ADDITIONAL TRUNK TRAINING IMPROVES SITTING BALANCE FOLLOWING ACUTE STROKE: A PILOT RANDOMIZED CONTROLLED TRIAL

*Vijaya Kumar.K MPT, Karthick Babu. S MPT, Akshatha Nayak, Department of Physiotherapy, Kasturba Medical College, Mangalore, Karnataka

Corresponding author*

E-Mail: appuvijaympt@yahoo.co.in

Background: One of the primary goals of physical therapy during the early phases of stroke rehabilitation is to facilitate static and dynamic sitting balance. There is convincing evidence that trunk performance is an early predictor of functional outcome and also activities of daily living after stroke. Sitting balance and selective trunk movements are remain impaired after stroke. Hence selective trunk training early in the rehabilitation process may result better improvement in sitting balance and functional mobility.

Objective: To investigate whether provision of additional trunk training improves sitting balance following acute stroke.

Design: A pilot randomized controlled trial.

Setting: Department of Physiotherapy,Kasturba Medical College,Mangalore

Participants: Twenty subjects having first ever unilateral stroke and who can able to sit on a stable surface independently for 30 seconds were recruited for the study.

Intervention: Each participant was randomly allocated into a control (conventional physiotherapy) or experimental group (conventional therapy plus an additional session of trunk training). In addition to conventional physiotherapy subjects in the experimental group received a total 10 hours of individual and supervised trunk exercises for 45 minutes with adequate rest periods, 6 times a week, for 3 weeks.

Outcome measures: Trunk Impairment Scale (TIS) and Brunel Balance Assessment (BBA) were used on admission to the study and at 3 week intervals following intervention by an blinded observer.

Results: Following three weeks of intervention subjects in both groups had higher scores in Trunk Impairment Scale and Brunel Balance Assessment. Compare to control group participants completing additional trunk training in the experimental group had statistically significant difference in TIS and BBA scores ($p< 0.05$).

Conclusions: This pilot study concludes that additional trunk training in acute phase of stroke rehabilitation improves sitting balance and mobility.

Introduction

Stroke is one of the most common neurological conditions that results in impairment of both sensory and motor processes of postural control systems. Postural control deficits are presented with more posture sway, asymmetric weight distribution, impaired weight – shifting ability and decreased stability capability which leads to diminished balance in stroke. Poor sitting ability is a common problem after stroke. Impairment of posture and balance in sitting affects the ability to perform the activities of daily living. Recovery of sitting ability is important because independent sitting is a prerequisite for most functional activities and a determinant of functional recovery following stroke.[1,2]

Stability and dynamic stability are two important aspects of the sitting position. Stability reduces the body's motion or sway. In the sitting position, the body, without trunk support, is unstable and its configuration must be controlled through muscle activity. When weight is shifted in any plane, the trunk responds with a movement to counteract the change in the center of gravity (COG). Maintaining a stable seated position requires good trunk control and sitting balance.[3] Trunk control is the ability of the body to maintain the trunk stable and to the basic movement patterns of the body and the extremities. Impairment of trunk control in hemiplegic or paretic patients has been documented and characterized by asymmetry in performance of rotatory and side bending activities. This loss of selective trunk activity could result from a reduction in the strength and amplitude of trunk movements, especially on the paretic side. Several studies have identified deficits of trunk muscle strength and poor trunk control in unihemispheric stroke patients. [4-7]

One of the primary goals of physical therapy during the early phases of rehabilitation is to facilitate static and dynamic sitting balance. Thus, accurate and reliable measures of sitting balance, along with appropriate treatment program to gain sitting ability should be implemented in early phase of rehabilitation. In a recent systematic review of clinical utility of measures of balance activity in people with neurological conditions has recommended that scales with hierarchical order of items with established lack of redundancy are advantageous and feasible to use in clinical practice.[8]

Sitting balance and selective trunk movements are remain impaired after stroke. There is convincing evidence that trunk performance is an early predictor of functional outcome and also activities of daily living after stroke. Hence selective trunk training early in the rehabilitation process may result better improvement in sitting balance and in long-term functional mobility. Therefore, it was the aim of this study to investigate the effect of additional trunk exercises on sitting balance after stroke.

Material and method

Subjects:

Participants are stroke subjects who were admitted for a comprehensive rehabilitation program in Kasturba Medical College and Hospital, Mangalore. The clinical diagnose of Stroke was confirmed by the consultant appointed at the hospital on the basis of neurological examination and Computed Tomography or Magnetic Resonance Imaging. Subjects were included if they met the following criteria 1) first onset of unilateral supra-tentorial stroke (ischemic or hemorrhagic) who are stable and referred by physician for rehabilitation 2) post stroke duration less than 1 month duration 3) Mini Mental Status Scale score ≥24 4) subject can able to sit unsupported on a bed with their feet touching the ground for 30 seconds. Subjects were excluded from the study if they were 1)70 years of age or older 2) subjects who were not able to understand the instructions 3) subjects with non-stroke related sensory or motor impairments which affecting their motor performance.

Design

The design of this study was an assessor-blinded randomized controlled trial. After screening, eligible participants completed an initial assessment are then randomized into an experimental or control group by block randomization.5 blocks made with 4 subjects in each block were made to ensure equal number of participants in both groups. A total of 10 subjects were allotted to both experimental and control group. To reduce bias, pre and post outcome measures were collected by the blinded assessor who was blinded to group allocation.

Procedure

Ethical committee clearance was obtained from the institution to conduct the study. A briefing regarding the purpose of study and the procedure were given to all the participants and a signed informed consent was taken from the interested participants. Over a 12-month period (January 2009 to December 2009), 53 patients were attending the stroke rehabilitation program and total of 26 subjects were interested and eligible for inclusion criteria. with 6 drop outs because of early discharge, recurrent stroke and musculoskeletal complaints, 10 subjects were assigned to control group(conventional rehabilitation program) and the experimental group (conventional rehabilitation program and 10 hours of additional trunk exercises over a period of 3 weeks).Variables collected to describe our sample were age, gender, time since stroke onset, type of stroke ,paretic side, and the primary outcome measures Trunk Impairment scale (TIS) by Verheydan et al and Brunel Balance Assessment (BBA) was assessed by blinded assessor, a qualified physical therapist. At the end of 3 weeks of intervention period, the same blinded assessor reevaluated participant's performance in BBA and TIS scores. All the participants were evaluated before discharge from the hospital and included in the analysis.

Intervention

During the study period participants in the experimental and control group received the conventional multidisciplinary stroke rehabilitation program. This program is patient-specific with main emphasis on the neurodevelopmental concept and on motor relearning strategies. In addition to the conventional treatment, patients from the experimental group received 45 minutes of extra trunk training with adequate rest periods, 6 times a week, for 3weeks. In total, 10 hours of additional training were given to the experimental group. This additional exercise consisted of selective movements of the upper and lower part of the trunk in supine and sitting.

The exercise protocol for trunk training on therapeutic mat as follows:

Supine exercises

1) Bridging: this is done with the legs bent and the feet resting on the mat, included selective anterior-posterior movements of the pelvis and extension of the hips. the weight bearing is at the shoulders and the feet.

2) Unilateral pelvic bridging: done with one foot resting on the mat and lifting the pelvis of the mat with the other leg raised in the air for about 60 degree of hip flexion and with knee in extension. weight bearing is on the shoulder and on the foot of the leg which is placed on the mat.

3) Trunk rotations:

Upper trunk rotation: the subject is in crook lying and is asked to rotate the upper trunk with the two hands clasped together around his chest.

Lower trunk rotation: the subject is in crook lying and is asked to rotate his lower trunk by turning his knees to the either sides. And is progressed by asking the subject to flex his hips and knees and bring the knees to the opposite shoulder.

Sitting exercises

1) Static sitting balance: the subject is made to sit with his hips and knees in 90 degree flexion position, and then his body alignment is corrected by giving verbal feedback to maintain proper position.

2) Trunk flexion:

The subject flexes and extends the trunk without moving the trunk forwards or backwards (i.e slouch to straight)

Flexion and extension of the lumbar part of the spine: This involves selective anteflexion and retroflexion of the lower part of the trunk.

3)Trunk lateral flexion: lateral flexion of the trunk initiated from the shoulder and pelvic girdle (from the shoulder girdle means that the patient touches the exercise table with one elbow and returns to the starting position, from the pelvic girdle means that the patient lifts one side of the pelvis and returns to the starting position).

4) Trunk rotations:

Upper Trunk Rotation: the subject clasps his hands around his chest moves each shoulder forwards and backwards alternatively keeping his lower trunk stable.

Lower Trunk Rotation: the subject while sitting in the upright position, maintaining his upper trunk erect moves each knee forwards and backwards alternatively.

5) Weight shifts: subject shifts the weight from one side to the other both in anteroposterior and mediolateral directions i.e moves forwards and backwards and side to side on the mat.

6) Forward reach: subject in sitting position attempts to reach destined object by forward flexing the trunk.

7) Lateral reach: subject attempts to reach a destined object by lateral flexing his trunk to both sides.

8) Perturbations: subject while in sitting position on mat, is given perturbations in all directions.

Exercises were gradually introduced and the progression of the exercise was determined based on patient's performance and by increasing the repetitions and hold time of the exercises.

Outcome measurement

The primary outcome measures used in this study was Brunel Balance Assessment (BBA) and Trunk Impairment Scale (TIS). Both Scales are found to be good psychometric properties to measure balance in stroke.

The BBA consists of a hierarchical series of functional performance tests that range from supported sitting balance to advanced stepping tasks. There are three sections to the assessment: sitting, standing and stepping. Each section can be used either individually or together. The sections are divided into several levels each of which increase the demand on balance ability, ranging from assisted balance to moving within the base of support, and changes of the base of support. For each test there is a minimal level of performance required for the patient to 'pass' at that level. The score also reflects how well the individual is functioning within that section e.g. sitting, standing or stepping.

For TIS, a standardized sitting position is used throughout the assessment. Movements are performed in the sagittal, frontal and horizontal plane. Quality of movement is taken into account by observing whether or not the task is performed with compensations. The TIS assesses static sitting balance, dynamic sitting balance, and trunk coordination on a scale ranging from 0 to 23 points, a higher score indicating a better trunk performance. The subscale static sitting balance evaluates if a patient can maintain a sitting posture with both feet on the floor and with the legs crossed. Furthermore, the patient is asked to cross the nonaffected leg over the hemiplegic leg while keeping the trunk upright and stable. The dynamic sitting balance subscale evaluates lateral flexion initiated from the upper and lower part of the trunk. Adequate movement and possible compensations are scored on a dichotomous scale. Finally, trunk coordination is assessed by asking the patient to selectively rotate the upper and lower part of the body. Again adequate rotation and compensations are evaluated. The maximum score on the subscales of the TIS are 7, 10, and 6 points, respectively.

Data analysis

Data analysis was performed using SPSS for windows version 14.0 and the level of significance for all analyses was set at $p < .05$.Descriptive statistics were generated in order to obtain frequency tables for all independent variables. Mann- Whitney U Test was used to test difference between the scores of control group with that of the experimental group.Wilcoxon Signed Rank Sum test was used to test the within group difference in pre and post intervention scores.

Results

Of the 20 subjects included, 10 were randomly allocated to control group, and the remaining to experimental group. Table 1 indicates the group means and Standard Deviations (SDs) for age and duration of time post stroke and frequency counts for sex and hemiparetic side. There were no statistically significant differences between groups for age, stroke onset, sex, and hemiparetic side.

Table 1: Demographic Variables of the Participants

Variables		Control (n=10)	Experimental (n=10)	p value
Age (yrs)		57.8± 13.49	59.5 ± 12.09	0.715(NS)
Post Stroke Duration in days		15.8± 10.69	15.0 ± 6.16	0.749(NS)
Sex	Male (n)	7	5	0.650(NS)
	%	70	50	
	Female (n)	3	5	
	%	30	50	
Hemi-Paretic Side	Right (n)	6	3	0.178(NS)
	%	60	30	
	Left (n)	4	7	
	%	40	70	

*NS- Non Significant

Table 2 show pre and post results of outcome measures with mean and standard deviations of scores for control and experimental group. A highly significant difference in both the groups following intervention in all measures was observed as denoted by the p values <0.05 (Graphs 1-5).

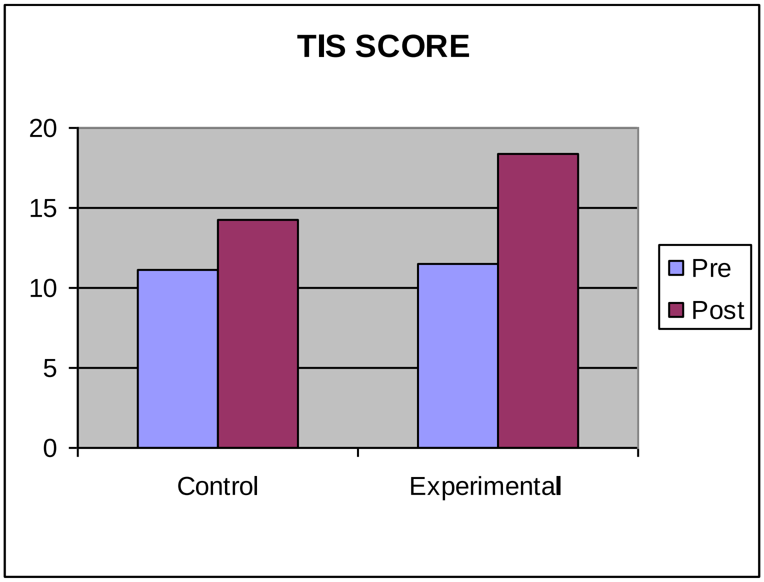
Table 2: Pre and Post outcome measures in Control and Experimental Group

Outcome Measures	**Control Group**			**Experimental Group**		
	Pre	**Post**	**P Value**	**pre**	**post**	**p value**
TIS (range 0-23)	11.07±1.95.	14.20±1.5	<.001*	11.47±2.3	18.43±1.1	<.001*
Static Sitting (0-7)	40±.63	6.63±.31	<.001*	5.53±.494	6.80±.10	<.001*
Dynamic Sitting (0-10)	4.03±1.2	6.83±.88	<.001*	4.23±1.16	8.30±.82	<.001*
Coordination (0-6)	1.47±.51	2.64±.61	<.001*	1.67±.88	3.90±.84	<.001*
Brunel Balance Assessment Score	3.40±.07	7.80±1.15	<.000*	3.37±1.06	10.47±.29	<.000*

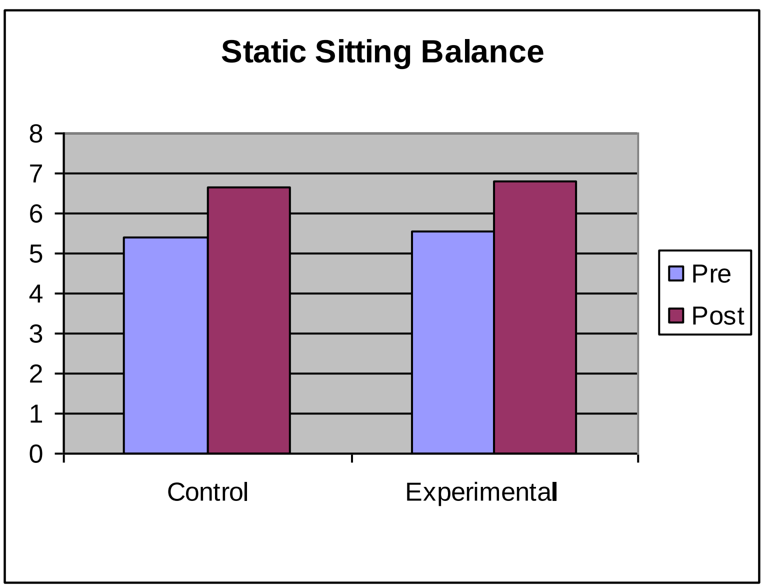
Values presented as mean±SD

*: Highly Significant

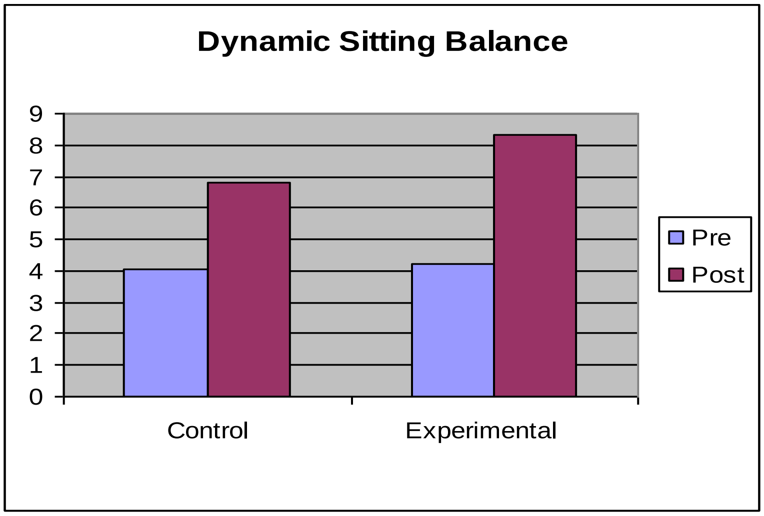
Graph 1- represents TIS Scores between Control and Experimental Group



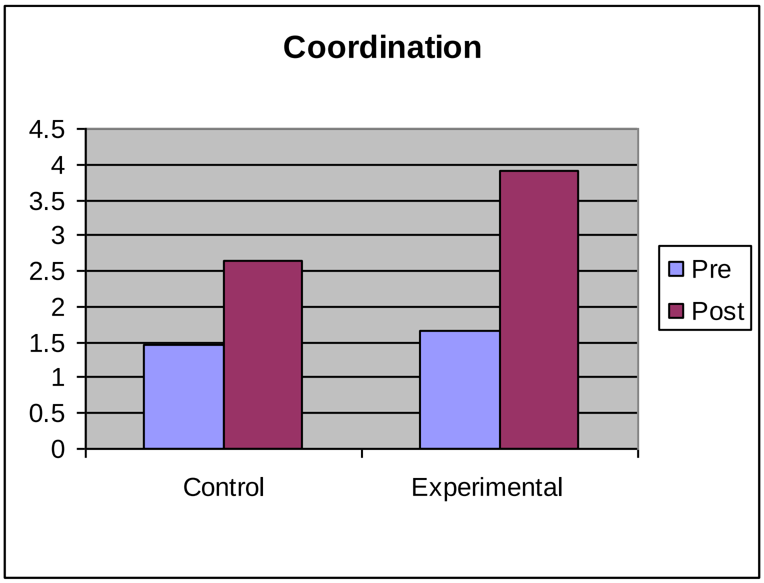
Graph 2- represents Static Sitting Balance between Control and Experimental Group



Graph 3- represents Dynamic Sitting Balance Score between Control and Experimental Group



Graph 4- represents Coordination Scores between Control and Experimental Group



Graph 5- represent Brunel Balance Assessment Scores between Control and Experimental Group

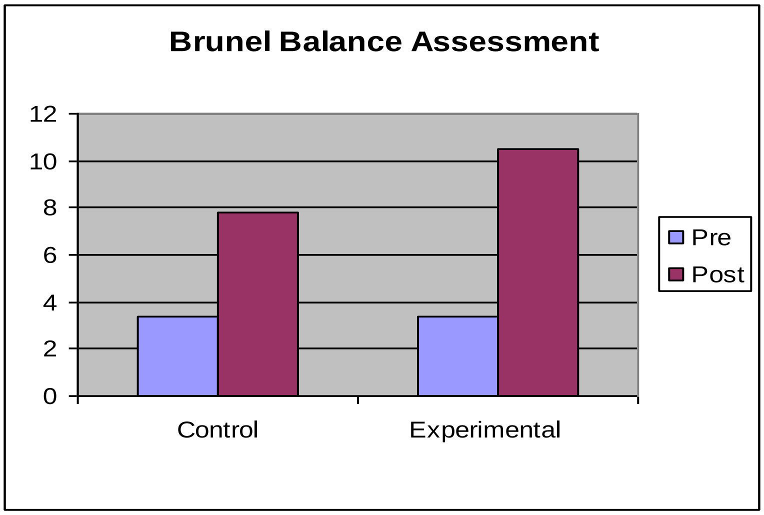


Table 3 shows there was a statistical significant difference between groups in all the outcome measures (Graph 6). However there was no statistical difference in static sitting balance item of TIS between the groups.

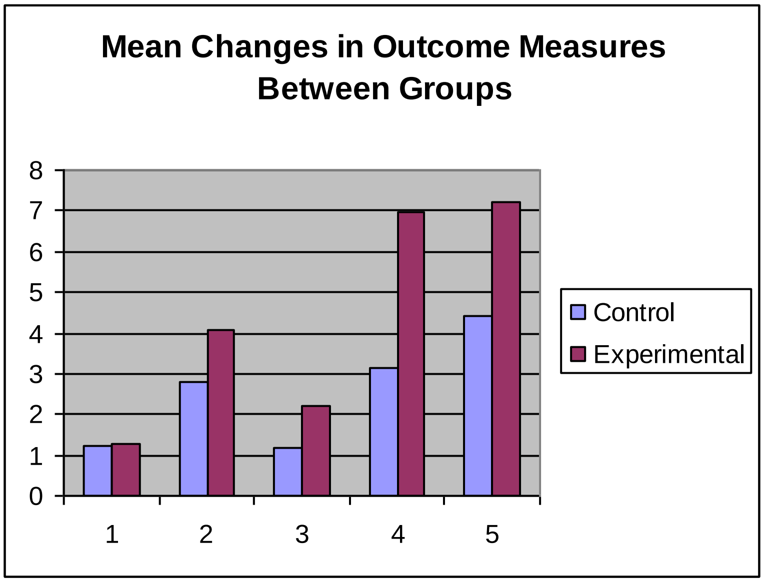
Table 3: Mean Scores of TIS and BBA between Control and Experimental groups

Outcome measure	Control	Experimental	p value(<.05)
TIS score	3.13±1.24	6.96±1.28	<.000(HS)
Static sitting balance	1.23±.67	1.27±.59	.612(NS)
Dynamic sitting balance	2.80±.98	4.07±1.22	<.002(HS)
coordination	1.17±.51	2.23±.31	<.001(HS)
Brunel Balance Assessment score	4.40±.82	7.20±.09	<.000(HS)

Values presented as mean±SD

HS: Highly Significant NS: Not Significant

Graph 6-represent mean difference in outcome measures between Groups



1-Static Sitting Balance 2-Dynamic Sitting Balance 3-Coordination

4-TIS Score 5-Brunel Balance Assessment Score

Discussion

It was the aim of the study to evaluate the effects of additional trunk exercises on sitting balance after stroke. our results suggests that compare to control group additional trunk exercises in the experimental group aiming to improve sitting balance resulted in short-term improvement on Brunel Balance Assessment and also the dynamic sitting balance and coordination subscale of the Trunk Impairment Scale.

Experts in the field of neurological rehabilitation have addressed the trunk as the central key point of the body and proximal stability of trunk is a prerequisite for distal head and limb movement and therefore expected to be related to functional ADL. The purpose of this therapy program was to treat the trunk as functional and in line with the daily rehabilitation setting.

Both control and experimental group has shown improvement pre and post TIS and BBA scores following intervention. This improvement may be the selected samples in this study are acute stroke subjects who were less than one month post stroke duration and this time course has striking potential for spontaneous motor recovery and functional performance.[9] Thus effects may attributable to spontaneous recovery and conventional training.

Significant within group differences were found for the total trunk impairment scale indicating improvement in trunk performance as a whole. After 2 weeks of intervention the total TIS mean score changed from 11.47 to 18.43 in experimental group and from 11.07 to 14.20 in control group. That is an improvement of 69% in experimental group and 32% in control group. This shows that the experimental group almost has improved almost 2 times than that of the control group after intervention. Significant improvement of TIS scores in experimental group may be argued that the additional treatment was similar to some of the items measured in the TIS and therefore better results are no surprise. However, the TIS are a scale designed on the basis of stroke literature, existing scales, and opinion of experts in the field of neurological rehabilitation. Therefore, items of the TIS are indeed related to clinical practice. It is our opinion that this is one of the strengths of this study, which presents an interaction between a therapy approach and a scientific tool applicable in clinical practice.

Static sitting balance evaluates ability to sit upright in sitting position with normal base of support and when the base of support has been reduced. Results showed significant improvement in both groups following intervention. The mean score improved from 5.53 to 6.80 in experimental group while the control group improved from 5.40 to 6.63 following intervention. Experimental group and control group improved 12.7% and 12.3% respectively suggests no statistically significant improvement between them (p value .612). At the beginning of the study, the included patients could sit independently without support for 30 secs. This suggested that patients had already attained a sub maximal score in static sitting balance subscale of TIS. Since both the groups showed good static sitting balance at the time of inclusion, the scope of further improvement was not likely.

The dynamic sitting balance subscale evaluates selective lateral flexion of upper and lower part of the trunk. Stability during selective trunk movements, appropriate shortening and lengthening of the trunk, and eventual compensations are evaluated. The study showed better dynamic balance improvement in experimental group when compared to control group (p=0.002). Over a 2 week period, the mean scores of the dynamic sitting balance subscale in the experimental group improved from 4.23 to 8.30 while the control group from 4.03 to 6.83, indicating experimental and control group improved 41% and 28% respectively.

The co-ordination subscale evaluates the upper and lower trunk rotation separately and the symmetry in the rotations. Post intervention the mean scores of coordination in experimental group changed from1.67 to 3.90 and 1.47 to 2.64 in control group. The percentage of improvement seen is 22% in experimental group and 11% in control group. The improvement in experimental group is twice that of control group after intervention.

A study by Verhedyan et al who has concluded that 10 hours of additional trunk exercises on ground level results change in dynamic sitting balance and not coordination subscale in TIS.[10] . A recent study on posturographic assessment of sitting balance recovery has shown that lateral balance control which depends on trunk muscles is most crucially affected than Anterior-Posterior direction in stroke and also suggested to improve lateral postural instability. [11]This present study we found significant change in both dynamic sitting balance and coordination subscale of TIS in the experimental group. The change in coordination subscale may be additional trunk training programme in acute phase of rehabilitation may result in better recruitment of trunk muscles and also stress the anticipatory postural control system.

After 2 weeks of intervention the mean scores of BBA changed from 3.37 to 10.57 in experimental group and from 3.40 to 7.80 in control group. That is the improvement of 72% in experimental group and 44% in control group. The improvement in the control group may be that all participants were receiving standing up training as part of their multidisciplinary rehabilitation program. Significant improvement in experimental group compare to control may be the carry over of biomechanical similarities between reaching in sitting and the pre extension phase of standing up. During trunk training, subjects practiced moving their trunk forward rapidly over their centre of mass whilst loading their legs. Although these components were practiced with the intention of improving sitting ability, they are also critical biomechanical components of the early phase of sit-to-stand.[12]

Implications

Although several studies reported the importance of trunk performance after stroke as a predictor of functional outcome, evidence concerning the beneficial effect of trunk training after stroke is sparse. The results of the present study indicate that additional trunk exercises have a positive effect on sitting balance and trunk performance following acute stroke. Future work is needed with regard to functional implications of our results. This could be examined by means of functional scales or 3-dimensional measurements of functional movements such as forward reach, lateral reach, or turning.

Limitations

There are limitations that warrant caution when generalizing the results of our study. First, this study included only a small number of participants. Future studies with a larger number of participants are therefore needed to confirm our results. Furthermore, our study only analyzed the results between pretreatment and post treatment assessment. We did not perform a follow-up assessment. Future studies should evaluate long-term effects of additional exercises. Finally, our control group did not receive placebo therapy and therefore received less therapy in comparison to the experimental condition. However it is suggested that including a group of patients who receive 10 hours of additional but usual physiotherapy exercises as a control group would be favorable for a next study.

References

1. 1.Oliveira CB,Medeiros IRT,Frota NAF, Greters, ME,Conforto AB.Balance control in hemiparetic stroke patients: Main tools for evaluation. J

Rehabil Res. 2008; 45(8):1215–1226.

2. Amusat N.Assessment of sitting balance of patients with stroke undergoing inpatient rehabilitation.Physiother Theory Pract. 2009; 25(2):138–144.
3. Lanzetta D, Cattaneo D, Pellegatta D, CardiniR. Trunk control in unstable sitting posture during functional activities in healthy subjects and patients with multiplesclerosis. Arch Phys Med Rehabil 2004; 85:279-83.
4. Tanaka S, Hachisuka K, Ogata H. Muscle strength of trunk flexion-extension in post-stroke hemiplegic patients. Am J Phys Med Rehabil 1998; 77:288-90.
5. Bohannon RW, Cassidy D, Walsh S. Trunk muscle strength is impaired multidirectionally after stroke. Clin Rehabil 1995;9:47-51.
6. Dickstein R, Shefi S, Marcovitz E, Villa Y. Anticipatory postural adjustment in selected trunk muscles in poststroke hemiparetic patients. Arch Phys Med Rehabil 2004; 85:261-67.
7. Dickstein R,Heffes Y, Laufer Y, Ben-Haim Z. Activation of selected trunk muscles during symmetric functional activities in post-stroke hemiparetic and hemiplegic patients. J Neurol Neurosurg Psychiatry 1999;66:218-21.
8. Tyson SF,Connell LA.How to measure balance in clinical practice.A Systematic review of the psychometrics and clinical utility of measures of balance activity for neurological conditions.Clin Rehabil 2009;23:824-840.
9. Verhedyan G et al.Time Course of trunk,arm,leg,and functional recovery after ischemic stroke.Neurorehabil Neural Repair.2008;22:173-179.
10. Verheyden G, Vereeck L, Truijen S, Troch M, Saeys W, Leenaerts E, et.al. Additional exercise improve trunk performance after stroke: a pilot randomized controlled trial. Neurorehabil Neural Repair 2008; 1-6.
11. Van Nes J.W I, Nienhuis B, Latour H, Geurts A.C.H.

Posturographic assessment of sitting balance recovery in the subacute phase of stroke. Gait Posture.2008; 28:507-512.

12. Dean CM, Channon EF, Hall JM . Sitting training early after stroke improves sitting ability and quality and carries over to standing up but not to walking: a randomised controlled trial. Aust J Physiother.2007; 53: 97–102.