International Journal of Physical Education, Sports and Health 2018; 5(6): 70-75

P-ISSN: 2394-1685
E-ISSN: 2394-1693
Impact Factor (ISRA): 5.38
IJPESH 2018; 5(6): 70-75

www.kheljournal.com
Received: 03-09-2018
Accepted: 05-10-2018

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Effectiveness of 4 weeks task specific training in improving postural control and balance in Subacute and chronic stroke: A randomized control trial

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Abstract
Balance forms the "foundation for all voluntary motor skills". Impaired postural control and balance is a key characteristic of mobility problem presented in stroke patients who have greater postural sway during quite standing and voluntary movements than healthy people. Therefore purpose of the study is to evaluate the effects of task specific training to improve postural control and balance both static and dynamic in subacute and chronic stroke.
Randomized Controlled Trial consisting both males and females participants (40) who are clinically and radio logically diagnosed with subacute and chronic stroke having hemiparesis. Group A: 20 participants underwent Conventional treatment (Control group).
Group B: 20 participants underwent Task Specific Training with conventional treatment (Experimental group) Outcomes measures were in terms of Functional Independence Measure and Postural Control & Balance for Stroke (PCBS) test. Readings were recorded on the first session and 12th session of treatment.
The results showed better improvement in postural control and balance in stroke patients with the (PCBS) test (p=0.000) & functional independence measure (p=0.000) in experimental group than in conventional group.
The present study suggests that task specific training is superior compared to the conventional treatment in improving balance and postural control in subacute and chronic stroke. Although both groups have been found to be effective in improving balance and postural control, task specific training is more effective than the sham group.

Keywords: Postural control, task specific training, postural

1. Introduction
Humans are the most superior beings with respect to ability to exploit their physical environment. The remarkable range of human behavior with the complexity of the environment, humans have been able to discriminate an enormous variety of events and adapt to any change in the environment. All behaviors are mediated by the central nervous system which consists of brain a soft mass of supportive tissues & nerve cells connected to the spinal cord.
Central nervous system is the core of our existence. It controls our personality, senses, basic body function, movement, balance, posture & co-ordination [1].
Balance forms the "foundation for all voluntary motor skills" [2]. Normal balance requires control of both gravitational forces to maintain posture and acceleration forces to maintain equilibrium (Massion and Woollacott 1996).
Together, the postural and equilibrium components of balance control, ensure stability of the body during widely differing activities. The exact demands on the balance control system are determined both by the task itself and the environment in which it is performed.
Postural control is an act of maintaining, achieving and restoring a state of balance during any static posture or a dynamic activity (Pollock *et al*. 2000). Impaired postural & balance of a moving body is a hallmark residual deficit following a disease or an injury like Stroke [3].
Stroke is the major consequence of cerebrovascular disease. WHO defined stroke as, "Rapidly developed clinical signs of focal disturbances of cerebral function,

lasting more than 24 hours or leading to death, with no apparent cause other than vascular origin" [3].

1.1 Incidence

It occurs at all ages and is more common in the elderly with incidence increasing dramatically with age (Paniker *et al*). It is about 1.25 times more in males than in females [4, 5]. Presently, the prevalence of stroke worldwide is 518/100,000 population and in India is 203/100,000 population [6].

The decreased ability to maintain static & dynamic balance after stroke could be related to the inability to select reliable sensory information (visual, vestibular & somatosensory systems) in order to produce the proper motor action necessary to maintain postural stability.

In the past, considerable treatment intervention programs for improving balance and functional ability in stroke patients were, use of Proprioceptive neuromuscular facilitation technique [7], Motor relearning program [8], aqua therapy, biofeedback, Bobath approach [9], aerobic exercise training, problem oriented willed movement therapy, perceptual learning exercises have found to be beneficial.

Motor relearning program includes various approaches one among them being task specific training. Task specific training is a therapeutic approach to retrain the patients with movement disorders, based on systems theory of motor control.

Carr and Shepherd focus on motor relearning where relearned movements are structured to be task specific. This approach utilizes a training program that focuses on specific functional tasks to engage neuromuscular and musculoskeletal systems.

Impaired postural control and balance is a key characteristic of mobility problem presented in stroke patients who have greater postural sway during quite standing and voluntary movements than healthy people (Shumway Cook *et al*. 1988, de Haart *et al*. 2004) [10].

Number of studies are focused on task specific training in regaining upper limb mobility and gait training, and less studies are available regarding training postural control and balance in combination [11].

Repetitive task practice with the use of different surfaces, base of support and vision manipulation to challenge balance could improve the process of somatosensory integration and have a positive effect on postural control.

Therefore, the purpose of this study is to evaluate the effects of task specific training to improve postural control and balance, both static and dynamic in subacute and chronic stroke.

1.2 Objective of the Study

1. To evaluate the effectiveness of task specific training with conventional treatment on postural control, balance and functional outcome.
2. To compare the effectiveness of task specific training with conventional treatment on postural control, balance and functional outcome.

1.3 Review of Literature

A review of information available on stroke was put forth by Anand K *et al*. The review estimated the morbidity of stroke in India. The prevalence of stroke in India was estimated as 203 per 100,000 population above 20 years, amounting to a total of about 1 million cases [6].

Snehal Bhupendra Shah (2006) conducted a study on Balance Training using stability trainer in 10 ambulatory hemiplegics between 40 yrs and 60 yrs and 60 yrs of age. The study concluded that training on stability trainer in various postures, both static and dynamic, at appropriate challenge levels, helps to improve balance in ambulatory hemiplegics. Training can be generalized to functional activities such as ascending and descending staircase, going up and down ramp and walking on uneven surfaces [12].

Pepperall N *et al*, found the effects of external cues on balance and alignment in sitting after stroke & aimed to relate sitting balance and alignment to hemiplegic side and sensory, visual and perceptual impairments in thirteen stroke patients. This study provides evidence that physiotherapy intervention can improve sitting balance and alignment even when used on a single occasion.

Langhammer B and Stanghelle JK (2000) did a study on acute stroke rehabilitation to see the outcome of two different approaches. One group received Bobath technique of physiotherapy and the other received Motor Re-learning Program. Both the groups received the same supplemental treatment. They concluded that patients treated with MRP stayed fewer days in hospital than those treated with Bobath technique. Motor improvement was better in MRP hence MRP was preference to that of Bobath [13].

Bayouk JF *et al* (2006) conducted a randomized control study to find the effects of task-oriented exercises with and without altered sensory input for Balance training following stroke. 16 patients participated in an 8-week task-oriented exercise program focusing on balance and mobility exercises. It concluded that a task-oriented exercise program, assisted by sensory manipulation, is more effective at improving the standing balance of stroke subjects than a conventional task-oriented program [14].

Outi Pyoria *et al* (2007) found the validity of the Postural Control and Balance for Stroke Test. In the initial phase of stroke the PCBS test scores were compared with values obtained for the Barthel Index (BI) and the four neuropsychological domains most widely studied in the literature. The ability of the PCBS test at an early stage to predict functional status, as measured by the BI, and tendency to falls at 90 days after stroke was studied in 40 stroke patients. The results confirm that the PCBS test has good construct validity, good ability to predict functional capacity and safe moving, and it is sensitive to changes in balance control after stroke [15].

2. Methodology

2.1 Study Design: Randomized Controlled Trial.

2.2 Source of Data: Both males and females who were clinically diagnosed with stroke having hemiparesis referred to the physiotherapy department, KLES Dr. Prabhakar Kore hospital and MRC and BM Kankanwadi Ayurveda Hospital Belgaum.

2.3 Sample Size: 40 participants

The sample size was calculated based on the past hospital records. The number of cases referred to the physiotherapy department for the treatment of subacute and chronic stroke each year for three consecutive years.

2.4 Sampling design: Convenient sampling. However 40 participants were randomly allocated into 2 groups using envelope method.

2.5 Inclusion Criteria

- Participants with clinical diagnosis of stroke.
- Age 40- 65 years.

- Ability to stand independently and walk with or without an assistive device.
- Cognitively sound.

2.6 Exclusion Criteria
- Quadriplegics
- Comatosed
- Serious heart and lung diseases.
- Malignancy & Infection to brain.

2.7 Materials and Equipments Used
- Record or data collection instrument.
- Consent form.
- Low plinth / bed / pillow, mats, chair
- Stepper (shoe box of 10cm high x 19 cm wide x 33cm long)
- Measuring tape, stopwatch, obstacles (blocks).
- Swiss ball, trampoline.
- Assistive devices like cane, sticks etc.
- Parallel bar.
- Objects like glass, water bottles, ball, coloured chalks etc.

2.8 Procedure
All patients referred to Department of Physiotherapy with clinical diagnosis of hemiparesis and fulfilling the inclusion criteria were included in the study. Ethical clearance was obtained from the institution ethical clearance board.
The participants were briefed about the nature of the study and the intervention. A written informed consent was taken from the participants after explanation of the procedure & its expected outcome.
The following data were collected as a baseline scores: age, sex, side affected, duration of stroke & history of fall.

2.9 Outcome measures
Functional Independence Measure and Postural control & Balance for Stroke (PCBS) test was measured on day one and end of 4th week.

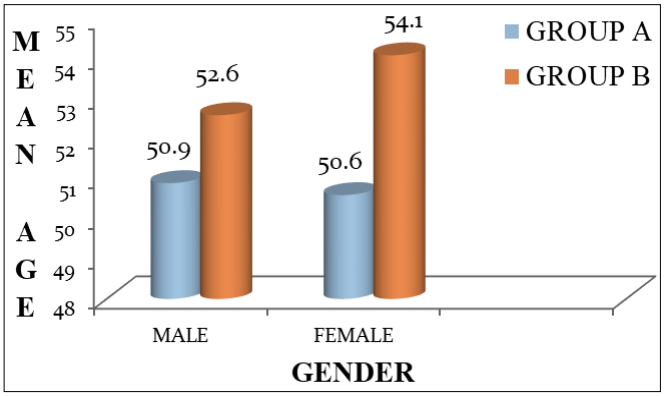
2.10 The training includes
2.10.1 Group A (Conventional group): performed active movements 10 repetitions, stretching for 30 sec hold 10 repetitions, bed mobility exercises each for 10 repetitions, sitting on chair depending on the patients minimum for 5 min maximum to 20 min, sitting on stool minimum for 5 min maximum for 20 min, standing, walking in parallel bars.

2.10.2 Group B (Experimental group): Participants were made to perform, sitting at a table and reaching in different directions; sit to stand from various stool heights; rising from a chair without the use of the arms; stepping forward, backward and sideways; picking objects from floor, obstacle crossing; stepping over blocks; reaching for objects in standing; standing eyes closed, standing eyes open, standing on different surfaces, walking four steps forward; performing double-legged stance for 10 s; performing tandem stance for 10 s and many more.
The tasks were repeated over a period of 45 minutes with adequate rest in between the session. Accuracy and independence of performing the task were noted. Precautions regarding falls were noted and patients with moderate to high risk of falls were observed and guided throughout the training period.
The training session was of 45 minutes duration per day/ session (3 days a week) with a total duration of 4 weeks (total 12 sessions). Post scores of FIM & PCBS were measured at the end of 4th week.

3. Results
The results of the study were analyzed in terms of improvements in functional independence measure & improvement in postural control, sitting balance, weight distribution & standing balance.
Improvement in FIM & PCBS score was done by comparing the scores on the 1st session before intervention & 12th session after intervention in all subjects within each group, as well as in between the two groups so as to evaluate the intra group & inter group effectiveness of training in the present study.
Statistical analysis was done manually as well as by using the SPSS statistical software version 10.0. Various statistical measures such as mean, standard deviation (SD) and test of significance such as paired & unpaired 't' test with p value ≤ 0.0001. Paired & unpaired 't' test was used to compare the difference of functional independence measure & postural control and balance for stroke (PCBS) test, within each group as well as in between the groups, before and after the treatment respectively.

Table 1: Age & sex comparission between groups

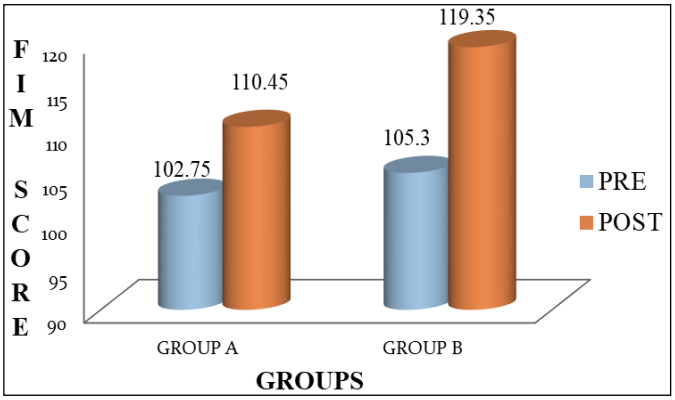
	Male		Female		Total		t	P
	Mean	SD	Mean	SD	Mean	SD		
Group A	50.9	6.77	50.6	6.4	50.85	6.5	1.054	0.299
Group B	52.6	7.15	54.1	7.13	53.1	6.99		



Graph 1: Comparison of Mean Age among Males & Females

Table 2: Intra Group Comparison of Fim Score

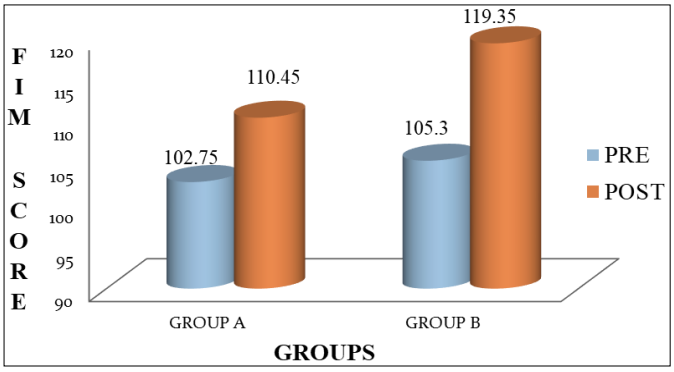
	Pre		Post		Diff		T	P
	Mean	SD	Mean	SD	Mean	SD		
Group A	102.75	9.21	110.45	6.63	7.7	4.01	8.578	0.000
Group B	105.3	13.89	119.35	6.85	14.05	8.51	7.381	0.000



Graph 2: Intra Group Comparison of Fim Score

Table 3: Inter Group Comparison of Fim Score

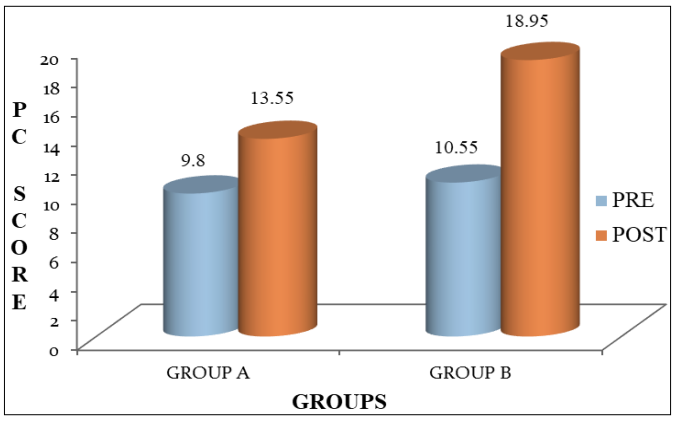
	Pre		Post	
	Mean	SD	Mean	SD
Group A	102.75	9.21	110.45	6.63
Group B	105.3	13.89	119.35	6.85
t	0.684		4.174	
p	0.498		0.000	



Graph 3: Inter Group Comparison of Fim Score

Table 4: Intra Group Comparison for Postural Control of Pcbs Test

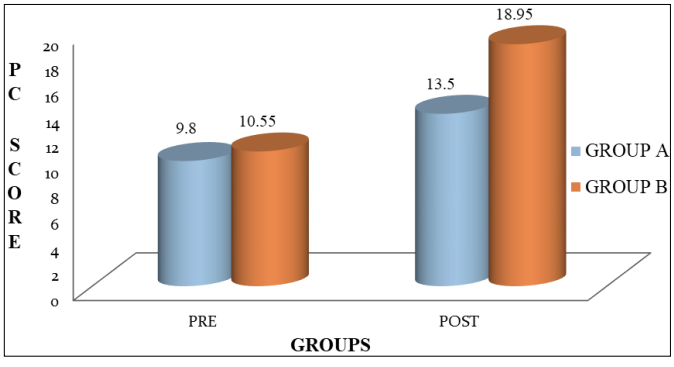
	Pre		Post		Diff		T	p
	Mean	SD	Mean	SD	Mean	SD		
Group A	9.8	2.23	13.5	2.46	3.7	1.65	9.983	0.000
Group B	10.55	3.73	18.95	2.14	8.4	2.89	12.994	0.000



Graph 4: Intra Group Comparison for Postural Control of Pcbs Test

Table 5: Inter Group Comparison for Postural Control of Pcbs Test

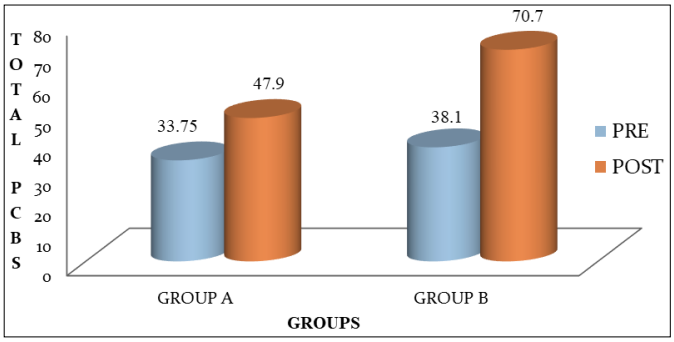
	Pre		Post	
	Mean	SD	Mean	SD
Group A	9.8	2.23	13.5	2.46
Group B	10.55	3.73	18.95	2.14
t	0.77		7.476	
p	0.446		0.000	



Graph 5: Inter Group Comparison for Postural Control of Pcbs Test

Table 6: Intra Group Comparison for Total Score of Pcbs Test

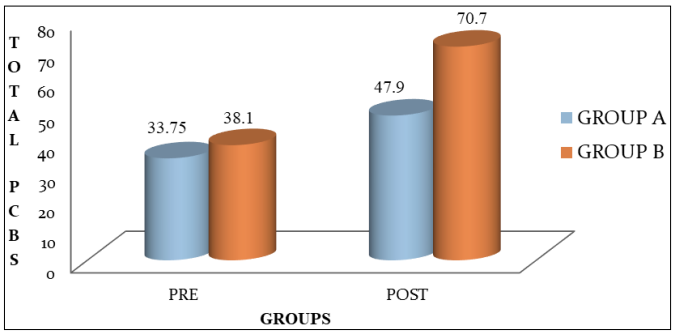
	Pre		Post		Diff		t	p
	Mean	SD	Mean	SD	Mean	SD		
Group A	33.75	7.31	47.9	8.61	14.15	4.96	12.743	0.000
Group B	38.1	10.36	70.7	4.47	32.6	8.06	18.07	0.000



Graph 6: Intra Group Comparison for Total Score of Pcbs Test

Table 7: Inter Group Comparison for Total Score of Pcbs Test

	Pre		Post	
	Mean	SD	Mean	SD
Group A	33.75	7.31	47.9	8.61
Group B	38.1	10.36	70.7	4.47
t	1.533		10.505	
p	0.134		0.000	



Graph 7: Inter Group Comparison for Total Score of Pcbs Test

4. Discussion

Postural control, balance and functional mobility are the key focus areas for therapeutic intervention after stroke. Balance behavior is complex and is influenced by multiple factors. The primary goal of this study was to see the effects of balance & postural control training using task specific approach in ambulatory hemiplegics which results in good functional outcome [16].

The study included training individuals, taking into account the individual differences of activity limitation and participation restriction. No two individuals with stroke have similar impairments and thus same functional limitations. So therapy was based more on individual needs & functional requirement. Various impairments were addressed and trained accordingly using exercises for balance & postural control. In some studies which focused on circuit training for balance problems, participants were able to attain only certain tasks like standing & reaching and not other tasks like sit to stand [14, 17]. Hence, the present study focused on training of the lost abilities or tasks.

The mean age in the study was 50.85 in the control group and 53.1 in the experimental group & both groups had equal number of male and female participants (14 male & 6 female). The age and sex ratio were matched statistically and also matched with various other studies which dealt with

balance training in subacute and chronic stroke patients [14, 18]. (table 1, graph 1)

The study showed improvement in functional performance of activities of daily living in the control & in the experimental group by an increase of FIMS score. (Table 2)

Studies suggest that FIM gives the effectiveness of therapy services even when some of the domains of the scale are not improved or not affected by the disease [19].

Functional gains have been achieved following task specific training.

Repeated task practice improved motor performance. Previous studies have shown repetitive performance of simple movements with concentration of lost tasks like use of arm, weight shifts on paretic leg, reveal definite functional benefits. Thus, due to the additional training in the experimental group by task specific activities, the improvement can be attributed to the repetitive training of functional tasks in all static & dynamic positions (sitting, standing, walk standing etc). (Table 2, graph 2).

Previous studies on task specific training for balance, did not concentrate on the tasks concerned, based on their limitations, but focused on performing either single or dual task in circuit training sessions. In the present study, participants had more difficulty in performing standing balance tasks compared to the other subsets of PCBS test.

They were given tasks based on their limitations and the same were repeated until further up gradation. The mean pre score of standing balance in group A was 10.6 and group B was 12.2 which was not statistically significant, suggesting that there was equal distribution of participants in terms of limitations among the groups. Hence, comparison of the concerned training was possible in improving balance and postural control.

Exercises taken in the study have been already used in various other studies [14, 18]. Hence, combination of those exercises which were already proven to be effective is customized according to the patient's functional requirements in the present study. The present study concentrated on single task performance at a time because performance of two tasks in a compromised individual may even decline the performance of one or both of the tasks.

Several studies utilized sophisticated equipments in training for balance and laboratory measures to score balance outcomes. Some studies suggested that there was not much difference in laboratory measurements and clinical measurements and also added on the effects of training without using any equipments like balance trainer. This study focused on task training in a clinical setup.

The study, suggest that clinicians can use task specific training in improving balance and postural control in hemiplegics and hence, reduce falls. Tasks focused on patients functional limitations and exercises tailored according to the patients needs gives better effects compared to meaningless tasks. Repetition and progression of the tasks is essential in enhancing the outcomes.

Clinicians can utilize the Postural control & Balance for stroke (PCBS) test to measure balance, postural control & functional outcomes in a clinical setup for planning treatment intervention as well as evaluating the treatment effects in stroke individuals. The test is easy to administer and predicts the balance outcomes accordingly.

5. Recommendation

Further studies are recommended with longer duration and several follow ups. Present study did not include measurements of center of pressure which gives the accurate measurements of postural control. Hence further studies should incorporate this measurement.

6. Conclusion

On the basis of the present study, it has been concluded that task specific training in treatment of balance and postural control in subacute and chronic stroke, is beneficial. Although both groups have been found to be effective in improving balance and postural control, task specific training is more effective than the sham group. Performing any task in day to day life require good balance and postural adjustments. Training with both task specific and conventional exercises gives the combined effects and faster recovery in functional outcomes. Therefore, can be incorporated in daily rehabilitation of stroke patients.

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