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Evaluation of the Development in Balance in Patients with Stroke in the Rehabilitation Program in the Early Period

Erken Dönemde Rehabilitasyon Programına Alınan İnmeli Hastalarda Dengedeki Gelişmenin Değerlendirilmesi

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ABSTRACT Objective: To evaluate the balance improvement in subacute and chronic stroke patients who received rehabilitation program for the first time. **Material and Methods:** This prospective study evaluated twenty-five hemiplegic patients who received a rehabilitation program for the first time in an inpatient rehabilitation clinic. Patients' demographic datas (age, gender, post-stroke duration, affected extremity side, etiologic factors of stroke, comorbidities) were recorded. A conventional rehabilitation program (neurophysiological exercises, joint range of motion exercises, balance and coordination exercises, posture exercises, walking exercises, stretching exercises and relaxation exercises) was applied to the patients. The patients were evaluated with the Brunnstrom Recovery Stage (BRS), the Trunk Control Test (TCT), the Berg Balance Scale (BBS), and the Barthel Index (BI). **Results:** The study included 8 (32%) female and 17 (68%) male patients with a median age of 66 (54.5-76.5) years. The median scores of the control BBS, BI, TCT, BRS of the hand, upper extremity and lower extremity were higher than the initial evaluation scores (all $p<0.01$). A positive significant correlation was detected between BBS difference and BI difference, TCT difference and BRS lower extremity difference ($rs=0.578$, $p=0.002$; $rs=0.426$, $p=0.034$, $rs=0.622$, $p=0.001$, respectively). **Conclusion:** As a result, although the initiation of the rehabilitation program in the early post-stroke period showed improvement according to the initial values of the balance assessment data, balance disorder still continues according to the BBS classification. Therefore, the balance of the patients should be evaluated in depth, and balance education should be included in the rehabilitation program.

Keywords: Stroke; hemiplegia; balance impairment; rehabilitation

ÖZET Amaç: İlk kez rehabilitasyon programı alan subakut ve kronik inmeli hastalarda denge gelişimini değerlendirmek amaçlandı. **Gereç ve Yöntemler:** Bu prospektif çalışmada, rehabilitasyon kliniğinde yatarak tedavi gören, ilk kez rehabilitasyon programı alan 25 hemiplejik hasta değerlendirildi. Hastaların demografik verileri (yaş, cinsiyet, inme sonrası süre, etkilenen ekstremite tarafı, inmenin etiyolojik faktörleri, komorbiditeler) kaydedildi. Hastalara konvansiyonel rehabilitasyon programı (nörofizyolojik egzersizler, eklem hareket açıklığı egzersizleri, denge ve koordinasyon egzersizleri, postür egzersizleri, yürüme egzersizleri, germe egzersizleri ve gevşeme egzersizleri) uygulandı. Hastalar Brunnstrom İyileşme Evresi (BİE), Gövde Kontrol Testi (GKT), Berg Denge Skalası (BDS) ve Barthel İndeksi (Bİ) ile değerlendirildi. **Bulgular:** Çalışmaya ortanca yaşı 66 (54,5-76,5) olan 8 (%32) kadın ve 17 (%68) erkek hasta dâhil edildi. Kontrol BDS, Bİ, GKT, BİE el, üst ekstremite ve alt ekstremitenin ortanca puanları ilk değerlendirme puanlarından daha yüksekti (tümü $p<0,01$). BDS farkı ile Bİ farkı, GKT farkı ve BİE alt ekstremite farkı arasında pozitif yönde anlamlı bir korelasyon saptandı (sırasıyla $rs=0,578$, $p=0,002$; $rs=0,426$, $p=0,034$, $rs=0,622$, $p=0,001$). **Sonuç:** Sonuç olarak, inme sonrası erken dönemde rehabilitasyon programına başlanması, denge değerlendirme verilerinin başlangıç değerlerine göre iyileşme göstermesine rağmen BDS sınıflamasına göre denge bozukluğu hâlâ devam etmektedir. Bu yüzden hastaların dengesi derinlemesine değerlendirilmeli ve rehabilitasyon programına denge eğitimi dâhil edilmelidir.

Anahtar Kelimeler: İnme; hemipleji; denge bozukluğu; rehabilitasyon

Stroke is the leading cause of disability in the world.[1] Balance impairment is one of the major reasons for locomotor impairment in stroke patients besides the motor, sensory, cognitive, and emotional problems.[2,3] Since the rehabilitation program is a time-consuming and costly treatment, evaluation of

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balance, which is very important for activities of daily living (ADL), and determining the individual specific-rehabilitation program come into prominence.[4-6]

Balance is a complex interaction of the musculoskeletal and the neuronal system. Balance is maintained by the combination of the interaction of sensorial organization and postural control systems in the central nervous system.[7] Balance is essential for optimal locomotor system function, which provides maintaining the body position during ADL, stability during changing positions, and moving independently in public.[8,9]

Balance impairment is an important problem for ADL, mobility, and fall risk in patients after stroke. Spatial neglect, increased postural oscillation, asymmetric weight distribution, impaired weight shifting ability, and decreased balance capacity have been reported in post-stroke patients. For this reason, the adaptation of postural changes while standing or sitting and maintaining balance is very difficult.[10] Left hemiplegic patients' balance while sitting or standing is worse than right hemiplegic patients' since neglect is more common in left hemiplegic patients.[11]

In this study, we analyzed the balance improvement in subacute and chronic stroke patients who received rehabilitation program for the first time and we analyzed the balance training timing after stroke by considering the patients' rehabilitation consequences.

MATERIAL AND METHODS

STUDY DESIGN AND POPULATION

This prospective study evaluated thirty-seven hemiplegic patients who received rehabilitation program for the first time in an inpatient rehabilitation clinic. All patients were evaluated twice: initial within three days of applying to inpatient rehabilitation clinic and at the sixth month of the initial evaluation. Six months after discharge, the patients were called by phone. Patients who spent this time at home, and did not receive any rehabilitation program were called to the hospital and evaluated. After the initial evaluation, twenty-five patients were re-evaluated at the sixth month since four patients died after discharge from the hospital and eight patients left the study on their request.

The study was approved by Education Planning and Coordination Board of Ankara Physical Therapy and Rehabilitation Training and Research Hospital (date: February 28, 2014, no: 169/3). The study was conducted in accordance with the principles set forth in the Declaration of Helsinki. Written informed consent was obtained from all patients before the study.

Post-stroke patients between the ages of 40-80 who have the first stroke, able to sit independently at the bedside for at least 30-60 seconds, adequate cognitive function for understanding and following instructions, post-stroke duration between two and six months, and independently ambulatory before stroke included in the study. Patients with comorbidities for which exercise is contraindicated and/or causes impairment in the evaluation of balance such as vertebrobasilary or peripheral vestibular insufficiency, visual impairment, cognitive impairment, cerebellar pathology, joint contracture in the lower limb, and other neurologic or orthopedic disabilities were excluded from the study.

Patients' demographic (age, gender, post-stroke duration, affected extremity side, etiologic factors of stroke, comorbidities such as hypertension, myocardial infarction, atrial fibrillation, and diabetes mellitus) variables were recorded. A conventional rehabilitation program (neurophysiological exercises, joint range of motion exercises, balance and coordination exercises, posture exercises, walking exercises, stretching exercises and relaxation exercises) was applied to the patients included in the study for 4 weeks, 5 days a week, 45 minutes a day.

OUTCOME MEASURES

Patients' motor function was evaluated according to the Brunnstrom Recovery Stage (BRS). The patients are staged as the lowest Stage 1 and the highest Stage 6, Stage 1 shows no motor movement, Stage 6 shows normal extremities.[12]

Patients were assessed using the Berg Balance Scale (BBS) for postural balance. BBS is a reliable psychometric measure and is currently the gold stan-

dard for balance evaluation.[9] The total score of BBS rages from 0-56. BBS score of 0-20 is considered as high fall risk, 21-40 as a medium fall risk, and 41-56 as low fall risk.[8]

The Trunk Control Test (TCT), which is developed for evaluating trunk control in post- stroke patients, was applied to all patients. It includes four axial movements; 1) rolling to the weak side in the supine position, 2) rolling to strong side in the supine position, 3) sitting up from lying down and 4) balance in sitting position on the edge of the bed with the feet off the ground for at least 30 seconds. TCT scored as 0=if the patient was unable to perform the task without assistance, 12=if the patient was able to perform the task in an abnormal style, 25=if the patient was able to complete the task normally. The maximum score of TCT is 100.[13]

The functional independence level in personal ADL was assessed using Barthel Index (BI) which involves 10-items and measures. It consists of the parts of feeding, bathing, grooming, dressing, bowel and bladder habits, toilet use, transfers (bed to chair and back), mobility (on smooth surfaces), and up and down the stairs. The BI scored as: 0-20=total dependency, 21-61=severe dependency, 62-90=moderate dependency, 91-99=slight dependency and 100=independency.[14]

Comparisons were made between BBS, TCT, BI, and BRS at the patients' initial evaluation and at the next evaluation six months later. In addition, the score difference between these scales, which were evaluated at the first and six months later, was calculated and correlation analysis was performed.

STATISTICAL ANALYSIS

Statistical analyses were performed using SPSS 22.0 (Statistical Product and Service Solutions for Windows, Version 22.0, IBM Corp., Armonk, NY, U.S., 2013) software package. Shapiro-Wilk's test was used for testing the normality of continuous variables. The descriptive statistics were expressed as mean±standard deviation for the normally distributed continuous variables, median (minimum-maximum) for the non-normally distributed variables, and frequencies (n) and percentages (%) for the categorical variables. Comparisons of two independent groups were made using the independent samples t-test and the Mann-Whitney U test in the case of normally distributed and non-normally distributed continuous variables, respectively. Additionally, categorical variables were compared using Pearson's chi-square test or Fisher's exact test for proportion. Pearson's and Spearman's correlation analyses were used to examine the relationship between normally distributed continuous and unspecified variables, respectively. A point biserial correlation analysis was performed for categorical variables. All significance tests were 2-tailed. The probability (p) statistics of <0.05 were deemed to indicate statistical significance.

RESULTS

The median age of the 25 patients included in the study, of whom 17 (68%) were males, was 66 years. The mean post-stroke duration was 90.16±23.61 days. The demographic characteristics are presented in Table 1.

The median scores of the control BBS, BI, TCT, BRS of the hand, upper extremity and lower extremity were higher than the initial evaluation scores (all $p<0.01$). BBS, BI, TCT, and BRS of hand, BRS of upper extremity, and BRS of lower extremity scores in the initial and control evaluations are given in

TABLE 1: Demographic characteristics of the patients (n=25).

Variable	
Age (years)	66 (54.5-76.5)
Post-stroke duration (days)	90.16±23.61 (60-136)
Gender	
Female	8 (32)
Male	17 (68)
Hemiplegic extremity side	
Right	11 (44)
Left	14 (56)
Etiology	
Thromboembolic	21 (84)
Hemorrhagic	4 (16)
Comorbidities	
History of myocardial infarction	5 (20)
Atrial fibrillation	7 (28)
Hypertension	17 (68)
Diabetes mellitus	6 (24)

The data are expressed as median (minimum-maximum) or n, (%).

TABLE 2: Comparison of the data of the patients evaluated in the initial evaluation and the control evaluation (n=25).

	Initial evaluation	Control evaluation	p value
Berg Balance Scale	3 (0-37.5)	7 (2-43)	**<0.001**
Barthel Index	25 (12.5-62.5)	40 (20-70)	**<0.001**
Trunk Control Test	48 (0-74.5)	61 (30.5-93.5)	**0.001**
BRS (upper extremity)	2 (1-3.5)	2 (2-4)	**<0.001**
BRS (hand)	2 (1-3)	2 (2-4)	**0.003**
BRS (lower extremity)	3 (2-5)	4 (2-5)	**0.002**

BRS: Brunnstrom Recovery Stage; The data is expressed as median (minimum-maximum). Significant p values are written in bold.

Table 2.

In the correlation analysis performed by calculating the difference between the scales evaluated at the first and 6 months after the patients, a positive significant relation was found between the BBS difference and the BI difference, TCT difference and BRS lower extremity difference (rs=0.578, p=0.002; rs=0.426, p=0.034, rs=0.622, p=0.001, respectively) (Table 3).

No significant correlation was found between the BBS difference and TCT difference of the patients and the correlation between gender, hemiplegic extremity side and comorbidities (hypertension, myocardial infarction, atrial fibrillation and diabetes mellitus) (p>0.05).

DISCUSSION

According to this study in stroke patients although trunk control improved in subacute and chronic period, balance during standing up and walking continues as a big problem. In this study, significant improvements were found in BBS, BI, TCT and BRS scores with regular conventional rehabilitation programs in subacute and chronic stroke patients. In addition, it was determined that although the trunk control of subacute and chronic stroke individuals improved, balance disorder during standing and walking continued as an important problem (BBS score <20).

Abnormal muscle tonus, muscle weakness, loss of sensation and impairment in vestibular mechanism which occur following stroke may cause balance impairment during both sitting and standing.[15] Recent studies showed that sitting balance is one of the early determinants for prediction of functional status.[4,16,17] TCT, which evaluates trunk balance and sitting balance, is an easy and feasible test.[13] We evaluated trunk balance and sitting balance with TCT in our study, the median of TCT was 48 (0-74.5) and 61

TABLE 3: Correlation analysis according to the difference in scores between the scales in the initial evaluation and control evaluation.

		Age	Post-stroke duration	BBS difference	BI difference	TCT difference	BRS upper extremity difference	BRS hand difference	BRS lower extremity difference
Age	rs	1							
	p								
Post-stroke duration	rs	0.105	1						
	p	0.617							
BBS difference	rs	-0.148	-0.447	1					
	p	0.482	**0.025**						
BI difference	rs	-0.211	-0.563	0.578	1				
	p	0.312	**0.003**	**0.002**					
TCT difference	rs	-0.027	-0.171	0.426	0.571	1			
	p	0.899	0.413	**0.034**	**0.003**				
BRS upper extremity difference	rs	-0.212	-0.261	0.091	0.267	0.268	1		
	p	0.309	0.207	0.665	0.198	0.195			
BRS hand difference	rs	0.276	-0.044	0.142	0.160	0.068	0.621	1	
	p	0.182	0.834	0.498	0.444	0.747	**0.001**		
BRS lower extremity difference	rs	-0.227	-0.317	0.622	0.384	0.170	0.206	0.063	1
	p	0.275	0.123	**0.001**	0.058	0.417	0.323	0.765	

BBS: Berg Balance Scale; BI: Barthel Index; TCT: Trunk Control Test; BRS: Brunnstrom Recovery Stage; Significant p values are written in bold.

(30.5-93.5) in initial and sixth month evaluation; respectively. This difference was statically significant. Considering that TCT score is defined as normal above 25 and maximum score of TCT is 100, the patients' initial evaluation scores although low at the start of a rehabilitation program were still be considered in normal range in our study. Previous studies showed that neurologic recovery is more pronounced in first three months after stroke.[1,18] Due to including the patients to this study after 3-6 months from stroke, TCT score may be high in our study. In light of this information, patients should receive rehabilitation program in the early stage of the disease. In addition, clinicians should attach importance to the improvement of trunk balance in these patients.

Achieving postural control and balance during sitting and standing are very important steps for independence in ADL and ability of walking after stroke.[19,20] Balance control provides walking safely with decreasing the fall risk. BBS was used for evaluating standing and walking balance in this study. The median score of BBS was 3 (0-37.5) in initial evaluation and was 7 (2-43) at sixth month control. Although this difference was statistically significant, these data showed that balance impairment was presented in the initial and in control evaluation. Since balance impairment during standing and walking continues, patients have fall risk even after rehabilitation program.

Balance and motor function of upper and lower extremities are affected in post-stroke patients, in addition to this as motor function impairment was increased, the balance gets worse too. The patients with balance impairment have longer duration of hospitalization and poor outcome of rehabilitation program.[20] Our data support the literature that, TCT and BBS were positively correlated with BRS of hand, BRS of upper extremity and BRS of lower extremity.[21-23]

All of four extremities move in a coordination in a normal walking cycle, so that the swing of the arms is in harmony with the step frequency. Restricting the arms' movement causes worse balance during walking even in healthy individuals.[24] Upper extremity function is affected in 50-80% of acute stroke patients and 50-40% of subacute patients.[25] The synchronization between the step frequency and paretic upper extremity oscillation is impaired during upper extremity moving in post-stroke patients.[26] In addition, muscle weakness in hemiparetic arm and moment change due to extremity weight may cause balance impairment by affecting the ability of changing position and impairing the sitting or standing posture.[21] During a fall upper extremities protect patients by reaching the outside supports, upper extremity rehabilitation is important for not only motor recovery, but also for balance improvement and preventing falls. In our study, BRS of upper extremity and hand scores were found to be statistically significantly higher than the first evaluation in the control evaluations. However, no significant correlation was found between BRS (upper extremity, and hand) difference and BBS difference and TCT difference in the correlation analysis. In light of these results rehabilitation in stroke patients between 2-6 months after stroke contributes to the recovery of motor function.

Balance impairment, which is main reason of fall, is a common problem in post-stroke patients.[20,21,25] Although falls are more common in post-stroke patients comparing to healthy individuals of same age, falls are seen in especially in late stage of the disease. During walking 90% of chronic post-stroke patients have balance impairment which causes increase in fall risk and restrictions in ADL.[3] Therefore, determining the reasons of balance impairment gains importance for specifying the rehabilitation program.[20] Asymmetric weight distribution and lateral postural instability, which caused by neurologic damage and changed postural mechanisms including asymmetric body weight, re-control of each lower extremities, affects balance negatively.[10] The change of center of gravity while standing on healthy extremity is more than during standing on hemiparetic extremity in post-stroke patients. In this context, hemiparetic extremity could be compensated by increased range of motion of joint with increased somatosensorial input and muscle contractions of healthy extremity. Therefore, if healthy extremity couldn't compensate hemiparetic extremity, balance impairment is more significant in post-stroke patients.[22] In our study, the BRS of lower extremity

score was found to be statistically significantly higher than the first evaluation in the control evaluation. In addition, a significant positive correlation was found between BRS lower extremity difference and BBS difference. Recent studies reported that patients could remain standing for 10 seconds after 44 (38-57) days after stroke.[22,25] In addition fall risk is more significant in chronic stage of disease. In view of these reasons, our study emphasizes on start of an early phase rehabilitation program after stroke, in addition to this, this rehabilitation should cover not only to the hemiparetic side and but also to the healthy muscles of lower extremity to strengthen them, which would improve the balance and decrease the fall risk.

In this study comorbidities such as hypertension, diabetes mellitus, atrial fibrillation and history of myocardial infarction found to be not related to BBS difference and TCT difference. The reason of these results could be due to that these comorbidities of our patient group were under control with appropriate medical treatment.

The limitations of the study are that presence of neglect, functional ambulation scale whether the affected extremity was the dominant or not were not evaluated. In addition to this, we could not have a control group.

One of the most important limitations of our study is the lack of an early recovery program control group. Another limitation is that the patients were not re-evaluated at the end of the 4-week rehabilitation program. Therefore, the effect of the rehabilitation program on balance in the short term could not be evaluated. Our other limitations are the presence of neglect, functional ambulation scale whether the affected extremity was the dominant or not were not evaluated.

CONCLUSION

As a result, although the initiation of the rehabilitation program in the early post-stroke period showed improvement according to the initial values of the balance assessment data, balance disorder still continues according to the BBS classification. Balance disorder may increase the risk of falling in stroke patients. Therefore, the balance of the patients should be evaluated in depth, and balance education should be included in the rehabilitation program.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

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