International Journal of Physiotherapy and Research,
Int J Physiother Res 2018, Vol 6(4):2813-22. ISSN 2321-1822
DOI: https://dx.doi.org/10.16965/ijpr.2018.156

Original Research Article

EFFECT OF SWISS BALL TRAINING AND CONVENTIONAL PHYSIOTHERAPY TO IMPROVE BALANCE AND MOBILITY IN POST-STROKE PATIENTS

Kanika D. Muniyar [1], Shrikant B. Darade [2].

[1] Nanded Physiotherapy College & Research Center, Nanded, Maharashtra, India.

[2] Assistant Professor, Nanded Physiotherapy College & Research Center, Nanded, Maharashtra, India.

ABSTRACT

Background: Post-stroke is a major heath disorder which is the commonest cause of disability worldwide. There is multi directional impairment of group of muscles. Balance & postural control is an important functional outcome & also an early predictor for functional activities of daily living after stroke. Early treatment focusing on the aspects of disabilities is needed. Swiss ball training & conventional physiotherapeutic interventions are superior methods to improve the agility of weaken core- muscles by increasing their demand & trunk balance on individuals.

Methodology: A total of 40 subject were selected from the age group between 45 and 65 and the study group was formed by using convenient sampling technique. Pre –evaluation was done on the basis of Berg Balance Scale(BBS) & Time up and go test (TUG). The Intervention used was Swiss ball training program with conventional physiotherapeutic techniques for a time –period of 45min to 1 hour. Treatment session was done 2-3 times per day & 3-5 times per week. Then a post-evaluation was done to conclude the results from data obtained.

Results: By using Graph Pad version3.0, the considered p value for BBS & TUG was > 0.05 where they obtained value was p < 0.0001, which is statistically significant.

Conclusion: Effect of Swiss ball training & conventional physiotherapy was effective to improve balance & mobility and also showed a better quality of life in post stroke patients.

KEY WORDS: Balance, mobility, stroke, BBS, TUG, Swiss ball, conventional physiotherapy.

Address for correspondence: Kanika Muniyar, Nanded Physiotherapy College & Research Center, Nanded, Maharashtra – 431606. **E-Mail:** kanumuniyar@gmail.com

Access this Article online	Journal Information
Quick Response code	**International Journal of Physiotherapy and Research** ICV for 2016 86.93 ISSN (E) 2321-1822 | ISSN (P) 2321-8975 **https://www.ijmhr.org/ijpr.html** **DOI-Prefix:** https://dx.doi.org/10.16965/ijpr
DOI: 10.16965/ijpr.2018.156	**Article Information** Received: 08 Jun 2018 Accepted: 06 Jul 2018 Peer Review: 08 Jun 2018 Published (O): 11 Aug 2018 Revised: None Published (P): 11 Aug 2018

INTRODUCTION

Stroke is a neurological disorder which Causes damage to brain. It is a major health problem which needs a significant rehabilitation programme [1]. 'stroke' is also known as 'cerebral vascular accident' or 'brain attack' or 'apoplexy' [2-4]. In stroke there is reduced oxygen supply & blood supply to the brain. Which may be because of blood clots in an artery to the brain or a narrowing of the arteries (carotid stenosis) blocking the blood flow.

Stroke is further classified as thrombotic, ischemic and embolic ischemic stroke. Thrombotic ischemic is caused as blood clots form throughout the blood vessels causing disruption of blood flow to areas of brain whereas embolic ischemic stroke occurs when blood clots travels through blood stream into the brain. Further

the clot travels to a small blood vessel to block its passage [5]. Stroke leads to chronic disability which results motor, sensory, balance, speech and perceptual cognitive deficits [6,7]. Major Risk factors for stroke are hypertension, cardiovascular disease, diabetes mellitus, arterial disease and risk factors like cigarette smoking, alcoholism, increased serum cholesterol levels, obesity, sedentary lifestyle, diet, stress and various other factors [5,8].

Stroke is a global health problem. WHO defines stroke as an '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". Globally, stroke is the 2nd leading cause of death above the age of 60 years and 5th leading cause of death in people aged 15-59 years [9,10]. Stroke Patients suffer from Hemiparesis. "Hemiparesis refers to weakness of one side of the body, weakness includes muscles of upper limb, lower limb, trunk &face. The Major disability because of neural injury is impairment of balance regulation. With balance impairment there is muscular weakness, shortening of muscle with loss of ROM, Abnormal muscle tone & stiffness.

There will be sensory & motor impairments [11]. There will be reduced functional mobility in stroke patients. Hemiplegic stroke patients frequently suffer with balance & mobility abnormalities and diagnosed with poor balance and falls [12]. With the hemiplegic limb muscles, the trunk muscles also get impaired which affects the core muscle stability of the body [13]. Stroke patients show the disturbances in gait pattern. They show kinematic deviations which affect the daily functional activities. They suffer from reduced walking speed, inability to walk independently, reduced cadence, endurance, stride length & symmetry leading to prolonged stance duration on the non-paretic side & reduced step length on the paretic side [14].

There will be loss of anticipatory activation during voluntary movements, increase in sway & reduced area of stability in quiet stance. Anticipatory postural adjustments of trunk muscles play a major role in maintaining antigravity postures like sitting & standing when a reaching task is initiated [15]. In stroke patients there was an impaired dynamic postural control during sitting & standing [16,17]. The trunk is the central key point of body with its major work to stabilize the spine & trunk (proximal trunk & distal trunk) both counterbalances each other to Maintain appropriate trunk control. Trunk control is related to measures of balance, gait, mobility & functional ability in stroke patients [18]. Studies on hand held and isokinetic dynamometer muscle strength testing found that the trunk muscles are weak in stroke patients [19]. Function of upper & lower trunk is impaired which counterbalances each other in order to maintain an overall trunk stability which is correlated with the functional outcome of the stroke patients [20-22].

What is post-stroke? Post-stroke is the condition after stroke characterized by Weakness in arm, leg or both which further causes impairment of balance &impairment of contralateral voluntary movements. Numbness in a part of body. Disturbed muscle tone in limbs. Sensorimotor deficits. Loss of proprioception. Aphasia & emotional changes occur. Cognition becomes challenging. Impaired postural control & disturbances in gait patterns after stroke results in fall [23-27].

Swiss Ball & Its Use: Swiss ball (physio ball) was developed in 1963 by Aquilinocosani, an Italian plastic manufacturer. Swiss ball is widely used for recreational & rehabilitation training programmes. As the liable surface of the Swiss ball provides greater challenge for the dynamic balance, co-ordination & trunk control. Safe exercises on stable ground have been examined with a detailed biomechanical model which provide an excellent balance between muscle stress and low compressive stress. Upper body strength exercises on a Swiss ball, stress the spinal stabilizing musculature to achieve beneficial endurance training effects. Studies have found that selective movements of upper and lower trunk are Impaired and leads to balance impairments following stroke and the studies suggest 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 & further it helps in maintaining core stability.

Stability is brought by the co-activation of trunk muscles; therefore, endurance training. Swiss exercises facilitate postural control, trunk control, sitting & dynamic balance control by reducing impaired balance & co-ordination by maintaining interaction between nervous system, musculoskeletal system & contextual effects. "BALANCE" is a complex motor control task involving the detection & integration of sensory information to assess the position & motion of the body in space & execution of appropriate musculoskeletal responses to control body position. Swiss ball exercises are effective in improving functional mobility, Trunk control, in promoting anticipatory activation by maintaining the synergy between group of muscles [28-30]. Exercises facilitate stretching &flexibility. Improves proprioception, visual sensory feedback and thus, restores function after stroke. Helps to create a significant body awareness & sense of symmetry. Improves equilibrium reaction, strength & endurance of weak muscles [31-39].

Other therapeutic approaches used with Swiss ball exercises such as Motor learning, Neurophysiologic approach, Gait training, stretching & Strengthening exercises had more effectiveness to maintain balance & mobility. Conventional physiotherapy was also used with Swiss ball training which included Gait training, stretching, strengthening, icing / Cryotherapy, passive movements & (Proprioceptive Neuromuscular Facilitation Techniques) PNF techniques [29].

There are evidences that exercise can prevent fall by improving the balance and mobility impairments [40]. The main initiative of this study was to determine Swiss ball exercise program as a Stand-Alone intervention to improve balance in post stroke patients, so that they can lead an independent & healthy lifestyle.

METHODOLOGY

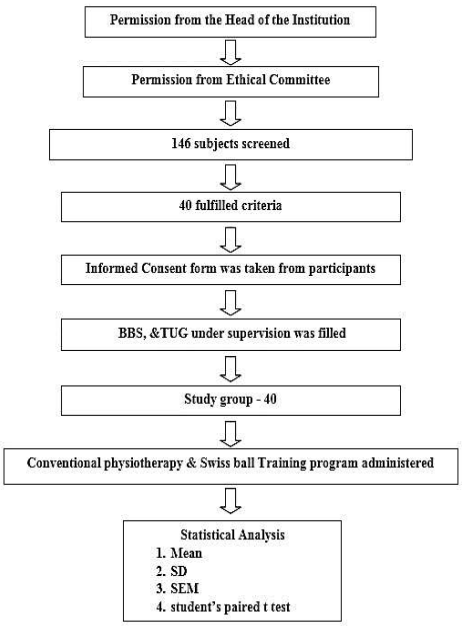
At the beginning of study an Institutional ethical committee (IEC) permission with the ethical clearance was obtained

Design: This study was experimental study of 40 subjects aged 45 to 65 were older allocated into study group. The institutional ethical committee approval has been obtained.

Patient selection: Study setting was done in the indoor patient department. Subjects were recruited & assessed on the basis of inclusion and exclusion criteria and were added to the study group by using convenient sampling technique (non-probability sampling technique). A brief explanation about the advantages and disadvantages of the study were explained to the participants. An informed written consent from all the participants was taken into consideration. A detailed evaluation following the standardized protocols and potential risk factors was undertaken. Participants with clinically diagnosed symptoms of post-stroke, subjects with acute & sub-acute stroke, hemiplegic subjects, etc. were included in the study. The modified ashworth scale score, (which is used as a simple measure of spasticity grading) should be 1+ or 2 in the selected participants. Subjects with the history of any severe injury or defects, peripheral vascular disease, neuromuscular, orthopedic, cardiac abnormalities & uncooperative subjects were excluded from the study. The study was conducted for a duration of 1 year from the date of ethical clearance. The baseline (pre) assessment was performed initially with BBS & TUG, then further evaluation and assessments were taken after 4 weeks of protocol.

Variables were used for the study was Balance, mobility, postural co-ordination, body awareness, strength & flexibility were dependent variables. Swiss ball training was independent variable.

FLOW CHART



Outcome measures for the study: Outcome measures for the study were BERG BALANCE SCORE for BALANCE, & TIME UP and GO TEST FOR MOBILITY. Validity & reliability of outcome measures were assessed & considered for the study.

Berg balance scales [41,42]: The Berg Balance Scale (BBS) was used for evaluation of functional balance abilities. It is a 14 item scale which consists of sitting balance, standing balance & dynamic balance activities which are relevant to daily life activities.

Each item is scored on a five point ordinal scale ranging from 0 to 4 points,

with a maximal score level of 56. A higher score shows better

postural control & good balance.

INTERPRETATION FOR BBS

< 20 = poor Balance

21-40 = fair balance

41-56 = good balance

Time up & go (TUG) test [43-46]: It is test for Measure of function which correlates with balance & fall risk. Patient performs activity from sitting position in a standard height arm-chair , the patient independently stands up , walks 3m then turns around, walks back, turns around & sit down again on chair.

Adults without neurological impairements who are independent with balance & mobility skills are able to perform TUG test in less than 10 sec.

INTERPRETATION FOR TUG TEST

Less than

< 10 seconds = normal

< 20 seconds = good mobility, patient requires gait aid.

< 30 seconds = show problems, there will be a risk of fall & patient requires gait aids.

Intervention [29,36,39,47-49]: Swiss ball training with conventional physiotherapy was administered to subjects for 3 to 5 times a week for 6 weeks. At the beginning of treatment program ,5 minutes warm up exercises were given. Intermittent rest periods were conducted between each set of exercise. At the end of training program cool down exercises were carried out. During exercise sessions subjects were monitored and supervised with an adequate care to avoid the risks of falls or fracture.

WARM –UP :

a) 5 minutes brisk walking.

b) Mild stretching : Hamstring stretch, gluteus maximus stretch, quadriceps stretch , gastronemius & soleus stretch , trapezius & deltoid stretch,

biceps , triceps, erector spinae , latissimus dorsi and rhomboids stretch, paraspinal stretch. (5 repetitions and 10 seconds hold)

Swiss ball training protocols included: Swiss ball training includes supine exercises, sitting exercises, Standing exercises, Prone exercises, Trunk rotations, Swiss ball core stability enhancing exercises, Swiss ball balance and co-ordination exercises.

Conventional physiotherapy interventions included Stretching & strengthening exercises, PNF techniques, icing, passive movements & gait training.

Supine exercises:

· **Bridging (hamstring curl)**

· **Lower trunk rotation**

Bridging: Patient is asked to lie down on mat in supine position. With hip flexed and knee extended, patient's legs are kept on Swiss ball. Patient is asked to lift off the pelvis with the Swiss ball placed under knees, then slowly and progressively the ball is placed under the foot, in order to increase the ability to maintain balance. The position is maintained for 10sec.

Lower trunk rotations: In supine lying, with both the lower limbs supported on the Swiss ball. Then in crook lying position patient is asked to move the knees and rotate the pelvis on either sides. Slowly the position of Swiss ball is shifted

from knees to foot end in order to gain more control.

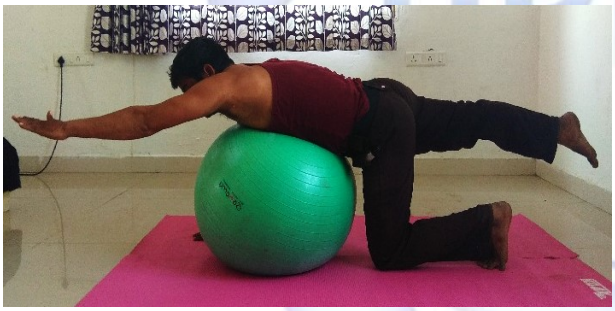
Prone exercises:

· **Swiss ball opposite arm and leg lift**

· **Back extension (abdomen supported on ball) or T-raise**

Swiss ball opposite arm and leg lift: In prone position, patient lies down on belly-side, so that the navel is over the center of Swiss ball and trunk is supported. Initially both hands and feet are supported on floor. Then slowly patient lifts his alternate one arm and one leg (right arm and left leg) and maintains the position for 10 sec.

Back extension: In prone position, patient lies on the ball with umbilicus over the center of Swiss ball. Initially the upper body was relaxed and both feet were in contact with the floor. Then, both hands were kept behind the head with both feet on ground and patient was asked to lift the upper body up and extend his back. The position was maintained progressively for 5-10 sec.



Sitting exercises:

· **Trunk flexion and extension**

· **Static sitting balance**

· **Swiss ball rocking**

· **Trunk lateral flexion**

· **Front and back bending**

· **Forward reach**

· **Lateral reach**

Trunk flexion & extension: In sitting position on Swiss ball, initially patient is asked to flex and extend the trunk without moving the forwards or backwards. Then patient is asked to flex and extend his lumbar spine. slight rotations of the trunk also occur with flexion and extension.

Static sitting balance: The patient is told to sit firm on the Swiss ball and asked to maintain a correct back posture and balance with both the feet on the ground. Position is maintained for 10 sec.

Swiss ball rocking: Patient is made to sit on the Swiss ball and asked to rock (bounce) the pelvis and hips from side to side, front to back, up & down or in circular direction.

Trunk flexion: In sitting position on Swiss ball, patient is asked to laterally flex his trunk. Upper and lower trunk lateral flexion initiates with the movement of shoulder and pelvis girdle.

Front and back bending: In sitting position on Swiss ball, with clasped hands position the patient is asked to bend the trunk forward and backward.

Forward reach: In sitting position on Swiss ball, patient is asked to reach the object in forward direction. So when the patient reaches forward towards the object, rotations also occur with the trunk flexion.

Lateral reach: In sitting position on Swiss ball, patient is asked to reach the object by flexing his trunk laterally

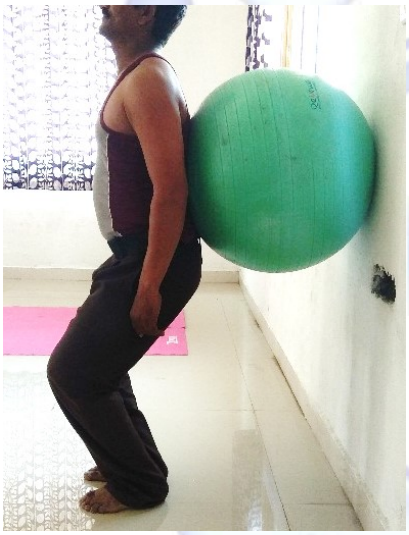
Standing exercises :

· **Wall squatting exercises (swiss ball squats) with knees in extension**

· **Wall squat with knees bending**

Swiss ball wall squats with knee extension: patient is asked to Stand and hold the swiss ball behind the back, so that the swiss ball should get pressed between the wall and patient's back. Keep the little distance between both the feets so that body can maintain balance. Maintain the position for 10sec.

Swiss ball wall squats with knee bending: Initailly, Patient is asked to stand and hold the swiss ball behind his back. Then patient is asked to slowly bend his knees with the ball supported where the ball is pinned between wall and patient's back. Maintain the position with bent knees for 10 sec.



Cool down: 5 Minutes walking, Light stretching - hip extensor and hip flexor stretch, Gastrocnemius and soleus stretch, core muscle stretch ,Paraspinal stretch (5 repetitions and 10 seconds hold).

The swiss ball training were performed with 10 repetitions , 3 sets of each segment, for 45 min. session

Data Analysis: Statistical analysis was performed by using SPSS for the windows evaluation version 21.0 and GraphPad 6.0 version. And $p<0.05$ is considered as level of significance. Data were presented as mean and standard deviation (SD). Difference within group were assessed by using student's t-test. The degree of association between TUG & BBS at pre and post-trial.

Complete data collection was done systematically following Statistical analysis using paired t-test. Graphical tables were made by using the data collected. The statistical analysis significantly demonstrated that there was a profound increase in berg balance score & decrease in Time up and go test time which concluded that there was a good improvement in balance & mobility of post-stroke patients. The significant p value resulted & implies that the study has shown positive results in post-assessment done after the training programme. (S – Significant, NS – Not Significant)

Results obtained from the study show that there was a good improvement in balance and mobility following the Swiss ball training & conventional physiotherapy.

1. The Table & graph no. 1 shows that the berg balance score has increased in post-assessment done after administered swiss ball training & conventional physiotherapy, which shows a good improvement in balance control & postural control of the body.

2. The Table & graph no. 2 for time up and go test shows that time up & go time was decreased in post-assessment done after administered swiss ball training & conventional physiotherapy.

Table 1: Berg Balance Score.

	Pre	Post
Mean ± SD	38 ± 2.58	47.7 ± 4.06
SEM	21.3	28.7
t	7.91	
df	24	
P value	**0.0001, S**	

Table 2: Time Up & Go Score.

	Pre	Post
Mean ± SD	21.9 ± 2.01	16 ± 3.12
SEM	17.64	13.64
t	5.64	
df	24	
P value	**0.0001, S**	

DISCUSSION

Balance is the complex motor control task which executes the appropriate responses between musculoskeletal, visual, vestibular, prioceptive, and cognitive systems. Balance is one's ability to maintain equilibrium in gravitational field by keeping the center of body mass over a base of support. The ability to maintain balance while sitting, standing, walking is necessary for all

functional activities performed in our day to day lives.

Post-stroke causes the multidirectional impairment of group of muscles characterized by poor balance and falls due to motor inco-ordination, sensory disintegration, muscular weakness, shortening of muscle with loss of ROM, Abnormal muscle tone & stiffness. Patients suffer from reduced walking speed, inability to walk independently, reduced cadence, reduced endurance, reduced stride length & symmetry leading to prolonged stance duration on the non-paretic side & reduced step length on the paretic side [12,14].

Balance and mobility impairments were the early predictor in post- stroke patients. The main objective of the study was to improve the overall balance and mobility with use of Swiss ball training and conventional physiotherapeutic interventions. Treatment given at the early stage of symptoms, improved a much better balance and mobility in post-stoke.

Swiss ball training and conventional physiotherapeutic interventions including traditional techniques such as stretching, strengthening, PNF etc. incorporates the improvement of central, neural and peripheral functioning and thus improves balance. Trunk control requires an appropriate sensiorimotor ability in order to provide a stable foundation for balance control after stroke. It has been shown that the trunk stabilization exercises on unstable surfaces shows improvement in Balance [30,50,52].

A quasi experimental study by Nayak et al (2012) concludes that Swiss ball training improves the trunk control after stroke. Training of swiss ball has an effect on trunk muscle activity as it influences the anticipatory postural response which may influence the trunk control [29].

According to Karthikbabu et al (2011), 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, following a task-specific effect. The trunk exercises performed on Swiss ball also improve lateral flexion and rotation of the trunk, measured by dynamic sitting balance and co-ordination subscales of the trunk impairment scale [36].

Another, comparative study by Viswaja et al (2015) suggested there was no significant difference between the trunk training exercises on sitting balance and gait parameters in subject with stroke. His researched data also showed that impaired balance is main cause in reduction of gait and functional mobility in patients affected with stroke [39]. Similarly studies according to Renald et al (2016) revealed that swiss ball training gave more significant improvement in trunk control than bed exercises among hemiparetic patients [47]. A study by Verheyden et al (2009) has concluded that 10 hours of additional trunk exercises on ground level, showed change in dynamic sitting balance but not in coordination subscale in Trunk Impairment Scale. So the trunk exercises performed on bed showed change in dynamic sitting balance and not in co-ordination subscale [25]. But the studies according to Renald et al (2016) revealed that Swiss ball training gave more significant improvement in trunk control than bed exercises among hemiparetic patients. So it concluded that Swiss ball exercises showed a significant change in both dynamic sitting balance and co-ordination in patients with trunk impairements [47].

According to Das et al (2016) a 5 weeks, Trunk Rehabilitation Program including supine exercises, sitting exercise and Swiss ball exercises, clinically show a significant improvement in trunk control and dynamic sitting balance in acute hemiparetic patients. Trunk rehabilitation programme shows statistically increased scores of TIS and forward reach distance measured using SRT from 1st Day to 3rd Week and end of the 5th Week of intervention [48]. A study conducted by Cosio-lima et al (2003), was about the effects of Physioball and Conventional Floor Exercises on Early Phase Adaptations in Back and Abdominal Core Stability and Balance in Women, The 5-week functional training program with the application of Swiss exercises resulted in significant increases in abdominal and erector spinae muscle EMG activity and increase in duration of static balance times when compared to other exercises [49].

In our study we have shown the use of Swiss ball exercises with conventional physiotherapy

such as strengthening, stretching, etc. which further more gives a better quality of balance and mobility in functionally impaired. Similarly, Rubenstein et al found that simple exercises such as PRE (progressive resistance exercises), walking and balance training can improve strength, endurance, gait and functional mobility in chronically impaired. Subjects increasing physical activity by performing simple exercises can improve a better balance and experience less fall. Thus exercises are key to improve mobility [52].

In Further studies a meta- analysis of randomized trials done by Ganvir et al (2014) Conclude that Swiss ball is more effective than other techniques for improving both trunk control and balance in acute stroke patients. This analysis also showed greater improvement in Swiss ball training group than any other exercise protocol or conventional physiotherapy group in terms of trunk performance and balance. The study also said that Swiss ball exercises are designed to bring controlled movements in spine and help to keep the discs nourished. Exercises are accompanied by proprioceptor activity. Postural stability is achieved through the co-activation of trunk muscles. Thus, with Swiss ball training, a significant improvement was seen in balance and coordination subscales [53]. Similarly, Gadhvi et al' (2016) restoration of independent gait and balance is a main aim of rehabilitation for stroke patients, because it is associated with independent mobility and reduced risk of fall. So this study concludes that trunk stabilization exercises can be incorporated to improve balance but when gait correction or symmetry is the goal of treatment, trunk stabilization exercises might not be that effective. Thus, trunk stabilization exercises improvs balance [50,54].

Recent studies aimed the additional effect of trunk stabilization exercises. Recent study suggests that additional trunk stabilization exercises with selective trunk movements improves trunk control, balance and gait speed measured by 10 MWT, cadence, step length and stride length of non-paretic side of limb. Trunk performance in stroke is related to the parameters such as balance, gait and functional ability, which are also early predictor for stroke [18,55-57]. Goldie et al said that the two determinants of gait speed, cadence and step length, decrease after stroke [58].

A study by Liaw et al found that a change of 7 BBS points in patients with chronic stroke is necessary in order to be 90% confident of a positive change [59].

Henceforth, our study concludes, post-stroke patient may become more independent with the treatment of Swiss ball training program and conventional therapeutic approaches, which improves balance and mobility and develops an overall good quality of life for post-stroke patients.

CONCLUSION

There was a significant improvement in Berg balance score & decrease in Time up and go test by using Swiss ball training & conventional Physiotherapy in post-stroke patients.

Clinical implications: Exercises performed on Swiss ball not only improves the balance but also corrects various abnormalities and thus helps to improve postural co-ordination, strength stability , flexibility, muscle endurance, body awareness, sense of symmetry by maintaining synergy between the group of muscles, trunk control, core stability, lower limb strength, equilibrium reaction, anticipatory activation, improves proprioception & sensory motor function , visual sensory feedback restores function after stroke. So, Swiss ball exercises are effective to improve the quality of life of stroke patients of post-stroke patient.

Future scope of the study: The stroke patients are facing problem with the reduced functional mobility and there is a potential risk of falls & fractures among them. In order to improve the quality of life in post-stroke patients, Swiss ball exercises, strengthening, stretching, PNF techniques, balance and co-ordination exercises, etc. are of great importance in rehabilitation programme. Exercises are cost-effective and are used globally. The study can be done for a longer duration. Future studies, conducted by randomized control trials with the help of other outcome measures which may also conclude, the patient will become more independent and there will be less burden on care-takers. Future studies could be directed at identifying appropriate

pathological groups and patient profiles that would most benefit from a cost-effective exercise program in community level.

Limitations: Exercise program is difficult to understand by the subjects, There was absence of control group, Small sample size was taken, Language problem was observed in scale measurement.

Conflicts of interest: None

REFERENCES

[1]. Dally S, and Ruff RL, Electrically induced recovery of gait components for older patients with chronic stroke, Am J Phys Med Rehabil. 2000;79:349- 60.

[2]. Thompson JE, The evolution of surgery for the treatment and prevention of stroke. The Willis Lecture, Stroke1996;27(8):1427- 34.

[3]. Kopito, and Jeff, A Stroke in Time. 6(9), 2001, MERGINET.Com.

[4]. Stroke recommendations on stoke prevention, diagnosis and therapy. Report of WHO task force on stroke and other cerebrovascular disorders, stroke 1989;20:1407-1431.

[5]. Darcy A.umphred, SusanP.Ryerson.Chapter 27 Hemiplegia.neurologicalRehabilita -tion 5th edition.Elesvier 2007;858,863,877.

[6]. Rajrupinder Kaur Rai, Lalit Arora, SmatiSambyal, Reena Arora. Efficacy of Trunk Rehabilitation and Balance Training On Trunk Control, Balance and Gait in Post Stroke Hemiplegic Patients: A Randomized Controlled Trial. IOSR-JNHS.May -Jun 2014;3:27-31.

[7]. Yuk LanTsang. "Sit and Reach Test can predict mobility of patients recovering from Acute Stroke "ArchPhysMedRehabil 2004;85:94-8.

[8]. O sullivan SB & Schimtz, Physical rehabilitation assessment and treatment. 2003;5thed,pp.705-709.

[9]. World Heart Federation.http://www.world-heart-federation.org/cardiovascular-health/stroke

[10]. Stroke –Wikepedia ,free encyclopedia

[11]. Karatas M, Cetin N, Bayramoglu M, Dilek A. Trunk muscle strength in relation to balance andfunctional disability in unihemispheric strokepatients. Am J Phys Med Rehabil. 2004 Feb;83(2):81-7.

[12]. jijimolg, fayazrk.Correlation of trunk impairment with balance in patients with chronic stroke.NeuroRehabilitation. 2013;32(2):323-5.

[13].Bohannon RW, Cassidy D, Walsh S. Trunk musclestrength is impaired multidirectionally after stroke.ClinRehabil. 1995 Feb 1;9(1):47-51.

[14]. Roerdink M, Lamoth CJ, Kwakkel G, et al.: Gait coordination after stroke: benefits of acoustically paced treadmill walking. PhysTher, 2007, 87: 1009–1022.

[15]. Hsieh CL, Sheu CF, Hsueh IP, Wang CH. Trunk control as an early predictor ofcomprehensive activities of daily living function in stroke patients, Stroke. 2002;33:2626-2630.

[16]. Dickstein r, Shefi s. Anticipatory postural adjustments in selected trunk muscles in post stroke hemiplegic patients. Arch PhysRehabil. 2004; 85(2); 261-73.

[17]. Vannesjw, Nenhusi b. Posturographic assessment of sitting balance recovery in sub acute phase of stroke. Gait Posture. 2008;28(3):507-12.

[18]. Verheyden G, Vereeck L, Truijen S, Troch M, Herregodtsl, Lafosse C, et al. Trunk performance after strokeand the relationship with balance, gait andfunctional ability. ClinRehabil. 2006;20(5):451-8.

[19]. Tanaka s, Ogata h. Trunk rotator muscle performance in post stroke hemiplegic patients. Am J PhysioRehabili. 1997;76(5):366-69.

[20]. Verheyden G, Nieuwboer A, Feys H, Thijs V, VaesK, DeWeerdt W. Discriminant ability of the TrunkImpairment Scale: A comparison between strokepatients and healthy individuals. DisabilRehabil.2005 Sep 2;27(17):1023-8.

[21].Monaco MD, Trucco M, Monaco RD, TapperoR,Cavanna A. The relationship between initial trunk control or postural balance and inpatientrehabilitation outcome after stroke: a prospective comparative study. ClinRehabil. 2010 Jun1;24(6):543–54.

[22].VanitaD'souza, Sydney RoshanRebello, NarasimmanS. Trunk performance correlates with functionaloutcome in stroke patients, Physiotherapy andOccupational Therapy Journal. April-June 2009;2(2):83-88.

[23]. Davis PM. Problems associated with the loss of selectivetrunk activity in hemiplegia. Right in the Middle.Selective trunk activity in the treatment of adult hemiplegia,sixth edition. Heidelberg: Springer, 2003;31–66.

[24]. Ryerson S and Levit K. Functional movement: A practicalmodel for treatment. Functional movement reeducation:a contemporary model for stroke rehabilitation.Edinburgh: Churchill Livingstone, 1997, pp.1–14.

[25].Verheyden G, Vereeck L, Truijen S, et al. Additionalexercises improve trunk performance after stroke: apilot randomized controlled trial. Neurorehabil NeuralRepair 2009; 23: 281–286.

[26].Liggett CA and Randolph M. Comparison of abdominalmuscle strength following ball and mat exercise regimens:a pilot study. J Man ManipTher1999; 7:197–202.

[27]. Mackintosh SFH, Hill K, Dodd KJ, Goldie P andCulham E. Falls and injury prevention should be partof every stroke rehabilitation plan. ClinRehabil2005;19: 441–451.

[28]. Segens medical dictionary, swiss ball definition, 2012

[29]. AkshathaNayak, KarthikbabuS, Vijayakumar K,Does Training on Swiss Ball Improve Trunk Performance after Stroke?- A single blinded, quasiexperimental study design. Indian Journal of Physiotherapy and Occupational Therapy – AnInternational Journal. 2012;6(1):172-5.

[30]. Gregory J Lehman, Trish Gordon, Jo Langley, Patricia Pemroseand Sara Tregaskis.Replacing a Swiss ball for an exercise bench causes variable changes in trunk muscle activity during upper limb strength exercises.Dynamic Medicine 2005, 4:6doi:10.1186/1476-5918-4-6.

[31]. BeateCarriere& Renate tanzberger; THE SWISS BALL theory, basic exercises and clinical application ;springerverlag publication ,January1998, Available fromURL-www.palmer.edu/pcc%5Flibrary/nexus/15%2820%29.htm The 'Swiss ball': an effective tool in physiotherapy for patients, families and physiotherapists. . B Carrière.Physiotherapy October 1999; 85(10): 552-61.

[32]. Nuzzojl, mc caulley. Trunk muscle activity during stability ball and free weight exercises. j strength Cond Res. 2008; 22(1): 95-102.

[33].Lehman G, HodaWand Oliver S. Trunk muscle activityduring bridging exercises on and off a swissball.Chiropractic Osteopathy 2005; 13: 14.

[34].Marshall PW and Murphy BA. Core stability exerciseson and off a Swiss ball. Arch Phys Med Rehabil2005; 86:242–249.

[35].Duncan M. Muscle activity of the upper and lowerrectusabdominis during exercises performed onand off a Swiss ball. J BodywMovTher. 2009Oct;13(4):364-7.

[36]. Karthikbabu S, Nayak A, Vijayakumar K, Misri ZK,Suresh BV, Ganesan S, et al. Comparison of physioball and plinth trunk exercises regimens on trunkcontrol and functional balance in patients with acute stroke: a pilot randomized controlled trial.ClinRehabil. 2011 Aug 1;25(8):709-19.

[37]. Cosio-lima LM , Jones MT , Paolone, Winter CR , Effects of a physioball training program on trunk and abdominal strength and static balance measures . Medicine And Science in Sports and Exercise . 2001; 33(5):p8325.

[38]. Horak , FB: Postural orientation & equilibrium : what do we need to know about neural control of balance to prevent falls? Age Ageing 35(suppl 2):ii7-ii11,2006.

[39]. KothalankaViswaja, KiranPrakashPappala, Pilladi R Sri Tulasi, &PatchavaApparao. EFFECTIVENESS OF TRUNK TRAINING EXERCISES VERSUS SWISS BALL EXERCISES FOR IMPROVING SITTING BALANCE AND GAIT PARAMETERS IN ACUTE STROKE SUBJECTS. International Journal of Physiotherapy, 2015;2(6):925-932.

[40]. Kuptniratsaikul V, Praditsuwan R, Assantachai P, Ploypetch T, Udompunturak S, Pooliam J. Effectiveness of simple balancing training program in elderly patients with history of frequent falls. ClinInterv Aging. 2011;6:111-7.

[41]. Kazon S, Grecco LAC, Pasini H, Corrêa JCF, Christovão TCL, De Carvalho PT, Giannasi LC, Lucareli PRG, de Oliveira LVF, Salgado ASI. Static balance and function in children with cerebral palsy submitted to neuromuscular block and neuromuscular electrical stimulation: study protocol for prospective, randomized, controlled trial. BMC Pediatr 2012; 12(1):53.

[42]. Kembhavi G, Darrah J, Magill-Evans J, Loomis J. Using the Berg Balance Scale to distinguish balance abilities in children with cerebral palsy. Pediatr. Phys. Ther 2002; 14(2):92-99.

[43]. Podsiadlo D, Richardson S. The Time "Up& Go": A Test Of Basic Functional Mobility For Frail Elderly Persons. Journal of American Geriatrics Society 1991; 39(2): 142148.

[44]. Shumway Cook A, Brauer S, WoollacottM.Predicting The Probability For Falls In Community Dwelling Older Adults Using The Timed Up & Go Test. Physical Therapy 2000; 80(9): 896903.

[45]. Lusardi MM, Pellecchia GL, Schulman M.Functional Performance In Community Living Older Adults. Journal Of Geriatric Physical Therapy 2003;26(3):14-22.

[46].Saskatoon Falls Prevention Consortium, Falls Screening And Referral Algorithm ,TUG, Saskatoon Falls Prevention Consortium, June 2005

[47]. S. Felix Renald, J. Raja Regan. EFFICACY OF TRUNK EXERCISES ON SWISS BALL VERSUS BED IN IMPROVING TRUNK CONTROL IN HEMIPARETIC PATIENTS. Int J Physiother Res 2016;4(2):1444-1450. DOI: 10.16965/ijpr.2016.115

[48]. Das J , Raja R , Vedavathi R, A Study to asses the effectiveness of trunk rehabilitation programme on Trunk control & Balance in acute ishaemic hemiparetic stroke patients: IOSR(JDMS'2016;15(12):72-81.

[49]. Lima LM, Reynolds KL, Winter C ,Paolone V, Jones MT, Effect of physioball & conventional floor exercises on early phase adaptations in back and abdominal core stability & balance in women: JOU of strength and conditioning RES 2003;17(4):721-725.

[50]. Stevens vk, bouche kg. Trunk muscle activity in healthy subjects during bridging stabilization exercises. bmc musculoskeletal disorder. 2006;7:75.

[51]. Navaltajw: core stabilization exercises enhance lactate clearance. J Strength Cond Res. 2007;21(4):1305 9.

[52]. Laurence ZR, Karen RJ, Peggy RT, Loy S, Harker JO, Pietruszkan FM, Robbins AS; Effects of a group exercise program on strength, mobility and fall among Fall-prone elderly men; Jou of Geront, 2000; 55(6).

[53]. Ganvir S, Shinde S, Effect of swiss ball training on trunk performance in patients with stroke: ROM JOU of PT: VOL 20/ NR 34/ 2014/97-107.

[54]. Gadhvi B et al , International Journal of Therapies and Rehabilitation Research 2016; 5 (4): 33-38.

[55]. Duarte E., Marco J., Muniese, R. Belmonte, P. Diaz, M. Tejero, et al., "Trunk Control Test as a Functional Predictor in Stroke," Journal of Rehabilitation Medicine, 2002;34(6):267-272.

[56]. G. Verheyden, A. Nieuwboer, L. de Wit, H. Feys, B. Schuback, I. Baert, et al. Trunk Performance after Stroke: An Eye Catching Predictor of Functional Outcome. Journal of Neurology Neurosurgery and Psychiatry,2007;78(7):694-698.

[57]. G. Verheyden, L. Vereeck, S. Truijen, M. Troch, I. Herregodts, C. Lafosse, et al., Trunk Performance after Stroke and Relationship with Balance, Gait and Functional Ability. Clinical Rehabilitation, 2006;20(5):451-458.

[58]. P. A. Goldie, T. A. Matyas and O. M. Evans. Gait after Stroke: Initial Deficit and Changes in Temporal Patterns for each Gait Phase. Archives of Physical Medicine and Rehabilitation, 2001;82(8):1057-1065. doi:10.1053/apmr.2001.25085

[59]. L. J. Liaw, C. L. Hsieh, S. K. Lo, H. M. Chen, S. Lee and J. H. Lin. The Relative and Absolute Reliability of Two Balance Performance Measures in Chronic Stroke Patients. Disability and Rehabilitation, 2008; 30(9):656-661.doi:10.1080/09638280701400698

How to cite this article: Kanika D. Muniyar, Shrikant B. Darade. EFFECT OF SWISS BALL TRAINING AND CONVENTIONAL PHYSIOTHERAPY TO IMPROVE BALANCE AND MOBILITY IN POST-STROKE PATIENTS. Int J Physiother Res 2018;6(4):2813-2822. **DOI:** 10.16965/ijpr.2018.156