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Effectiveness of swiss ball training vs trunk and pelvic proprioceptive neuromuscular facilitation pattern for improving trunk control in patients with acute and sub acute stroke

Shrikrishna Shinde[1], Suvarna Ganvir[2]

[1]*Assistant professor MVPS College of physiotherapy Nashik.*
[2]*Professor dvvpfs college of physiotherapy A Nagar.*
***Corresponding author: Shrikrishna Shinde**
Email: krishnashinde12989@gmail.com

ABSTRACT

Background

Most literatures concerning about motor rehabilitation after stroke focus on the upper and lower extremity. Trunk rehabilitation receives only little attention. The trunk imbalance makes the post stroke patient dependent on the family members for bedside activities such as rolling to sides, reaching etc. These increase the risk for falling even from bed also hence to improve the trunk Balance the trunk rehabilitation is the concerned area for this study

Aim

To evaluate the effectiveness Of Swiss Ball Training Vs Trunk And Pelvic Proprioceptive Neuromuscular Facilitation Pattern For Improving Trunk Control In Patients With Acute And Sub Acute Stroke.

Methods

In this randomized controlled trial, 64 patients with acute and subacute stroke were divided into 2 groups, 32 in each group were recruited from PDVVPFS College of physiotherapy and hospital. Group A- received swiss ball training, Group B received pelvic PNF. Both the groups were evaluated pre – treatment and post treatment using TIA & PASS and results carried out.

Results

The within group (Intra group) comparisons of the change in the Trunk Impairment Scale score and Postural Assessment Stroke Scale score PRE & POST was assessed by paired t test The between group (Inter group) comparisons of the change in the Trunk Impairment Scale score and Postural Assessment Stroke Scale score score PRE & POST was assessed by unpaired t test.

$P \leq 0.05$ were considered significant.

Conclusion

This three weeks study result showed equal improvement in both the group in terms of static setting balance Dynamic sitting balance, co-ordination, maintaining and changing posture. Therefore, these results concluded that both Swiss ball training and PNF techniques are equally effective on improving trunk control in acute and sub acute stroke patients.

Keywords: Proprioceptive Neuromuscular Facilitation Pattern, TIA – trunk impairment scale, PASS- postural assessment stroke scale

INTRODUCTION

Stroke is a common neurological disorder, representing a major cause of disability. It is considered as a significant health problem, which needs an unremitting and wide-ranging rehabilitation [1].Stroke is also known as "cerebral vascular accident", "brain attack" or "apoplexy" [2,3]. According to WHO Stroke is defined as "acute onset of neurological dysfunction due to abnormality in cerebral circulation with resultant signs and symptoms that corresponds to involvement of focal area of brain lasting more than 24 hours" [4,5].

In stroke trunk control is impaired in 80 % of patients. Thus patients are unable to maintain the balance in sitting, standing or move in weight bearing position. They demonstrate asymmetry with most of the weight in sitting or standing shifted toward the stroke side. They also demonstrate increased postural sway in due to impairment in trunk control. Balance is also disturbed in stroke with impairment in steadiness, symmetry and dynamic stability [6].

Following the stroke trunk function is impaired along with impairment of limb function. Many scales are available to measure trunk control like, the Sitting Balance Scale developed by Nieuwboeretal [7]. Showed poor reliability, especially for the items evaluating the quality of trunk activity. The Trunk Control Test by Collin and Wade is a quick and reliable measure with predictive validity,8 9 but, the limitations of the test are that it does not take the quality of movement into account as well as the moderate correlation with trunk strength10.To measure motor impairment of the trunk after stroke, the Trunk Impairment Scale (TIS) is used, it is a clinical test to measure motor impairment of the trunk after stroke as the test /retest and inter observer reliability for the TIS was 0.96 and 0.99 respectively [11] TIS measures static and dynamic sitting balance and co-ordination of the trunk. Item per item reliability, subtotal and scale total agreement were established as well as the internal consistency of the subscales and the total scale. The assessment can be used as a guideline for treatment and takes the quality of trunk movement into account. To enhance the independence of stroke patients in daily life, the Swiss ball training and PNF pattern have been followed. Many literatures have supported the Swiss ball, but some literatures show that PNF techniques can also improve the trunk balance in acute stroke patients. **Siddhartha Patrae et al**. Did study entitling "effectiveness of Swiss ball training over conventional physiotherapy to improve trunk balance of post stroke patients and concluded that Swiss ball training improve the strength of the abdominal and back muscles, balance, co-ordination and range of motion of the joints, hence thereby improve trunk balance, using less effort and increasing patient's confidence level [12]. **S Karthikbabu. et al.** did study entitling "Comparison of physio ball and plinth trunk exercises regimens on trunk control and functional balance in patients with acute stroke" and concluded that The trunk exercises performed on the physio ball are more effective than those performed on the plinth in improving both trunk control and functional balance in acute stroke patients. The results are attributed due to better trunk control improvement in the experimental group may be that the movement of the physio ball beneath the patients provides a postural perturbation in a gravitational field to which the trunk muscles respond reactively in order to maintain the desired postural stability [13].

Pelvis is a part of trunk that supports extremity motions. Hence, the pelvic motion comes from trunk muscles. The range of motion in the pelvic patterns depends on the amount of motion in the lower spine. Biomechanically it is impossible to move the pelvis without motion in the spine as it is connected with the spine. Specific pelvic patterns of Proprioceptive Neuromuscular Facilitation (PNF), which are mentioned in the literature not only exercise the pelvis motion and stability but also facilitate trunk motion and stability. In addition, these patterns help to improve functional trunk activities and treat the upper trunk & cervical areas indirectly through irradiation [14]. **Dildip Khanal, R. & M. Singaravelan et. Al** concluded that pelvic Proprioceptive Neuromuscular Facilitation technique is effective on facilitating trunk movement in hemiparetic stroke patients. The probable mechanism by which PNF could have worked is by facilitating the neuromuscular mechanism, thus by stimulating the proprioceptors [15]. Kabat reported that a greater motor response can be attained when employing facilitating

techniques in addition to resistance.But there is hardly little study that has investigated its effectiveness in trunk movements that is essential for normal symmetry of body, balance and in functional activities. The **CoAkosleet.al.** Also observed a general decline in the use of PNF technique among the physiotherapy clinician in their practice environment. This may be due to heavy patients load in most clinics and physical tasking nature of administering the PNF techniques. 15 Hence the Purpose of this study is to compare the effectiveness of Swiss ball training vs. trunk and pelvic PNF pattern to improve trunk control in acute and sub acute stroke patients.

METHODOLOGY

Study design: cross – Randomized controlled trial
Study setting: MVP'S college of physiotherapy, Nashik
Duration of study- 6 months
Sample size: 100
Sampling technique: convenient sampling technique

Method of data collection

The study has been approved by Institutional Ethical committee. Study Design was Randomized Controlled Trial. Patients were randomly divided into two groups. All subjects were recorded for demographic characteristic including Name, age, sex, and address, type of lesion, affected side, history and underlying disease.

The subjects who met the inclusion criteria were asked to participate in the study, all procedure were explained to the subjects, written informed consent was obtained from each subjects prior to participation. Then the participants were divided into two groups using simple random sampling method viz, Group A & Group B consisting of 32 patients in each group. In group A patients received Swiss Ball Training. Whereas Group-B received PNF Pattern for trunk and pelvic.

Group A - (Swiss Ball Group)

In group A patients received Swiss Ball Training for 30 minutes, Once in a day, 6 days per week for 2 weeks. The various exercises were given in Swiss ball training are Active Sitting, Rock back-and-forth, Rock side-to-side, Circles, Seated March, Crab exercise5 Each Swiss ball exercises was given for 5 minutes with total session of 30 minutes [29].

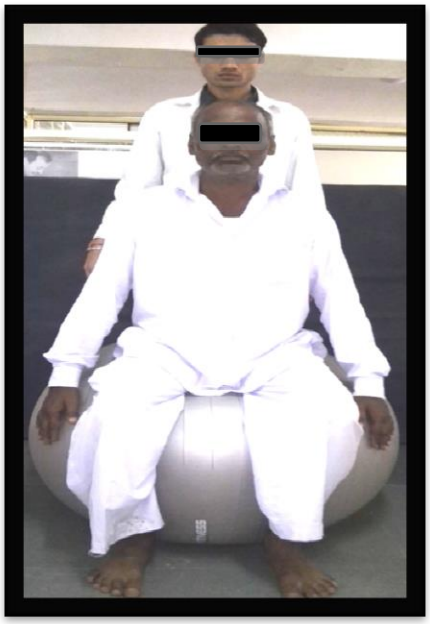


Fig.1: Active Sitting

Rock back-and-forth

The subjects were asked to sit on Swiss ball with hands on side and feet flat on the floor. Then they were asked to do the pelvic tilting slowly, anterior and posterior slowly with balance. While doing these patients were asked to keep your eye fixed straight ahead so that your neck and back are neutrally aligned.

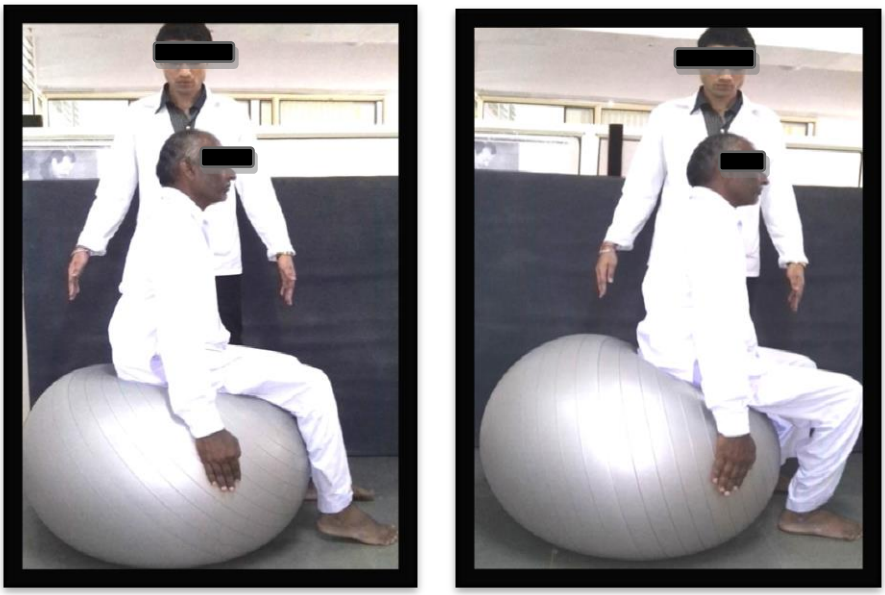


Fig. 2 : Rock back-and-forth

Rock side-to-side

The subjects were asked to sit on Swiss ball with hands on side and feet flat on the floor. Then they were asked to do the pelvic tilting slowly, to both sides with balance.

Fig. 3: Rock side-to-side

Seated March

The subjects were asked to sit on ball with hands on side and feet flat on floor, then patient they were asked to begin slow march lifting alternatively foot off the ground, progressing with comfortable speed and balance.

Fig. 4: Seated March

Crab exercise

In prone position over the ball with hands and feet parked on the floor. Arms and thigh embraced the ball and trunk maintains contact with the ball through the exercise. Then hands were pushed off from the one point of contact with to the floor with next point of contact in the following order; left hand to right hand, right hand to right foot, right foot to left foot and left foot to left hand and then alteration of direction was given i.e. anticlockwise.

Fig. 5 : Crab Exercise

Circles

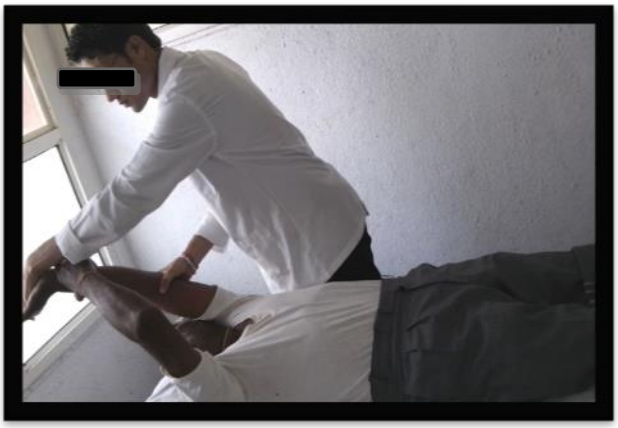
The subjects were asked to sit on ball with hands on side and feet flat on floor, then patient they were asked to rotate his pelvis forming large circles to the side, front, side, and back. Repeat this movement for 10 times clockwise, and then counter clockwise.

GROUP –B

Group-B (PNF group) received PNF Pattern for trunk and pelvic for 30 minutes, once in a day, 6 days per week for 2 weeks. The PNF patterns in the set used in the study are as described by Knott and Voss for the following 63

Upper trunk in supine position

Flexion with rotation to the left (Chopping),



Extension with rotation to the left (Lifting).

Extension with rotation with the right

For Lower Trunk in supine position

The pelvic patterns are

Flexion with rotation to the right,

Anterior elevation and

Posterior depression

Data Analysis

Graph Pad Instat version **5** was used for data analysis in this study. Baseline characteristics of the two treatment groups namely Swiss ball group and trunk PNF group were compared to evaluate the success of randomization.

The mean, standard deviation, minimum and maximum values for each test score, age and for time since onset of stroke (post-stroke period) was determined.The within group (Intra group) comparisons of the change in the Trunk Impairment Scale score and Postural Assessment Stroke Scale score PRE & POST was assessed by paired t test .

The between group (Inter group) comparisons of the change in the Trunk Impairment Scale score and Postural Assessment Stroke Scale score score PRE & POST was assessed by unpaired t test.

STATISTICAL ANALYSIS

Table 1- Baseline characteristics of Group –A & Group – B

Sr. no.	Demographic value	Group A N = 32	Group B N = 32	P value	Significant
1	Age	52.87	52.28	0.75	NS
Sex					
2	Male	13(40%)	20(62%)	0.9235	NS
	Female	19(60%)	12(38%)		
3	Duration of stroke	17.46	14.87	0.5060	NS
Affected side					
4	Right	18(56%)	20(62%)	0.99	NS
	Left	14(44%)	12(38%)		
Type of stroke					
5	Hemorrhagic	8(25%)	11(34%)	0.99	NS
	Ischemic	24(75%)	21(65%)		
Trunk impairment scale					
6	Score	9.53±2.36	10.15±3.03		NS
Postural assessment scale					
7	score	15.28±3.25	18.25±5.25	0.111	NS

Table No. 02 Comparison of TIS score pre & post-interventional 7th day within Group A and Group B

TIS	Group A	Group B
Pre-interventional Score	9.53±2.36	10.16 ± 3.07
Post- 7th day interventional Score	13.59±3.08	12.44 ±3.23
t value	15.531	8.326
p value	<0.0001	<0.0001
Results	Highly Significant	Highly Significant

Table No. 03 Comparison of TIS score pre & post-interventional 14th day within Group A and Group B

TIS	Group A	Group B
Pre-interventional Score	9.53±2.36	10.16 ± 3.07
Post- 14th day interventional Score	16.625±2.649	14.25 ±3.162
t value	23.992	12.848
p value	<0.0001	<0.0001
Results	Highly Significant	Highly Significant

Table No. 04 Comparison of PASS score pre & post-interventional 7thday within Group A and Group B

PASS	Group A	Group B
Pre-interventional Score	15.28+3.255	18.25-5.524
Post- 7th day interventional Score	22.72+3.752	22.68+5.264
t value	23.20	9.602
p value	<0.0001	<0.0001
Results	Highly Significant	Highly Significant

Table No. 05 Comparison of PASS score pre & post-interventional 14th day within Group A and Group B

PASS	Group A	Group B
Pre-interventional Score	15.28+3.255	18.25-5.524
Post- 14th day interventional Score	27.59+3.191	26.15+4.451
t value	24.29	15.79
p value	<0.0001	<0.0001
Results	Highly Significant	Highly Significant

Table No. 06 Comparison of TIS score pre & post-interventional 7th& 14thday Between Group A and Group B

TIS	Pre-interventional Score	Post- 7th day interventional Score	Post- 14th day interventional Score
Group A	9.53+2.36	13.59+3.07	16.62+2.64
Group B	10.15+3.03	12.43+3.23	14.25+3.16
t value	0.9176	1.465	3.257
p value	0.3624	0.1479	0.018
Results	Not Significant	Not Significant	Significant

Table No. 07 Comparison of PASS score pre & post-interventional 7th & 14th day between Group A and B

PASS	Pre-interventional Score	Post- 7th day interventional Score	Post- 14th day interventional Score
Group A	15.28+3.25	22.71+3.75	27.59+3.19
Group B	18.25+5.52	22.68+5.26	26.15+4.45
t value	2.619	0.02735	1.485
p value	0.111	0.9783	0.1427
Results	Not Significant	Not Significant	Not Significant

DISCUSSION

Results of present study indicate that Swiss ball training and trunk and pelvic PNF pattern are equally effective in improving trunk control.

In the PNF Group Post treatment, result shows improvement in terms of static and dynamic sitting balance and coordination when assessed by Trunk Impairment Scale, **(Table 2, 3)**.There was also improvement in maintaining and changing posture when assessed by postural assessment scale,**(Table 4,5**)

There was more improvement in post treatment trunk impairment scale, suggesting better trunk muscle activity. The probable mechanism by which PNF could have worked is by facilitating the neuromuscular mechanism, by stimulating the proprioceptors. **Kabat** reported that a greater motor response can be attained when employing facilitating techniques in addition to resistance. Facilitation resulted from a number of factors such as application of stretch, use of particular movement patterns and use of maximal resistance in order to induce irradiation. **Gellhorn and Loofbourroe et al.** Showed that when a muscle contraction is resisted, the muscles response to cortical stimulation increases. The use of particular movement patterns also causes changes in spinal and supraspinal level 5, All these facilitatory techniques might help to facilitate trunk motion and stability, treat upper trunk and cervical areas indirectly through irradiation thus enhancing the motor control and motor learning thereby improving performance of participants in post treatment group showed on TIS and PASS. A study done by **Deletis, Dimitrijevic, Sherwood and Kaisai et al**. [20] explained in detail about neuromuscular mechanism. They stated that in PNF position, sensory inputs from the periphery leads to stronger excitation of the cortical areas, leading to variations in the thresholds of a number of motor neurons, which was reflected in the motor evoked potentials. This was further supported by a study of **Benecke and Meyer et al** [21] found that the amount of sensory input coming from the periphery was greater in PNF position than in normal position, which induces changes in the excitability of the pyramidal tract and the final motor pathways. He stated that transcranial magnetic stimulation produce complex descending corticospinal volleys which usually contain a direct component via corticospinal neurons and an indirect trans-synaptic component. Even the treatment methods that allegedly are based on neurophysiological principles; however, do not have a fully comprehensive and experimentally proven neurophysiological basis. Neurophysiological approaches, however, focus on upgrading of the lost motor capacities. In that sense, **Knott and Voss19** [20, 21] referred to "hidden potentials" of the patients for the recovery.

The physiological mechanism for increasing the strength may be due to autogenic inhibition, reciprocal inhibition, and stress relaxation

[22,23,24].The techniques which were used in this study i.e. rhythmic initiation, slow reversal and agonistic reversal might help to normalized the tone of affected side trunk muscles, lengthening the contracted structures, relax the hypertonic muscles, help in initiating the movements, strengthening the weak muscles and help in improving the control of the trunk and pelvis. All these effects might directly or indirectly aid in improving the trunk control. [25]

There was more improvement in postural assessment scale after treatment intervention, suggesting carry-over effect of pelvic PNF in improving balance. The PNF approach uses the principle that control of motion proceeds from proximal to distal body regions25,26. The similar results found by **Trueblood et al**27 in this study, PNF based resisted anterior elevation and posterior depression of pelvic movements for lower trunk muscles resulted in an improvement in walking in early phase stroke participants. The result of the present study found improvement in Trunk performance in terms of static sitting balance and dynamic sitting balance and coordination However, the improvement in the entire outcome measures in this study could be due to natural recovery also, as we have recruited the acute and sub-acute stroke participants.

The result of this study shows that there was improvement in all the outcome measures in the Swiss Ball group. When evaluated by Trunk Impairment Scale **(Table 2, 3)** & Postural Assessment Scale**(Table 4,5**) .A study done by Tyson, et **al 28** found that Patients with acute stroke treated with the physio ball for four week were able to walk 5m without an aid in one minute, which means they could change the base of support between double and single stance. Furthermore, they had attained a dynamic single stance level (i.e. placing the sound leg twice on and off a step while standing on the hemiplegic leg for 15 seconds). The reason for the significant stepping balance improvement using the physio ball intervention may be an improvement in lower trunk muscle control which is essential for the stabilization of the pelvis. If an improved level of proximal pelvic stability is attained, better distal lower extremity mobility might be anticipated, such as that involved in stepping balance. The study findings are of clinical importance for the treatment of dynamic sitting balance, (i.e. physio ball) may thus be considered not only to have a beneficial task-specific effect on the selective trunk movement control but also a carry-over effect on functional balance in the comprehensive Rehabilitation of acute stroke care.

One more study by **carrierer et al (1999)** states that Swiss ball training decreases the physical strain and enhances automatic stabilization of all joints in post stroke hemiparetic subjects.

A study on electromyography analysis observed that the anticipatory postural adjustment of trunk muscles activity is impaired in patients with stroke.30Furthermore, there was a reduced recruitment of high threshold motor units of trunk muscles after stroke.32 These are, in fact, essential for reactive postural adjustments during external perturbation.31 The possible reason for improvement in trunk control in the Group A may be that the movement of the physio ball beneath the patients provides a postural perturbation in a gravitational field to which the trunk muscles respond reactively in order to maintain the Desired postural stability.

To date as per available information this study seems to be first objective investigations of the comparison between Swiss training vs. trunk and pelvic PNF pattern for improving trunk balance in acute and sub acute stroke patients. These results of the present study strongly support the rocking movement on Swiss ball increases alertness by connecting vestibular system with reticular formation. Exercises on Swiss ball restore the functions of movement and equilibrium and it encourage the patient's participation and also make the use of affected muscles easy. The uneven surface of Swiss ball reduces the chances of recitative stress on muscles. [32]

A study by **Mudie et al. [**33] found that training the patient in the awareness of trunk position could improve weight symmetry in sitting after the early phase of the stroke. Experts in the field of neurological rehabilitation have addressed the trunk as the central key point of the body. The neurodevelopmental treatment principle states that the control of movement proceeds from proximal to distal body regions. Proximal stability of the trunk is a prerequisite for distal limb movement.79Therefore, proximal trunk control improvement influences the functional balance

involved in activities such as standing and stepping.

CONCLUSIONS

This three weeks study result showed equal improvement in both the group in terms of static setting balance Dynamic sitting balance, co-ordination, maintaining and changing posture. Therefore, these results concluded that both Swiss ball training and PNF techniques are equally effective on improving trunk control in acute and sub acute stroke patients.

CLINICAL IMPLICATION

1. Both Swiss ball training and PNF techniques are simple and inexpensive, patient directed treatment strategies which can be used as important adjuncts in the treatment of trunk rehabilitation in both acute and sub acute stages of motor recovery.
2. Swiss ball training is easy to implement even in acute setting, highly motivated patients can be instructed to practice it on their own or added into their home program.

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