Trunk Rotation Training as a tool in improving weight transmission through the paretic lower limb in hemiplegiay

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Abstract

Aim: To determine the effectiveness of training trunk rotation as a tool in improving weight transmission through the paretic lower limb in subjects with hemiplegia.

Methods: Thirty stroke subjects were randomly assigned into control group (n=15) and experimental group (n=15).

Interventions: Subjects in the control group received conventional set of exercises alone and the experimental group received conventional set of exercises and trunk rotation training.

Main measures: The ability of weight shift in standing, in both groups, was measured using a bathroom scale inserted in a wooden platform for stability.

Findings: It revealed that within experimental group and control group there was a statistically significant ($p<0.00$) increase in weight transmission in affected extremity which signifies that both the intervention had an impact on improving weight transmission in the affected extremity and thereby restoring symmetry. Between group analysis also gave a statistically significant ($p<0.00$) results by further analyzing the difference in improvement of weight transmission between pre and posttest value associated with experimental group (13.44±3.91kgs) which received conventional exercises plus trunk rotation compared to control group (8.2±3.89kgs) that received conventional exercises alone.

Conclusions: Adding Trunk rotation training, along with conventional exercises, results in greater improvement of weight transmission in the paretic extremity compared to conventional exercises alone.

Key words: Trunk rotation training, symmetric weight transmission, gait, balance, stroke rehabilitation

Introduction

Cerebrovascular accidents lead to decreased weight bearing on the paretic lower limb resulting in abnormal stance stability due to muscle weakness and impaired postural control (Pai YC et al, 1994). Weight shift towards either leg is a pre requisite for independent walking in any individual. So learning to load and unload the affected limb while standing is an important step in balance and gait training of stroke patients (Brunnstrom S, 1965). There are many interventions to improve weight transmission in the affected limb like weight shifting exercises (Winstein et al, 1989), task specific exercises of lower limb (Carr J and Shepherd R 2003), use of auditory feedback (Wannstedt GT et al, 1998), use of postural sway feedback (Shumway cook A et al, 1988), use of vertical ground reaction force feedback etc (Engardt M, 1993).

Only a few studies have been done on trunk muscle contribution on lower limb movements. Out of them one study states that Leg and trunk muscle demonstrate a specific pattern of compensatory movement for every movement in the upper extremity. It has been shown that activities in these muscles began prior to the arm muscles (Friedli WG et al, 1984). A studies conducted on the role of the lower limb showed that they contribute control the trunk in sitting when a person reaches forwards (Chari VR and Kirby RL, 1986), and a study done with the subjects in a seated position stated that there is a considerable contribution from trunk, hip, knee and ankle when the subject moved his upper limb (Son K et al, 2001). During reaching movements beyond the upper limb length in a sitting position, lower limb helps to break the forward motion of the body and helps in maintaining posture (Dean CM et al, 1999). It has been revealed that since the paretic muscles of the trunk are probably used to control the leaning of the trunk towards the non-paretic side, the subject with hemiplegia may recruit the paretic foot to compensate for trunk weakness and maintain the posture. In another study it have been stated that lower limb muscles are recruited more significantly in reaching to contralateral side compared to the ipsilateral side (Sylvie Messier et al, 2005). As abdominal muscles are interconnected by Linea Alba, efficient action of the muscle of one side of the abdominal wall is therefore quite dependent on the activity of the other side, particularly for the activity involving rotation

of the trunk (Pai YC et al 1994). As the rotation requires the contraction of the bilateral oblique abdominal muscles it is anticipated that contribution from lower extremities will be more for reaching with trunk rotation than reaching without trunk rotation. Hence reaching with trunk rotation may be used as a tool to improve activity in paretic lower extremity. Studies have reported reaching the non-paretic side by the affected upper extremity and unaffected upper extremity, improving use of the paretic lower extremity to control trunk movement for stability. The efficacy of the rotation over weight shifting in the coronal plane has not been studied in detail. So this study is aimed to find out the efficacy of trunk rotation in sitting position in improving activity in the affected lower extremity in subjects with hemiplegia.

Methods

In this study the institutional ethical committee has approved the study protocol. 30 patients with acute stroke, who were admitted to A.C.S. medical college and hospital, were recruited. These patients were randomly assigned into two groups, namely Control group (n = 15) and experimental group (n = 15). Subjects included in the study had experienced first time cerebrovascular accidents resulting in hemiplegia, weight bearing of 30% of body weight or less through the paretic lower extremity during independent standing, Motor assessment scale score of 2 for standing balance (stand without support with foot apart for more than 30 seconds), with age group between 40 - 65 years. Only male subjects were included. Subjects were excluded if they had perceptual deficits, sensory aphasia, cognitive impairments, hearing impairments, visual impairments, subjects who were medically not stable.

Intervention: Patients were fully explained about the procedure and requested their co-operation. All the patients signed a informed consent form before participation.

Control Group (Group A)

Subjects in this group received conventional set of exercises, which included exercises to improve voluntary control with emphasis on improving muscles of lower, balance training in sitting, bed mobility and transfer and training in activities of daily life (ADL).

Experimental Group (Group B)

Experimental group received conventional set of exercises plus trunk rotation training. Trunk rotation training was done with the patients seated comfortably on a stool with their foot placed on ground with heels 30cms apart in a plantigrade position. The subjects were asked to reach for objects which were placed at an angle of 45 degrees (measured by drawing a straight line along the great toe on the side of the reaching upper limb and marking an angle of 45 degree from this line towards the reaching side) contralateral to the reaching limb and at a distance of 20 percent more than the length of their upper limb. Patients reached with both hemiplegic and normal upper limb 30 times respectively. Training session consisted of three sets of ten repetitions with rest time of two minutes each set. Therapy was stopped if the patient did not concentrate or became tired and then continued. Trunk rotation training along with conventional set of exercise was given twice daily for 6 weeks.

Data Collection

Data's were collected before and after intervention of the therapy. The ability of weight shift in standing, in both groups, was measured using a bathroom scale inserted in a wooden platform for stability. Foot markings were made on the scale to standardize the foot placement. Between each reading, the patient was made to sit, and then were made to stand, they stood without assistance on the bathroom scale. Three readings of the measure of the ability of the patients were taken in both the experimental and control group and the average of the three was calculated.

Findings

In this study results were analyzed using independent t-test for between group analysis for pretest and posttest values and paired t-test is used for within group analysis of both groups.

The difference between the pretest values in experimental group (16.83±3.78)and control group (14.73±2.60) was found to be not statistically significant ($p>0.07$) as shown in table 1 which signifies that both groups were similar before intervention. It was found that within experimental group and control group there was a statistically significant increase in weight transmission in affected extremity as shown in table 1 ($p<0.00$) which signifies that both the intervention had impact on improving weight transmission in the af-

fected extremity and thereby restoring symmetry. Between group analysis gave a statistically significant result ($p<0.00$) by analyzing the difference in improvement of weight transmission between pre and posttest value associated with experimental group (13.44±3.91kgs) which received conventional exercises and trunk rotation training compared to control group (8.2±3.89kgs) that received conventional exercises alone as shown in table 2. This signifying that adding trunk rotation training along with the conventional exercises has a superior effect on weight transmission in affected extremity compared to only conventional exercises.

	Pre-test Value (Mean±SD in Kgs)	Post-test Value (Mean±SD in Kgs)
Experimental Group	16.83±3.78	30.27±4.04
Control Group	14.73±2.60	22.93±5.19

Table: 1 Comparison of weight transmission before and after intervention
SD = Standard Deviation, Kgs = Kilograms

	Post-test Value (Mean±SD in Kgs)
Experimental Group	13.44±3.91
Control Group	8.2±3.89

Table: 2 Difference in improvement of weight transmission between groups after intervention
SD = Standard Deviation, Kgs = Kilograms

Discussion

Loss of symmetrical weight transmission in the lower extremities is one of the major problems faced in hemiplegic patients, because it is associated with poor gait and balance problems (Alexander S et al, 2000). Weight bearing ability is less for a paretic limb compared to a nonparetic limb (Janice J et al, 2002). Various factors contribute to the loss of symmetry, like impaired voluntary control in the lower limb, impaired postural control, lack of awareness of body parts (Pai YC et al, 1994), or learned disuse of the affected limb (Wall J and Turnbull J, 1986). Inability to bear weight in the affected extremity has been correlated with high rate of falls in hemiplegic patients compared to elderly (Lau YC et al, 1989), and falling has been reported as major cause of morbidity, mortality and hospitalization among stroke (Cryfe CI et al, 1977). So there is a need to find effective ways of training hemiplegic patients to improving weight transmission in their paretic lower extremity to restore function as early as possible. There are various techniques being employed to symmetry in lower extremity. Some of them are weight shifting exercises (Winstein CJ et al, 1989), task specific exercises of a lower limb (Carr J and Shepherd R 2003), use of auditory feedback (Wannstedt GT et al, 1998), use of postural sway biofeedback (Shumway cook A et al, 1988), use of vertical ground reaction force feedback (Engardt M, 1993), using shoe lifts (Kitisomprayoonkul W et al 2005), 20 and sit to stand training (Engardt M and Olsson E, 1992).

Most of these techniques train patients in standing. There are very few techniques for training patients in sitting to improve weight transmission in the paretic extremity. Training patients in sitting can be of immense help in patients who cannot stand independently, and can prepare the patient for standing. Improvement in weight transmission gained in sitting can be generalized to standing (Mudie MH et al, 2002).

In this study control group received conventional exercises that included voluntary control training with emphasize on improving muscles of lower extremity that helps in improving weight transmission in affected lower extremity, balance training in sitting, bed mobility and transfer and training in activities of daily life (ADL) and the experimental group received trunk rotation training in sitting in addition to the conventional exercises. Improvement in weight transmission trough paretic extremity was analyzed, both groups showed improvement, which was statistically significant. The improvement in control group can be attributed to the training given. The components of training like facilitation of extensor muscles of lower extremity muscles, sensory stimuli given in standing, trunk control training in lying would have helped in improving the ability to shift weight in standing.

The improvement in experimental group could be attributed to trunk rotation training in sitting and components listed under control group as well. Subjects trained with trunk rotation might have improved in weight transmission in their affected extremity because it is possible that movement of the upper limb could have elicited contraction in the paretic lower limb. It might be due to the fact that the lower limb helps in increasing the base of support, breaking the momentum of the moving trunk.

Lower limb muscles, being one of the postural muscles, might have got recruited well in advance before the upper limb moves in order to maintain posture. In this study subjects reached across the body in 45° angle because it was already proved to be effective compared to pure frontal or sagittal plane reach (Sylvie Messier et al, 2005). The subjects reached 20% beyond their arms length, as proved to be effective compared to reaching within arm's length (Catherine Dean et al, 1999). So, when reaching far away from the body the center of gravity would have been displaced out of the base of support. In order to maintain the balance muscles of lower limb might have been recruited along with the opposite trunk muscles. In this study thigh support was standardized by supported it fully, because literature states that the thigh support plays an important role in the demand imposed to an individual on reaching, there by recruitment of muscles also varies with extent of thigh support and lower limb helps in improving the sitting balance by increasing the base of support and further stated that lower limbs have also an influence on the reach distance from sitting position because subjects were able to reach more when both legs supported compared to unsupported (Vinjamuri R and Kirby RL, 1986). Another review stated that lower limb work cooperatively to control the motion of the body mass. The author states that lower limb muscles are more recruited when subjects reached beyond arms length. He further stated that the ground reaction force and electromyography data demonstrated that the lower limb activity is more when reaching objects were placed at a distance of 140% of arm's length (Dean CM et al,1999).

So in this study, trunk rotation training in sitting position has been proved in an attempt to improve weight transmission in the affected extremity by providing the intervention for six weeks twice daily alone with conventional set of exercises. In some patients, the symmetrical weight transmission was achieved before sixth week,. No patient was medically deteriorated in between the intervention time. Weight transmission achieved in one session didn't remain same the next session in some of the subjects which implies that the gain in weight transmission was short lived.

The limitations in this study are small size population, and both the groups not being equally treated (with the experiment group receiving an additional intervention which might have influenced the results); also, force plates could have been a better choice than bathroom scale. Thus, this study provides a good clinical implication to therapist, that even before the patients are made to stand, weight transmission in the affected extremity can be improved by means of trunk rotation training in a seated position with both legs supported.

Conclusion

Results of this study suggest that trunk rotation training, along with conventional exercises, results in greater improvement of weight transmission in the paretic extremity compared to conventional exercises alone. Future studies can focus on comparing trunk rotation training with some of the already proven techniques like sit to stand training, visual and auditory feedback, and so on, to achieve symmetrical weight transmission. The same study may be done with large population by using force plates.

Key points

- Trunk rotation training along with conventional exercises results in greater improvement of weight transmission in the paretic lower extremity compared to conventional exercises alone.
- Even before the patients are made to stand, weight transmission in the affected extremity can be improved by means of trunk rotation training in a seated position with both legs supported

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