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Original Research Article

Effects of Unilateral Vs Bilateral Lower Limb Strengthening Exercise on Stroke: A Comparative Study

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ABSTRACT

Background: The purpose of the study was to compare the effect of unilateral and bilateral lower limb strengthening exercise on balance in stroke.
Methods: Twenty two first onset of unilateral ischemic Middle Cerebral Artery (MCA) territory stroke patients were randomly allocated into two groups the unilateral lower limb training group (n=11) received strengthening exercises only in paretic limbs and the bilateral lower limb training group (n=11) received strengthening exercise in paretic and non paretic limbs. Intervention was given once in a day, 6 session /week for two weeks. The balance was analyzed using Berg Balance Scale (BBS).
Result: In both the groups, the lower limb strengthening exercise for balance significantly improved in Berg balance scale. Compared with the unilateral lower limb training group; the bilateral lower limb training group attained very statistically significant improvement.
Conclusion: Bilateral therapy using this lower limb strengthening exercises effectively promotes balance early in stroke patients.

Key words: Unilateral, Bilateral, MCA Territory, Ischemic Stroke, Paretic, Non Paretic, Berg Balance Scale.

INTRODUCTION

Stroke was defined by the World Health Organization (WHO) more than 40 years ago as "rapidly developing clinical signs of focal (or global) disturbance of cerebral function, lasting more than 24 hours or leading to death, with no apparent cause other than that of vascular origin". [1] Physiological changes followed by stroke include decreases in motor units, impaired motor unit recruitment, selective atrophy of type II muscle fibers, denervation potential, and decreased maximal contractions, all of which can cause muscle weakness. [2] Further, symmetrical bilateral movements are known to activate similar neural distributed networks in both hemispheres. Specific activated areas include the supplementary motor area, sensorimotor cortex, cingulate motor cortex, lateral pre-motor cortex, superior parietal cortex, and cerebellum. [2,4] Performing symmetric bilateral movement tasks, both the left and the right cerebral hemispheres are activated, reducing inhibition between the hemispheres and thereby promoting recovery of the paretic limb. [5] The use of bilateral arm training in stroke rehabilitation is based on the assumption that symmetrical bilateral movements activate similar neural

networks in both hemispheres, promoting neural plasticity and cortical repair that result in improved motor control in the affected limb. [5] The interlimb neural coupling between all four limbs appears in the form of unusual motor behavior. In post-stroke hemiparesis, the neural decoupling between the lower limbs perturbs the paretic lower limb function and strong interlimb coupling in bifunctional muscles impaired rhythmical bilateral coordination of the affected limb. [7] Bilateral training began more than a decade ago, comprises of symmetrical or alternating patterns of limb movement that utilizes the non-paretic limb in order to promote functional recovery of the damaged limb through the inter limb coupling effect. [8] However, to our knowledge, there have been few reports on the effect of bilateral lower limb strengthening exercise. There is sufficient evidence that motor function is abnormal on the non-paretic side of individuals following a stroke, as evidenced through muscle weakness. [9,10] Therefore, in this study, both the paretic and non-paretic lower limbs were trained. Therefore, in order to clarify the effect of bilateral movement training, this study was to examine the effects of unilateral and bilateral lower limb strengthening exercises in stroke patients.

MATERIAL AND METHODOLOGY

Participants: This study is a randomized control study, which includes pre-interventional evaluation, intervention, post-interventional evaluation. Twenty two stroke participants who participated in the intervention were recruited from the department of physical medicine and rehabilitation and department of neurology, PSG Institute of Medical Sciences And Research hospital, Coimbatore, Tamilnadu, India. Study received and ethical clearance from the institutional human ethics committee. The participants were screened to ensure that they followed the following inclusion criteria. Ischemic stroke involving Middle Cerebral Artery (MCA)territory on Magnetic Resonance Imaging findings are Computerized Tomography scan, the age group between 40 to 65 years, the first ever unilateral ischemic stroke ,the stroke duration less than one month ,Mini Mental Score Examination score 23 or above, medically stable, able to follow the commands during the therapy. The exclusion criteria were other neurological conditions, cardio respiratory and musculoskeletal condition, non correctable visual deficit and perceptual disorder. The informed consent was obtained from the participants before they were enrolled into the intervention .The twenty two participants included in the study were then randomly allocated either to unilateral lower limb training group or to the bilateral lower limb training group using the computer generated random number table, with eleven participants in each group. **Interventions:** The participants of the unilateral lower limb training group received unilateral strengthening exercises 30 minutes, once in a day, six days per week for two weeks. The exercises were performed in supine, side lying, sitting and standing position. The exercises in supine were static exercises to the quadriceps, hamstring and gluteus muscles, dragging the heel, unilateral straight leg raising, unilateral pelvic bridging, crossing and uncrossing of the affected limb. The exercises in side lying were bending of knee and hip(flexion and extension), lifting the leg up and holding and the exercises in sitting was weight shifting towards the affected side, raising the leg off the ground and ankle dorsiflexor training. The exercises in standing were weight shifting in the affected limb and lunge standing. The participants in the bilateral lower limb training group receive all the exercise bilaterally followed stretching and endurance training mode using motomed. Along with the whole exercises; both the group received regular physiotherapy treatment.

Ethical Clearance:

The study followed the ethical standards of institutional human ethics committee, PSG IMS&R. [Ref. project No: 17/325].

Outcome Measure:
Berg balance scale (BBS) was used to assess the balance, it has 14 items, each item scored between 0 to 4, with the maximum score of 56.The higher the score indicates the better balance. It was measured before the intervention and after 2 weeks of intervention.

Statistical Analysis:
Data were analyzed using GraphPad InStat software – Trial version 3.10. The data were entered into an excel spreadsheet, tabulated and subjected to statistical analysis. Various statistical measures were used for this study which includes mean, standard deviation (SD) and test of significance such as paired 't' & unpaired 't' test. Pre and post interventional outcome within the group were analyzed using paired 't' test. Unpaired 't' test was used to compare the difference in scores between the two groups (i.e) unilateral lower limb training group and bilateral lower limb training group.

RESULTS

A total of 22 participants participated in this study. Balance was measured with the help of Berg Balance Scale. The difference in pre and post test interventional score for unilateral lower limb training group was 4±4.20, this difference is considered to be statistically significant. The differences in the pre and post interventional score for the bilateral lower limb training group were 7.27±6.15 this difference is considered to be very statistically significant. (Table.1)

Table 1: Berg Balance Scale

Berg Balance Scale	Pre- test mean	Post- test mean	Mean difference	Standard deviation	't' value	'p' value
Unilateral lower limb strengthening group	29.82	33.82	4	4.20	3.1623	0.0101
Bilateral lower limb strengthening group	25	32.27	7.27	6.15	3.9223	0.0029

The difference in the post intervention for the unilateral lower limb strengthening and bilateral lower limb strengthening exercises was 1.55+4.43. (Table.2)

Table 2:

Berg Balance Scale	Post- test Mean	Mean difference	Standard deviation	't' value	'p' value
Unilateral lower limb strengthening group	33.82	1.55	4.43	0.3489	0.092
Bilateral lower limb strengthening group	32.27				

DISCUSSION

Most of the studies in stroke rehabilitation are concerned with the management of the lower extremity dysfunction in the paretic stroke side. In contrast with the paretic limb rehabilitation, the involvement of the non paretic limb for the restoration of the paretic side is a rather neglected area of stroke rehabilitation research especially in lower limb training. Hence, this study aimed to compare the effect of bilateral lower limb strengthening exercises and unilateral lower limb strengthening exercises. Both the group results showed a significant improvement in terms of berg balance scale. However the overall improvement in bilateral lower limb strengthening exercise group was greater and more significant than unilateral lower limb strengthening exercise group. According to the current literature, possible mechanisms underlying improvement from bilateral training include recruitment of the ipsilateral corticospinal pathways, increased control from the contralesional hemisphere and a normalization of inhibitory mechanisms. It is well established that there are corticospinal pathways which do not cross at the pyramidal decussation. The estimated percentage of uncrossed pathways is approximately 10-20%. These uncrossed, ipsilateral pathways have been implicated as a possible post-stroke recovery mechanism, [10] and some researchers suggested they

could be facilitated with bilateral training. [12] post-stroke bilateral symmetrical movement training may exploit the symmetry constraint by allowing greater use of the ipsilateral pathways. There are a variety of manifestations of neural reorganization after a stroke, one of which is increased activity in the contralesional cortex. In some stroke patients, contralesional activation increases after injury and then declines as ipsilesional recovery progresses. [13,14] The function of increased contralesional activation is the subject of much debate in the stroke literature. Spraker et al., 2007., An fMRI study determined that the contralateral hemisphere had a greater percent signal change and activation volume in comparison to the ipsilateral hemisphere. [14] The contralesional hemisphere has been implicated in improving post-stroke motor function, particularly following bilateral training. [15] The balance of inhibition and disinhibition between the cortices is disrupted after a stroke. The affected hemisphere has reduced excitability, while the nonaffected hemisphere has increased excitability. Transcallosal inhibition from the ipsilesional hemisphere to the contralesional one is greatly decreased, [17] and there are abnormally high levels of inhibition transferred from the contralesional to the lesioned hemisphere. [18] Intracortical inhibition is also decreased. Neural mechanism underlying post-stroke functional improvements following bilateral training is the normalization of inhibitory mechanisms between the hemispheres. [17] Researchers have cautioned against using an exclusively unilateral training paradigm. [19] This is because when both arms move together, there is a temporal component which is qualitatively different than if the same task was performed with exclusive unilateral movement. Thus, some types of bilateral training or priming might be appropriate for any level of post-stroke impairment.

CONCLUSION

This two weeks study results showed improvement in bilateral lower limb strengthening training group in comparison with unilateral lower limb strengthening training group. Therefore the results from Berg Balance Scale Score [20] concluded the bilateral lower limb strengthening exercise is more effective on improving the balance in stroke patients.

Based on the outcomes of this study, the following changes are suggested: The study can be extended to a large sample size and the duration of the study can be increased with a follow up.

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