Research Paper

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Effect of Modified Constraint Induced Movement Therapy (mCIMT) for lower limb on Weight Bearing Symmetry and Balance in Stroke Patients: a Pre-Post Experimental Study.

Medical Science

KEYWORDS : Modified Constraint Induced Movement Therapy; Stroke; Weight bearing symmetry; Balance.

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ABSTRACT

Background and Purpose: Falls are highly prevalent and it is a one of the complications in post stroke patients. One of the reasons for impaired balance and high risk of falls is asymmetry weight bearing between both the legs, so this study intends to find the effect of Modified Constraint Induced Movement Therapy of lower limb on weight bearing symmetry and balance in post stroke patients. Methodology: Total 22 participants were included in the study. All patients received Modified Constraint Induced Movement Therapy. Intervention was given for 1 hour a day for 6 days a week for 2 weeks. Outcome Measure: Weight bearing symmetry and balance was assessed using two weighing scales and Berg Balance Scale. 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: Modified Constraint Induced Movement can be easily administrated for treating stroke patients with balance problems due to asymmetrical weight bearing.

Introduction:

Stroke is a global health problem[1] and major cause of death and disability in adults worldwide.[2] In India, stroke contributed 41% of the deaths and 72% of Disability Adjusted Life Years amongst the non-communicable diseases.[3] 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.[4] Out of 75% of stroke survivors who initially lost the ability to walk, only half survivors regain their walking independence.[5] Impairment in balance after stroke exist more while reacting to destabilizing external force and during self initiating movement. Stroke related hemiparesis exhibit asymmetry in standing posture and walking,6-8 due to motor weakness[9], asymmetric muscular tone[10,11] and somatosensory[9] deficits in lower extremities which leads to balance impairment, postural sway,[10] disordered gait and increased probability of falls.[12] About 55.5% of chronic stroke survivors represent with asymmetric gait pattern due to altered weight distribution.[13] Altered weight distribution of lower limbs that is less weight is taken on affected side, less excursion on the weaker side, seen during static, dynamic and external perturbation.[4] Delay in onset of motor activity, abnormal timing, abnormal sequencing of muscle activity, impaired proprioception, visuospatial deficits, prolonged weakness and abnormal co-contraction results in disorganization of postural strategies which triggers learned disuse mechanism.[7] Constraint Induced Movement Therapy is an intervention which involves constraint of unaffected extremity, intensive mass practice by affected extremity and change in behavioural approach termed as shaping termed as 'shaping' for 90 percent of waking hours a day for two weeks. Modified Constraint Induced Movement Therapy approach targets motor recovery by giving functional task from the affected side for 3- 4 hours a day for two weeks limiting the use of the unaffected limb and promoting normal coordinated movement by functional use and reducing compensatory strategies through intensive massed practice activities of affected extremity.[14,15] Hence the purpose of this study was to find the effect of Modified Constraint Induced Movement Therapy of lower limb on weight bearing symmetry and balance in post stroke patients.

Methodology:

Primary data was collected from tertiary health care centre. The sample size was [22]. All participants received Modified Constraint Induced Movement Therapy who met the inclusion criteria: both male and female with subacute or chronic medically stable stroke patients with first time stroke, age group of 30-70years, ability to stand and maintain balance with minimal assistance, able to ambulate atleast 50 feet with or without assistive device. Minimum score of 30/56 on berg balance scale, 2/3 on upright motor control test and ability to understand and follow instruction. The exclusion criteria were unstable medical conditions, history of other neurological disease like parkinsonism, fixed contracture (figure1). Subjects were recruited in the study after the approval of Institutional Ethical Committee Review Board.

Intervention programme:

Modified Constraint Induced Movement Therapy was focused on functional activities such as sitting on a table and reach outs, sit to stand, stepping forward, backward and sideward, step up-step down, lifting objects from floor in varied base of support in standing, forward walking, backward walking, sideways walking and walking over obstacles, stair climbing, catching and kicking tasks, sit to stand using stepper and varied height chairs, Get Up and Go: get up from the chair, walk a short distance and return to chair and sit.[16] Sufficient amount of rest period was given between the exercises for both the groups. Duration of treatment was 1 hour per day for 6 days per week for two weeks. The outcome measure used was percentile weight bearing symmetry and Balance was assessed using two weighting scales[17] and Berg Balance Scale[18].



a) Clearing obstacles b) climbing and descending stairs.

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 ($p<0.001$).

Discussion:

The results of the present study suggested improvement in weight bearing symmetry and balance by Modified Constraint Induced Movement Therapy in subacute and chronic stroke patients.

In the present study, all the subjects who were included in the study had asymmetry weight bearing in their lower limb. This finding was similar with Hendrickson J. et al [19] who stated that unequal weight distribution while standing and walking is seen in post stroke survivors. Improvement could be because of the functional use of the unaffected side causing 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 weight transfer required to accomplish particular task.

Traditionally, Modified Constraint Induced Movement Therapy comprised of constraining the unaffected side and restraining the affected side (shaping) with intensive mass practice. In this study, no constraining of unaffected lower limb was done as functional activities like ambulation requires both the lower limbs and constraining of non paretic leg will increase the risk of fall. A study done by Bonnyaud C. et al had used weight cuff as a constraint on non paretic ankle with gait training for thirty minutes and found no improvement in gait parameters in hemiparetic patients.[20-22] A study done by Edward Taub et al stated that intensive therapy is one of the main components of Constraint Induced Movement Therapy to bring out improvement in affected side upper limb of stroke survivors.[23,24] In the present study, intense mass practice was used for lower limb and showed significant improvement in participants who received Modified Constraint Induced Movement Therapy in terms of weight bearing symmetry. Intense mass practice which is a repeated training of affected leg for all functional tasks would have lead to change in a behavioural approach towards the task. The functional tasks like stair climbing and descending in a reciprocal manner, instead of step together manner would have increased the demand on affected leg thereby increasing weight bearing on affected leg. Catherine M. D. et al [16] found similar results on intense task related circuit training with the use of stair climbing and gait training showing improvement on lower limb functional performance, weight bearing symmetry and gait parameters. In order to gain functional mobility there should be equal weight bearing in different postures and direction which is lacking in stroke patients. This therapy causes reduction in compensatory approach to the task and encourages symmetrical pattern of approach, resulting in increase force generating capacity and strength of affected limb with increase loading on affected leg thereby causing reduction in weight bearing of unaffected leg and bring out an equal weight distribution in both the lower limbs.

Intensive mass practice in Modified Constraint Induced Movement Therapy engages the individual extensively on repetitions of functional task, and enhancement of skilful performance of those tasks. As the task were functional based, these activities would have been a part of patients activities of daily living and repeated practice of these functional activities in a symmetrical manner would have helped individuals to overcome learned disuse. The repetition of tasks could have stimulated specific neural pathways to bring about a cortical reorganization in order to increase motor output which was correlated in a study, by measuring a functional MRI that had a positive correlation with degree of increase in arm use and its ability.[25] Neural plasticity can be assumed for the improvement in weight bearing symmetry and functional use of affected leg which help them to overcome learned disuse of paretic lower limb as evident in a study done by Numata K et al.[26]

There was no significant difference in pre intervention values of Berg Balance scores all participants suggesting of similar amount of balance deficit. Impaired balance after stroke increases the Activities of Daily Living (ADL) dependency and the risk of falls in stroke survivors.[4] Studies have also shown weight bearing asymmetry leads to impaired balance in post stroke survivors[19]. Studies have shown that 70% of somatosensory system information are required for normal postural control.[20-27,33-39]And studies have also proven that hemiparetic patient mostly rely on visual input as an compensatory response in order to attain their postural control.[28-30,33] The repeated use of affected leg in intense manner for functional task which could have 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. Studies have shown hemiparetic individuals have reduced proprioception in their affected side ankle joint.[4,33-35] The forced used of both the legs in symmetrical manner which could have resulted in increased proprioceptive stimuli to all the joints of the paretic leg causing increased stability to the joints. This in turn could have increased the weight bearing on the affected limb causing a reduction in the weight bearing of the unaffected leg thereby improved balance score post assessment. Studies have shown positive correlation between balance and decreased lower limb strength.[4,30,31,33-35] intensive practice administered could have resulted in improved the strength and normal co-contraction of lower limb resulting in improvement in balance in stoke patients.

During the analysis of the components of Berg Balance Scale pre and post intervention, a significant improvement in every component was noted. The emphasisment on symmetrical weight bearing while performing all task may have caused increase use of affected leg into functional activities which could have bought overall improvement in the strength of muscles of lower limbs and the various components of functional task were part of the Berg Balance Scale 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 limitation of the study was, a particular type of stroke was not considered in the study all patients met the inclusion criteria were included and effect obtained from the study cannot be generalized because of small sample size. As present study had intervention of two weeks, In future long term follow up with large sample size can be considered. And scales to measure risk of falls and functional scales can be considered to find the improvement in the functional use of the affected leg and quantify its effect on Activities of Daily Living in subacute and chronic stroke patients.

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Conclusion:
Modified Constraint Induced Movement Therapy has showed more statistically significant improvement in terms of weight bearing symmetry and balance and component wise Berg Balance Scale. Hence this therapy can be considered to be included in the 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.

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Table 1: Demographic data of the study

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*

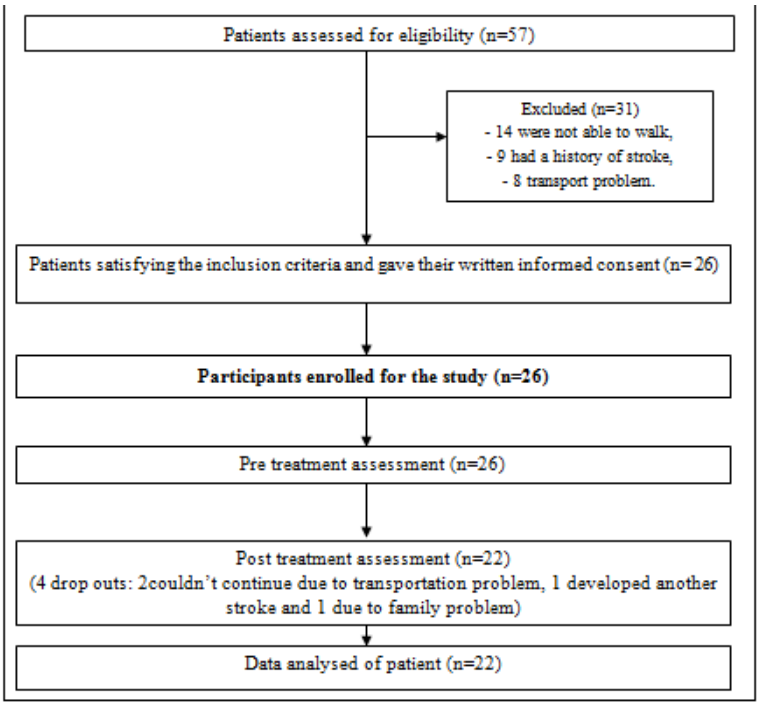
Table 3: Pre-post intervention values of Berg Balance Scale

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*

Table 1: Demographic data of the study
Figure1: Flow chart of the study



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