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Original Article

EFFECT OF COMPELLED BODY WEIGHT SHIFT THERAPY ON WEIGHT BEARING SYMMETRY AND BALANCE IN POST STROKE PATIENTS: AN EXPERIMENTAL PRE-POST STUDY

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ABSTRACT

Introduction: Stroke related hemiparesis also exhibit asymmetry in standing posture and walking. Chronic stroke survivors represent with asymmetric gait pattern due to altered weight distribution. Altered weight distribution of lower limbs that is less weight is taken on affected side, fewer excursions on the weaker side, is seen during static and dynamic balance as well as external perturbation.
Objective: To evaluate the effect of Compelled Body Weight Shift Therapy on weight bearing symmetry and balance in post stroke patients.
Methods: Total 22 participants were included in the study. All patients received 10mm shoe insole which is to be used on their unaffected side and along with this conventional rehabilitation program were given for 1 hour per day for 2 weeks.
Results: There was significant difference in pre-post weight bearing distribution ($p<0.001$) and balance ($p<0.001$). There was also significant difference in all the component of Berg Balance Scale ($p<0.001$).
Conclusion: Compelled Body Weight Shift Therapy can be easily administrated in the daily rehabilitation protocol, while treating stroke patients with balance problems due to asymmetrical weight bearing. With more symmetrical weight bearing, balance can be improved for better ambulation and reduced risk of falls.
KEYWORDS: Compelled Body Weight Shift Therapy; stroke; weight bearing symmetry; balance; Berg Balance Scale.

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INTRODUCTION

Stroke is a global health problem[1] and major cause of death and disability in adults worldwide.[2] It is a leading cause of impairment with 20% of survivors who require institutional care after 3 months and 15% - 30% being permanently disabled.[3] The lower limb weakness comprises of 48.6% of the common impairments seen in stroke survivors.[4] Although rehabilitation is given to reduce the level of disability with the standard rehabilitation protocol, approximately 50% - 60% of survivors experience some degree of motor impairment and approximately 50% are more or less partially dependent in their activities of daily living.[5] Disturbance in balance after stroke is a major problem which increases the level of dependency for activities of daily living and increases the risk of fall.[6] Out of 75% of stroke survivors who initially lost the ability to walk, only half survivors regain their walking independence.[7] Impairment in balance after stroke exist more while reacting to destabilizing external force and during self initiating movement. Stroke related hemiparesis also exhibit asymmetry in standing posture and walking.[8-10] This may be due to motor weakness[11], asymmetric muscular tone[12,13] and somatosensory[11] deficits in lower extremities which leads to balance impairment, postural sway,[12] disordered gait and increased probability of falls.[14] About 55.5% of chronic stroke survivors represent with asymmetric gait pattern due to altered weight distribution.[15] Altered weight distribution of lower limbs that is less weight is taken on affected side, less excursion on the weaker side, is seen during static, dynamic and external perturbation.[6] Delay in onset of motor activity, abnormal timing, abnormal sequencing of muscle activity, impaired proprioception, visuospatial deficits, prolonged weakness and abnormal cocontraction results in disorganization of postural strategies which triggers learned disuse mechanism.[9] Compelled Body Weight Shift Therapy involves prolonged lift of the unaffected lower extremity through the use of shoe insert which forces loading of body weight towards the affected lower extremity during treatment and daily activities, thus helping in overcoming learned disuse of affected lower limb.[16] Aruin et al studied the immediate effect of shoe lifts on static balance and weight bearing symmetry, ranging from 0.6 to1.2 cm with more symmetrical weight distribution with increase in the size of lifts.[17] The present study aims to evaluate the effect of Compelled Body Weight Shift Therapy on weight bearing symmetry and balance in post stroke patients and also to find the effect of Compelled Body Weight Shift Therapy in each component of Berg Balance Scale.

METHODOLOGY

This study was based on an experimental pre-post design. Twenty two stroke patients were recruited from Tertiary Health Care Centre located in Belgaum, India. One Research assistant screened participants using the following inclusion criteria: subacute and chronic patients with first time stroke, both male and female within the age of group of 30-70 years, able to ambulate at least 50 feet with or without assistive device, minimum score of 30/56 on Berg Balance Scale, at least 2/3 on upright motor control test, ability to understand and follow instruction. Patients were excluded if unstable medical conditions, history of other neurological diseases and fixed contracture or deformities were observed. All the patients were enrolled by assistant researcher, coordinated by the principal investigators signed a written informed consent form after receiving a detailed explanation of the study (figure 1). All the procedure was approved by the KIPT Institutional Ethics Committee on Human Research and conducted in conformity with ethical and humane principles of research.

Fig. 1: Demographic data of the study.

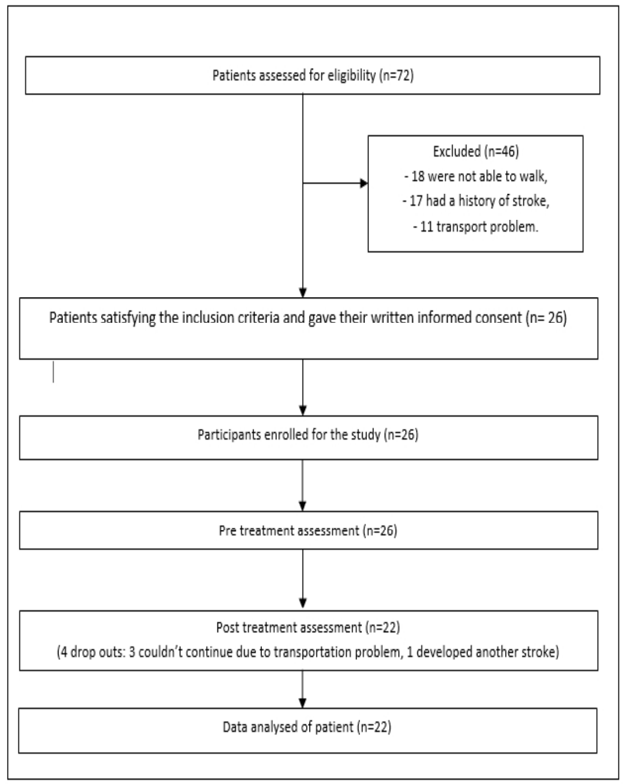

Fig. 2: 10 mm insole inserted in unaffected leg footwear.

Interventional programme: The interventional programme was given one to one basis. All the patients received Compelled Body Weight Shift Therapy where patients were asked to insert an insole of 10mm made up of vinly ethelene acetate in their unaffected lower limb footwear throughout the day (figure 2). The insole was given tailored made as per size of the patient feet. Along with this, conventional therapy was given which included strengthening of hip extensors, abductors and adductors, knee flexors and extensors and ankle dorsiflexors using weights, wall squats, bed mobility exercises like bridging, quadruped, and kneeling, wobble board, gait training using parallel bars, weight shift exercises like leg raise, one leg stand with support and later with minimal or no support, marching at a place and stair climbing.[18] All patients performed the above exercise with their footwear on and were asked to wear the footwear throughout the day for all the activities. Sufficient amount of rest period was given between the exercises. Duration of the therapy was 1 hour per day for 6 days per week for two weeks. Balance was assessed using Berg Balance Scale and weight bearing symmetry using two weighing scales before starting with the intervention.

Outcome measures: The patients were assessed before and after the intervention period. The principal investigator and assistant were in charge to perform the assessment test. The Berg Balance Scale[19] includes grading of patient's different balance abilities, monitors functional balance over time and evaluates patient's responses to treatment. It is a test of 14 items; the first 5 are basic balance items while the last 9 are considered as advanced balance tasks and has a scale of 0-4 for each item (higher score for independent performance) with a maximum score of 56 where potential risk of all is estimated on the basis of total scores; (0 –20) high, (21-40) medium and (41-56) low fall risk. Weight bearing was measured using weighing scale[20]. Patients were ask to stand straight on the platform of 2 weighing scales, placed side by side, one leg on each of the scale. Weight measurement was recorded and converted into percentage in terms of percent weight distribution of both affected and non affected leg.

Statistics Analysis: The statistical analysis was performed using SPSS version 21.0 software. Mean and standard deviation were calculated for age, gender, Body Mass Index and side affected for independent variables. The outcome measures of Berg Balance Scale (BBS) and Weight Bearing Symmetry, paired't' test was used with p value less than 0.05 ($p<0.05$) as statistical significance.

RESULTS

Table1 show the demographics variables of the study that is the mean age of the participants was 53.9 ± 12.45 years with Body Mass Index 26.75 ± 4.00 kg/m^2. In the present study there were 22 patients out of whom, 14 (63.63%) were males and 8 (36.36%) were female and in term of side affected, 17 subjects (77.27%) had right side affected whereas 5 subjects (22.73%) had left side affected. Table2 shows changes in weight distribution on affected leg, the mean pre test value 40.96% ± 3.94%, post test value was 48.31% ± 1.15% and the difference in weight distribution on affected leg pre-post values 7.35% ± 3.47% . There was a significance difference in pre post values in terms of weight difference on affected leg ($p< 0.001$). Whereas on the unaffected leg there was a reduction in weight distribution on unaffected; the mean pre test value was 59.03% ± 3.94%, post test values were 51.64 % ± 1.18% and difference in weight distribution on affected leg pre-post values 7.39 % ± 3.44%. There was a significance difference in pre and post values in terms of weight distribution on unaffected leg ($p< 0.001$). There was a symmetry seen between both the legs in terms of difference in weight distribution; the mean pre test value was 18.08% ± 7.88%, post test values were 3.32% ± 2.35% and difference in weight distribution on affected leg pre-post values 14.74 % ± 6.88%. There was a significance difference in pre and post values in terms of weight distribution between both the legs ($p< 0.001$). Table3 shows the changes in the total Berg Balance Scale, the mean pre test value was 32.04 ± 2.17 and the post test value was 50.31 ± 1.96. The difference in scores between pre and post values was 18.27 ± 2.64. There was a significance difference in pre post values of

Berg Balance scores ($p < 0.001$). Table4 shows changes in component wise of Berg Balance Scale where there was significant difference in all the 14 components of Berg Balance Scale ($p<0.001$).

Table1: Demographic data of the subjects.

Gender (%)		Age (years)
Female (%)	8 (36.36%)	58.2 ± 12.93
Male (%)	14 (63.63%)	51.4 ±11.93
Total (%)	22 (100%)	53.9 ± 12.45
Body Mass Index (kg/m^2)	26.75 ± 4.00	
Right side affected (%)	5 (22.7%)	
Left side affected (%)	17 (77.3%)	

Table 2: Pre-post intervention vales of Weight bearing symmetry.

Weight Bearing Symmetry(%)	Pre	Post	Difference	paired t	p value
Affected leg (%)	40.96 ± 3.94	48.31 ± 1.15	7.35 ± 3.47	9.034	<0.001*
Unaffected leg (%)	59.03 ± 3.94	51.64 ± 1.18	7.39 ± 3.44	10.053	<0.001*
Difference in weight distribution (%)	18.08 ± 7.88	3.32 ± 2.35	14.74 ± 6.88	10.053	<0.001*

Table 3: Pre-post intervention values of Berg Balance Scale.

Berg Balance Score (BBS)	
Pre	32.04 ± 2.17
Post	50.31 ± 1.96
Difference	18.27 ± 2.64
Paired t value	32.464
p value	<0.001*

Table 4: Pre-post intervention values of components of Berg Balance Scale.

COMPONENTS	Pre	Post	Difference	paired t	p valve
1. Sitting to standing	2.59 ± 0.50	3.95 ± 0.21	1.36 ± 0.49	12.99	<0.001*
2. Standing unsupported	2.95 ± 0.5	4 ± 0	1.04 ± 0.5	8.521	<0.001*
3. Sitting with back unsupported but feet supported on floor or on a stool	3.54 ± 0.51	4 ± 0	0.45 ± 0.51	4.183	<0.001*
4. Standing to sitting	1.95 ± 0.57	3.91 ± 0.29	1.95 ± 0.57	15.931	<0.001*
5. Transfers	2.22 ± 0.42	3.63 ± 0.49	1.41 ± 0.50	13.133	<0.001*
6. Standing unsupported with eyes closed	2.86 ± 0.56	3.86 ± 0.35	1 ± 0.43	10.747	<0.001*
7. Standing unsupported with feet together	2.31 ± 0.47	3.72 ± 0.46	1.41 ± 0.50	13.133	<0.001*
8. Reaching forward with outstretched arm while standing	2.04 ± 0.21	3.36 ± 0.49	1.32 ± 0.56	10.887	<0.001*
9. Pick up object from the floor from a standing position	1.90 ± 0.42	3.50 ± 0.51	1.6 ± 0.73	10.164	<0.001*
10. Turning to look behind over left and right shoulders while standing	2.09 ± 0.29	3.59 ± 0.50	1.5 ± 0.51	13.748	<0.001*
11. Turn 360 degrees	2 ± 0	2.95 ± 0.57	0.95 ± 0.57	7.75	<0.001*
12. Placing alternate foot on step or stool while standing unsupported	2 ± 0	3.27 ± 0.45	1.27 ± 0.45	13.096	<0.001*
13. Standing unsupported one foot in front	2 ± 0.31	3.31 ± 0.47	1.31 ± 0.47	12.969	<0.001*
14. Standing on one leg	1.54 ± 0.51	3.22 ± 0.43	1.68 ± 0.47	16.547	<0.001*

DISCUSSION

In the present study, all the subjects who were included had asymmetry weight bearing in their lower limb. This finding was similar with Hendrickson J. et al[21] who stated that unequal weight distribution while standing and walking is seen in post stroke survivors. The significant improvement in term of weight bearing symmetry on affected leg could be because of the lift of insole on the unaffected side cause changes in biomechanical alignment of the body that is a shift of body weight from sound leg to paretic leg, which ultimately resulted in equal transfer of body weight to both the lower limbs. Also there is an increase in the proprioceptive stimuli of all the joints of the paretic leg causing increased stability to the joints which in turn causing increased in weight bearing on the affected limb. This symmetrical weight bearing along with exercise may have caused increase use of affected leg into functional activities which could have also increased the weight bearing on affected leg. Similar results were obtained in a study done by A. Aruin et al[17] who had stated that an immediate effect of lift on unaffected leg, brings out equal weight distribution in the both the lower limbs in hemiparesis individuals.

In the present study, there is a significant improvement in Berg Balance Scores in post Compelled Body Weight Shift Therapy is effective to cause improvement in balance. The use of insole leads to shifts of line of gravity from unaffected leg to centre causing reduction in muscle imbalance at all the joints and also equal weight bearing in the both limbs which increases proprioceptive stimuli at all the joints leading to stability of joints. Studies have shown that hemiparetic individuals have reduced proprioception in their affected side ankle joint[6,22-24] Mulder and Hochstenbach stated that no control, learning, change, hence no improvement can exist without sensory input.[25] Van peppan et al demonstrated that proprioceptive stimulation can influence postural control and ambulation.[26] Along with insole, exercises were administered which could have improved the strength and normal co-contraction of lower limb, resulting in improvement in balance in stroke patients. Functional tasks like sit to stand using varied height of chair, stair climbing and descending, crossing over obstacles etc requires great amount of co-ordination and muscle strength. By intense practice of these tasks could have resulted in symmetry in weight bearing causing improved proprioception to the joints and more functional used of affected limb which resulted in improved muscle strength, motor co-ordination and sensory organization without or reduced use of compensatory strategies like holding objects or wall etc thereby causing normal biomechanical adjustments of joints which must have results an improvement in balance in post stroke patients. The increased proprioceptive stimuli by the mean of insole on the affected leg, which may have caused increased in central nervous system activation at both cortical as well as spinal level, and could have led to effective brain reorganization, enhancing motor relearning in these patients.

During the analysis of the components of Berg Balance Scale pre and post intervention, a significant improvement in every component was noted. The overall improvement in the strength of muscles of lower limbs and the various components of conventional therapy could have improved every component of Berg Balance Scale. Hence, there was no masking of one component over the other in terms of overall improvement in balance.

The future scope of the present study is to conduct a randomized controlled trial with long term follow-up, in order to determine the sustenance of the improvement brought about by the insertion of the insole in the unaffected leg footwear.

Clinical message: The weight bearing symmetry and balance was improved after inserting a 10 mm insole in the unaffected leg footwear along with the conventional rehabilitation protocol in subacute and chronic ambulatory stroke patients.

A stroke rehabilitation program, which includes the use of an insole on the unaffected lower limb, improves weight bearing symmetry and balance

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