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Original Article

Evaluation of the relationship of balance and posture with speech functions in stroke patients

İnmeli hastalarda denge ve postürün konuşma fonksiyonları ile ilişkisinin değerlendirilmesi

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ABSTRACT

Aim: Balance disorders, postural dysfunctions, and speech disorders are common after stroke. This study aims to investigate whether there is a connection between language and speech function and posture and balance in paralyzed patients and to which speech area function the connection is related.
Methods: Eighteen stroke patients with speech impairment and no cognitive impairment were included in the study. Balance and postures of stroke patients were evaluated using the Berg Balance Test (BBT) and Postural Assessment Scale for Stroke Patients (PASS-T), while their quality of life was evaluated using the Stroke and Aphasia Quality of Life-39 Test (SAQOL-39). Patients' speech functions were evaluated using the Gülhane Aphasia Test-2 (GAT-2), voice-related assessments were made with the Voice-Related Quality of Life Scale (V-RQOL), and objective voice analysis.
Results: The mean age of the participants was 59.10±14.72 years, the mean score of the Mini-Mental Test was 26.16±2.00. According to statistical analysis, there was a significant relationship between BBT score and GAT-2 (r: 0.552, p=0.017), and BBT score and SAQOL-39 mean score (r: 0.589, p=0.010), there was no significant relationship between BBT and V-RQOL (r: -0.075, p=0.768). While there was a significant relationship between PASS-T (r: 0.499, p=0.035) and SAQOL-39, no significant relationship was found with GAT-2 (r: 0.388, p=0.112). In addition, a significant correlation was found between the SAQOL-39 mean score and the GAT-2 total score (r: 0,606, p=0.008).
Conclusion: It was observed that there is a significant relationship between balance functions and speech function and quality of life, and patients with good balance have better functional independence and speech functions. However, it was found that posture did not change speech function. Due to the importance of evaluation in treatment, it is thought that the evaluation of stroke patients who will receive speech and language therapy in terms of balance and postural functions will contribute to the speech functions of patients.

Keywords: Balance, posture, quality of life, speech, stroke

ÖZ

Amaç: İnme sonrasında denge bozuklukları, postüral disfonksiyonlar ve konuşma bozuklukları sık görülmektedir. Bu çalışmanın amacı inme hastalarında dil ve konuşma fonksiyonu ile postür ve denge arasında ilişkinin olup olmadığını,ve bu ilişkinin konuşma fonksiyonunun hangi alt alanı ile arasında olabileceğini araştırmaktır.
Yöntem: Çalışmaya konuşma bozukluğu olan ve kognitif bozukluğu olmayan on sekiz inme hastası dahil edilmiştir. İnmeli bireylerin denge ve postürleri Berg Denge Testi (BBT) ve İnmeli Hastalar İçin Postural Değerlendirme Ölçeği (PASS-T) kullanılarak değerlendirilirken yaşam kaliteleri İnme ve Afazi Yaşam Kalitesi-39 Testi (SAQOL-39) kullanılarak değerlendirilmiştir. Bireylerin konuşma fonksiyonları Gülhane Afazi Testi-2 (GAT-2) kullanılarak değerlendirilirken sesle ilgili değerlendirmeler Sesle İlişkili Yaşam Kalitesi Ölçeği (SİYKÖ) ve objektif ses analizi ile yapılmıştır.

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Bulgular: Araştırmaya katılan bireylerin yaş ortalaması 59,00 ± 14,72 yıl; Mini Mental Test puan ortalaması 26,16±2,00'dir. İstatistiksel analizlere göre BBT puanı ile GAT-2 (r: 0.552, p=0.017) ve BBT puanı ile SAQOL-39 ortalama puanı (r: 0.589, p=0.010) arasında anlamlı ilişki bulunurken; BDT'nin SİYKÖ (r: -0.075, p=0.768) ile anlamlı ilişkisi bulunmamıştır. PASS-T'nin SAQOL-39 ile anlamlı ilişkisi bulunurken (r: 0.499, p=0.035), GAT-2 ile (r: 0.388, p=0.112) anlamlı ilişkisi bulunmamıştır. Ayrıca SAQOL-39 ortalama puanı ile GAT-2 toplam puanı arasında anlamlı ilişki bulunmuştur (r: 0,606, p=0.008).
Sonuç: İnmeli bireylerde denge fonksiyonları ile konuşma fonksiyonu ve yaşam kaliteleri arasında istatistiksel açıdan anlamlı ilişkinin olduğu, dengeleri iyi olan hastaların genel seviyelerinin ve konuşma fonksiyonlarının daha iyi olduğu görülmüştür. Ancak postürün konuşma fonksiyonunu değiştirmediği bulunmuştur. Değerlendirmenin tedavideki önemi dolayısıyla dil ve konuşma terapisi alan ve alacak olan inmeli hastaların denge ve postüral fonksiyonlar açısından da değerlendirilmesinin bireylerin konuşma fonksiyonlarını geliştirecek uygun tedavi programı hazırlanmasına katkı sağlayacağı düşünülmektedir.

Anahtar kelimeler: Denge, inme, konuşma, postür, yaşam kalitesi

INTRODUCTION

Stroke is a clinical condition that occurs when blood flow to the brain is affected by occlusion or rupture of blood vessels (1). After a stroke, individuals may suffer from sensorimotor, cognitive, and functional disorders, and some problems may be permanent (2). Postural control disorders and balance problems are common in stroke patients due to weakness of the trunk and extremity muscles, which effectively provide postural control (3,4). Oscillations occur during standing due to the deterioration of postural control, lack of symmetrical weight transfer, and a decrease in body position information with the sense of pressure coming from the sole (5). While disruption of the postural alignment negatively affects many things, good alignment is also an important factor in optimal vocal function, so good trunk stability affects the function of the articulatory organs (6).

The ability to speak is a neuromuscular process in which the central nervous system, respiratory function, laryngeal regulation, some anatomical structures on the face, and soft tissues in the oral cavity work in synchrony (7). People who have had a stroke may experience various language disorders such as aphasia, and as a result, they may encounter problems such as inability to communicate and difficulty in daily activities.

As a result of the studies, it has been determined that motor and language activities are not completely independent in humans and that improvements in motor and language functions can occur simultaneously in individuals with paralysis (8,9). At the same time, it is known that pelvic stability provides trunk control, trunk stability provides head control, head stability provides jaw control, and chin stability provides control of tongue movement and lip mobility (6). Therefore, it is important not to ignore the relationship between speech function, balance, and posture.

The aim of the study is to determine whether there is a relationship between language and speech function and posture and balance in stroke patients, to draw attention to the importance of this evaluation in creating an appropriate treatment program for stroke patients, and to contribute to clinical studies.

MATERIALS AND METHODS

The study was carried out as a dual-center study on 18 individuals between the ages of 18-80 years who had a stroke and applied to Private Karadeniz Ereğli Echomar Hospital and Bolu Abant İzzet Baysal University İzzet Baysal Physical Therapy Training and Research Hospital. Written consent was obtained from all individuals who agreed to participate in the study by signing the "Informed Consent form". This study was approved by the Ethics Committee of Bolu Abant İzzet Baysal University for clinical research (2021/270).

Participants

Stroke patients who developed speech disorders after the cerebrovascular diseases, had no pathological condition that prevented them from

walking, and were willing to participate in the study were included. Stroke patients with mental involvement (Mini-Mental Test Score <24), severe lower extremity spasticity, neurological disorders other than stroke, and global aphasia were excluded from the study. In addition to the demographic information , participants were also asked about their height and weight, history of stroke, affected and dominant sides, presence of chronic diseases, information on regular medication use, previous physiotherapy and rehabilitation, and attendance to speech therapy.

Evaluation

Demographic information of stroke patients who met the inclusion criteria of the study was collected and recorded. The Mini-Mental Test (MMT), Berg Balance Test (BBT), Gülhane Aphasia Test-2 (GAT-2), Stroke and Aphasia Quality of Life-39 Test (SAQOL-39), Postural Assessment Scale (PASS-T), Subjective and Objective Sound Analysis tests were performed on the patients. After the individuals were evaluated once using these scales by the physiotherapists of İzzet Baysal Physical Therapy Education Research and Private Karadeniz Ereğli Echomar Hospital, the data were recorded numerically and no other evaluation was performed except for these tests. During the evaluations, the patients were allowed to rest whenever they needed.

Berg Balance Test (BBT): The Berg Balance Test is a test consists of 14 items and should be performed by direct observation of the performance; each item is scored between 0-4, and the highest possible score is 56. The test states that a score below 44 indicates a high risk of falling (10,11).

Gülhane Aphasia Test 2 (GAT-2): The GAT-2 is a valid and reliable test developed by Tanrıdağ, Topbaş and Maviş to diagnose aphasia and to provide information about speech disorders that may accompany aphasia, such as dysarthria and apraxia (12). The Gülhane Aphasia Test (GAT) was later developed and became the Gülhane Aphasia Test-2, which provides practical data for the assessment and diagnosis of aphasia. It consists of 7 sub-sections: spontaneous speech, speech comprehension, reading comprehension, oral motor assessment, automatic speech, repetition, and naming. The maximum score to be obtained is 83, and a higher score indicates that the individual has better speech function (13).

Stroke and Aphasia Quality of Life-39 Scale (SAQOL-39): The SAQOL-39 is a valid and reliable 39-item scale applied to individuals with aphasia and aims to evaluate the quality of life. In 21 items of the scale, the difficulties experienced by individuals with aphasia in their activities in the last week were asked, while in 18 items, the emotions and problems experienced by the individuals in the last week were asked. It has 4 subdomains: physical, psychosocial, communication, and energy (14).

Postural Assessment Scale for Stroke (PASS): Consisting of 12 items, the PASS is an assessment method that can be used to evaluate posture and balance even in stroke patients with very poor physical status. Sitting without support, standing with support, maintaining posture, turning, sitting on the back, and being able to come to the supine and lying position without sitting are among the parameters evaluated. The scale is scored between 0-36 and each question is tested with a value between 0-3; "0" is the lowest and "3" is the highest value. Studies showed that the Turkish version of the Postural Assessment Scale for Stroke Patients (PASS-T) is a valid, reliable scale and has a strong positive correlation with the Berg Balance Test (15).

Voice Analysis: Voice analysis can be divided into two as objective and subjective analysis. Objective Voice Analysis is used to diagnose voice disorders and record data. Voice-Related Quality of Life Scale is a tool that can be used in all adults in need, which allows specific evaluation of patients with voice disorders. It consists of 10 items and higher scores indicate better quality of life (16).

Subjective voice assessment was performed with V-RQOL. The Smart Tools (https://play.google.com/store/apps/details?id=kr.aboy.tools) mobile application offered by Smart Tools Co. was used while performing objective sound analysis on the patients. During the sound analysis, the environment was quiet, the patients were assessed at rest, and all patients were asked to say the same sounds at a fixed distance for equal evaluation. The 'a' phonation was preferred as the sound to be evaluated, because 'a' is easier to express because it is a thick, wide, and rounded vowel, and the item in which the 'a' phonation is evaluated is also included in the Gülhane Aphasia Test 2.

Statistical Analysis

IBM SPSS VERSION 21 was used for statistical analysis of the data. Histogram graphs and Shapiro-Wilk test were used to determine the conformity of the data to the normal distribution. Pearson correlation analysis was used for normally distributed data, Spearman correlation analysis was performed for non-normally distributed data, and regression analysis was performed for data with significant correlations. Interquartile range and median values were calculated for the analysis of the numerical data obtained from the scales. Confidence interval values of correlational findings were also calculated to determine the adequacy of the number of participants required for the study and to increase the power of the study. For $p<0.05$, the results were considered statistically significant.

RESULTS

A total of 18 stroke patients, 8 female (44.44%) and 10 male (55.55%), with a mean age of 59.00 ± 14.72 years were included in the study. According to the post-hoc power analysis of GAT scores, the effect size was found to be 0.59 and the power of the study was found to be %86. All 18 patients (100%) had an affected left hemisphere of the brain, 17 patients (94,4%) were right-side dominant and one patient (5.6%) was left-side dominant.

A statistically significant, moderate correlation was found between BBT and the total score of GAT-2 (rp:0.552, n=18, p=0.017). A statistically significant, moderate correlation was found between BBT and the mean score of SAQOL-39 (r:0.589, n=18, p=0.010). There was no significant relationship between BBT and the Voice-Related Quality of Life Scale (r: -0.075, n=18, p=0.768). Similarly, BBT did not have a significant relationship with objective voice analysis (r:0.425, n=18, p=0.078) (Table 1).

While there was a statistically significant and moderate correlation between BBT and the physical subdomain of the SAQOL-39 (r:0.536, n=18, p=0.022), no significant correlation of the

Table 1. Statistical relationship between BBT and other assessment methods.

BBT Pearson: r_p	GAT-2 Total Score	SAQOL-39 Average score	V-RQOL Total Score	Average Frequency Value
r_p	**0,552***	**0,589***	-0,075	0,425
p	**0,017**	**0,010**	0,768	0,078
N	18	18	18	18
CI	0,265-0,815	0,321-0,832	-0,447-0,496	-0,066-0,787

*r_p: Pearson correlation coefficient, * p<0.05 at the significance level , the relationship is significant, GAT-2: Gülhane Aphasia Test-2, BBT: Berg Balance Test, SAQOL-39: Stroke and Aphasia Quality of Life Scale-39, V-RQOL: Voice-Related Quality of Life Scale, CI: Confidence Interval*

Table 2. Statistical relationship between the BBT and other assessment methods.

BBT Pearson: r_p	SAQOL-39 Energy Score	SAQOL-39 Physical Score	SAQOL-39 Psychosocial Score	SAQOL-39 Communication Score	V-RQOL Physical-Functional Score
r_p	0,297	**0,536***	0,468	0,364	-0,092
p	0,231	**0,022**	0,050	0,137	0,717
N	18	18	18	18	18
CI	-0,150-0,675	0,242-0,812	0,110-0,729	0,013-0,631	-0,453-0,363

*r_p: Pearson correlation coefficient, * p<0.05 at the significance level, the relationship is significant, SAQOL-39: Stroke and Aphasia Quality of Life Scale-39, BBT: Berg Balance Test, V-RQOL: Voice-Related Quality of Life Scale, CI: Confidence Interval.*

SAQOL-39 was found with the energy (r:0.297 n=18, p=0.231), psychosocial (r:0.468, n=18, p=0.050), and communication (r:0.364, n=18, p=0.137) subdomains.

In addition, BBT was not significantly associated with the 'physical-functional' subdomain of V-RQOL (r: -0.092, n=18, p=0.717) (Table 2).

PASS-T, GAT-2's 'awareness' (r:0.140, n=18, p=0.579), 'understanding' (r:0.381, n=18, p=0.119), 'oral-motor assessment' (r:0.141, n=18, p=0.577), 'automatic speaking' (n=18), 'repetition' (r:0.150, n=18, p=0.552) and 'naming' (r: 0.434, n=18, p=0.072) were not significantly associated with any of the subdomains (Table 3).

A moderate correlation was found between the mean score of SAQOL-39 and GAT-2 (r: 0.502, p=0.034, CI: -0.108-0.901). Similarly, a strong correlation was found between the 'communication' subdomain of SAQOL-39 and GAT-2 (r: 0.719, p≤0.001, CI: 0.444-0.873) (Table 4).

A positive and moderate relationship (r: 0.556, p=0.017, CI: 0.227-0.751) was found between the 'psychosocial' subdomain of the SAQOL-39 and mean frequency. Similarly, a moderate and positive correlation was found between the 'energy' subdomain of the SAQOL-39 and the average frequency value (r: 0.575, p=0.012, CI: 0.118-0.813) (Table 5).

In addition to the information given in the tables, a moderate correlation (r: 0.574, p=0.013, CI:0.129-0.851) was found between V-RQOL and the 'psychosocial' subdomain of the SAQOL-39, and a moderate correlation was found between V-RQOL (r=0.501, p=0.034, CI:0.102-0.745) and the 'communication' sub-domain of the SAQOL-39.

Table 3. Examination of the relationship between PASS-T and other assessment methods.

PASS-T	Spearman Correlation Coefficient (rs)	P	N	CI
GAT-2 Total Score	0,388	0,112	18	-0,039-0,693
GAT-2 Awareness	0,140	0,579	18	-0,387-0,684
GAT-2 Understanding	0,381	0,119	18	-0,138-0,757
GAT-2 Oral-Motor Evaluation	0,141	0,577	18	-0,403-0,690
GAT-2 Auto Talk	-	-	18	-
GAT-2 Repeat	0,150	0,552	18	-0,412-0,668
GAT-2 Naming	0,434	0,072	18	-0,009-0,202

r_s: Spearman correlation coefficient, GAT-2: Gülhane Aphasia Test-2, PASS-T: Postural Assessment Scale for Stroke Patients, CI: Confidence Interval.

Table 4. Statistical analysis of the relationship between GAT-2 and SAQOL-39.

GAT-2 Spearman: r_s	SAQOL-39 Average Score	SAQOL-39 Communication Subdomain	SAQOL-39 Physical Subdomain	SAQOL-39 Psychosocial Subdomain	SAQOL-39 Energy Subdomain
rs	**0,502**	**0,719**	0,374	0,370	0,370
p	0.034	≤0.001	0,127	0,130	0,130
N	18	18	18	18	18
CI	-0,108-0,901	0,444-0,873	-0,228-0,847	-0,194-0,789	-0,194-0,789

r_s: spearman correlation coefficient, GAT-2: Gülhane Aphasia Test-2, SAQOL-39: Stroke and Aphasia Quality of Life Scale-39, CI: Confidence Interval.

Table 5. Investigation of the relationship between the mean frequency value and SAQOL-39.

Average Frequency Spearman: r_s	SAQOL-39 Psychosocial Subdomain	SAQOL-39 Energy Subdomain	SAQOL-39 Physical Subdomain	SAQOL-39 Communication Subdomain	SAQOL-3 Average Score 9
r_s	**0,556**	**0,575**	0,575	0,575	0,317
p	0.017	0.012	0.012	0.012	0,200
N	18	18	18	18	18
CI	0,227-0,751	0,118-0,813	0,118-0,813	0,118-0,813	-0,116-0,597

r_s: spearman correlation coefficient, SAQOL-39: Stroke and Aphasia Quality of Life Scale-39, CI: Confidence Interval.

According to the results of the regression analysis, there is a statistically significant and positive linear relationship between balance and speech function. It was found that 30% of the variance in the dependent variable (R2=0.305) was explained by the independent variable. In other words, the Berg Balance Test score, which is the independent variable, positively and significantly affects the dependent variable, the Gülhane Aphasia Test-2 score (β= 0.552, t= 2.651, p= 0.017).

According to another regression analysis result, there is a statistically significant and positive linear relationship between speech function and quality of life. It was found that 36% (R2=0.368) of the variance in the dependent variable was explained by the independent variable. In other words, the GAT-2 result, which is the independent variable, positively and significantly affects the SAQOL-39 score, which is the dependent variable (β= 0.606, t= 3.050, p= 0.008).

DISCUSSION

As a result of this study, a statistically significant relationship was found between balance, speech function, and quality of life. While there was a significant relationship between posture and quality of life in stroke patients, no significant relationship was found with speech function. According to the findings of the statistical analysis, the speech function and quality of life of stroke patients with good balance may be better, but this relationship is not completely valid for posture.

Studies indicate that complex functions, such as linguistic functions occur with the involvement of the whole brain (17). The striatum plays an important role in the motor functions, attention, and memory; the study showing that it is also involved in the control of linguistic functions is an important example that supports the absence of a single language center (17). Harnish et al. also stated that motor and language activities in humans are not completely independent and that improvements in motor and linguistic functions are simultaneous in individuals with stroke (9). Jankowska et. al.[6] also stated that pelvic stability provides trunk control, trunk stability provides head control, head stability provides jaw control, and chin stability provides control of tongue movements and lip mobility.

The most important finding of this study is the statistically significant positive linear relationship between balance and speech function. According to the theoretical interpretation of this finding, when stroke individuals' BBT scores increase and they have better balance, their GAT-2 scores also increase, thus individuals have better speech function. Although this interpretation seems possible in terms of equations, it does not seem possible in terms of clinical findings. However, considering both previous studies and the results of this study, a statistical relationship between them is possible. In the literature, stroke patients tend to improve their ability to speak and motor skills, with no significant difference between the two[18], stroke patients who experience positive changes in their motor skills also tend to have improvement in their language abilities (19). Additionally, a study suggests that the vestibular system plays a key role in language development, as it is connected to the same brain areas responsible for speech, reading, and writing (20). Another study found that the severity of aphasia was higher in patients with right hemiplegia, low ambulation level, and poor function level (21). Findings that directly support this are not included in this study, but the results are mutually supportive. Various studies has found that both aphasia and balance affect the functional independence and activities of daily living, so the relationship between aphasia and balance should not be ignored.

Another important finding of this study is that there is no significant relationship between posture and speech function. When the literature was reviewed to support this finding and hypothesis, no study was found that directly examined the relationship between posture and speech function in stroke patients. However, studies have reported that the cerebellum, which

plays a role in maintaining balance and postural stability, is also involved in the control of motor speech (22). Patients with cerebellar involvement have increased syllable repetition times and impaired speech fluency (23). In one study, participants were asked to say certain words while sitting unsupported, and stroke patients were found to be less stable than healthy individuals and postural instability increased significantly during the repetition of words (24). Studies in the literature do not support the finding of this study that 'posture does not have a significant relationship with speech function' . This may be due to the fact that the PASS-T is not detailed and distinctive enough to evaluate posture.

Significant, positive, and linear relationship between quality of life and speech function are among the other important findings of this study. This finding is theoretical. It means that as the scores of stroke patients with aphasia increase, speech functions and the patients' quality of life are better. As a result of the studies, it was found that the probability of depression after dominant hemisphere lesions is relatively higher (25-27). It has been stated that the memory and speech functions of stroke patients with moderate or severe depressive symptoms are adversely affected (28). It is known from studies that depression affects quality of life. Therefore, it can be suggested that the significant relationship between quality of life and speech function obtained as a result of this study supports the finding that depression affects speech functions in stroke patients obtained as a result of studies.

The results of the literature review can be a source for this study, and the results overlap. However, no study in the literature has examined the relationship between balance, and posture and speech function in stroke patients. Although the nature of the relationship between balance and posture and speech function is not fully known, this study is the first original study in the literature by contributing to the finding of statistically significant values between balance and posture and speech function.

Considering the findings of this study and other studies in the literature, it can be concluded that speech is a function that is affected by many factors, therefore its evaluation should be comprehensive. A comprehensive evaluation is required in the preparation of the appropriate treatment program for the patient. After a detailed evaluation of this study, the inclusion of not only speech and language therapy but also functional exercises and balance exercises in the treatment of stroke patients with speech problems will contribute to the recovery process.

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