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Comparison of Balance in Sub-Acute Stroke Patients with Dominant Lobe versus Non-Dominant Lobe Involvement of Age Group 25 to 60 Years Using Balance Evaluation System Test (BESTest): A Pilot Study

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ABSTRACT

Background: Brain is divided into two hemispheres which work together to carry out various functions. However, there are a few functions which are specifically carried out by a particular hemisphere. This is called as 'hemispheric specialization or lateralization'. Stroke affects a particular hemisphere, thus resulting in loss of the common as well as the specialized functions of that hemisphere. Balance issues are the most commonly seen deficits post-stroke. It is thus important to study whether the side of the stroke has any differentiating effect on the balance deficits. Hence, we compared balance in sub-acute stroke patients with dominant versus non-dominant lobe involvement. Also, Balance Evaluation Systems Test (BESTest) was used in the study, which evaluates balance under various sub-components. This will help in formulating a treatment plan targeting the specific components of balance which were seen to be affected with stroke patients of specific lobe involvement.
Methodology: 24 patients suffering from stroke were selected for the study according the to the inclusion criteria. They were further divided into 2 equal groups depending on the side of involvement: dominant lobe stroke group and non-dominant lobe stroke group. BESTest was administered to both the groups. The scores of both the groups were compared.
Result: Statistical analysis was done using Mann Whitney U test. The difference was found to be significant with lower balance scores in patients with non-dominant lobe stroke.
Conclusion: Balance deficits were found to be more common in stroke patients with non-dominant lobe affection than in those with dominant lobe affection.

Keywords: Hemispheric specialization, Stroke, Balance, BESTest (Balance evaluation systems test).

INTRODUCTION

Stroke is one of the leading causes of death and disability in India.[1] Clinically a variety of motor, sensory, cognitive, perceptual, language etc deficits are seen post stroke.[2] Balance issues are commonly seen in patients with stroke. Many studies have shown that balance issues are associated with risk of falls, mobility, independence and recovery of ADLs.[3-5] Hence, balance recovery forms an important goal in stroke rehabilitation.

Balance is the ability of the person to maintain their body's centre of gravity within the base of support.[6] Balance involves a complex interaction of neural and musculoskeletal systems. Musculo-skeletal components include joint range of motion, muscle properties, spinal flexibility and biomechanical relationships among linked

body segments. Neural components involve sensory system, motor system and higher level cognitive and perceptual processes[7].

Both, the cerebral hemispheres work together to carry out various sensory, motor and cognitive functions. However, a few functions are dominantly carried out by only one specific hemisphere. This is called as 'hemispheric specialization'. It is the idea that one hemisphere has specialized function or that it exerts greater control over a particular function. Thus according to research, the non-dominant hemisphere (mostly the right hemisphere) dominates in functions like spatial orientation, visual imagery, attention, emotions, creativity, art, music and manual drawing.[8] Hence, right brain injury commonly causes visuo-spatial impairments, agnosias, unilateral neglect of opposite side, perceptual problems and behavioural issues.[2,8] The dominant hemisphere (commonly the left hemisphere), specializes in speech, language and writing as well as logic and reasoning. Hence, left brain damage commonly manifests with aphasia i.e. speech and language related dysfunctions and apraxias.[6, 28]

Stroke causes damage of one cerebral hemisphere and thus affects various functions according to its specialization. As we had seen earlier, balance control requires integrity of various systems. Cognition and perception are few such aspects which play an important role in balance control[9]. Perceptual deficits found in stroke patients are divided into the following types: body scheme and body image impairments, spatial relation impairments, agnosia and apraxia. The visuo-spatial impairments are commonly seen in non-dominant hemisphere lesions, whereas apraxias are common with dominant hemispheric lesions.[2, 8]

Various previous studies suggest postural imbalance to be more prevalent with damage of the non-dominant lobe.[10-13] However, a few other studies contradict this by suggesting that both dominant and non-dominant stroke patients are equally prone to having balance deficits. Thus, correlation of side of hemispheric damage and balance impairment is still not clear and research needs to be done for the same. Hence, the aim of the study is to assess the affection of balance and compare it in dominant versus non-dominant stroke patients.

This will help the therapist understand whether balance affection will be seen in a stroke patient according to the side of lesion and decide whether to include the balance exercises in the treatment protocol. Balance impairment has several causes.[14] Hence, it is important to know which component of balance is commonly affected with stroke of any of the hemispheres. This will guide the therapist to appropriately train the patient with exercises specific to that component considering the specificity principle. It will help in yielding better results. Hence, BESTest was used to assess balance in the study. BESTest assesses various sub-components of balance, thus helping us find the cause of balance impairment. Also, the prognosis of patient with respect to balance and mobility can be predicted by knowing the affected hemisphere.

MATERIALS AND METHODOLOGY

This was a cross-sectional, observational study done in sub-acute stroke patients of 25 to 65 years of age. The study was conducted in tertiary hospitals and physiotherapy OPD settings. A sample size of 24 was calculated using statistical formula. Purposive sampling was done. Power of the test was set at 90% and confidence interval at 95%.

Inclusion Criteria:

Patients with:

a. Dominant lobe as well as non-dominant lobe stroke.

b. Onset of stroke from 3 months to 12 months.

c. MCA, ACA infarct or combination of both.

d. 25 to 60 years of age.

e. Both males and females.

Exclusion Criteria:

Patients with:

a. Onset of stroke < 3 months or >12 months.[15]

b. Those suffering from any systemic disorders like neurological (other than stroke), cardiorespiratory or musculoskeletal.

c. PCA infarct.

d. Fugl Meyer motor assessment score of lower limb less than 19.[16]

e. Impaired cognition. (MMSE score less than 24).

Procedure:

Ethical clearance was obtained from the institutional ethics committee before the commencement of the study. 74 participants having stroke were considered for the study. They were assessed using Fugl Meyer lower extremity motor components and MMSE. The participants with Fugl Meyer scores 19 or more and those with MMSE scores more than 27 were further included in the study. They were further screened according to the inclusion and exclusion criteria. Accordingly 24 participants were selected for the study. They were divided into 2 groups depending on the side of involvement: dominant lobe stroke and non-dominant lobe stroke, having 12 participants each. BESTest was administered to them with 2 trials taken for each component (best score of the 2 was taken). The total score as well as final score for each of the 6 components of BESTest was calculated.

Statistical Analysis:

The data was entered in MS Excel and analysed using Graph pad instat 3.1. The mean age and Fugl Meyer score of Lower extremity component were matched using Mann Whitney U test. The scores of each component and the total scores of BESTest were compared between both the groups using Mann Whitney U test.

RESULTS

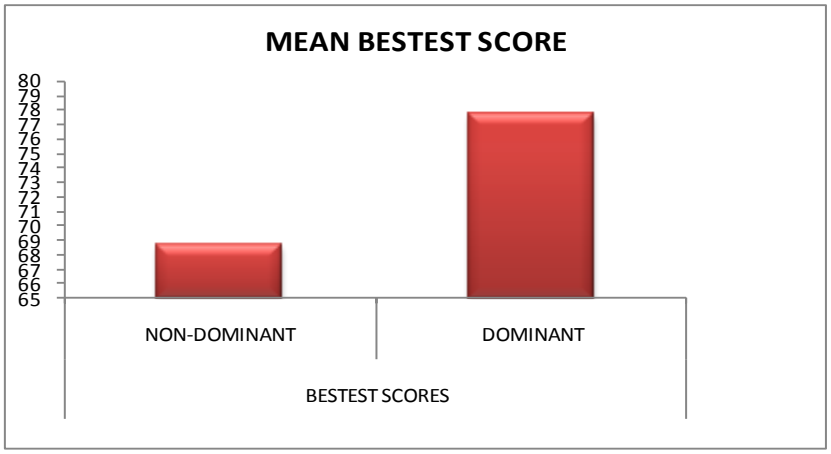
The data was statistically analysed and the results were as follows:

Table 1 shows the comparison of age and Fugl Meyer lower limb scores of both the groups using Mann Whitney U test. It was found to be statistically non-significant with p value 0.33 and 0.27 respectively. Thus, age and Fugl Meyer scores for both the groups were matched.

Table 1: Comparision of age and Fugl Meyer LL score in both the groups.

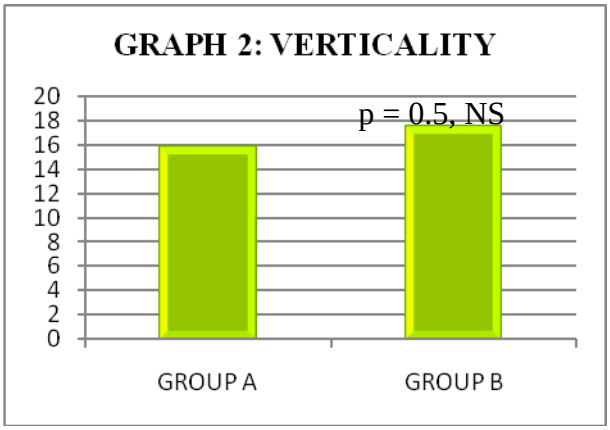
GROUP	AGE MEAN	FUGL MEYER LL SCORE MEAN
NON-DOMINANT STROKE	49	28.25
DOMINANT STROKE	52.75	29.33

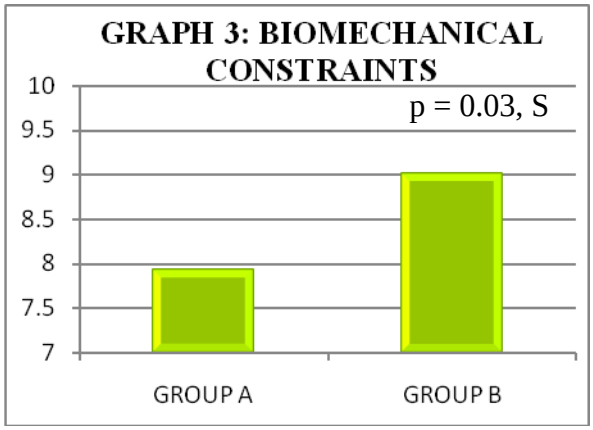
The total BESTest scores were compared between dominant and non-dominant stroke group using Mann Whitney U test. The result was found to be statistically significant with p value 0.02.

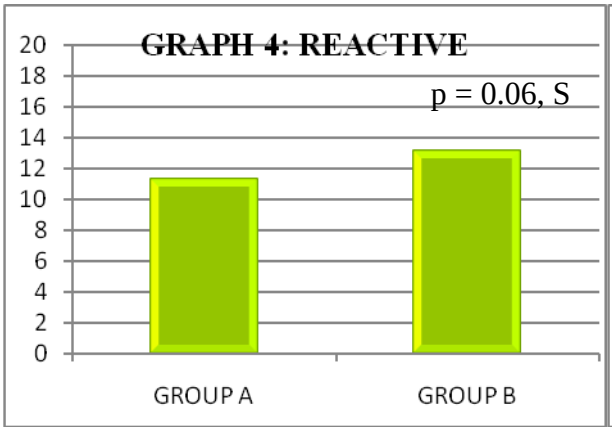


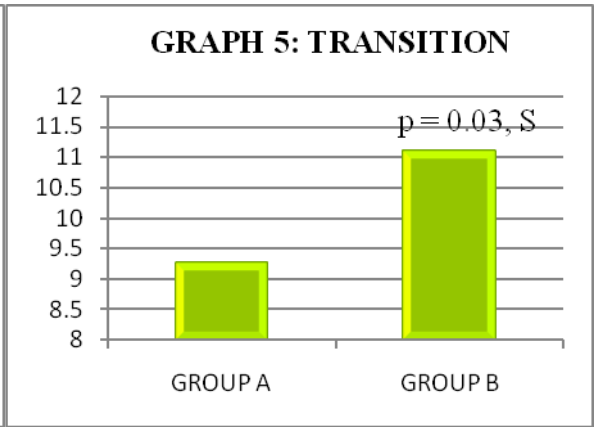
Graph 1: Comparison of mean BESTest scores between both the groups.

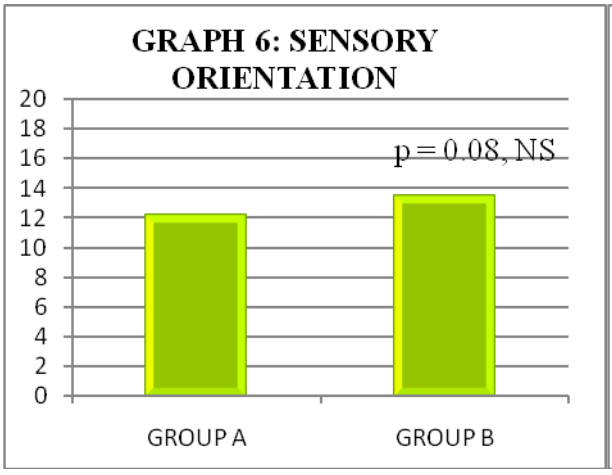
The mean scores of all the 6 components of BESTest were compared between both the groups using Mann Whitney U test. The comparison is seen in graphs 2 to 7. The difference was found to be significant in two components: biomechanical constraints and transition with p value 0.03 for both the components as seen in graph 3 and 5 respectively. The difference was non-significant in other components: verticality, reactive, sensory orientation and stability in gait as seen in graph 2, 4, 6 and 7 respectively.

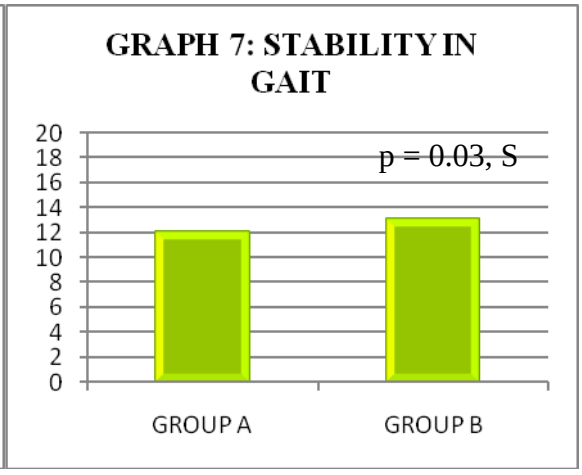












DISCUSSION

According to this study, balance affection was found to be greater in participants with non-dominant lobe stroke compared to the participants with dominant lobe stroke on BESTest. Age-matching was done for both the groups. Both the groups were at same functional/motor level as Fugl

Meyer lower extremity motor scores were matched for both the groups. Thus, the possibility of participants with greater balance deficits being enrolled in a particular group causing bias was being ruled out.

The results of our study are supported by various other researches. A study done by G. Rodes and colleagues concluded that patients with non-dominant lobe affection had more balance deficits.[11] Another study of concluded that damage to the non-dominant hemisphere leads to poorer postural responses in quiet and pertubated body balance.[17] They found that it was because the right cerebral hemisphere plays a more prominent role in efferent process responsible for postural control. Greater COP movements from side to side and front to back were seen in patients with left hemiparesis than right hemiparesis according to a study since, non-dominant hemisphere specializes in the function of visuo-spatial orientation.[18] Another suggested that patients with right hemispheric lesion have lesser ability of weight shifting to non-paretic leg than those with patients of left cortical brain damage.[10] Ekaterina B. et. al. concluded from their study that patients with right hemispheric lesion have less ambulatory ability than those with left lesion.[19] According to this study, greater sensorimotor deficits are seen in patients with lesions of non-dominant hemisphere than in those with dominant hemispheric lesions. Manor B et. al. conducted a study which concluded that subjects with non-dominant hemisphere MCA infarcts are associated with greater balance impairment.[20] Another study conducted by I Hsunan Chen et. al concluded that participants with chronic right MCA stroke exhibit slower and more asymmetrical gait than participants with chronic left MCA infarct.[21] The reasoning for this was said to be distortion of spatial postural representation as well as body's perception of verticality in non-dominant hemisphere

According to various studies quoted above, non-dominant cerebral hemisphere specializes in the function of visuo-spatial and body orientation. It includes problems with body schema and body image.[11,18] Body image is the mental and visual representation of own body that includes feelings related to health and disease about own body by oneself.[7] Body schema is the internal representation of our body, its parts and their relation with each other as well their orientation in space.[7] The sensory inputs from visual, vestibular and somato-sensory systems are collected. The CNS organizes these sensory inputs, compares them with the normal body schema and makes its own judgement according to the previous experiences. Finally a decision is made about the muscles to be recruited and strategy to be used to bring about a correction in body posture and thus maintain balance. Inappropriate perception of body schema changes the normal frame of reference and hence affects the body alignment.[22,23] This further leads to change in centre of mass and base of support of the person causing unequal weight bearing. This asymmetry affects the balance of the person causing impaired postural control. Hence, along with sensory and motor deficits seen in stroke of both the hemispheres, perceptual deficits is an additional factor contributing to balance issues which is specifically seen in non-dominant lobe damage. This additional factor seems to be the probable cause of greater prevalence of balance impairments in participants with non-dominant hemispheric stroke.

BESTest was used to assess and compare balance in the two groups of dominant and non-dominant stroke. This test was especially chosen for the study since it is sub-divided into 6 components: biomechanical constraints, verticality, transitions, sensory orientation, reactive and stability in gait. Thus, along with the intensity of balance impairment, BESTest also throws light on the type of balance impairment and further helps in determining the cause of balance affection[16,17]. Hence,

the scores of each component of the BESTest were individually compared between the two groups. The results showed statistically significant difference only for two components though the total scores showed significant difference (as seen in graph 2 and 5). The two components were biomechanical constraints and transitions.

The items of the component biomechanical constraints were as follows:

1. Base of support (BOS)
2. Centre of mass (COM)
3. Ankle strength and range
4. Hip/ trunk lateral strength
5. Sit on floor and stand up[16,17].

The items of the component transitions were as follows:

1. Sit to stand
2. Rise to toes
3. Stand on one leg
4. Alternate stair touching
5. Standing arm raise.

The sub-tests of these components when observed carefully were found to be assessing the perceptual component of balance to certain extent. The role of perceptual systems in maintaining appropriate postural control is known. Any problems with body schema or inappropriate perception of internal representation of body can cause loss of balance as explained above.[7] The sub-components of biomechanical constraint, can get affected by inappropriate perception of body schema. For example, with the affection of body schema, there is tilting of the body to one side causing asymmetrical weight bearing. Thus, it affects the base of support, centre of mass of the body. BOS and COM alignment are two sub-tests of component of Biomechanical constraints of BESTest. Also, one leg standing and unilateral hip abduction in standing (which also requires one leg standing); both are affected by asymmetrical weight-bearing. It has been found that asymmetrical weight bearing causes imbalance and falls in sit to stand activity. All these are the sub-tests of the two affected components of BESTest. Also, in verticality disorders, pusher syndrome or in unilateral neglect, which are common in non-dominant stroke [2,7,24,13], weight bearing on the affected leg causes imbalance. The items one leg standing, hip abduction in standing and alternate stepping require WB on affected leg which can result in loss of balance hence lowering the scores. Thus, this explains the lower scores in specifically the two components: biomechanical constraint and transition of BESTest.

Clinically, the study inferred that, perceptual deficits also play an important role in causing balance impairment along with sensory and motor deficits. Hence, strategies to cope with perceptual problems need to be incorporated in the balance rehabilitation program along with conventional balance training exercises.

Patients with perceptual disorders were not specifically considered in the inclusion criteria due to time restrains.

CONCLUSION

From this study, it can be concluded that, balance deficits were found to be more common in stroke patients with non-dominant lobe affection than in those with dominant lobe affection. Clinically, the study inferred that, perceptual deficits also play an important role in causing balance impairment along with sensory and motor deficits. Hence, strategies to cope with perceptual problems need to be incorporated in the balance rehabilitation program along with conventional balance training exercises.

Future Scope

- The study can be conducted in participants with acute and chronic stroke.
- A prospective study can be conducted to compare the recovery of balance impairments in both the groups of participants with stroke having dominant lobe and non-dominant lobe involvement respectively.

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