demographic characteristics of patients

Age (year) X ± SD	64.83±11.26
Gender n (%)	
Female	25 (45.50)
Male	30 (54.50)
Type of lesion n (%)	
Ischemic	51 (92.70)
Hemorrhagic	4 (7.30)
Affected side n (%)	
Right	25 (45.50)
Left	30 (54.50)
Dominant side n (%)	
Right	52 (94.50)
Left	3 (5.50)
$TIS_{baseline}$ (point) X ± SD	13.41±5.13
$TIS_{1\text{-month}}$ (point) X ± SD	16.65±0.72
$WMFT_{baseline}$ (point) X ± SD	50.72±26.24

TIS: Trunk Impairment Scale, WMFT: Wolf Motor Function Test.

Table 2. Correlation values of the trunk impairment scale in the first month after discharge

Variables	$TIS_{baseline}$		$WMFT_{baseline}$	
	r	p	r	p
$TIS_{1\text{-month}}$	0.725	<0.001	0.645	<0.001
$WMFT_{baseline}$	0.818	<0.001	-	-

r: Correlation Coefficients, TIS: Trunk Impairment Scale, WMFT: Wolf Motor Function Test.

Table 3. Regression model summary of trunk impairment scale at one month after discharge

Variable	Unstandardized coefficients		95% confidence interval		Standardized coefficients		p	Model summary	VIF
	B	SE_B	Lower	Upper	B	t		Adjusted R^2	
Constant	15.304	0.193	14.916	15.692	-	79,111	<0.001	0.516	-
$TIS_{baseline}$	0.084	0.023	0.037	0.131	0.595	3.618	<0.001		3.017
$WMFT_{baseline}$	0.004	0.005	-0.005	0.014	0.159	0.966	0.339		

TIS: Trunk Impairment Scale, WMFT: Wolf Motor Function Test, VIF: Value Inflation Factor, SE: Standard Error.

analysis, it was seen that there was a strong relationship between the TIS score in the first month and the initial TIS and WMFT scores. In addition, there was a relationship between the TIS and WMFT scores in the initial assessment made in the neurology ward after intensive care. Although there was a strong positive relationship between the $TIS_{baseline}$ and WMFT scores and the $TIS_{1\text{-month}}$, the regression analysis showed that WMFT did not contribute enough to the model. However, the constructed model could still explain 51.60% of the trunk function of the patients in the first month after stroke.

The recovery period of trunk functions after stroke can vary between one and three months, similar to that of the upper and lower extremities (5). Weakness in the trunk muscles after the cerebrovascular event results in abnormal postural alignment and upper extremity dysfunction (6,15). The presence of compensatory movements that may develop due to trunk involvement may also negatively affect the functional capacity of the upper extremity in the long term (16).

TIS, a frequently used tool for assessing trunk involvement, predicts walking skills, prognosis of daily living activities, and hospitalization duration in acute stroke patients (7,17,18). Alhwoaimel et al. (19) also reported that trunk performance after stroke is an essential predictor for walking, balance, and daily living activities. A three-point increase between measurements with this tool indicates improvement in daily living activities (20). In addition, a TIS score of ≤13 points indicates unsatisfactory trunk control (21). In our study, it was observed that there was an improvement of more than three points in the patients' TIS scores between the baseline and one month later. Also, the patients' TIS scores were close to approximately 17 points in the final measurements. When our main results were examined, strong relationships were found between the patients' $TIS_{baseline}$ and $TIS_{1\text{-month}}$ and $WMFT_{baseline}$ values. The relationship between the $TIS_{baseline}$ and $TIS_{1\text{-month}}$ scores may seem to be expected. However, the main question in this study was whether the upper extremity function could predict trunk gains in the future together with trunk involvement. When we looked at the regression analysis results, it was seen that WMFT did not contribute to the model. The vast majority of studies were about the effect of trunk control on the functions of the extremities (22,23). In the study of Wee et al. (24), it was reported that upper extremity functions increased in parallel with the improvement in trunk control in the first six months after stroke. According to this report, while the gains in trunk control entered a slowing trend towards the sixth month, the recovery curve of upper extremity motor functions continued linearly. As a possible reason for this, it was emphasized that the improvement in trunk control also affected trunk stabilization and that the stabilization occurring in the proximal part may have positively affected the distal and proximal segments of the upper extremities (24). In addition, trunk motor impairment was found to be directly and closely related to trunk instability during walking (25). In a meta-analysis, it was reported that trunk exercises improved trunk performance in every stage of stroke. Still, there was no evidence that this improvement also affected upper extremity functions (19). We could not find any study on how early trunk-upper extremity functions might affect later trunk gains. According to the results of our study, early trunk control and upper extremity skills can significantly predict post-cerebrovascular events trunk gains. Although the effect of upper extremity functions on later trunk gains was not visible in the model in the regression analysis results, there was a strong relationship with the initial trunk involvement level according to the correlation analysis results. This strong relationship and initial interaction may have directly affected the regression analysis results. However, it should not be forgotten that these results were obtained with evaluations made in the first months after the stroke of the patients. Repeating the motor gains that may occur in motor functions in the first six months in the third and sixth months by adhering to the study method may offer different ideas.

As far as is known, this study is the first paper to estimate the level of trunk involvement in the acute period and upper extremity functions for the subacute trunk capacity in first month. In this respect, it can guide other predictive models for trunk gains. Apart from this, there are also limitations to the study. The most important one is that the trunk involvement levels of the patients were followed only one month later. This situation is the biggest obstacle to generalizing about the long-term results of the patients. Secondly, most of the patients consisted of individuals with ischemic stroke. In future studies, the study can be further customized by classifying according to the level of ischemic stroke or hemorrhage area. In addition,

the performance times of the patients in the WMFT could not be tested due to clinical conditions, and only the performance was scored.

CONCLUSION

This study investigated whether we could predict trunk functions in the first month after stroke using trunk involvement and upper extremity function parameters. As a result, this two-parameter model was able to explain 51.60% of the trunk involvement levels of the patients one month later. Although upper extremity functions did not contribute to the regression model, the strong relationship between them and the initial trunk involvement levels may have contributed to the model. As a result, increasing clinicians' awareness of trunk control after stroke may be useful in rehabilitation processes, mainly by providing an idea about the patient's functionality in the early period. Conducting studies on late-term interaction and using predictive models for trunk recovery in the patient clinic may play an active role in determining rehabilitative approaches.

Ethics: Ethical approval for the study was received from the Karadeniz Technical University Health Sciences Scientific Research Ethics Committee (file number: 2024/76, date: 01.07.2024).

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Author Contributions:

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