ORIGINAL ARTICLE

IJPHY

# EFFECTIVENESS OF TRUNK TRAINING EXERCISES VERSUS SWISS BALL EXERCISES FOR IMPROVING SITTING BALANCE AND GAIT PARAMETERS IN ACUTE STROKE SUBJECTS

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## ABSTRACT

***Background:*** The aim of this study is to evaluate the effectiveness of trunk training and Swiss ball exercises in acute stroke subjects. Trunk is often neglected part in the stroke rehabilitation, trunk training exercises and Swiss ball exercises result in better recruitment of trunk muscles thus improving sitting balance and gait parameters in acute stroke subjects. However literature evidences for trunk training exercises and Swiss ball exercises in improving sitting balance and gait are scarce in acute stroke population.

***Methods:*** A total of 60 subjects who met the inclusion criteria were recruited from department of physiotherapy, G.S.L general hospital and were randomly allocated into 2 groups with 30 subjects in each group. Initially all of them were screened for balance and gait using trunk impairment scale and by assessing gait parameters, after that they were given a 30min of trunk training and Swiss ball exercises for 5 days a week for 4 weeks. Both the groups received conventional physiotherapy for 4 weeks.

***Results:*** Post intervention there was no significant difference between the two groups. There was improvement post treatment in trunk training group ($P < 0.04$) and Swiss ball group ($P < 0.03$). The level of significance between groups was ($P > 0.5$).

***Conclusion:*** The results had shown that both groups noted significant difference. But when comparing between these two groups there is no statistical significance noted. So this study concluded that there is no significant difference between trunk training exercises and Swiss ball exercises on sitting balance and gait parameters in subjects with stroke.

***Keywords:*** Stroke, Trunk Training, Swiss Ball, Sitting Balance, Gait, Conventional physiotherapy.

Received 05th October 2015, revised 20th October 2015, accepted 14th November 2015

DOI: 10.15621/ijphy/2015/v2i6/80750

www.ijphy.org

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## INTRODUCTION

Stroke is the most common life threatening neurological disease. According to WORLD HEART FEDERATION every year 15 million people worldwide suffer from stroke, nearly 6 million die and 5 million left disabled.

It is a major health problem in India and is the third leading cause of disability and second leading cause of death. About 1.2% of deaths in India are due to stroke, the incidence is 105 per 1 lakh population in urban community and 262 per lakh in rural community.[1] Among the non communicable diseases stroke contributes for 41% of deaths and 72% of disability as estimated by Indian council of medical research.

Common problems after stroke are impaired motor functions including balance and gait disturbances.[2] The trunk being the central key point of the body, proximal trunk control is a pre requisite for distal limb movement control, balance and functional activities.[3] The sensory and motor impairments of upper limb and lower limb and trunk interfere with the functional performance after stroke. Many hemiplegics shift their center of gravity to unaffected side when maintaining quiet stance and show left right asymmetry and decreased balance ability.

In addition to limb and trunk impairments hemiplegic stroke patients frequently present with balance abnormalities and are associated with poor balance and falls . According to Tsuji, Liu M et al, the trunk muscles are impaired on both sides of the body following a unilateral stroke as evaluated by motor evoked potential studies.[4] Studies on hand held and isokinetic dynamometer muscle strength testing found that the trunk muscles are week in patients with stroke, when compared to that of age matched healthy control individuals.[5]

Effective trunk control is the ability of trunk muscles to allow the body to remain upright, adjust weight shifts and perform selective trunk movements against gravity and maintain base of support during static and dynamic postural adjustments in sitting, standing and stepping.[6]

It has been demonstrated by Yavuzer G et al, that stroke patients have abnormal and delayed postural responses in the lower extremity muscles in standing, loss of activation of the trunk muscles during voluntary movements, an increase in sway during quiet standing, a decreased area of stability in stance, delayed and disrupted equilibrium reactions, and reduced weight bearing on the paretic limb and increased risk of falling.

A study on electromyography analysis by Dickstein R et al, found an impaired postural trunk muscles activity in patients with stroke, which in turn essential for static postural control. Post urographic analysis found an impaired dynamic postural control in patients with stroke during sitting and standing.[7, 8]

A cross sectional study by verheyden et al, demonstrated that trunk control is related to measure of balance, gait and functional ability in patients with stroke. Counter rotation between the upper and lower trunk is the mobility over stability task which is essential for all the functional movements. The rotation of the trunk muscle activity is not unilateral, but requires static holding of contra lateral muscles to stabilize the central aponeurosis, so allowing the antagonist shorten and draws one side the pelvis or thorax forwards.[9]

A study by Loewen and Anderson et al., found that initial sitting balance and gait ability post stroke were found to be moderately correlated. Sadin and Smith's study determined that those patients with poor or no sitting balance also had poor mobility, transfers and independency in activities of daily living.

Poor sitting ability is a common problem after stroke.[10] The disability associated with poor sitting arises primarily because of muscle weakness and loss of dexterity and also because of tendency to adapt behavior to avoid threats to balance. Recovery of sitting after stroke is important for individuals because sitting is a skill that is critical to independent living.[11] After stroke the individuals do not load their affected foot or active muscles of the affected leg sufficiently when reaching beyond arms length in sitting.[12] Furthermore, sitting ability has been shown to be a useful prognostic indicator of this population. A study by mudic et al found that, training the patient with awareness of trunk position could improve sitting weight symmetry in stroke.

Stroke patients particularly those of advanced age are often unable to maintain their most efficient gait speed comfortably for more than a very short distance. Following hemiplegic stroke many people present with kinematic deviations from normal gait which affects in reducing the independent gait thus effecting daily activities. Approximately two-thirds of acute hospitalized stroke patients cannot walk independently, of those who recover their ability to walk, many are still disabled by slow walking speed and limited endurance.

Core is the biggest part of our body and plays an important role in the stabilization and movement

of body segments. The trunk makes it possible for us to maintain the posture and enables the movement of legs or arms, opposing gravity. It also contributes to smooth central movement so that our body easily changed to new posture (Ryeson et al., 2008). The common problem of hemiplegics is decrease in core muscle function, especially the external muscles, causes paralysis of core muscle, decreases contraction and increases tendency to fall towards the paralyzed side causing asymmetry (Handa et al, 2000) core stability is a highly reliable important predictive factor for the recovery of normal life activity and skilled tasks, which require the smooth movements of legs and arms (Hsieh et al., 2002).

A recent study on dynamic posturography analysis stated that the trunk movements in person with stroke are impaired.[13] Therefore, selective trunk muscle exercises are required. A randomized trial by G.Verheyden concluded that added 10 hours additional trunk exercises to regular rehabilitation had a beneficial effect in improving trunk control in acute stroke.[14]

Hemiplegic stroke patients frequently present with balance abnormalities and are associated with poor balance and falls.[15] Besides trunk rehabilitation, exercises to improve balance are also essential for post stroke patients. Balance training is aimed at retraining of postural control, development of effective specific strategies so that functional tasks can be performed in changing environmental contexts and improving gait performance after stroke. Thus balance retraining is an important component of a comprehensive physical rehabilitation program.

According to Marie-Helene the strengthening protocols did not match the requirements of functional tasks and as the forward propulsion of body centre of mass is a central task of walking, TRUNK TRAINING exercises are given to improve their trunk stability and balance. Another method is by giving the Swiss ball exercises, there will be improved proximal trunk control which is a pre-requisite for distal limb movement and therefore prominent gait changes can be seen.[16]

Despite of evidence demonstrating the importance of trunk performance which has been found to be important early predictor of ADL'S and long term functional outcome after stroke studies evaluating therapy aimed at improving trunk control are limited in literature.

Various studies have demonstrated the effects of therapeutic approaches used after stroke for example neurophysiologic, motor learning, strengthening exercises of limb muscles etc. But the evidence supporting the effectiveness of trunk rehabilitation and balance training is scarce. So this study was aimed at determining the effect of trunk rehabilitation and balance training on trunk control, sitting balance and gait in post stroke patients.

Intervention to train sitting is a common focus of rehabilitation after stroke. Dean and Shepherd demonstrated the efficacy of sitting training protocol in individuals who had suffered with stroke. Trunk training exercises are effective to improve sitting balance and effective loading and activation of muscles of paretic leg. Core stability exercises are effective in achieving effective balance in a multi- system and multi- dimensional task approach.

Verheyden et al. (2009) conducted a study to investigate core exercises on core conduction in stroke subjects. They suggested inclusion of core stability exercises for improving balance and selective trunk movement in stroke patients. Lee and beak (2007) concluded that core stability exercise is an effective method for improving the ability to maintain stationary posture and balance after a dynamic posture.

Swiss ball are commonly used in stroke rehabilitation as it provides greater challenge to trunk control and dynamic balance and there are evidences that Swiss ball training is superior to ground based exercises in their ability to recruit trunk muscles by increasing their demand and trunk balance on athletes. However reliable literature evidences for Swiss ball training on trunk performance is not available in stroke population.

One of the study found that selective movements of upper and lower trunk are Impaired and leads to balance problems following stroke and this study state that exercises performed on physio ball lead to better trunk muscle activity in Patients with stroke. When the exercises are performed on the Swiss ball the trunk musculature gets activated, since the Movement of a ball beneath the participants provides a postural perturbation to which muscles respond in order to main posture and therefore improves the balance.

Training on Swiss ball as a change in the stability may influence trunk muscle activity due to different biomechanical demands of the exercises and also influence the anticipatory postural adjustment which may improve trunk performance.

Hence from the above literature both the intervention that is trunk training exercises and Swiss ball, both are effective in improving the

balance and there is no study comparing these two groups till date. So this study is the first of its kind which compares the effectiveness of trunk training exercises and Swiss ball exercises on sitting balance and gait in stroke subjects.

## METHODOLOGY

Subjects are recruited from department of physiotherapy, general wards, neurology department, GSL General Hospital, Rajahmundry. A total of 70 stroke patients were taken, out of that a sample of 60 subjects were recruited who are willing to participate in the study after obtaining the consent form and the patients who met the inclusion criteria, First onset of unilateral stroke, Independent ability to sit for 30 seconds, The ability to reach with intact arm, Age between 50-70 years. The exclusion criteria for this study involves Neurological disease affecting balance other than stroke, visual problems which would interfere with reaching to pickup objects, Vestibular lesions, Hemi spatial neglect, Musculoskeletal disorders of trunk or lower extremities affecting the motor performance, Cardio- vascular conditions like myocardial infarction, Pusher's syndrome, Cognitive impairments, Severe aphasia.

## PROCEDURE

These 60 subjects were randomized into two groups, trunk training and swiss ball group by simple random sampling. Subjects were selected by lottery method. Initially all of them were screened for balance and gait using trunk impairment scale and by assessing gait parameters. After that they were given treatment for 30 mins a day, 5 days a week for 4 weeks. All 60 members in this study participated in regular physiotherapy as per regular treatment followed in rehabilitation setting.

### PROTOCOL FOR TRUNK TRAINING GROUP:

It was designed to improve sitting by reaching beyond arms length using unaffected hand while focusing on, Smooth coordinated motion of the trunk and arm to get the object, Appropriate loading of affected foot, preventing the use of mal adaptive strategies like widening base of support. Sitting with feet touching ground and reaching with unaffected arm in forward and across directions FOR EXAMPLE reach to grasp and drink a glass of water in all directions. While reaching beyond arms length, reach distance, direction and task were varied systematically.

Core stability exercises were given to enhance the trunk stability. The core stability-enhancing program was performed as follows.

All core stability-enhancing exercises were preceded by reducing lumbar lordosis by placing a pillow under both knee joints. Shoulder is placed in abduction and a towel should be placed under the scapula to prevent the compensatory action of pectoralis major. Align the neck by flexing the abdominal region. From this position subject is asked to contract the multifidus and flexor muscles simultaneously. Upper back was lifted and twisted in the diagonal direction so that right hand can face the left knee. Therapist can assist by providing minimum help for patients who have difficulty in doing it due to weak abdominals. This exercise was repeated on the other side, while performing this see to that jaw is not twisted.

### PROTOCOL FOR SWISS BALL GROUP

**SUPINE EXERCISES:**

- Bridging
- Unilateral bridging
- Trunk rotations (upper trunk and lower trunk).

**SITTING EXERCISES:**

- Static sitting balance
- Trunk flexion
- Flexion- extension of the hip
- Trunk lateral flexion
- Trunk rotations (upper trunk and lower trunk)
- Weight shifts
- Forward reach
- Lateral reach
- Perturbations.

## RESULTS

Statistical analysis was done using the statistical software SPSS 16.0 version for this purpose the data was entered into Microsoft Excel spreadsheet, tabulated and subjected to statistical analysis.

All 60 subjects completed the entire study protocol as defined by 4 weeks in the training session.

To observe the treatment impact before and after the treatment in the groups, analysis is carried out by using paired t- test, the outcome measure – Trunk impairment scale, Gait parameters (step length, stride length, cadence).

**TABLE 1:** Analysis means values of pre and post interventions of sitting balance and gait parameters in trunk training group

To compare Pre – Post exercises of the parameters, the t-test for paired sample observations has been utilized. It is observed that the post exercises have shown some significant impact on the subjects.

| Parameters | N | Mean | SD | T Value | P Value |
|---|---|---|---|---|---|
| PRE TIS | 30 | 12.70 | 1.878 | -26.072 | 0.04 |
| POST TIS | 30 | 17.87 | 1.978 | | |
| PRE STEP L | 30 | 35.57 | 5.847 | -19.823 | 0.03 |
| POST STEP L | 30 | 60.53 | 9.232 | | |
| PRE STRIDE L | 30 | 62.10 | 9.813 | -10.287 | 0.02 |
| POST STRIDE L | 30 | 68.40 | 9.261 | | |
| PRE CAD | 30 | 58.13 | 10.634 | -11.088 | 0.03 |
| POST CAD | 30 | 69.03 | 10.558 | | |

**TABLE2:** Analysis mean values of pre and post interventions of sitting balance and gait parameters in swiss ball group

| PARAMETERS | N | MEAN | SD | T VALUE | P VALUE |
|---|---|---|---|---|---|
| PRE TIS | 30 | 12.80 | 1.808 | -21.163 | 0.04 |
| POST TIS | 30 | 17.87 | 1.978 | | |
| PRE STEP L | 30 | 35.57 | 5.847 | -19.823 | 0.02 |
| POST STEP L | 30 | 60.53 | 8.232 | | |
| PRE STRIDE L | 30 | 62.10 | 9.813 | -10.287 | 0.03 |
| POST STRIDE L | 30 | 68.40 | 9.261 | | |
| PRE CAD | 30 | 57.93 | 10.003 | -4.942 | 0.01 |
| POST CAD | 30 | 67.43 | 12.039 | | |

**TABLE 3:** Analysis of effectiveness of the treatment among two groups

| Parameters | N | Mean | D f | SD | T Value | P Value |
|---|---|---|---|---|---|---|
| POST TIS GR 1 | 30 | 17.87 | 58 | 1.979 | .075 | 0.07 |
| POST TIS GR 2 | 30 | 17.87 | 58.054 | 2.979 | | |
| POST SL GR 1 | 30 | 70.53 | 58 | 13.232 | .547 | 0.06 |
| POST SL GR 2 | 30 | 71.53 | 59.754 | 14.232 | | |
| POST STR L GR 1 | 30 | 68.40 | 58 | 9.216 | .085 | 0.07 |
| POST STR L GR 2 | 30 | 68.40 | 58.087 | 10.216 | | |
| POST CAD GR 1 | 30 | 69.03 | 57 | 10.558 | .547 | 0.08 |
| POST CAD GR 2 | 30 | 70.03 | 57.029 | 11.558 | | |

On observing the means of post test parameters of TRUNK TRAINING and SWISS BALL groups, independent t-test was done and the p-value is less than 0.05. It shows there is no significant difference BETWEEN the two groups.

Overall results of the present study were analyzed which shows a significant improvement in both trunk training group and Swiss ball group. It is important to note that every parameter in both groups, when compared post to pre values, had shown significant improvement.

## DISCUSSION

Aim of this study is to evaluate effect of trunk training exercises and Swiss ball Exercises on sitting balance and gait parameters in acute stroke subjects.

Results of this study showed significant differences in both trunk training group and Swiss ball group in pre and post interventions, but results are not in the favor of either of these two groups and found that there is no statistical significance between the two groups.

Trunk control has been a key factor for balance and it is an early predictor of functional outcome after stroke. Lack of trunk control is attributed to muscle weakness, motor in-coordination and multi-sensory disintegration in subjects affected with stroke.

In this study we have included trunk training (GROUP 1) and Swiss ball training (GROUP 2) which are promising approaches in addressing these trunk impairments. So in this study we wanted to compare between trunk training and Swiss ball exercises in improving balance and I want to see to what extent these balance trainings can lead to gait changes in stroke.

Research data had shown that impaired balance is the preliminary cause in reduction of gait and functional mobility in subjects affected with stroke. This study results shows trunk training group improved both in balance and Gait after 4 weeks of training.

Holden et al, reported that the amount of physical assistance needed for functional ambulation was significantly related to measures of stride length, step length and cadence. It was suggested that these measures were meaningful in measuring treatment outcomes in hemiplegic patients. So in this study we have taken stride length, step length and cadence as gait parameters.[17, 18]

Trunk impairment scale is the clinical scale used to assess the trunk control in static and dynamic sitting balance and trunk co-ordination. This is a sensitive tool to assess the sitting balance in acute stroke subjects

Hemiparesis is the most frequent neurological deficit after stroke. Hemiparetic stroke patients frequently present with balance and gait abnormalities. Trunk control requires appropriate sensorimotor ability of the trunk in order to provide a stable foundation for balance functions in patients with stroke.

Another abnormality that can be seen in stroke subjects is gait. It is characterized by slow gait speed, poor endurance and adaptability of walking Pattern. Walking speed is widely used as an indicator of gait performance on Stroke. Several studies have related that there will be impaired walking speed in stroke subjects due to muscle weakness, spasticity and impaired balance. Although the majority of stroke patients achieve independent gait but they may not reach the level that enables them to perform all their daily activities.

Burnt et al, conducted a study and observed that the distribution of the body weight between the 2 legs was asymmetrical in hemiplegics, since the body weight was mainly supported by the sound leg during the Postural phase. So, it takes longer to transfer the body weight from their sound leg onto the hemiplegic leg. Hesse et al and Kirker et al reached similar conclusions.

Kirker et al, who studied the EMG activity of the hip abductor and adductor muscles in hemiplegic patients, reported that the EMG activity decreased in the hemiparetic muscles and that the onset latencies of these muscles were lengthened during the transfer of the body weight onto the supporting leg (the sound or hemiplegic leg).

This change in the pattern of muscle activity may be responsible for the increase in the duration of the postural phase. The third possible explanation might be that due to the lack of equilibrium in the hemiplegic leg, transferring the body weight onto the hemiplegic side may require more time. [19, 20,21]

The positive findings in this group (GROUP 1) may be because of effective load bearing through effected limb which is carried over to standing up. Trunk stabilization exercises to strengthen the muscles of the abdomen help to maintain dynamic stability of the body these exercises using functional movements are important.[22] Core stability exercises improves sitting balance and ability to maintain a static posture after dynamic posture by activation of trunk musculature especially transverse abdominis and multifidus which are deep seated muscles and they help in spinal stabilization, these muscles were trained for 4 weeks and there was improvement in sitting balance which in turn enhanced quality of gait.

Improvements in balance and gait occurred because both the trunk rehabilitation program and balance training consist of the use of lower limb muscles which account in change of balance and gait. Gait improved just not because of selective flexion and extension movements but also because of rotation exercises of upper and lower trunk. Gait and balance also improved because the motor control proceeds from proximal to distal, the improved level of proximal trunk control leads to improvement in distal lower limb control which helped in attaining better balance and gait.

The other experimental group (GROUP 2) we have included physio ball which is a good module in physical therapy to improve trunk performance and balance where there is less existing data on physio ball training in stroke.

Previous studies have reported the positive effects of trunk stabilization exercises on unstable surfaces possibly due to stimulation of the proprioceptors of the joint and muscle. Trunk stabilization training on unstable surfaces activates the postural muscles around the abdomen and pelvis, more than that on a stable surface. It has been reported that stroke patients showed improvements of balance and gait ability after trunk stabilization exercise on an unstable surface.[23, 24, 25]

In a study done by Abraham et al, concluded that there was significant improvement in stroke subjects with physio ball training. But there were no confined measures for improvements in gait.

A study on EMG analysis observed that anticipatory postural adjustment of trunk muscle activity is impaired in stroke patients and they also found that reduced recruitment of high threshold motor units in trunk muscles which are essential for postural adjustments. EMG activity following upper limb movement caused a significant attenuation in erector spinae, external oblique and internal oblique and rectus abdominis when activities are performed on a ball.

Physio balls can provide postural perturbations to trunk muscles which need to be activated in order to gain the postural stability. The possible reason for better trunk control improvement the experimental group may be that the movement of the physio ball beneath the patient provides a postural perturbation in a gravitational field to which the trunk muscles respond reactively in order to maintain the desired postural stability.

In biomechanical aspects when weight is shifted in any plane, the trunk responds with a movement to counteract the change in the center of gravity training on Swiss ball as a change in the surface stability may influence trunk muscle activity and also influences anticipatory postural adjustments and trunk performance.

Improved weight shifting ability through rotations also can enhance trunk muscle stability and balance. Improved lower trunk control effectively stabilizes the pelvis, which can lead to improved mobility and gait in the Swiss ball group.

Because of all these reasons we have hypothesized that Swiss ball would be a better medium to train hemiplegic subjects in recruiting trunk muscles thus affecting the outcomes of the study than trunk training group. We have expected better results in the Swiss ball group but at the end of the study we are accepting null hypothesis as both of the groups are equally significant.

Although Swiss ball exercises are effective in recruiting different postural muscles, it is not an easy task for hemiplegic subjects to complete all the levels of exercises. Especially, ipsilateral reaching and trunk lateral flexion to the effected side in sitting. This may be the reason even though Swiss ball group has gained better results, but it is not so different from the trunk training group as there is no greater statistical difference between two groups.

## CONCLUSION

The results had shown that both Trunk training group and Swiss ball group who received 4 weeks of therapy has improved significantly on pre and post values within the group. But when comparing between these two groups there is no statistical significance noted. So this study concluded that there is no significant difference between trunk training exercises and Swiss ball exercises on sitting balance and gait parameters in subjects with stroke.

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***Citation***

Kothalanka Viswaja, Kiran Prakash Pappala, Pilladi R Sri Tulasi, & Patchava Apparao. (2015). EFFECTIVENESS OF TRUNK TRAINING EXERCISES VERSUS SWISS BALL EXERCISES FOR IMPROVING SITTING BALANCE AND GAIT PARAMETERS IN ACUTE STROKE SUBJECTS. *International Journal of Physiotherapy*, 2(6), 925-932.