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COMPARISON OF BALANCE IN HEMIPARETIC PATIENTS WITH RIGHT AND LEFT HEMISPHERIC LESION

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ABSTRACT

AIM: Present study aimed to compare balance ability in patients with single lesion of either the right or the left hemisphere.

MATERIALS AND METHODS: A total of fifty hemipheric lesion survivors (25 patients with right hemispheric lesion-Group 1, 25 patients with left hemispheric lesion-Group 2) were included in this study.The Barthel Index(BI) was used to determine independency level of the sample.The following tests were used to evaluate their balance ability:(1)One leg stand test and Portable Computerized Kinesthetic Ability Trainer(Sport-KAT 550) were used to static balance measurement. (2)Timed Up-Go test, 10-meter walk test,Sit-to-stand test and Berg Balance Scale(BBS) were used to for dinamic balance assessment.

RESULTS: The independency level of two groups was similar.The results showed that the patients with left hemispheric lesion had better scores for balance measurements($p \leq 0.05$).

CONCLUSION: The patients with lesion of either the right or the left hemisphere perform balance ability poorly. Hemispheric lesion location is related to balance disturbances in brain lesion survivors. There is effect of lesion location on severity of balance impairments. This study is important to create data bank for health professionals dealing with this issue. Rehabilitation programs should be revised in the light of the data obtained.

Keywords: Hemispheric Lesion, Hemiparesis, Balance

INTRODUCTION

Hemiparesis with classic symptoms of neurovascular disease, is a clinical entity characterized by loss of voluntary movement, sensory disorders and various neurological manifestations as a result of brain lesions developing in the opposite half of the body.[1] Different symptoms are seen in lesions of the right and left hemispheres, because they have different tasks.

Balance is affected due to muscular weakness, abnormal muscle tone, loss of deep sense, vestibular disorders, deterioration of righting reflex and neglect syndrome following hemiparesis table.[2-4] Balance is an ability to maintain the line of gravity of a body within the base of support with minimal postural sway.[5-7] Balance is required to be able to demonstrate the optimum function of the locomotor system, the realization of activities of daily life, the continuation of a specific position, ensuring stability while passing from one position to another, and act independently in the community.[2,7,8] Balance functions need sufficiently to carry out social activity, continue safely, activities of daily life for hemiparetic patients. Therefore, it is necessary to be considered detailed evaluation in terms of balance and while determining the objectives of rehabilitation whether they have balance disorders before the start of the rehabilitation program in these patients.

The objective of this study was to examine how balance was affected and whether there were differences according to localization of brain lesions.

MATERIALS AND METHODS

Study design and participants

Our study was completed with participation of a total of 50 hemiparetic-volunteer patients, 20 and over years, having 25 right and 25 left hemisphere lesions according to the inclusion and

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exclusion criteria between February 2013 - April 2014. Inclusion criteria; ≥ 20 years having left or right hemisphere for the first time the lesion, no cognitive impairments (eight points and above for Hodkinson Mental Test), maximum 3 points for Modified Rankin Scale. Exclusion criteria; vision and hearing problems, moderate or severe aphasia, inability to stand by using assistive devices (canes or glider) or a fully independent for at least 10 seconds, comorbid neurological problems, can not be completed designated tests and failure to comply with study plan. 103 hemiparetic patients were evaluated for the study. 53 patients were excluded from the study for various reasons (Figure 1).

Data collection instruments

Demographic characteristics, and the clinical information about dominant side, affected side anatomical localization of lesion, cause of hemiparesis, comorbid diseases, urinary problems, visual impairment, hearing impairment, rehabilitation duration, walking aids, marital status, educational status, social insurance, and occupational status were recorded. Barthel Index was used to determine the functional independence level of patients. The BI consists of 10 items, which measures performance in activities of daily living and mobility.[9] The maximum score of 100 indicates a person is completely independent for physical function. 0 points is the lowest score; indicates person is completely dependent.[10]

Static balance was evaluated using single leg stance test and Sport-KAT 550 double-leg static balance measurements. The participant must stand looking straight ahead for single-leg stance test, unsupported on one leg and is timed in seconds from the time one foot is flexed off the floor to the time when it touches the ground or the standing leg. The participant is expected to maintain stability for 30 seconds.[11] Sport-KAT 550 device, consists of two main components, a mobile platform and a computer connected to the bottom of the tilt sensor. The pressure of the mobile platform can be changed to modify the difficulty of testing. Measurements were made using 10 PSI stability values for patients included in the study. The monitor screen has a cross representing the center of the platform on. Participants standing on the platform during the static test follow the cross and try to keep weight in the center transferring forward, backward, left, or right. During the test, participants on the platform receive continuous feedback from the monitor, following the position according to the target point of the mark indicating their center of gravity changes. Low scores in tests indicate that balance performance is good.[12] Dynamic balance was evaluated using Timed Up and Go(TUG) test, sit-to-stand test, 10-meter walk test and Berg Balance Scale(BBS) Assessment. TUG is an objective, reliable and simple measurement used to assess balance and functional mobility. Participants are asked to get up from a chair, walk three meters, turn around, walk back and sit in the chair. Scoring is calculated by measuring how many seconds the test took to finish. Use of walking aids during the test is permitted.[13] Sit-to-stand test is administered using an armless chair with a seat height of 45cm. The test begins with the participant seated in the middle of the chair, back straight. Arms are crossed at the wrists and held against the chest. The participant rises to a full stand and returns back to the initial seated position. The numbers of repetition are noted in one minute time limit.[14] During 10-Meter Walk test, the patient walks with a normal gait speed between two cones placed at a range of 10 meters. Test time in seconds is recorded.[15] BBS consists of 14 items representing functional movements common in everyday life.[16] Some items require that the patient maintains positions of increasing difficulty, from sitting to standing on one leg.Other items evaluate the ability to perform specific tasks, such as reaching forward, turning around and picking up an object from the floor. Scoring is based on the ability to meet certain time or distance requirements and to perform the items independently.[17,18] Each task is scored on a 5-point scale from 0 to 4 giving a maximum score of 56, which indicates balance ability within the normal range.[16,19]

Statistical Analysis

The data was analyzed by using Statistical Package of Social Science-SPSS software(version 18) for Windows. The Kolmogorov-Smirnov test was used to test normality of distribution. The arithmetic mean and standard deviation were used for descriptive data of hemiparetic patients. Independent t-test was applied to TUG and sit-to-stand scores between right and left hemispheric lesions, as scores were normally distributed. Mann-Whitney's U-test was used to compare other balance scores and descriptive variables, as scores were not normally distributed. A level of $p<0.05$ was considered significant.[20, 21] According to the results obtained from the study, power of the study was obtained 93% in 95% confidence level.

Ethical considerations

The study was approved by the Ethical Board Committee of Pamukkale University Medical

Faculty (Ref No: 06, Date: 27.11.2012). Patients were recruited from Denizli Special Norobilim Medical Center after signing the informed consent form. This study was supported by the Pamukkale University Scientific Research Projects Foundation (Ref No:2013SBE005).

RESULTS

Group 1 shows participants with right hemispheric lesion, Group 2 shows participants with left hemispheric lesion. Group 1 included 12(48%) females, 13(52%) males, and 10(40%) females, 15(60%) males for Group 2. Table 1 summarizes the mean and standard deviation of demographic and clinical characteristics related to hemiparetic subjects.

Table 1. Comparison of demographic and clinical characteristics

Variables	Group 1 (n=25)		Group 2 (n=25)		
	Min.-Max.	X± SD	Min.-Max.	X ± SD	P
Age (years)	23-82	50.64±19.20	24-81	56.36±14.19	0.382
Height (m)	1.54-1.80	1.67±7.38	1.48-1.74	1.65 ±5.90	0.340
Weight (kg)	48-89	72.28±10.17	51-87	71.40±9.21	0.627
Body mass index (kg/m^2)	18.68-31.24	25.90±3.21	21.61-30.82	26.11±2.47	0.961
Duration of rehabilitation (month)	3-28	10.56±7.59	3-36	9.36±7.73	0.397
Barthel Index score	75-100	87.40±9.02/100	75-100	87.60±8.30/100	0.992

*Mann-Whitney U test

Analyzing the results of the static balance tests; there was no statistically significant correlation between groups for Single leg stance eyes open and eyes closed test comparisons between groups (Table 2).

Table 2. Comparison of static balance results

Single-leg stance test	Group 1 (n=25)		Group 2 (n=25)		
	Min.-Max.	X ± SD	Min.-Max.	X± SD	P
Eyes open test (sec)	2-21	7.09±4.28	1.46-28.85	9.82±6.68	0.160
Eyes closed test (sec)	0.67-12.56	4.12±3.11	1.06 –7.53	6.93±6.51	0.146

*Mann-Whitney U test

Platform stability was set to 10 PSI on Sport-KAT 550 used to evaluate static balance by standing on two legs. Sport-KAT 550 static balance scores are given in Table 3. There were significant differences in Sport-KAT 550 double- leg standing static balance index scores (p=0.026) and double-leg static balance index left scores (p=0.000). There were no statistically significant differences in double-leg static balance index front, back and right scores (p>0.005) (Table 3).

Dynamic balance test results are compared between groups and statistically significant difference was not found (p> 0.005). The comparison of dynamic balance between the groups is shown in Table 4.

DISCUSSION

This study was conducted in order to determine balance disorders caused by hemiparesis table occurred due to right and left hemisphere lesions and prepare a base for the planning of appropriate treatment program according to the level of affection and create a guiding knowledge base for the relevant health personnel working for this topic.

Although hemispheres are such mirror images of each other, some function of the body are controlled by the right hemisphere and some of them are controlled by the left hemisphere. As a result, different symptoms may occur in patients in any lesion according to affected hemisphere.[22, 23] The appropriate treatment technique should be used by determining the symptoms in this context and the affected function should be focused on.

The results in the study that we have evaluated the balance function after hemiparesis developed due to vascular or non-vascular causes showed that the balance worsened as a result of hemispheric lesions and the balance results were worse in patients with right hemisphere lesion.

Table 3. Comparison of Sport-KAT 550 balance scores

Variables	Group 1 (n=25)			Group 2 (n=25)			
	Min.-Max.	X± SD	Median	Min.-Max.	X± SD	Median	P
Double-leg Standing Static Balance Index score	242.00-2453.00	1083.00±574.64	1041.00	366.00-2539.00	791.44±484.75	637.00	0.026
Right	41.00-1574.00	460.00±373.94	353.00	159.00-1419.00	480.32±274.30	453.00	0.322
Left	76.00-1518.00	626.80±348.80	596.00	18.00-1120.00	309.64±259.62	236.00	0.000
Front	32.00-1639.00	459.28±374.97	350.00	32.00-1639.00	291.72±374.97	234.00	0.053
Back	152.00-1700.00	625.00±415.18	524.00	104.00-1667.00	501.04±340.58	437.00	0.299

*Mann-Whitney U test

Table 4. Comparison of dynamic balance test results

Dynamic Balance Tests	Group 1 (n=25)		Group 2 (n=25)		
	Min.-Max.	X ± SD	Min.-Max.	X± SD	P
TUG Test (sec)	9.62-26.34	17.13±4.65	9.27-29.09	17.73±5.37	0.672**
10 m walk test (sec)	17.28-58.32	30.63±12.53	18.00-59.32	33.98±12.39	0.222*
Sit-to-stand test (repetation/min)	7-23	14.44±4.70	8-21	13.92±3.37	0.655**
Berg Balance Scale scores	37-54	44.44±4.96	38-54	46.24±5.11	0.213*

*Mann-Whitney U test
**Independent-t Test

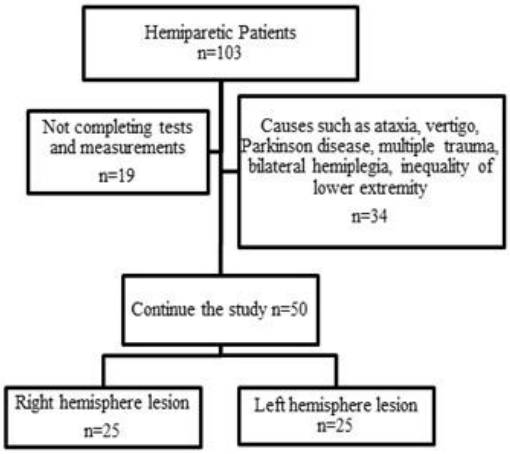
There are some studies in the literature showing that the balance is affected according to the location of lesion.[24-26] It has been observed that the studies on this subject compare mostly the balance performance with healthy control group without separation according to lesion location.[27-29] Balance is adversely affected in patients with hemiplegia and hemiparesis. Sackley *et al.*[30] have reported that weight-bearing symmetry was impaired in hemiparetic patients and 61-80% of the weight that they carried was carried by non-affected lower extremities.

Different clinical and instrumental test methods have been developed assessing post-stroke balance.[8,31,32] Whitney has determined that BDS scores under 36 particularly in the elderly hemiparetic and healthy subjects were associated with higher risk of falling.[33] Sawacha *et al.* have used TUGT, Tinetti Balance Test, BBS to assess the post-stroke affection of balance on 10 hemiparetic patients and on the healthy control group including 10 people. [29] The average of BBS and TUGT results were found to be as 42.9 points and 24.75 sec, respectively. As a result, it was emphasized again that balance was adversely affected in hemiparetic subjects. The tests and results used in our study are in line with the balance measurement methods and results of Sawacha et al.

Walker *et al.* have used Berg Balance Scale and Timed Up and Go test in their study for assessment of balance of stroke patients. They have explained the reasons to choose these tests that they were easily applied for the clinical use.[28] In addition, it has been reported that the reliability of BBS was high for researchers and between researchers in the evaluation of functional standing balance in the elderly and in patients with stroke.[34] Bohannon has stated in his study that the shortening of the time of standing on one leg was an indicator for decreased balance function.[11] According to the results obtained in their study; healthy individuals between 60-69 years of age must be able to stand on one leg with eyes open for at least 5 seconds. Duration of standing on one leg in hemiplegic patients varies depending on the duration of rehabilitation received and lesion localization.[27] According to the results of our study, durations of standing on one leg in patients with left and right hemisphere lesions were found to be 9.82 sec and 7.09 sec, respectively. As a result, duration of

standing on one leg in patients with left hemisphere lesions was found to be better.

Figure 1– Study design and drop-outs



It has been reported in the literature that the force platforms using visual feedback were more objective and gave precise results to assess the balance function in stroke patients.[4,35-37] Nicholssuggests the use of force platforms due to they provide visual feedback in hemiplegic patients and there is a possibility for patients that they can follow the displacement of the center of gravity. It was also noted that force platforms were reliable for the evaluation of static standing balance.[38]

In our study, Sport-KAT 550 was used as an instrument for measuring balance. A statistically significant difference between groups was found in double leg static balance index scores of hemiparetic subjects with left and right hemisphere lesions. In addition, a statistically significant difference between groups in double leg static balance left index scores was found. Although there was no statistically significant difference between the groups in terms of front, back and right scores of double leg static balance scores measurements obtained by using Sport-KAT 550, the balance scores were determined to be worse in patients with right hemisphere lesion.

In conclusion; it has been determined that the balance function of patients with right hemisphere lesions were affected more than patients with left hemisphere lesions.

These results obtained from our study are in line with some studies in the literature. Geiger *et al.* have used Balance Master for balance measurements in 5 hemiplegic patients with left hemisphere lesions and 8 hemiplegic patients with right hemisphere lesions.[24] It has been reported that there was no significant difference between both groups, but balance scores of left hemiplegic patients were affected more due to loss of visual-perception. Similarly, Gok *et al.* have evaluated the balance of 15 hemiplegic (5 right hemisphere, 10 left hemisphere) patients and 15 healthy subjects with Sport-KAT device. The balance of hemiplegic patients was reported to be worse than healthy cases. Significant difference between the results of balance according to the lesion location in hemiplegic patients could not be found. It has been reported that balance function of hemiplegic patients with right hemisphere lesion was actually worse but the difference could not be demonstrated due to lack of sufficient sample size and the numbers of right and left hemiplegic patients were not equal.[26] However Laufer *et al.* have achieved different results in their study. In the study that the balance of 50 hemiparetic patients with 31 left and 19 right hemisphere lesions were evaluated by using Tetrax Portable Posturographic System, the tests were performed in the first and second months after stroke. It has been determined that there was no difference between the individuals with the right and left hemisphere lesions in terms of balance function in both measurements.[25]

The results in the literature and the results obtained from our study indicate that versatile examinations should be done to assess the balance organized by a complex system. In addition, it was demonstrated clearly that the tests used in the clinic were suggestive but not sufficient for balance function, computerized systems should be used for more clear and accurate results. The most powerful aspect of our study is that it is a study including more number of cases than the studies made in this regard in recent years and in addition, it is the only study examining the level of balance disorder.

CONCLUSION

The results of this study suggest that balance ability of hemiparetic patients decreased. Although the duration of entering the rehabilitation program in patients with right hemisphere and left hemisphere lesions and functional independence levels were similar, the balance was showed to be impaired more in patients (with right hemisphere lesion) whose left side was affected more and it has been seen again that there were differences depending on the hemisphere involvement. In this context, to determine the influences in the balance function according to the hemisphere involvement and to plan the appropriate treatment program will prevent the formation of secondary problems such as risk of falling. Further study must be done

to create a larger pool of data about the affection of state of balance function in different hemisphere lesions. Rehabilitation programs should be revised in the light of the data obtained.

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