A COMPARATIVE STUDY ON THE EFFECTIVENESS OF TRUNK STABILIZATION EXERCISES ON STABLE AND UNSTABLE SURFACES ON BALANCE AND GAIT AMONG SUB ACUTE STROKE PATIENTS

A dissertation submitted in partial fulfillment of the requirement for the degree of

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(ELECTIVE – PHYSIOTHERAPY IN NEUROLOGY)

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INTERNAL EXAMINER:

EXTERNAL EXAMINER:

A dissertation submitted in the partial fulfillment of the requirement for the degree of **Masters of Physiotherapy-May 2019** to The Tamil Nadu Dr.MGR Medical University, Chennai.

CERTIFICATE

Certified that this is bonafide work of Mr.D.Muthuraj, R.V.S.College of Physiotherapy, Sulur, Coimbatore submitted in partial fulfillment of the requirements for Master of Physiotherapy Degree course from The Tamilnadu Dr M.G.R Medical University under the Registration No: 271720021

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Muthuraj.D

DECLARATION

I hereby declare and present my project work entitled "**A COMPARATIVE STUDY ON THE EFFECTIVENESS OF TRUNK STABILIZATION EXERCISES ON STABLE AND UNSTABLE SURFACES ON BALANCE AND GAIT AMONG SUB ACUTE STROKE PATIENTS.**" The outcome of the original research work under taken and carried out by me, under the guidance of Mrs.S.Seema M.P.T.,Professor RVS College of Physiotherapy, Sulur, Coimbatore.

I also declare that the material of this project work has not formed in any way the basis for the award of any other degree previously from The Tamil Nadu Dr.M.G.R.Medical University.

Date: Signature

Place: Muthuraj.D

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Introduction

CHAPTER I
INTRODUCTION

A Cerebro Vascular Accident (CVA) or Stroke is a common nervous system disorder that occurs due to abnormal blood circulation in the brain. The individual who sustains a CVA may have temporary or permanent loss of function as a result of injury to the brain tissues **(Forster *et al.*, 2008)**.

Stroke as"rapidly developed clinical signs of focal disturbance of cerebral function, lasting more than 24 hrs or leading to death, with no apparent cause other than vascular origin **(WHO, 1989).**

Stroke incidence may vary considerably from country to country. The prevalence of stroke in India was estimated as 203 per 100,000 populations.78 per cent of strokes in 40 - 65 age group **(Dinesh, 2007).**

There are two major types of strokes: Ischemic Stroke and Hemorrhagic stroke. Ischemic stroke is by far the most common type of stroke, accounting for approximately 80-90% of all strokes. Ischemic stroke refers to a situation in which a region of the brain is deprived of blood flow, which deprives brain cells of oxygen and essential nutrients, leading to death of brain cells**.** A hemorrhagic stroke is bleeding in the brain. This type of stroke occurs when small blood vessels in the brain burst. The blood flow from the burst vessel damages brain cells. Two types of weakened blood vessels that typically cause hemorrhagic stroke are aneurysms and arteriovenous malformations **(Hopkins,2011).**

Pathological process that results from cerebrovascular accident can be divided in to three groups: thrombotic changes, embolic changes and hemorrhagic changes. Thrombotic infarction- Atherosclerotic plaque and hypertension interact to produce cerebrovascular infarcts. The plaques usually form in front of the branches of the cerebral arteries. Intermittent blockage may produce permanent damage. Embolic infarction-The embolus that causes the stroke comes from the heart, from an internal carotid artery thrombus or non atheromatus plaque of the carotid sinus. The branches of middle cerebral artery (MCA) are infarcted most commonly as a result of its direct continuation from internal carotid artery collateral blood supply is not established with embolic infarct than with thrombotic infarct. The most common intra cranial hemorrhage causing stroke is hypertensive. Massive hemorrhage frequently result from hypertensive cardiac renal disease and causes leading into brain tissues in on oval or round mass that displaces midline structure **(Umpherd,2012).**

Clinical manifestation of stroke can be numbness, weakness, and paralysis of face, arm, and leg especially on one side of the body, sudden severe headache, and loss of balance. Its depends on the concerned artery, the vascular syndromes are namely anterior cerebral artery, middle cerebral artery syndrome, posterior cerebral artery syndrome, lacunar syndromes and vertebra basilar artery syndrome. The most common characteristics anterior cerebral artery syndrome is contra lateral hemi paresis and sensory loss with greater involvement of lower extremity because the somatotropic organization of the medial aspect of the cordex, includes the functional area of the lower extremity. The most common characteristics of Middle cerebral artery syndrome are contra lateral spastic hemi paresis and sensory loss of the face, upper extremity and lower extremity, with the face and upper extremity more involved than the lower extremity. The MCA is the most common site of occlusion in stroke. Posterior cerebral artery syndrome, occlusion of thalamic branch may produce thalamic pain, occipital infarction produces homonymous hemianopsia, visual agnosia, prosopagnosia, bilateral, cortical blindness, temporal lobe ischemia results in amnesia **(Sullivan.,2014).**

Post stroke Changes in lower extremity, can cause decreased walking ability and gait pattern. Often persists long term and includes increased tone, gait asymmetry, muscle activation changes and reduce functional ability. Lower extremity strength was important for improve the gait speed, endurance and functional balance to promote the ADL activities **(Patricia *et al.*,2009).**

Many assessment tools available for the balance and gait abnormality. Balance are assessed by Berg balance scale,Burnel balance scale, Activities specific balance confidence scale,Tinetti assessment tool, balance efficacy scale, Ottawa sitting balance scale, Gait evaluated by dynamic gait index scale, Gait assessment rating scale and Functional gait assessment scale **(Collin,2003).**

Berg balance scale was developed to measure balance among stroke patients with impairment in balance function by assessing the performance of functional tasks.

It is a valid instrument used for evaluation of the effectiveness of interventions and for quantitative descriptions of function in clinical practice and research.

Dynamic Gait index is the four item scale and the gait assessment shows sufficient validity responsiveness and reliability for assessment of walking function in patients with stroke undergoing rehabilitation. Dynamic Gait index scales evaluate not only usual steady state walking, but also walking during more challenging tasks. They are graded on their ability to vary speed, turn their heads, turn their bodies, step over around the obstacles, climb stairs, turn while walking, pickup objects from the floor and perform alternate step ups on tool. It assesses individual’s ability to modify balance while walking in the presence of external demand. Dynamic Gait index scale is the assessment tool which has highest reliability and validity. So for this study berg balance scale and Dynamic gait index scales is used. A systemic review clinical of clinical tools designed to evaluate balance is assessed berg balance scale and gait is assessed by dynamic gait index scale **(Young *et al.*,2011).**

Rehabilitation consists of various techniques which are used to manipulate elements of the central and peripheral nervous system which include Mirror therapy, muscle reeducation, Brunnstroms approach, Strengthening, Stretching, Balance training, Gait training, Robotic assisted gait training **(Mehrholz *et al.*,2017).**

Trunk being the central key point of body, Trunk control ability is very essential for lower extremity movements control with balance, gait, and functional ability of the stroke. The trunk exercises performed on different support surface improved trunk muscle activation, postural control, and the gait speed of stroke. Kinematics during walking in stroke patients, pelvic movement was reportedly unstable and asymmetrical gait speed and symmetry were improved by trunk exercises **(Karthikbabu *et al.*,2011).**

Muscle weakness which is primary reason for physical function disorder its lead to hypo mobility of pelvis. Trunk plays an important role in stabilizing the pelvis and spinal column. However, stroke patients are less capable of balance and postural control due to trunk muscle weakness and damaged proprioception. In addition, postural sway increases in the sitting position, whereas weight shifting ability diminishes. Sitting balance is a predictor of functional recovery and the role of the trunk muscles in maintaining balance is important because the center of mass becomes lower than that in the standing position. Trunk muscle activation during a reaching task in stroke patients is highly correlated not only with trunk control but also with balance (**Kim *et al*.,2011).**

Balance ability is an important factor for independent life, for improving balance ability, Symmetrical weight bearing is necessary for performing daily and various functional activities such as sitting, standing up, walking, and climbing stairs. However, stroke patients supported 80% of the total weight bearing to the non-affected side while performing ADL.This problem could reduce weight bearing in the stance phase during walking and walking ability by changing the alignment and decreasing postural control ability. In addition, asymmetrical weight bearing increases psychological anxiety and restricted ADL and gait ability **(Cheng *et al*., 2004).**

Trunk stabilization exercise help to stabilize the trunk used as a part of rehabilitation program after stroke. Trunk stabilization exercises performed on an unstable surface which activates variety of trunk muscles the moment of trunk acts backward to maintain stability as the centre of mass move forward and postural sway occurs because of this shift in the centre of mass and reaction force. This exercise performed on the balance ball trunk muscle activation have been further promoted, the reaction force acting against of the shaking of the surfaces **(Teyhen *et al*.,2008).**

Strengthening the trunk muscles is crucial for improving stroke patients balance abilities and physical performance. Trunk stabilization exercises can be done both on stable and unstable surface. This present study to analyze whether the difference in surface has an effect on the improvement in balance ability and gait in stroke subjects as evidence by outcome measures berg balance scale and dynamic gait index Scale **(Dekker *et al*.,2004).**

STATEMENT OF THE PROBLEM

A comparative study on the effectiveness of trunk stabilization exercises on stable and unstable surfaces on balance and gait among sub acute stroke patients.

OBJECTIVE OF THE STUDY

- To evaluate the effect of trunk stabilization exercises on stable surface on balance ability in patients with sub acute stroke.
- To evaluate the effect of trunk stabilization exercises on unstable surface on balance ability in patients with sub acute stroke.
- To compare the effect of trunk stabilization exercises on stable and unstable surfaces on balance ability of patients with sub acute stroke.
- To evaluate the effect of trunk stabilization exercises on stable surface on gait in patients with sub acute stroke.
- To evaluate the effect of trunk stabilization exercises on unstable surface on gait in patients with sub acute stroke.
- To compare the effect of trunk stabilization exercises on stable and unstable surfaces on gait of patients with sub acute stroke.

NEED FOR THE STUDY

Most of the approaches for stroke patients focus on the gait, balance and limb function without addressing trunk stability. So present study is mainly focused on the trunk stabilization exercises using stable and unstable surfaces for balance and gait among sub acute stroke patients.

Hypothesis

- It is hypothesized that there may not be significant difference following stable surface exercises on balance and gait among sub acute stroke patients.
- It is hypothesized that there may not be significant difference following unstable surface exercises on balance and gait among sub acute stroke patients.
- It is hypothesized that there may be significant difference between stable surface exercises on unstable surface exercises balance and gait among sub acute stroke patients

Operational definitions

Stroke

Stroke is an acute onset of neurological dysfunction due to an abnormality in cerebral circulation with resultant signs and symptoms that corresponds to involvement of focal areas of the brain **(WHO,1989).**

Trunk control

Trunk control is the ability of the trunk muscles to allow the body to remain upright, adjust weight shift, and performs selective movements of the trunk**.** So as to maintain the center of mass within the base of support during static and dynamic postural adjustments **(Karthikbabu *et al*.,2011).**

Trunk stabilization exercises

Trunk stabilization exercises to strengthen the muscles of the abdomen help to maintain dynamic stability of the body. Trunk stabilization exercises using functional movements are important. In particular, trunk exercise is necessary for stroke patients with difficulties with gait and balance **(Teyhen *et al.*,2008).**

Balance

Balance is a complex process involving the reception and integration of sensory inputs and planning and execution of movement to achieve a goal requiring upright posture. It is the ability to control the centre of gravity over the base of support in a given sensory environment **(Umphehred,1995).**

Gait

Gait is a manner of ambulation or locomotion involves the total body. Gait speed determines the contribution of each body segment. Normal walking speed primarily involves the lower extremities, with the arms and trunk providing stability and balance. The faster the speed depends on the lower extremities and trunk for propulsion as well as balance and stability **(Shultz,2017).**

Berg balance scale

Berg balance scale is an objective measure of static and dynamic balance abilities. The scale consists of 14 functional tasks performed in everyday life. The items range from sitting or standing unsupported, to movements transition, variation in standing position, feet together, forward reach retrieving an object from the floor, turning, standing on one foot ,to put on a stool. Score uses a five point ordinal scale, with scores ranging from 0-4 **(Sullivan,2014).**

Dynamic index scale

Dynamic index scale was developed as a clinical tool to assess the gait. It evaluates not only usual steady state walking, but also walking during more challenging tasks. Dynamic Gait index is the four item scale and the gait assessment shows sufficient validity responsiveness and reliability for assessment of walking function in patients with stroke undergoing rehabilitation **(Herdman,2000).**

Review of literature

CHAPTER II
REVIEW OF LITERATURE

Section A: Studies on General aspects of Stroke
Section B: Studies related to trunk stabilization exercises on stable surfaces
Section C: Studies related to trunk stabilization exercises on unstable surfaces
Section D: Studies on the reliability and validity of berg balance scale
Section E: Studies on the reliability and validity of Dynamic Gait index scale

Section A: Studies on General aspects of Stroke

Thomas *et al.,(*2013) studied the patients on 208 infarction of the middle cerebral artery (MCA) corresponding to 7.6% of all ischemic infarction seventy two patients had complete infarction in the whole middle internal carotid artery (ICA) Occlusion (41%) and ICA dissection (12%) were more common than in limited superficial MCA infarct and anterior circulation infarct. Severe neurologic deficit (hemiplegic and hemi sensory loss in face, arm and leg, hemianopia, global aphasia, reduced consciousness) was more common than in other types of infarct. A sixteen of the 35 deaths could attributed to brain edema. Patients who died because of brain edema were younger. Furthermore large middle cerebral artery infarction is associated with cardiogenic embolism, ICA dissection and ICA occlusion. It is a major predictor of death and severe disability; although a lower brain infarction was found than previously reported.

Sridharan *et al*.,(2011) studied the incidence, types, risk factors. Outcome of stroke in a developing country. The participants are 204 stroke patients with acute ischemic stroke revealed the matched pair odds ratio for hypertension, ECG abnormality, heart disease, diabetes, smoking and alcohol intake, High-density lipoprotein (HDL) cholesterol and uric acid were lower and the ratio of total cholesterol to HDL was higher among stroke patients. They found out come that among the stroke survivors, at 3 weeks of stroke onset, 39% had mild disability 44% had moderate disability and 17% had bedridden nearly two-third of survivors were moderately or severely disabled at 3weeks, high lighting the social burden lower HDL cholesterol and uric acid and higher ratio of total cholesterol/HDL to be a significant factors.

Deepti *et al*.,(2010) conducted a study on stroke in young and elderly, it is a retrospective study carried out in the CVA patients. The etiology of acute ischemic stroke is significantly influence management, prognosis, and risk of recurrence. The cardio embolic infarctions are common in India. The patients were studied over a period of three months. The study population consisted of 500 patients. The study was undertaken to analyze the clinical profile and to arrive at the factor contributing strokes in less than 45 years. The result shows that stroke is common in more than 45 years, but still young stroke carries important due to loss of productive years. Most of the patients are alcohol and tobacco abusers.

VanPapen *et al*.,(2004) conducted a Study on the evidence of physical therapy intervention to improving functional outcome after stroke.123 randomized control studies and 28 control group were included in this study. Based on high quality randomized control trails study strong evidence was found in favor of task oriented exercise training to restore balance and gait ,and for strengthening the lower parasitic limb in particular when applied intensively and early after stroke onset**.**

Jorgensen *et al*.,(1995) did a study to assess the time course for recovery depends on initial severity of impairments. 1,197 acute stroke patients were selected. Impairments were classified using the Scandinavian Neurological Stroke Scale (SSS) and functional disability was defined according to the Barthel Index (BI). Neurological recovery occurred on average two weeks earlier than functional recovery. The best neurological recovery occurred within 4.5 weeks in 80% of the patients, ADL function was achieved by 6 weeks. For 95% of the patients, best neurological recovery was reached by 11 weeks and best ADL function within 12.5 weeks. The best walking function was reached within four weeks for patients with mild paresis of the affected lower extremity, six weeks for those with moderate paresis and 11 weeks for severe paralysis. Consequently, the time course of both neurological and functional recovery was strongly related to both initial stroke severity and functional disability. He found two-thirds of all stroke survivors have mild to moderate strokes and are able to achieve independence in ADL.

Section B: Studies related to trunk stabilization exercise on stable surfaces

Cabanas *et al*.,(2013) conducted the literature on trunk training exercises (TTE) in adult patients with stroke. To establish if TTE can improve trunk performance and sitting balance. The primary outcomes were trunk performance and sitting balance. A total of 11 studies with 317 participants were analyzed. Trunk training exercises showed a moderate evidence to improve trunk performance and dynamic sitting balance. Trunk training exercises, performed with stable surface to improving trunk performance and dynamic sitting balance after stroke.

Hyunbae *et al*.,(2013) did a study the effects on stroke patients of trunk stabilization exercise on different support surfaces. Sixteen stroke patients with onset of stroke six months earlier or longer were randomly and equally assigned to group I (exercise performed on a stable support surface) and group II (exercise performed on an unstable support surface). The two groups conducted the trunk stabilization exercises on the respective support surfaces, in addition to existing rehabilitation exercises five times per week for 12 weeks. Result showed that Exercise on the stable support surface to improve the trunk muscles and balance ability.

Yoo *et al*.,(2012) studied the effect of trunk stabilization exercise using an stable surface on the abdominal muscle structure and balance. 30 moderate stroke patients were selected. Two groups are divided into control group (n=15) and experimental group(n=15).Trunk stabilization exercise was performed either on a fixed mat for 30 minutes session, 3 days a week for 6 weeks. On measuring the abdominal thickness of internal oblique and transverses abdominal muscles using ultra sound, the result showed that the abdominal muscle thickness improved significantly for the people who practiced the stabilization exercises on both group. Also, the mean change in the BBS scale.

Karthikbabu *et al*.,(2007) evaluated the benefits of plinth based trunk exercise protocol in 15 people with sub-acute stroke (mean 6-1.5 years). Study population practiced 45 minutes trunk specific exercise session on a stable, 4 days a week for 4 weeks duration. Post training, the mean change was larger for the trunk control(1.6 points) and balance ability (6 points) as measured by TIS and BBS than the gait speed (change of 0. 1 m/s) and cadence (increased by 5 steps).

Bae *et al*.,(2002) investigated the effects of trunk stabilization exercises using stable support surfaces and examined the cross-sectional area of the trunk muscles and balance ability in 16 stroke patients (mean, 18 months). 30 minutes of trunk exercises using the stable support daily, 5 days a week for 12 weeks duration. The changes in the cross-sectional area of the trunk muscles were examined using computed tomography, and changes in the balance ability were assessed using a BBS and DGI. The cross sectional area of bilateral multifidus and par vertebral muscles was shown significant changes in stable surface group. The Exercise practiced using stable support surface improved trunk muscles and balance ability.

Section C: Studies related to trunk stabilization exercise on unstable surfaces

Tamayavan *et al*.,(2017) a study conducted the effect of trunk rehabilitation using unstable support surfaces compared to stable support surfaces, on static and dynamic balance after stroke. 184 Adult stroke patients were included in this study, Two groups were divided and trunk training was provided in the Unstable support surfaces like Physio balls, balance pads, air cushions, tilting boards, etc. in another group were included mat exercise additional therapy or without conventional therapy. Result showed that Trunk training on unstable support surfaces seemed to be superior to stable support surfaces in improving static and dynamic balance.

Young *et al*.,(2016) conducted study on effects of trunk stabilization exercises performed on an unstable surface on trunk muscle activation, postural control, and gait speed in stroke patients. Twenty-four participants with stroke were recruited in this study and randomly distributed into experimental (n = 12) and control groups (n = 12). Subjects in the experimental group participated in trunk exercises on the balance pad for 30 min, five times a week for 4 weeks; those in the control group performed trunk exercises on a stable surface for 30 min, five times a week for 4 weeks. Trunk muscle activation was measured by using surface electromyography, and trunk control was evaluated with the Trunk Impairment Scale (TIS). Gait speed was measured with the Dynamic gait index score. Result showed that Activity of the external and internal oblique muscles in the experimental group was significantly higher than that in the control group. Dynamic gait index score also significantly improved in the experimental group. Trunk exercises on an unstable surface improve trunk muscle activation, postural control, and gait speed in patients with hemi paretic stroke.

Jung *et al*.,(2015) conducted the study on effects of trunk stabilization training using visual feedback on an unstable surface to improve balance and trunk stability of individuals with sub-acute stroke. Twenty-six patients after stroke were enrolled and randomly allocated to a training group and a control group. Participants in both groups performed patient-specific therapeutic exercise for 5 days per week, 1 hour per day, for 4 weeks. Participants in the training group received trunk stabilization training using visual feedback while sitting on an unstable surface. The result showed that there was significantly greater in the training group than in the control group. Trunk stabilization training using visual feedback improved sitting balance. This training would be an effective way to exercise in order to promote functional activity and balance.

Junsangyoo *et al*.,(2014) studied to assess the effect of trunk stabilization exercise using an unstable surface on the abdominal muscle structure and balance of stroke patients. Total 25patients are selected. Patients were divided into two groups: an unstable surface trunk stabilization exercise group (n=13), and a stable surface trunk stabilization exercise group (n=11). Both groups performed trunk stabilization exercise for 30 minutes, 3 days per week for 6 weeks. Abdominal muscle thickness and the Berg Balance Scale (BBS) were measured at the baseline and after 6 weeks. The result showed that there was a significant improvement in the internal oblique muscle thickness, transverses abdominal thickness and balance ability of the unstable surface trunk stabilization exercise group. The unstable surface trunk stabilization exercise improved the internal oblique and transverses abdominal muscles and balance ability. These results suggest that unstable surface trunk exercise is useful in the rehabilitation stroke patients.

Lee *et al*.,(2011) conducted Study on the effects of balancing exercises on unstable surfaces on the balance ability of stroke patients in a comparison with balancing exercises on stable surfaces.30 stroke patients (16 males and 14 females)were selected. They were separated into two groups; a stable surface exercise group (n=15) and an unstable surface exercise group (n=15). The balance ability of patients was measured using the Berg balance scale (BBS) and parameters of sway of the center of pressure (COP). Exercises were conducted six times a week for six weeks. The result shows that only the velocity moment decreased in the stable surface exercise group, whereas mediolateral and anteroposterior movement distances and the velocity moment decreased in the unstable surface exercise group. The BBS scores of both groups increased, indicating improved balance ability, and balancing exercise on an unstable surface was more effective than on a stable surface at improving the balance of stroke patients.

Section D: Studies on the reliability and validity of berg balance scale

Kim *et al.*, *(*2017) did a study investigate the 7 item Berg balance scale (BBS) 3–point, which is a short form of the BBS, has compatible psychometric properties in comparison with the original BBS, and also to study the concurrent validity using a 10-meter walk test and a timed up and go test, which are widely used with BBS in clinical settings.255 patients were selected. Results obtained from 188 patients who completed both 10mWT and TUG. The three levels in the center of the BBS were collapsed to a single level (i.e., 0-2-4) to form the SFBBS. The concurrent validity was assessed by computing the Spearman coefficients for correlation among outcome measures and in between each outcome measure and the SFBBS. The corrected p-value for significant correlation was 0.013 .Spearman coefficients for correlations and evaluation instruments for concurrent validity revealed significantly high validity for both of SFBBS and BBS (r=0.944). 10mWT and TUG were –0.749 and –0.770 respectively, which are in the high margin and are statistically significant (p>0.000).The result showed that BBS has sound psychometric properties for evaluating patients with stroke. Thus, we recommend the use of SFBBS in both clinical and research settings.

Wong *et al.*, (2015) conducted the study to validate the utility of the berg balance scale among 325 patients stroke unit were from rehabilitation centre. These results generally concur with previously published results, obtained at different rehabilitation setting. Age did not correlate significantly with the outcomes measured in this study. This was conducted in geriatric population. This study validates the use of the BBS scores in assisting to estimate approximate LOS and eventual discharge destination.

Blum *et al.*,(2008) studied the systematic review of the psychometric properties of the BBS specific to stroke and to identify strengths and weaknesses in its usefulness for stroke rehabilitation**.** Twenty-one studies examining the psychometric properties of the BBS with a stroke population were selected. Internal consistency was excellent. Sixteen studies focused on validity and generally found excellent correlations with the Barthel Index, the Postural Assessment Scale for Stroke Patients, Functional Reach Test, the balance subscale of Fugl-Meyer Assessment, the Functional Independence Measure, the Rivermead Mobility Index (except for weight shift and step-up items), and gait speed. Berg Balance Scale scores predicted length of stay, discharge destination, motor ability at 180 days post stroke, and disability level at 90 days, but these scores were not predictive of falls. Eight studies focused on responsiveness, all reported moderate to excellent sensitivity. The result showed that the BBS is a psychometrically sound measure of balance impairment for use in post stroke assessment.

Weng *et al.*,(2007) conducted a study to validate of Berg Balance Scale (BBS) in patients with stroke. Forty patients with stroke selected. Each participant performed the assessment of BBS, Fugl-Meyer Scale, maximum walking speed and Barthel Index on the same day. Construct validity was investigated by using a factor analysis. The confirmatory factor analysis suggested a two-factor structure. Two factors were accounted for 70.6% of the variance. The first factor measured static-related problems and the second factor measured dynamic-related problems. The measurements indicated a good factorial validity for BBS. The scores of BBS closely correlated with maximum walking speed and Barthel index $P<0.001$, and indicated a high level of convergent validity for BBS. The lower limb section at Fugl-Meyer scale assessment had positive correlation with scores of BBS, $P<0.001$ and Fugl-Meyer scores>25 group achieved a significantly higher scores of BBS than Fugl-Meyer scores ≤ 25 group, $P=0.007$. The result showed that BBS scale was good construct validity in patients with stroke.

Yehchou *et al.*,(2006) investigated to improve the utility of the Berg Balance Scale (BBS), and to develop a short form of the BBS (including test reliability, validity, and responsiveness) to the original BBS for people with stroke. 226 subjects with stroke were selected, 167 of these subjects also were examined at 90 days after their stroke. The BBS, Barthel Index, and Fugl-Meyer Motor Test were administered at these 2 time points. By reducing the number of tested items by more than half the number of items in the original BBS (ie, making 4-, 5-, 6-, and 7-item tests) and simplifying the scoring system of the original BBS (ie, collapsing the 5-level scale into a 3-level scale [BBS-3P]), we generated a total of 8 SFBBSs. The distributions of scores for all 8 SFBBSs were acceptable but featured notable floor effects. The 4-item BBS, 5-item BBS, 5-item BBS-3P, and 7-item BBS-3P demonstrated good reliability. The subjects' scores on the 6-item BBS, 6-item BBS-3P, 7-item BBS, and 7-item BBS-3P showed excellent agreement with those on the original BBS. The 6-item BBS-3P and 7-item BBS-3P exhibited great responsiveness. Only the 7-item BBS-3P demonstrated both satisfactory and psychometric properties similar to those of the original BBS. The result shows that the 7-item BBS-3P was found to be psychometrically similar to the original BBS. The 7-item BBS-3P, compared with the original BBS, is simpler and faster to complete in either a clinical or a research setting and is recommended.

Section E: Studies on the reliability and validity of dynamic gait index scale

Anuja Pawar *et al.*,(2018) conducted a study on the effects of trunk control exercises on gait using dynamic gait index in stroke patient and effects of trunk control exercises on balance using berg balance scale in stroke patients. 30 samples were selected, at age group 40yrs to 60yrs. Assessment was done on trunk impairment scale, berg balance scale for assessing trunk, balance and dynamic gait index scale for assessing the balance and gait. Group A were given conventional exercises and 15 samples with group B were given trunk control exercises with conventional exercises. Total 3 sessions per week for 4 weeks were given. The result showed that pre and post readings were compared for trunk impairment scale with berg balance scale and dynamic gait index which shows more significant improvement in experimental group.

Alghwiri., (2014) studied the reliability and validity dynamic gait index scale in people with post stroke51 patients with stroke (age between 33 to 66 years).were enrolled in this study.DGI score reflected high agreement for both the intra rater and inter rater reliability. Hence the availability of Dynamic gait index facilitates a valid and reliable measure of gait in patients with post stroke.

Jonsdottir *et al*.,(2007) studied the test, retest and inter rater reliability as well as construct validity of the dynamic gait index as a measure of dynamic balance in people with chronic stroke .A consecutive sample of 25 participants at least 3 months post stroke and able to walk at least 10miniutes with or without a walking aid, participated in this study. A dynamic gait index shows high reliability and evidence of concurrent validity with other balance and mobility scale. It is a useful tool for clinical evaluation for dynamic balance in ambulatory people with stroke.

Simon *et al.*,(2004) conducted a study to establish the test-retest and inter rater reliability as well as the concurrent construct validity of the Dynamic Gait Index (DGI) as a measure for dynamic balance in people with sub acute stroke. A consecutive sample of 25 participants, at least 3 months post stroke and able to walk at least 10m with or without a walking aid, participated in the study. Two independent raters rated performances on the DGI. The DGI was administered in 2 testing sessions 3 days apart. In the second session, the participants were rated by 2 raters. Interclass correlation coefficients (ICCs), and were used to analyze total scores and item scores. Concurrent construct validity was tested by correlating results to the Burg Balance Scale, the timed walking test and the Activities-specific Balance Confidence Scale. The result shows that ICCs for test-retest and inter rater reliability of total scores were good. The hypotheses for concurrent construct validity were confirmed with all measures. DGI showed high reliability and showed evidence of concurrent validity with other balance and mobility scales. It is a useful clinical tool for evaluating dynamic balance in ambulatory people with stroke patients.

Methodology

CHAPTER III

METHODOLOGY

3.1 Study setting

This study was conducted in Physiotherapy outpatient department RVS College of Physiotherapy, Sulur, Coimbatore.

3.2 Selection of subjects

20 Clinically diagnosed post sub acute stroke patients were selected for the study who fulfilled the inclusion and exclusion criteria and randomly divided into two equal groups**.**

GROUPA: Trunk stabilization exercises on stable surface

GROUP B: Trunk stabilization exercises on unstable surface

3.3 Variables:

3.3.1 Independent variables

- Trunk stabilization exercises on stable surface
- Trunk stabilization exercises on unstable surface

3.3.2 Dependent variable

- Balance
- Gait

3.2 Measurement tools

Variables	Tools
Balance	Berg balance scale
Gait	Dynamic gait index scale

3.3 Study design

Pre-test and Post- test experimental study

3.4 Study duration

The duration of treatment for each individual patient was six weeks, five days per week

3.5 Inclusion Criteria

- Stroke patients with duration between 6-12 months
- Clinically diagnosed as middle cerebral artery stroke
- Both sexes were included in the study
- Age between 55-65 years
- Subjects who are independently able to sit and perform exercises on Swiss ball
- Subject with ability to understand therapist direction and communication

3.6 Exclusion criteria

- Disease affecting balance other than stroke neurological disorders such as cerebellar disease, Parkinson's disease, vestibular lesions
- Postural hypertension
- Subject who depend on any orthotic devices
- Orthopedic problems such as fracture, arthritis, deformities and contractures
- Brain tumors
- Cognitive and perceptual disorders
- Traumatic brain injury
- Subject with musculo skeletal problems
- Subject with psychiatric illness
- Visual impairments and hearing deficit

Orientation to the subjects

A total 20 subject were selected on the basis of inclusion and exclusion criteria and were divided equally into two groups. Group A and group B using randomized sampling of method. Each group consisted of 10 subjects, the study procedures were explained to the subjects and informed consent was obtained prior to the study. The group A performed trunk stabilization exercises on stable surface (mat) while the group B performed on unstable surface (Swiss ball).Both groups underwent 45 minutes of supervised trunk stabilization exercises 5 times a week for 6 weeks. Assessment was taken on the first day and on the completion of the treatment. The outcome measures were Berg Balance Scale & Dynamic Gait Index Scale.

3.7 Materials used

- Mat
- Swiss ball
- Chair
- Stop Watch
- Paper & Pencil
- Patient Consent form
- Berg balance scale scoring sheet
- Dynamic gait index scale scoring sheet

3.8 Test administration

Balance

Purpose: To assess the balance of each patient

Equipment required: Berg balance scale, stop watch, inch tape

Procedure: There are about 14 items to check balance, each score has to marked by therapist, maximum score in 56

Gait

Purpose: To assess the functional gait ability of each patient

Equipment required: Box (shoebox), cones (2), stairs, 20’ walkway, 15” wide, dynamic index scale

Procedure: There are about 4 point ordinal scales, ranging from 0-3. 0 indicates the lowest level of function and 3 the highest level function. Each score has marked by therapist maximum score is 24.

3.12 Treatment procedure

Group A: Stable surface exercises

Treatment duration: 45minutes /day
Session applied : 5 times a week / 6week

The group A receives supervised trunk stabilization exercises on stable surface (mat) for 45 minutes, in which group performed 5 minutes warm-up exercise before the start of training such as raising the upper extremities, trunk flexion and rotation for range of motion and flexibility.

Supine exercises

1. **Pelvic Bridge**
   Performed by raising the pelvis off the plinth from crook lying position

Figure 1: Shows pelvic bridge exercise

2. **Unilateral pelvic bridge**

Performed by raising the non-paretic limb off the plinth while maintaining the Pelvic bridge position

Figure 2: Shows unilateral pelvic bridge exercise

3. Upper trunk flexion rotation

Performed by having the patient lying supine on the mat with knee and the feet flat on the support surface. The patient was asked to perform a task specific reach out for an object by bringing clasped hands on either side.

Figure 3a: Shows upper trunk Flexion rotation (Right)

Figure 3b: Shows upper trunk flexion rotation (Left)

4. **Lower trunk flexion rotation**

Performed by moving the knees on either side from crook lying position

Figure 4a: Shows lower trunk Flexion rotation Right

Figure 4b: Shows lower trunk flexion rotation Left

5.Sitting exercises (Weight shifting exercise)

Patient was seated on the on the high table or mat hip and knee bend at 90 degree angels and the feet kept flat In the floor. Performed by moving trunk side to side and forward to backward.

Figure 5a: Shows weight shifting forward

Figure 5b: Shows weight shifting backward

6. Trunk flexion

Subject is in sitting position on the functional re-educational plinth in this position he is asked to flex and extend his trunk without moving his trunk forwarded.

Figure 6: Shows trunk flexion

7. Flexion extension of the hip

Subject is in sitting position on the plinth in this position he is asked to do flexion and extension of the hip with trunk extended (with on extended trunk the movement is initiated in the hips and the subject bring the extended trunk forward and backward).

Figure 7a: Shows right hip flexion **Figure 7b: Shows Left hip flexion**

8. Lateral Flexion

In sitting position he asked to laterally flex his trunk, initiating movement from the shoulder girdle so as to bring the elbow towards the plinth

.

Figure 8a: Shows right lateral flexion

Figure 8b: Shows Left lateral flexion

Group B: Un stable surface exercises

Treatment duration: 45 minutes /day

Session applied : 5 times in a week/6 weeks

The group B receives supervised trunk stabilization exercises on unstable surface (Swiss ball) for 45 minutes in which group performed 5 minutes warm-up exercise before the start of training such as raising the upper extremities, trunk flexion and rotation for range of motion and flexibility.

Supine exercises

1. Pelvic bridge

Performed by placing both the patients' leg on the Swiss ball and asking him or to her to lift the pelvis off the support surface. Initially the ball was kept beneath the knees and advanced to the lower leg. The exercise intensity was further increased by flexing the un involved upper limb.

Figure 9: Shows pelvic bridge exercise

2. Unilateral Pelvic Bridge

Performed by raising the non-paretic limb off the plinth while maintaining the Pelvic bridge position on swiss ball

Figure 10: Shows unilateral pelvic bridge exercise

3. **Upper trunk flexion and rotation**

The subject is in lying position, maintain the limb on the Swiss ball he is asked to rotate his upper trunk by moving his each shoulder forward and back ward.

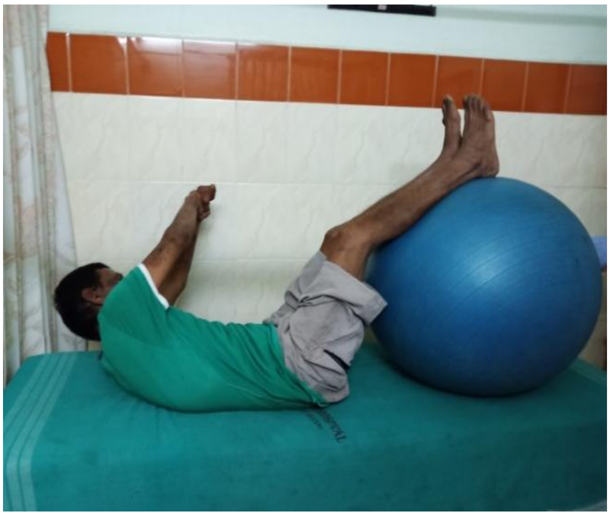

Figure 11a: Shows upper trunk Flexion and Rotation right

Figure 11b: Shows upper trunk flexion and rotation left

4. **Lower trunk flexion and rotation**

The subject is in lying position, maintain the limb on the Swiss ball he is asked to rotate his lower trunk by moving his pelvis rotate right and rotate left.

Figure 12a: Shows lower trunk flexion and Rotation right

Figure 12b: Shows lower trunk flexion and Rotation left

5. **Sitting exercises (Weight shifting activities)**

The patient was seated on the Swiss ball with and knees bent at 90 degrees and the feet. Kept flat on the support surfaces and performed all task specific dynamic exercise while balancing in a sitting posture on the ball.

In sitting position on the Swiss ball the subjects shifts weight from one side the other and by moving forward and backward and side ways

Figure 13: Shows weight shifting activities

6. **Trunk flexion**

Subject is in sitting position on the Swiss ball in this position he is asked to flex and extend his trunk without moving his trunk forward or backward.

Figure 14: Shows trunk flexion

7. Flexion extension of the hip

Subject is in sitting position on the swiss ball he is asked to do flexion and extension of the hip with trunk extended (with on extended trunk the movement is initiated in the hips and the subject bring the extended trunk forward and backward).

Figure 15a: Shows right hip flexion

Figure 15b: Shows left hip flexion

8.Lateral flexion

In sitting position on the Swiss ball is asked to laterally flex his trunk initiating movement from the shoulder girdle so as to bring the elbow towards the ball

In sitting position on the Swiss ball the subject attempts to reach the object by flexing the trunk laterally

Figure 16a: Shows lateral flexion right

Figure 16 b: Shows lateral flexion left

3.13 Collection of data

The selected 20 stroke patients were divided into 2groups.

Group A received trunk stabilization exercises on stable surface

Group B received trunk stabilization exercises on unstable surface

Both the experimental groups were given treatment for 6 weeks, 5 days in a week. Before and after completion of 6 weeks treatment intervention balance and gait was evaluated by berg balance scale and dynamic gait index scale.

3.14 Statistical techniques

The collected data were analyzed by paired ‘t’ test to find the significance difference between pre -posttest values of experimental group and further unpaired ‘t’ test was applied to find out the difference between groups.

Data analysis and results

CHAPTER IV

DATA ANALYSIS AND RESULTS

4.1 Data analysis

The chapter deals with systematic presentation of the analysed data followed by the interpretation of the data.

Paired't' test was used as a parametric test to find the intra group significance. Unpaired' test was used as a parametric test to find the inter group significance.

a) Paired't' tests

$$\bar{d} = \frac{\sum d}{n}$$

$$\frac{\sqrt{\sum d^2 - \frac{(\sum d)^2}{n}}}{n-1}$$

$$t = \frac{\bar{d}\sqrt{n}}{s}$$

Where.

d- Difference between pre – test and post test values

$\bar{d} = \frac{\sum d}{n}$ – mean of difference between pre test and post test values

n- Total Number of subjects

S- Standard deviation

Un Paired 't' tests

$$S = \frac{\sqrt{\sum(x_1 - \bar{x}_2)^2 + \sum(x_2 - \bar{x}_2)^2}}{n_1 + n_2 - 2}$$

$$T = \frac{\bar{x}_1 - \bar{x}_2}{S} \sqrt{\frac{n_1\, n_2}{n_1 + n_2}}$$

Where,

S= Standards deviation

n_1=Number of subjects in group A

n_2= Number of subjects in group B

x_1=Mean difference in values between pre-test and pot-test in Group A

x_2= Mean difference in values between pre-test and pot-test in Group B

Table -1

The table shows mean value, mean difference, Standard deviation and paired 't' value between pre-test and post-test scores of balance among Group A

Measurement	**Mean**	**Mean difference**	**Standard Deviation**	**Paired 't'value**
Pre-test	31.6	7.1	1.22	21.99*
Post-test	38.7			

***0.005 level of significance**

In group A for balance calculated paired 't' value is 21.99 and the table 't' value is 2.977at 0.005 level of significance. Since the calculated 't' value, is more than the 't' table value, it shows that there is significant difference in balance following stable surface exercises among sub acute stroke patients.

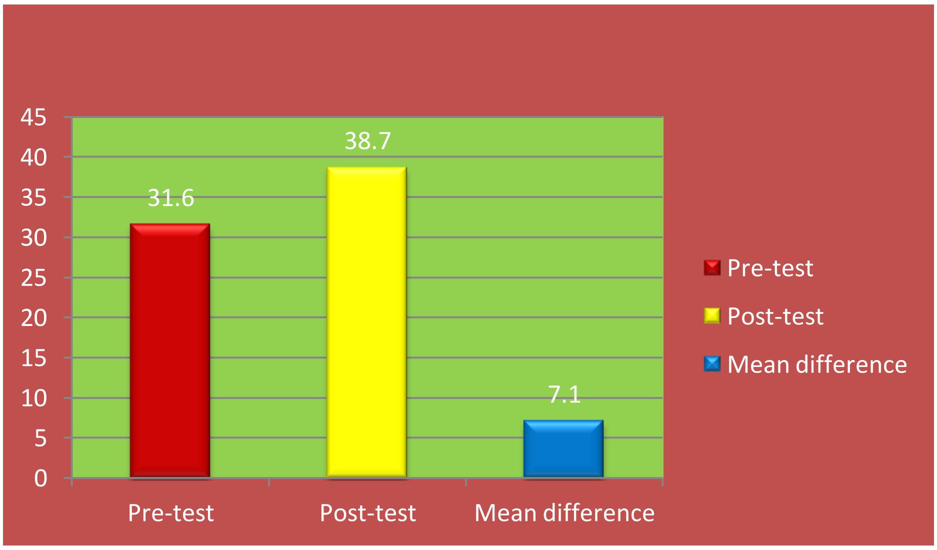

Figure 17: Shows the graphical representation of the Pre- test, Post-test and mean difference values of balance among group A.

Table -2

The table shows mean value, mean difference, Standard deviation and paired 't' value between pre-test and post-test scores of balance among Group B.

Measurement	Mean	Mean difference	Standard Deviation	Paired 't'value
Pre-test Post-test	33.3 45.2	11.87	1.8	24.30*

*0.005 level of significance

In group B for balance calculated paired 't' value is 24.30 and the table 't' value is 2.977 at 0.005 level of significance. Since the calculated 't' value, is more than the 't' table values, it shows that there is significant difference in balance following unstable surface exercises among sub acute stroke patients.

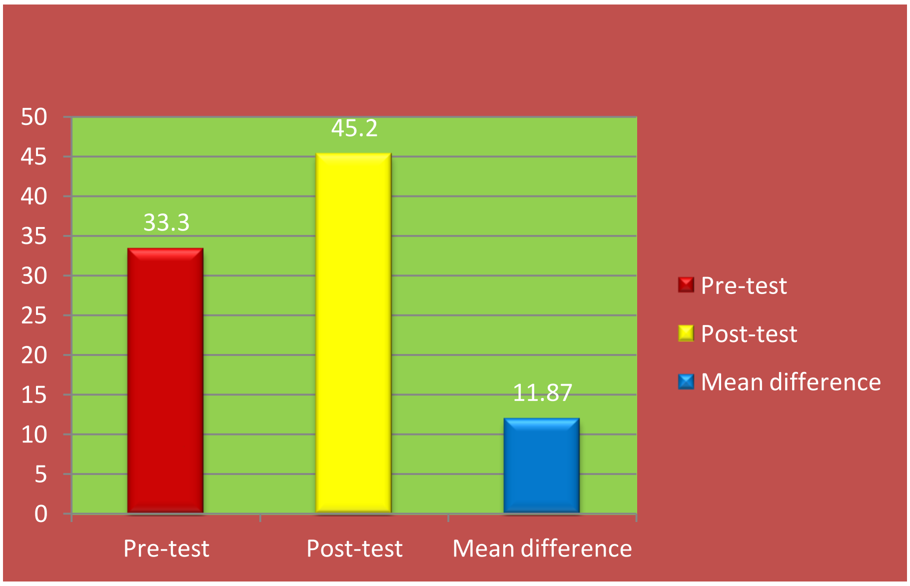

Figure 18: Shows the graphical representation of the pre- test, post-test and mean difference values of balance among group B.

Table -3

The table shows mean value, mean difference, Standard deviation and unpaired 't' value between pre-test and post-test scores of balance among Group A and Group B.

S.NO	Groups	Improvement		Standard deviation	Unpaired 't' Test
		Mean	Mean difference		
1.	**Group A**	13.338	10.796	1.58	8.543*
2	**Group B**	24.134			

*0.005 level of significance

In group A and Group B for balance calculated unpaired' value is 8.543 and the table 't' value is 2.67 at 0.005 level of significance. Since the calculated 't' value, is more than the 't' table value, it shows that there is significant difference between stable surface exercises and unstable surface exercises on balance among sub acute stroke patients.

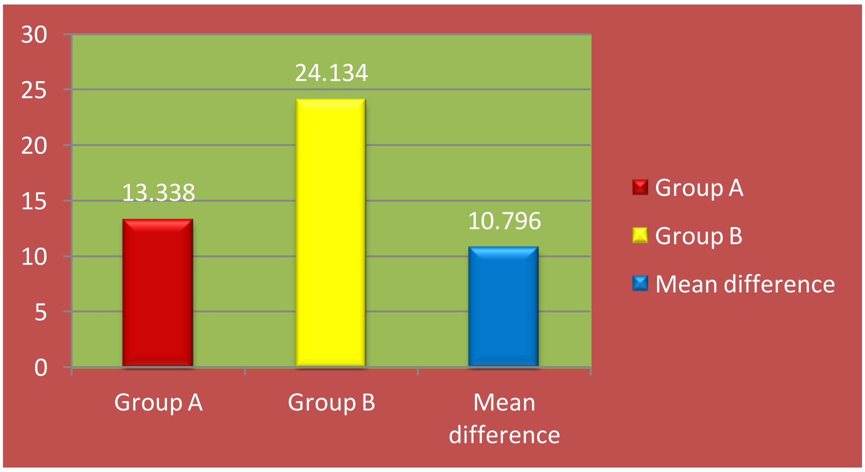

Figure 19: Shows the graphical representation of the pre- test, post-test and mean difference values of balance among group A and Group B.

Table -4

The table shows mean value, mean difference, Standard deviation and paired 't' value between pre-test and post-test scores of Gait among Group A.

Measurement	Mean	Mean difference	Standard deviation	Paired 't' Value
Pre-test	11.2	7.9	1.26	19.81*
Post-test	19.1			

***0.005 level of significance**

In group A for gait calculated paired' value is 19.81 and the table 't' value is3.250 at 0.005 level of significance. Since the calculated 't' value, is more than the 't' table value, it shows that there is significant difference in gait following stable surface exercises among sub acute stroke patients.

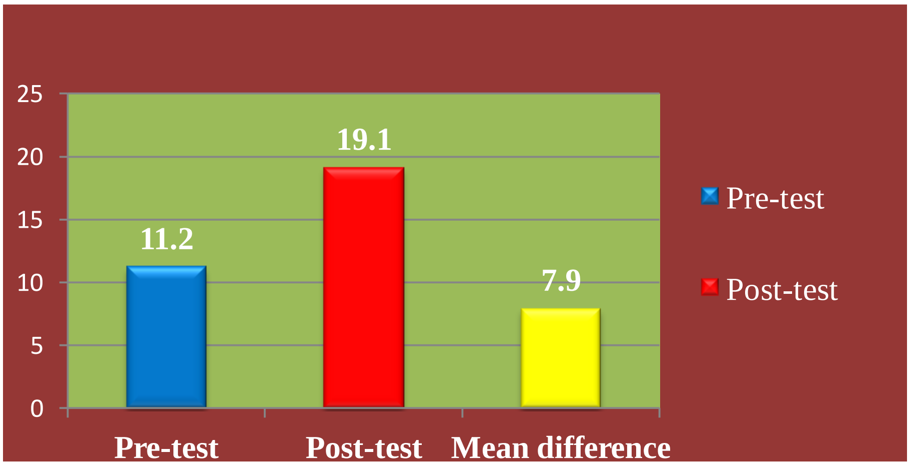

Figure 20: Shows the graphical representation pre- test, post-test and mean difference values of gait among group A.

Table -5

The table shows mean value, mean difference, Standard deviation and paired 't' value between pre-test and post-test scores of Gait among Group B

Measurement	Mean	Mean difference	Standard deviation	Paired 't' Value
Pre-test	8.8	12.0	1.63	23.26*
Post-test	20.8			

*0.005 level of significance

In group B for gait calculated paired 't' value is 23.26 and the table 't' value is3.250 at 0.005 level of significance. Since the calculated 't' value, is more than the 't' table value, it shows that there is significant difference in gait following unstable surface exercise among sub acute stroke patients.

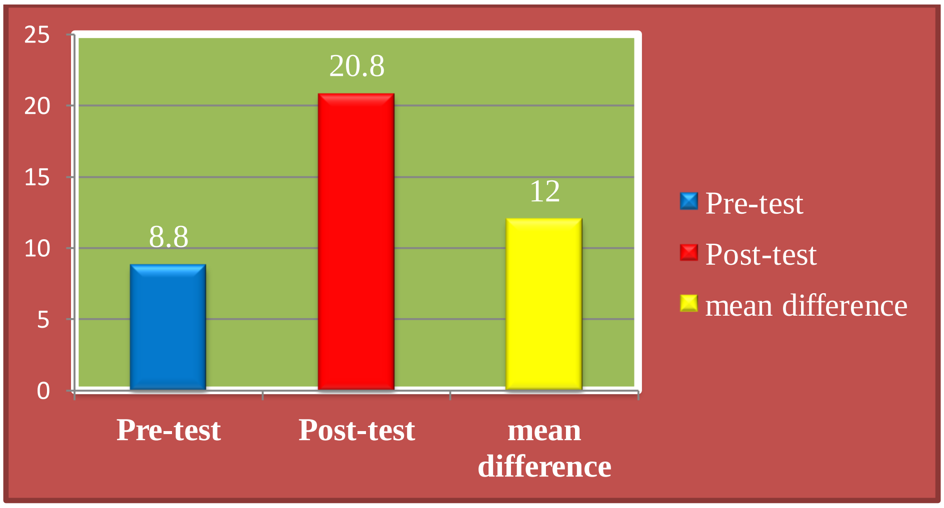

Figure 21: Shows the graphical representation of the pre- test, post-test and mean difference values of gait among group B.

Table -6

The table shows mean value, mean difference, Standard deviation and unpaired 't' value between pre-test and post-test scores of Gait among Group A and Group B.

S.NO	Groups	Improvement		Standard deviation	Unpaired 't' Test
		Mean	Mean difference		
1.	**Group A**	12	4.2	1.196	4.14*
2	**Group B**	16.2			

*0.005 level of significance

In group A and Group B for gait calculated unpaired 't' value is 4.14 and the table 't' value is 2.76 at 0.005 level of significance. Since the calculated 't' value, is more than the 't' table value, it shows that there is significant difference between stable surface exercises and unstable exercises on gait among sub acute stroke patients.

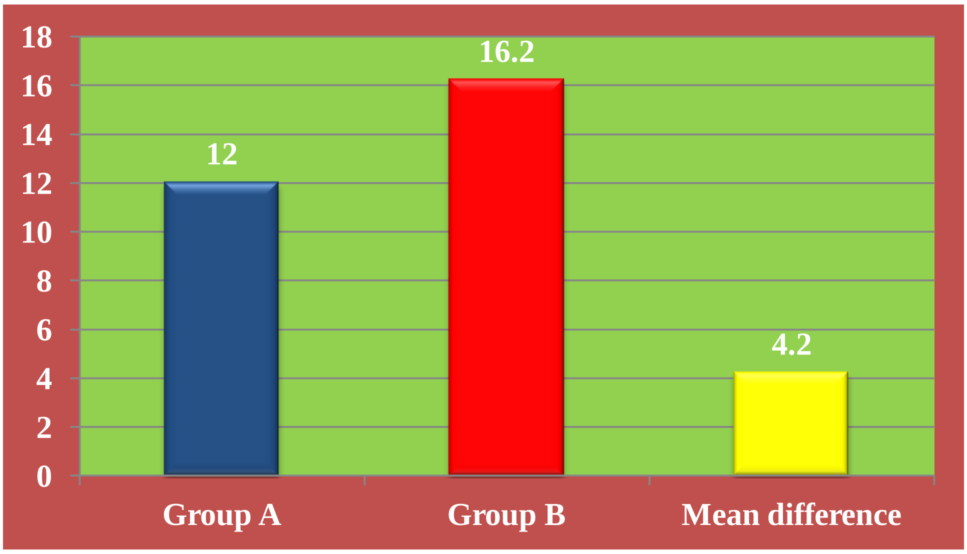

Figure 22: Shows the graphical representation of the pre- test, post-test and mean difference values of gait among group A and Group B.

4.2 Results

20 Sub acute stroke subjects were selected for the study. The subjects were randomly divided into two equal groups, group A and Group B. For group A trunk stabilization exercises on stable surface was given and for Group B trunk stabilization exercises on unstable surface was given.

The patients were treated 45 minutes a day, 5 times for 6 weeks. Before starting the treatment, balance was assessed by Berg balance scale and gait was assessed by Dynamic gait index scale. The measurement was repeated at the end of the study.

Analysis of dependent variable of trunk balance in Group A: Calculated paired ‘t’ value is 21.99 and the table ‘t’ value is 2.977 at 0.005 level of significance. Since the calculated ‘t’ value, is more than the ‘t’ table value, it shows that there is significant difference in balance following unstable surface exercise among sub acute stroke patients.

Analysis of dependent variable of trunk balance in Group B: Calculated paired ‘t’ value is 24.30 and the table ‘t’ value is 2.977 at 0.005 level of significance. Since the calculated ‘t’ value, is more than the ‘t’ table value, it shows that there is significant difference in balance following unstable surface exercise among sub acute stroke patients.

Comparing the dependent variable of trunk balance in Group A and Group B: Calculated unpaired ‘t’ value is 8.543 and the table ‘t’ value is 2.67 at 0.005 level of significance. Since the calculated ‘t’ value, is more than the ‘t’ table value, it shows that there is significant difference between stable surface exercise and unstable exercise on balance among sub acute stroke patients.

When comparing the mean values of group A and B. Group B subjects treated with unstable exercises showed more difference than group A. Hence it is concluded the unstable exercises is more effective than stable exercise in improving the trunk balance among stroke patients.

Analysis of dependent variable of Gait in Group A: Calculated paired ‘t’ value is 19.81 and the table ‘t’ value is 3.250 at 0.005 level of significance. Since the calculated ‘t’ value, is more than the ‘t’ table value, it shows that there is significant difference in gait following stable surface exercises among sub acute stroke patients.

Analysis of dependent variable of Gait in Group B: Calculated paired ‘t’ value is 23.26 and the table ‘t’ value is 3.250 at 0.005 level of significance. Since the calculated ‘t’ value, is more than the ‘t’ table value, it shows that there is significant difference in gait following unstable surface exercises among sub acute stroke patients.

Comparing the dependent variable of Gait in Group A and Group B: Calculated unpaired ‘t’ value is 4.14 and the table ‘t’ value is 2.76 at 0.005 level of significance. Since the calculated ‘t’ value, is more than the ‘t’ table value, it shows that there is significant difference between stable surface exercise and unstable exercises on gait among sub acute stroke patients.

When comparing the mean values of group A and B.Group B subjects treated with unstable surface exercises showed more difference than group A. Hence it is concluded the trunk stabilization exercises on unstable surface is more effective than stable surface exercises in improving gait among stroke patients.

Discussion

CHAPTER V

DISCUSSION

Stroke is defined as a sudden onset of neurological dysfunctions resulting from impairment of blood supply to the brain.

The aim of the study was to compare the effectiveness of trunk stabilization exercise on stable and unstable surface on balance and gait among sub acute stroke patients.20 stroke patients divided into 2 groups. Group A and Group B.10 patients in each group. Group A was treated with trunk stabilization exercises on stable surface and Group B treated with trunk stabilization exercises on unstable surfaces.

The trunk is the center of the body, and it plays a postural role in functional movement by preparing the body for the movement of the extremities against gravity. It also plays an active role in smoothing the movement of the center of gravity. This is an integral component of postural control. Balance is the result of interactions among the visual system, vestibular system, proprioceptive system, musculoskeletal system, and cognitive ability. Balance maintenance is a very important element for safe and independent performance in ordinary life of movements and walking **(Ryerson *et al.*,2008).**

In present study balance and gait is improved significantly following trunk stabilization exercises on stable and unstable surface. This is supported by **Junsangyoo.,(2014)** Conducted a study to assess the effect of trunk Stabilization exercise using an unstable surface on the abdominal muscle structure and balance of stroke patients. Total 25patients are selected. Patients were divided into two groups. Both groups performed trunk stabilization exercise for 30 minutes, 3 days per week for 6 weeks. Abdominal muscle thickness and the berg balance scale (BBS) were measured at the baseline and after 6 weeks. The result showed that there was a significant improvement in the internal oblique muscle thickness, transverses abdominal thickness and balance ability of the unstable surface trunk stabilization exercise group.

Young *et al.*,(2016) conducted a study on effects of trunk stabilization exercises performed on an unstable surface on trunk muscle activation, postural control, and functional gait ability in stroke patients. Twenty-four participants with stroke were recruited in this study. Subjects in the experimental group participated in trunk exercises on the balance pad for 30 min, five times a week for 4 weeks; those in the control group performed trunk exercises on a stable surface for 30 min, five times a week for 4 weeks. Trunk muscle activation was measured by using surface electromyography. Functional gait ability was measured with the dynamic gait index score. Result showed that trunk exercises on an unstable surface improve trunk muscle activation, postural control, and functional gait ability in patients with hemi paretic stroke.

Jung *et al.*,(2015) conducted a study on effects of trunk stabilization training using visual feedback on an unstable surface to improve balance and trunk stability of individuals with sub-acute stroke. Twenty-six patients were selected. Participants in both groups performed patient-specific therapeutic exercise for 5 days per week, 1 hour per day, for 4 weeks. Participants in the training group received trunk stabilization training using visual feedback while sitting on an unstable surface. The result showed that trunk stabilization training using visual feedback improved sitting balance. This training would be an effective way to exercise in order to promote functional activity and balance.

Hence in stroke patients, rehabilitation is vital to improve strength and balance ability for functional recovery and activities of daily living. Trunk stabilization is an important prognosticator of the recovery of balance ability and ambulation **(Feigin *et al.*,2011).**

Unstable surfaces stressed the musculature and activated the neuroadaptive mechanism that led to the gains in stability and proprioceptive activity. The neural adaptation includes more efficient neural recruitment patterns increased CNS activation, improved synchronization of motor units and lowering the neural inhibitory reflexes **(Bohn *et al.*,2002).**

Unstable surface sensitizes muscle spindle through gamma motor neuron, resulting in the improvement of motor output and also increases cerebral blood flow. Training on an unstable surface can generate more external sway thus improving postural control ability can induce more diverse motion and can increases proprioceptive senses.

Exercise on unstable surfaces activates postural muscles around the abdomen and pelvis more than that of the stable surface. Exercise on unstable surface also effective in improving proprioception and trunk asymmetry **(Lima *et al.*,2003).**

Unstable surface can cause increase in size and co contraction of the trunk muscles which in turn improves the balance ability. In other words, diverse movement on an unstable surface appears to provide postural perturbation enhancing the maintenance of desired posture. Voluntary efforts to maintain the desired postures during exercise on an unstable surface may stimulate the activation of bilateral cerebral cortex. In addition to that lower trunk muscles adjustment occurs to increase the stability of the pelvis and affecting distal lower extremity and mobility of upper trunk thereby improving the balance. **(Verhetden *et al.*,2004)**.

Swiss ball reduces the amount of body weight a patient has to lift when weak or partially paralyzed. A weak patient may be able to move partially leg if it is resting on a ball because the effect of gravity reduced **(Carriere *et al.*,1999).**

From the above literature, present study is concluded that the effect of trunk stabilization exercises on an unstable surface may be due to increased sensory motor integration, increased in proprioception and co-activation of trunk muscle.

Trunk stabilization exercises on stable and unstable surface to improve balance and gait. It is found that both techniques are improved balance and gait but group B is more effective. Hence the hypothesis 1 and 2 are rejected 3rd is accepted.

Conclusion

CHAPTER VI
CONCLUSION

A comparative study was conducted to compare the effectiveness of trunk stabilization exercises on stable and unstable surfaces on balance and gait among sub acute stroke patients.

20 Sub acute stroke patients were included in this study and were randomly divided into two groups, group A and B, each group consist of 10 patients.

Group A was treated with trunk stabilization exercises on stable surfaces and Group B was treated with trunk stabilization exercises on unstable surfaces. Balance was assessed before and after intervention by berg balance scale and gait was assessed before and after intervention by dynamic gait index scale.

The present study statistically demonstrates that the both the techniques is effective in improving the balance and gait in subjects with sub acute stroke. When comparing the mean values it was found that there was mean significant improvement in patients treated with trunk stabilization exercises on unstable surface than stable surface exercises.

6.1 Limitations

- The study was done in sub acute cases only
- The study was conducted in patients already treated with some other techniques
- The study did not include follow up
- The study duration is small
- The sample size is small

6.2 Suggestion

- The study can be compared with other treatment variables
- The sample size can be more
- Number of exercise can be increased
- The study duration can be increased

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Annexures

ANNEXURES

ANNEXURE I

PHYSIOTHERAPY ASSESSMENT

SUBJECTIVE ASSESSMENT

Name	OP No	IP No
Age	Sex	Date

Address

Growth and Development

Chief complaints

History of illness

Past history of current condition

Past medical and surgical history

RISK FACTORS

Personal History

Family History

Occupational History

History of living environment

Social History

Previous functional status

Pain History

Side

Site

Onset

Duration

Type

Aggravating factors

Relieving factors

Severity

Vital signs

Temperature

BP

Heart rate

Respiratory rate

OBJECTIVE ASSESSMENT

ON OBSERVATION

Built

Posture

Attitude of limbs

Muscle wasting

Pattern of movement

Gait

Pressure sore

Edema

Tropical changes

External appliances

ON PALPATION

Tone

Edema

Tenderness

Warmth

On examination

HIGHER MENTAL FUCTION

Level of consciousness

Orientation

Person

Place

Time

Memory

Immediate

Recent

Remote

Attention

Communication

Emotional status

HIGHER CORTICAL FUNCTION

Cognition

Fund of knowledge

Calculation

Proverb interpretation

Perception

Body scheme/body image disorders

Spatial relation disorders

Agnosias

Apraxia

CRANIAL NERVE EXAMINATION

SENSORY SYSTEM

MOTOR SYSTEM

Muscle tone

Upper limb	**Lower limb**

Muscle power

Voluntary motor control

	Right	Left
Upper limb		
Lower limb		

Muscle girth

AREA	Rt(cms)	Lt(cms)
Arm		
Forearm		
Thigh		
Calf		

Movement time

Associated Reactions

REFLEXES

Superficial reflexes

Abdominal

Plantar

Deep

JERKS	Rt	Lt
Biceps		
Brachio-radialis		
Triceps		
Knee		
Ankle		

Tonic postural reflexes

INVOLUNTRYMOVEMENTS

CO-ORDINATION

Non equilibrium test

Equilibrium test

BALANCE

Balance	Static	Dynamic
Sitting		
Standing		

Centre of Gravity control

Balance Reactions

Motor Strategies

Sensory Strategies

GAIT

Bio mechanical deviations

HAND FUNCTIONS

Reaching

Grasping

Releasing

ASSISTIVE DEVICES

OTHER SYSTEM

Integumentary system

Pressure sore

Respiratory system

Secretion

Pattern of breathing

Deformity

Cardio vascular system

Deep vein thrombosis

Edema

Musculo sketal system

Contracture

Subluxation

Stiffness

Heterotopic ossification

Osteoporosis

Bladder and bowl function

Gastro intestinal system

Sexual function

Autonomic system

Vasomoter

Pseudomotor

Tropic changes

Postural hypotension

Reflex sympathetic dystrophy

FUNCTIONAL STATUS

Bed mobility

Transfer

Motor performance

PHYSICAL THERAPY DIAGNOSIS

Direct impairments

Indirect impairment

Composite impairments

Functional limitations

PHYSICAL THERAPY MANAGEMENT

ANNEXURE II

ASSESSMENT TOOLS

BERG BALANCE SCALE

Berg balance scale was developed to measure balance among old people with impairment in balance function by assessing the performance of functional tasks .It is a valid instrument used for evaluation of the effectiveness of interventions and for quantitative descriptions of function in clinical practice and research. The BBS has been evaluated in several reliability studies. recent study of the BBS Which was completed final and, indicates that a change of eight (8) BBS points is required to reveal a genuine change in function between two assessments among older people who are dependent in ADL and living in residential care facilities

Description:

14item scale designed to measure balance of the older adult in a clinical setting

Equipment required:

- A ruler
- 2 standard chairs (one with arm rests, one without)
- A footstool or step
- 15 ft walkway
- Stopwatch or wristwatch

Completion time

15-30 minutes

Scoring

Five point scales, ranging from 0-4, 0 indicates the lower level of function and 4 the highest level of function. Total score =56

Interpretation

41-56 = Low fall risk

21-40 = Medium fall risk

0-20 = High fall risk

A Change of 8 points is required to reveal a genuine change function between 2 assessments

The scale

Name: ___________________________________ Date: ____________________

Location: _________________________________ Rater: ____________________

ITEM DESCRIPTION SCORE (0-4)

Sitting to standing ________

Standing unsupported ________

Sitting unsupported ________

Standing to sitting ________

Transfers ________

Standing with eyes closed ________

Standing with feet together ________

Reaching forward with outstretched arm ________

Retrieving object from floor ________

Turning to look behind ________

Turning 360 degrees ________

Placing alternate foot on stool ________

Standing with one foot in front ________

Standing on one foot ________

Total ________

General instructions for completing the scale

Please document each task and/or give instructions as written. When scoring, please record the lowest response category that applies for each item.

In most items, the subject is asked to maintain a given position for a specific time. Progressively more points are deducted if:

- the time or distance requirements are not met
- the subject's performance warrants supervision
- the subject touches an external support or receives assistance from the examiner

The subject should understand that they must maintain their balance while attempting the tasks. The choices of which leg to stand on or how far to reach are left to the subject. Poor judgment will adversely influence the performance and the scoring.

Equipment required for testing is a stopwatch or watch with a second hand, and a ruler or other indicator of 2, 5, and 10 inches. Chairs used during testing should be a reasonable height. Either a step or a stool of average step height may be used for item # 12.

BERG BALANCE SCALE

1. SITTING TO STANDING

INSTRUCTIONS: Please stand up. Try not to use your hands for support.

( ) 4 able to stand without using hands and stabilize independently

( ) 3 able to stand independently using hands

( ) 2 able to stand using hands after several tries

( ) 1 needs minimal aid to stand or to stabilize

( ) 0 needs moderate or maximal assist to stand

2. STANDING UNSUPPORTED

INSTRUCTIONS: Please stand for two minutes without holding.

( ) 4 able to stand safely 2 minutes

( ) 3 able to stand 2 minutes with supervision

( ) 2 able to stand 30 seconds unsupported

( ) 1 needs several tries to stand 30 seconds unsupported

( ) 0 unable to stand 30 seconds unassisted

If a subject is able to stand 2 minutes unsupported, score full points for sitting unsupported. Proceed to item #4.

3. SITTING WITH BACK UNSUPPORTED BUT FEET SUPPORTED ON FLOOR OR ON A STOOL

INSTRUCTIONS: Please sit with arms folded for 2 minutes.

( ) 4 able to sit safely and securely 2 minutes

( ) 3 able to sit 2 minutes under supervision

( ) 2 able to sit 30 seconds

( ) 1 able to sit 10 seconds

( ) 0 unable to sit without support 10 seconds

4. STANDING TO SITTING

INSTRUCTIONS: Please sit down.

( ) 4 sits safely with minimal use of hands

( ) 3 controls descent by using hands

( ) 2 uses back of legs against chair to control descent

( ) 1 sits independently but has uncontrolled descent

( ) 0 needs assistance to sit

5. TRANSFERS

INSTRUCTIONS: Arrange chairs (s) for a pivot transfer. Ask subject to transfer one way toward a seat with armrests and one way toward a seat without armrests. You may use two chairs (one with and one without armrests) or a bed and a chair.

( ) 4 able to transfer safely with minor use of hands

( ) 3 able to transfer safely definite need of hands

( ) 2 able to transfer with verbal cueing and/or supervision

( ) 1 needs one person to assist

( ) 0 needs two people to assist or supervise to be safe

6. STANDING UNSUPPORTED WITH EYES CLOSED

INSTRUCTIONS: Please close your eyes and stand still for 10 seconds.

( ) 4 able to stand 10 seconds safely

( ) 3 able to stand 10 seconds with supervision

( ) 2 able to stand 3 seconds

( ) 1 unable to keep eyes closed 3 seconds but stays steady

( ) 0 needs help to keep from falling

7. STANDING UNSUPPORTED WITH FEET TOGETHER

INSTRUCTIONS: Place your feet together and stand without holding.

( ) 4 able to place feet together independently and stand 1 minute safely

( ) 3 able to place feet together independently and stand for 1 minute with supervision

( ) 2 able to place feet together independently but unable to hold for 30 seconds

( ) 1 needs help to attain position but able to stand 15 seconds with feet together

( ) 0 needs help to attain position and unable to hold for 15 seconds

8. REACHING FORWARD WITH OUTSTRETCHED ARM WHILE STANDING

INSTRUCTIONS: Lift arm to 90 degrees. Stretch out your fingers and reach forward as far as you can. (Examiner places a ruler at end of fingertips when arm is at 90 degrees. Fingers should not touch the ruler while reaching forward. The recorded measure is the distance forward that the finger reaches while the subject is in the most forward lean position. When possible, ask subject to use both arms when reaching to avoid rotation of the trunk).

( ) 4 can reach forward confidently >25 cm (10 inches)

( ) 3 can reach forward >12 cm safely (5 inches)

( ) 2 can reach forward >5 cm safely (2 inches)

( ) 1 reaches forward but needs supervision

( ) 0 loses balance while trying/requires external support

9. PICK UP OBJECT FROM THE FLOOR FROM A STANDING POSITION

INSTRUCTIONS: Pick up the shoe/slipper which is placed in front of your feet.

( ) 4 able to pick up slipper safely and easily

( ) 3 able to pick up slipper but needs supervision

( ) 2 unable to pick up but reaches 2-5cm (1-2 inches) from slipper and keeps balance Independently

( ) 1 unable to pick up and needs supervision while trying

( ) 0 unable to try/needs assist to keep from losing balance or falling

10. TURNING TO LOOK BEHIND OVER LEFT AND RIGHT SHOULDERS WHILE STANDING

INSTRUCTIONS: Turn to look directly behind you over toward left shoulder. Repeat to the right. Examiner may pick an object to look at directly behind the subject to encourage a better twist turn.

( ) 4 looks behind from both sides and weight shifts well

( ) 3 looks behind one side only other side shows less weight shift

( ) 2 turn sideways only but maintain balance

( ) 1 needs supervision when turning

( ) 0 needs assist to keep from losing balance or falling

11. TURN 360 DEGREES

INSTRUCTIONS: Turn completely around in a full circle. Pause. Then turn a full circle in the other direction.

( ) 4 able to turn 360 degrees safely in 4 seconds or less

( ) 3 able to turn 360 degrees safely one side only in 4 seconds or less

( ) 2 able to turn 360 degrees safely but slowly

( ) 1 needs close supervision or verbal cueing

( ) 0 needs assistance while turning

12. PLACING ALTERNATE FOOT ON STEP OR STOOL WHILE STANDING UNSUPPORTED

INSTRUCTIONS: Place each foot alternately on the step/stool. Continue until each foot has

Touched the step / Stool four times.

( ) 4 able to stand independently and safely and complete 8 steps in 20 seconds

( ) 3 able to stand independently and complete 8 steps in >20 seconds

( ) 2 able to complete 4 steps without aid with supervision

( ) 1 able to complete >2 steps needs minimal assist

( ) 0 needs assistance to keep from falling / unable to try

13. STANDING UNSUPPORTED ONE FOOT IN FRONT

INSTRUCTIONS: (DEMONSTRATE TO SUBJECT) Place one foot directly in front of the other. If you feel that you cannot place your foot directly in front, try to step far enough ahead that the heel of your forward foot is ahead of the toes of the other foot. (To score 3 points, the length of the step should exceed the length of the other foot and the width of the stance should approximate the subject's normal stride width)

( ) 4 able to place foot tandem independently and hold 30 seconds

( ) 3 able to place foot ahead of other independently and hold 30 seconds

( ) 2 able to take small step independently and hold 30 seconds

( ) 1 needs help to step but can hold 15 seconds

( ) 0 loses balance while stepping or standing

14. STANDING ON ONE LEG

INSTRUCTIONS: Stand on one leg as long as you can without holding.

( ) 4 able to lift leg independently and hold >10 seconds

( ) 3 able to lift leg independently and hold 5-10 seconds

( ) 2 able to lift leg independently and hold = or >3 seconds

( ) 1 tries to lift leg unable to hold 3 seconds but remains standing independently

( ) 0 unable to try or needs assist to prevent fall

TOTAL SCORE (Maximum) = 56: _______

ANNEXURE III

DYNAMIC GAIT INDEX SCALE

Dynamic gait index scale was developed as a clinical tool to assess gait, balance and fall risk. It evaluates not only usual study state walking, but also walking during more challenging tasks**.**

Methods of use

8 functional walking tests are performed by the subject and marked out of three according to the total individual score possible .Scores of 19 or less have been related to increase incidence of falls

Equipment needed: Box (Shoebox), Cones (2), Stairs, 20’ walkway, 15” wide

Completion:

Time: 15 minutes

Scoring: A four-point ordinal scale, ranging from 0-3. “0” indicates the lowest level of function and “3” the highest level of function.

Total Score = 24

1. Gait level surface _____

Instructions*:* Walk at your normal speed from here to the next mark (20’)

Grading: Mark the lowest category that applies.

(3) Normal: Walks 20’, no assistive devices, good sped, no evidence for imbalance, normal gait pattern

(2) Mild Impairment: Walks 20’, uses assistive devices, slower speed, mild gait deviations.

(1) Moderate Impairment: Walks 20’, slow speed, abnormal gait pattern, evidence for imbalance.

(0) Severe Impairment: Cannot walk 20’ without assistance, severe gait deviations or imbalance.

2. Change in gait speed _____

Instructions*:* Begin walking at your normal pace (for 5), when I tell you “go” walk as fast as you can (for 5). When I tell you “slow” walk as slowly as you can (for 5).

Grading: Mark the lowest category that applies.

(3) Normal: Able to smoothly change walking speed without loss of balance or gait deviation. Shows a significant difference in walking speeds between normal, fast and slow speeds.

(2) Mild Impairment: Is able to change speed but demonstrates mild gait deviations, or not gait deviations but unable to achieve a significant change in velocity, or uses an assistive device.

(1) Moderate Impairment: Makes only minor adjustments to walking speed, or accomplishes a change in speed with significant gait deviations, or changes speed but has a significant gait deviation, or changes speed but loses balance but is able to recover and continue walking.

(0) Severe Impairment: Cannot change speeds, or loses balance and has to reach for wall or be caught.

3. Gait with horizontal head turns _____

Instructions: Begin walking at your normal pace. When I tell you to "look right" keep walking straight, but turn your head to the right. Keep looking to the right until I tell you, "look left" then keep walking straight and turn your head to the left. Keep your head to the left until I tell you "look straight" then keep walking straight, but return your head to the center.

Grading: Mark the lowest category that applies.

(3) Normal: Performs head turns smoothly with no change in gait.

(2) Mild Impairment: Performs head turns smoothly with slight change in gait velocity, i.e., minor disruption to smooth gait path or uses walking aid.

(1) Moderate Impairment: Performs head turns with moderate change in gait velocity, slows down, staggers but recovers, can continue to walk.

(0) Severe Impairment: Performs task with severe disruption of gait, i.e., staggers outside 15" path, loses balance, stops and reaches for wall.

4. Gait with vertical head turns _____

Instructions: Begin walking at your normal pace. When I tell you to "look up," keep walking straight, but tip your head up. Keep looking up until I tell you, "look down" then keep walking straight and tip your head down. Keep your head down until I tell you "look straight" then keep walking straight, but return your head to the center.

Grading: Mark the lowest category that applies.

(3) Normal: Performs head turns smoothly with no change in gait.

(2) Mild Impairment: Performs head turns smoothly with slight change in gait velocity, i.e., minor disruption to smooth gait path or uses walking aid.

(1) Moderate Impairment: Performs head turns with moderate change in gait velocity, slows down, staggers but recovers, can continue to walk.

(0) Severe Impairment: Performs task with severe disruption of gait, i.e., staggers outside 15" path, loses balance, stops, reaches for wall.

5. Gait and pivot turn _____

Instructions: Begin walking at your normal pace. When I tell you, "turn and stop" turn as quickly as you can to face the opposite direction and stop.

Grading: Mark the lowest category that applies.

(3) Normal: Pivot turns safely within 3 seconds and stops quickly with no loss of balance.

(2) Mild Impairment: Pivot turns safely in > 3 seconds and stops with no loss of balance.

(1) Moderate Impairment: Turns slowly, requires verbal cueing, requires several small steps to catch balance following turn and stop.

(0) Severe Impairment: Cannot turn safely, requires assistance to turn and stop.

6. Step over obstacle ____

Instructions: Begin walking at your normal speed. When you come to the shoebox, step over it, not around it, and keep walking.

Grading: Mark the lowest category that applies.

(3) Normal: Is able to step over the box without changing gait speed, no evidence of imbalance.

(2) Mild Impairment: Is able to step over box, but must slow down and adjust steps to clear box safely.

(1) Moderate Impairment: Is able to step over box but must stop, then step over. May require verbal cueing.

(0) Severe Impairment: Cannot perform without assistance.

7. Step around obstacles _____

Instructions: Begin walking at normal speed. When you come to the first cone (about 6' away), walk around the right side of it. When you come to the second cone (6' past first cone), walk around it to the left.

Grading: Mark the lowest category that applies.

(3) Normal: Is able to walk around cones safely without changing gait speed; no evidence of imbalance.

(2) Mild Impairment: Is able to step around both cones, but must slow down and adjust steps to clear cones.

(1) Moderate Impairment: Is able to clear cones but must significantly slow, speed to accomplish task, or requires verbal cueing.

(0) Severe Impairment: Unable to clear cones, walks into one or both cones, or requires physical assistance.

8. Steps _____

Instructions*:* Walk up these stairs as you would at home, i.e., use the railing if necessary. At the top, turn around and walk down.

Grading: Mark the lowest category that applies.

(3) Normal: Alternating feet, no rail.

(2) Mild Impairment: Alternating feet, must use rail.

(1) Moderate Impairment: Two feet to a stair, must use rail.

(0) Severe Impairment: Cannot do safely.

TOTAL SCORE: ___ / 24

ANNEXURE IV

Table 9: Pre and Post test value of Berg balance scale in Group A and B

S.NO	GROUP A		GROUP B	
	Pre test	Post test	Pre test	Post test
1	25	33	20	35
2	26	35	18	35
3	25	32	20	37
4	24	33	21	34
5	25	35	16	34
6	26	37	16	34
7	23	37	19	36
8	24	38	22	38
9	29	37	18	36
10	29	39	16	38

ANNEXURE V

Table 10: Pre and Post-test value of dynamic gait index scale in Group A and B

S.NO	GROUP A		GROUP B	
	Pre test	Post test	Pre test	Post test
1	10	18	8	21
2	10	17	8	21
3	10	19	9	19
4	12	19	10	20
5	10	17	9	21
6	14	20	7	20
7	10	20	8	22
8	12	21	7	21
9	10	19	11	22
10	14	21	11	21

ANNEXURE VI

PATIENT CONSENT FORM

I **---** voluntarily consent to participate in the research named on **"A COMPARATIVE STUDY ON THE EFFECTIVENESS OF TRUNK STABILIZATION EXERCISES ON STABLE AND UNSTABLE SURFACE ON BALANCE AND GAIT AMONG SUB ACUTE STROKE PATIENTS."**

The researcher has explained me the treatment approach in brief, risk of participation and has answered the questions related to the study to my satisfaction.

Signature of patient **Signature of researcher**

Name and signature of witness

Place:

Date: