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Original Research Article

Analysis of Sitting Limits of Stability in Stroke Patients

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ABSTRACT

Introduction: The most common presentation of stroke or cerebrovascular disease is hemiparesis. One of the important goals of physical therapy in these patients is to improve balance. Evaluation of balance helps in designing effective treatment strategies. Sitting balance is a prerequisite for functional activities like reaching for an object, however there is limited evidence on sitting balance deficit in chronic stroke patients. Objective of the study was to explore Sitting Limits of Stability in chronic stroke patients.
Methodology: 17 chronic stroke patients were made to sit on an adjustable seat placed on the Force plates and instructed to lean in eight directions to assess sitting Limits of Stability with Neurocom Basic Balance Master.
Results: Total values of sitting limits of stability parameters in all the directions were found to be affected in stroke patients compared to control group. However statistically significant reduction was seen in Maximum Excursion. When different directions were compared, lateral direction, both paretic and non paretic was found to be affected the most in terms of directional control, maximum and end point excursion.
Conclusion: Limits of stability in sitting were found to be affected in chronic stroke patients. Maximum deficit was in the lateral directions, paretic side more affected than non paretic.

Key words: stroke, sitting, limits of stability.

INTRODUCTION

Stroke is a major cause of disability and its incidence is rising rapidly in India. The resulting deficit is variable and can occur due to impairment of sensory, motor, cognitive, perceptual and language function. According to the World's Health Organization (WHO), the cerebrovascular accident (CVA) is considered a syndrome with "rapidly developing clinical signs of focal or global disturbance of cerebral function, with possible vascular origin and lasting more than 24 hours". The most common presentation of CVA is hemiparesis. Rehabilitation of such patients is very important to improve functional independence and overall quality of life. One of the important goals of physical therapy is to improve balance as balance impairments are common in hemiparetic patients.

Since Balance impairment is multifactorial, there are various single item tests or multidimensional scales available to evaluate stability. But force platforms are more sensitive measures than observational scales. [1] Mostly balance in standing and walking has been studied in chronic stroke patients. Balance is the

ability to control the center of mass over the base of support. One way to assess balance is limits of stability. Evidence suggests that stability limit in standing is affected in hemiparesis. [2] However there is limited evidence regarding sitting balance in terms of stability limits of hemiparetic patients.

Limits of stability refer to the greatest distance a person can lean without falling. When we reach for any object in sitting, appropriate weight shifting is required for task completion.

A previous study of the analysis of centre-of-pressure displacements during sitting posture indicated an increased postural disturbance in patients with stroke. The impairment has affected predominantly the displacements occurring along the antero-posterior axis. [3] Posturographic analysis in sub acute stroke concluded that lateral balance was more affected by stroke than balance in the antero-posterior direction, especially during visual deprivation and showed the strongest association with the Berg Balance Scale. [4] Impairment in leaning forward and to the paretic side showed the greatest number of correlations with the FIM scores. [5] Dynamic sitting balance and gait were also correlated. [6] Quantitative analysis of sitting balance with the help of force platform demonstrated that it was affected even in chronic stroke patients. [7,13] Earlier studies have explored standing limits of stability in stroke and balance training with force platform. [8] In standing, weight bearing on the affected leg i.e. motor control of limbs determines the stability limits. But in sitting balance, trunk control appears to be crucial for determining stability limits. Sitting limits of stability has been studied in paraplegics but not in stroke patients. [9]

Trunk control kinetics has been studied by various researchers in stroke patients. Trunk performance in sitting position after stroke has predicted functional ability. [10-12] Trunk is the midline structure that influences the movements of the limbs. Good sitting trunk control is required for the activities using upper extremities like reaching. Since trunk plays a dual role of stability as well as mobility, assessment of deficit in trunk control is essential for planning of physiotherapy management in stroke patients. In the present study, we explored the sitting limits of stability in hemiparetic, chronic stroke patients.

MATERIALS AND METHODS

The participants for the study were selected by convenient sampling method. There were two groups. Group A comprised of 17 subjects diagnosed with stroke having single unilateral lesion who could sit unsupported and were able to understand and follow simple verbal instruction, (scoring at least 24 on Mini Mental Scale) Group B had 17 age and gender matched healthy individuals. Demographic characteristics of both the groups are mentioned in Table no.1 in the Result section. Subjects complaining of neck or back pain were excluded from the study. After taking informed consent, they were assessed on the Neurocom balance master in sitting position. [14] They were made to sit on the adjustable seat on the forced platform of balance master and then assessed for limits of stability. The Limits of Stability quantifies the maximum distance a person can intentionally displace their Center of Gravity (COG) i.e. lean the body in a given direction without losing balance or reaching for assistance. The measured parameters were reaction time, movement velocity, directional control, end point excursion, and maximum excursion. For each of eight trials, the patient maintained their COG centered over the base of support as indicated by a cursor display relative to a center target. On command, the patient moved the cursor as quickly and accurately as possible towards a second target located on the LOS perimeter and

then holds a position as close to the target as possible. One practice trial was given in all the directions prior to the final reading.

Initially the total readings of different parameters of limits of stability were compared between the two groups (Table 2) since the lateral direction was found to be affected maximally, further comparative analysis was done between both paretic and non paretic side of the stroke patients and right and left side of subjects of control group. (Table 3 & Graph 1)

RESULT

Table 1.Demographic characteristics

	Stroke patients(Group A)	Age and gender matched control (Group B)
Number of participants	17	17
Mean Age(years)	61.13 ± 5.01	60.6 ± 3.2
Gender(M/F)	10/7	11/6
Length from onset of stroke(months)	9.06 ± 2.34	-
Affected Side (R/L)	10/7	-

Both the groups were matched for age (P>0.05) and gender.

Table 2: Limits of Stability Parameters

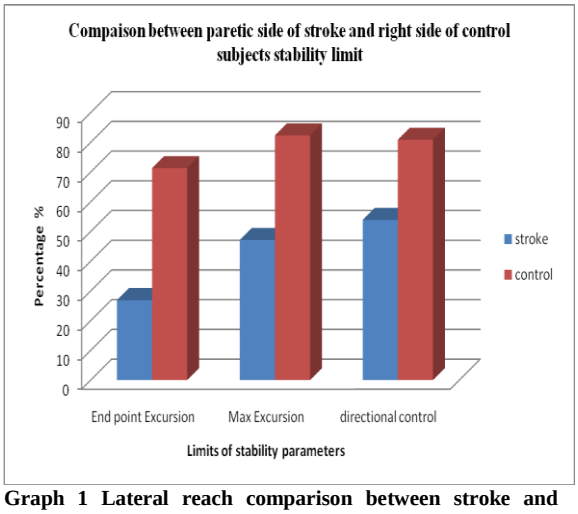
Parameters	Stroke Patients		Control		P Value
	Mean ± SD	CI	Mean ± SD	CI	
Reaction Time (sec)	1.57± 0.59	1.44-1.71	1.49 ±0.6	1.35-1.62	>0.05
Movement velocity(degree/sec)	1.70± 0.95	1.37 – 2	2.24± 1	2.02 – 2.46	>0.05
End point Excursion(%)	54.96 ±23.18	48.63-61.28	70.56 ±26.40	64.64-76.44	>0.05
Maximum Excursion(%)	71.90±25.62	66.15 -77.65	88.61± 19.92	84.17- 93.05	<0.05
Direction Control(%)	70.52±21.92	65.37-75.68	79.41±25.65	73.70-85.13	>0.05

Table 3: Comparison of End Point Excursion, Maximum Excursion and Directional Control in lateral direction (paretic vs non paretic and right vs left) in two groups

Parameters	Stroke Patients Mean±SD			Control Mean±SD		
	Paretic	Non Paretic	P Value	Right	Left	P Value
End point Excursion	26.94± 6.16	38.27±7.11	<0.001	71.35±11	65.2±15.12	>0.05
Maximum Excursion	47.2 ± 10.13	69.25±12.69	<0.001	82.37± 6.39	82.1 ±7	>0.05
Direction Control	53.93±16	64.4±11	<0.05	80.9±7.97	82.45±6.80	>0.05

Total/Average values of all the parameters viz. Movement velocity, End point excursion, Maximum excursion and Directional control in all the directions in stroke patients were less compared to control group and Reaction time was more in stroke patients. But only maximum excursion was statistically significantly less in stroke patients compared to control group using unpaired t test.

ANOVA was used to compare the above parameters between stroke and control groups. Within the group A Paretic side was significantly less than Non Paretic side (P<0.01) and there was no significant difference between right and left lateral limits of stability in group B (P>0.05) When compared with control group, both Paretic and Non Paretic side were significantly less in the parameters, End point Excursion, Maximum Excursion and Direction Control. (P<0.001)



Graph 1 Lateral reach comparison between stroke and control

DISCUSSION

We compared sitting limits of stability between hemiparetic patients and age-gender matched control group. The mean age of stroke patients was 61.13 ± 5.01and the mean age of the control group

was 60.6 ± 3.2 and when compared the difference was statistically insignificant with P=0.42(>0.05). Amongst 17 patients with CVA, 10 were males and 7 were females. Control group had 11 males and 6 females. The participants were chronic stroke patients whose mean Functional Independence Measure score was 100.

In the present study, limits of stability on Neurocom balance master in sitting were compared patients and control groups. Limits of stability test provides five sets of information i.e. reaction time, movement velocity, directional control, maximum excursion and end point excursion as a person shifts his/her centre of pressure from the centre towards the visual targets displayed on the screen. In our study we compared the parameters between both the groups.

Reaction time is the time in seconds between the command to move and the patient's first movement. We found average reaction time of hemiparetic patients on balance master more than the control group in sitting. But statistically it was not significant. The deficit may be more prominent in acute stage and improves with rehabilitation.

Other parameters of limits of stability were found to be affected(less) in stroke patients viz. average values of Movement velocity, End point excursion, Maximum excursion and Directional control when compared with control. But only maximum excursion was significantly less in stroke patients. Movement Velocity (MVL) is the average speed of COG movement in degrees per second. Endpoint Excursion (EPE) is the distance of the first movement toward the designated target, expressed as a percentage of maximum LOS distance. The endpoint is considered to be the point at which the initial movement toward the target ceases. Maximum Excursion (MXE) is the maximum distance achieved during the trial. Directional Control (DCL) is a comparison of the amount of movement in the intended direction (towards the target) to the amount of extraneous movement (away from the target).

Limits of stability were assessed in 8 different directions. In our analysis, when the mean values of the different directions were compared, reaction time and movement velocity was found to be affected in all the directions. But the maximum difference in other three parameters like End point excursion, Maximum excursion and Directional control was found in lateral direction on both paretic as well as non paretic side. The paretic side was statistically significantly more affected than non paretic side. There was no difference between right and left direction of limits of stability in age-gender matched control group. Lateral limit on both paretic and non paretic side in stroke patients is statistically significantly less when compared to control group.

Patricia Davies states that balance reactions in sitting are affected in stroke patients due to loss of selective trunk control. There could be problems in head righting, inappropriate trunk response and unstable pelvic control while moving the trunk in sitting. Most of the abdominal muscles have a common insertion at the central aponeurosis. So even if one side is affected in stroke, trunk deficit can be seen on both, affected as well as unaffected sides as each side is dependent on the other. [15] There are musculoskeletal impairments like postural malalignment, stiffness, loss of dissociation and problem in motor adaptability at the trunk. Perceptual problems can add to the deficit. [16] Previous Evidence also suggests that lateral balance is more affected in stroke. Kinetic study of abdominals showed reduced activity level, delayed onset and reduced synchronization between muscle pairs. [17] Trunk muscle strength was found to be reduced multidirectionally compared to control and mean lateral flexion force

was significantly less on paretic side compared to non paretic side. [18]

Stability limits in sitting are the boundaries of space in which the patient maintains balance without changing the base of support. If the stability limits in sitting are less, patient will not attempt more demanding tasks and will require assistance in functional activities like bathing, lower extremity dressing and picking up object from floor. Earlier evidence has also suggested that quantitative analysis of sitting limits of stability is a good way to assess sitting stability. [19] Thus accordingly specific treatment strategies to improve the various parameters of stability limits need to be considered in stroke patients.

CONCLUSION

Limits of stability in sitting were found to be affected in chronic stroke patients. Average values of Reaction time Movement velocity, End point excursion and Directional control were affected in stroke patients but not statistically significantly different compared to control. However the average values of Maximum excursion were significantly less in stroke patients when compared with age and gender matched control subjects. Maximum deficit was found to be in the lateral directions, paretic side more affected than non paretic in terms of Maximum excursion, Endpoint excursion and Directional control.

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