EFFECT OF SIMPLE KINETIC FEEDBACK TRAINING ON STANCE SYMMETRY IN INDIVIDUALS WITH ACUTE HEMIPARETIC STROKE.

AN EXPERIMENTAL STUDY

Dissertation submitted to the Tamilnadu Dr. M.G.R. Medical University towards partial fulfilment of the requirements of **MASTER OF PHYSIOTHERAPY (Advanced PT in Neurology)** Degree Programme.

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Certificate

CERTIFICATE

This is to certify that the research work entitled "**EFFECT OF SIMPLE KINETIC FEEDBACK TRAINING ON STANCE SYMMETRY IN INDIVIDUALS WITH ACUTE HEMIPARETIC STROKE."** was carried out by the candidate bearing the **Register No: 27101611**, KMCH College of Physiotherapy, towards partial fulfilment of the requirements of the Master of Physiotherapy (MPT) of the Tamil Nadu Dr. M. G. R. Medical University, Chennai - 32.

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Contents

CONTENTS

Abstract

ABSTRACT

OBJECTIVE: To find out the effect of simple kinetic feedback training on stance symmetry in individuals with acute hemiparetic stroke. **STUDY DESIGN:** Two groups pre and post test experimental study design. **SUBJECTS:** Fifteen hemiparetic individuals of acute middle cerebral artery stroke and age group between 45 to 65, who are medically stable including both the genders. Functional balance grade for standing- fair. **INTERVENTION:** 8 patients in the experimental group received simple kinetic feedback training and 7 patients in the control group received lateral weight shifting exercises and both the groups received conventional therapy. **OUTCOME MEASURE:** Weight bearing symmetry scores. **RESULTS:** Statistical analysis was done by using‘t’ test showed no significant improvement in weight bearing symmetry scores between experimental group and control group. **CONCLUSION:** It is concluded that there is no statistically significant improvement on stance symmetry even though there was a clinical improvement by simple kinetic feedback training in individuals with acute hemiparetic stroke. Larger sample size and longer treatment duration has to be carried out by using simple kinetic feedback training.

Introduction

1. INTRODUCTION

The WHO (World Health Organization) defines stroke as "rapidly developing clinical signs of focal(at times global) disturbance of cerebral function, lasting more than 24 hours or leading to death with no apparent cause other than that of vascular origin"[7,49].

Stroke is the third leading cause for the death in this world. It is one of the leading causes of severe handicap in the world. The etiology of stroke is classified into ischemic (90%) and hemorrhagic (10%) and further classifications of stroke are made by the brain's anatomic blood supply and neurological structure[51,53].

The Middle cerebral artery (MCA) is the largest cerebral artery and it is most commonly occluded in stroke. The middle cerebral artery is the largest branch of the internal carotid artery. The artery supplies a portion of the frontal lobe and the lateral surface of the temporal and parietal lobes, including the primary motor and sensory areas of the face, throat, hand and arm, and in the dominant hemisphere, the areas for speech. Perforating branches supply the posterior limb of the internal capsule, part of the head and body of the caudate and globus pallidus[51].

Stroke causes neurological impairment which severely reduces patient's ability to perform activities of daily living. Stroke is followed by disturbed balance with impairments in steadiness, symmetry and dynamic stability.

Following stroke, some patients will never be able to stand, whereas those who manage to stand have delayed and disrupted equilibrium reactions, exaggerated postural sway, reduced weight bearing on the paretic limb. Impaired standing balance greatly influences the activities of daily living (ADL), functional independence. These motor problems lead to difficulty in the execution of functional movements. The severity of these motor impairments has their negative impact on function in post stroke individuals.

Carr and Shepherd states that balanced standing involves the ability to stand relatively still, to make preparatory and ongoing postural adjustments without using undue muscular activity[42]. Geurts et al., and Deltaunt et al., stated in their exploratory studies of standing balance after stroke, they discussed about the various factors concerning loss of stance stability such as muscle weakness, loss of proprioceptive feedback, frontal plane instability, loss of balancing between ankle and hip strategies due to muscular imbalances, delayed postural and equilibrium reactions.[17] All this factors by its own and also having their sequential impact in turn on one another affects the stance stability. The compensation produced by stronger side to produce stance stability in turn shifts the center of mass affects stance symmetry and balance.

The standing balance problems of patients following a stroke are often related to uneven weight distribution and difficulties in muscle use, which increase postural sway during standing. Symmetry is equal weight bearing between the two feet in an upright stance. Balance status is also one of the predictors of length of stay in inpatient rehabilitation facilities and of the outcome of stroke rehabilitation. Balance is a prerequisite for all functional activities and depends on the integrity of the central nervous system.

Weight asymmetry and impaired balance function may be a consequence of a learned disuse of the paretic leg. Continued weight-bearing asymmetry may continue and foster a further disuse despite the probability that improved motor function in the lower limb has occurred than the initial period.

Haart et al., reported that the assessment of weight-shifting capacity provides unique information about balance recovery after stroke and can be used as an outcome parameter to develop new rehabilitation strategies[8].

Improving symmetry of weight distribution while bilateral standing, is one of the main treatment goals in the rehabilitation of patients with stroke, acknowledging that the degree of asymmetric weight distribution during quiet standing is negatively associated with motor function and independence .

Association for Applied Psychophysiology and Biofeedback (AAPB) defined that "Biofeedback is a process that enables an individual to learn how to change physiological activity for the purposes of improving health and performance. Precise instruments measure physiological activity such as brainwaves, heart function, breathing, muscle activity and skin temperature. These instruments rapidly and accurately "feedback" information to the user. The presentation of this information — often in conjunction with changes in thinking, emotions, and behavior — supports desired physiological changes. Over time, these changes can endure without continued use of an instrument[56].

Biofeedback is a method of treatment that uses electronic or electromechanical instruments to properly measure, process and feedback to individuals in auditory and/or visual feedback signal forms by utilizing information about their normal and/or abnormal neuromuscular or autonomic activity. Biofeedback treatment is used to help individuals develop greater awareness of and an increase in voluntary control over their physiological processes that are otherwise involuntary and unfelt events.

A recent study of systemic review on investigating the effect of biofeedback in lower limb activities by Stanton et al., found that augmenting feedback through the use of biofeedback is superior to usual or placebo therapy in lower limb activities. In biofeedback therapy, training focuses on repetitive and concentrated practice that might be playing a role in brain plasticity is the main principle39. It is suggested in a study by Erbil et al., that the neuro radiological studies investigating cortical reorganization are also needed in order to understand the mechanisms of recovery obtained by biofeedback treatment[9].

Sang-Hyun Cho et al., done a study on visual feedback tracking training which shows the evidence by functional magnetic resonance imaging that the primary sensorimotor cortex cortical activation shifted significantly from the unaffected to the affected hemisphere[32].

The use of biofeedback is a natural extension of their use of feedback to motivate and inform the patient about their success and progress. As like, Kinetic feedback renders the information about amount of loading through limbs. It is used to inform the patient that weight bearing is optimal or not. Providing feedback to ensure that the exercise is performed to maximize its effect. This is based on motor learning theory and motor learning can be described as "a set of processes associated with practice or experience leading to relatively permanent changes in the capability for producing skilled action[40,41]".

Kendal et al., stated the principle of operant or instrumental conditioning, which is a type of associative learning is the law of effect, behavior that are rewarded tend to be repeated at the cost of other behaviors. This is being used in the biofeedback training[41].

Incorporating biofeedback in stance symmetry to provide kinetic feedback can be provided with devices such as load monitor, feedback canes, and force platform feedback. Yet, Shumway-cook , suggested that kinetic feedback can be provided with devices such as simple as bathroom scale and can also be used to quantify static asymmetric standing alignment keeping by placing both scales together[40].

The kinetic feedback kind of equipments utilizes the type of augmented (extrinsic) concurrent feedback used during an open loop movement in the form of knowledge of results (KR)[21].

Walker and Wong et al., in their studies used visual feedback from a computer screen and auditory feedback from an alarm as two ways or providing knowledge of results. Constant feedback have its positive effect on performance. Annet et al.,in her study on analyzing knowledge of results stated that it is better in the aspects of skill acquisition and skilled performance[49].

Hass et al., used a device, Balance Performance Monitor (BPM), which provides auditory and visual feedback on weight distribution and the magnitude of lateral and anterior-posterior sway during quiet standing and also was a valid outcome too[119].

1.1. NEED FOR THE STUDY

For patients with neurological damage of the central nervous system, such as that due to cerebro vascular accident (CVA), standing balance training is a critical therapeutic procedure to be undertaken before walking and self-care training. Impaired stance balance is one of the primary impairment of stroke. Patients with stroke typically demonstrate asymmetry with most of the weight in standing shifted towards the stronger side.

The stance asymmetry occur secondary to the muscle weakness and by the compensatory strategies produced by stronger side. Symmetry of weight bearing through both the limbs has positive relation with the standing and walking parameters in stroke patients. If it is not occurring at the right time there is greater risk of falls and negative impact on static and dynamic stance balance. Weight symmetry plays a vital role in standing component of stroke rehabilitation.

Thus, a principal goal of physical therapy practice is the reestablishment of standing balance function in patients following stroke. Poor standing balance of hemi paretic stroke patients majorly contributed by muscular weakness of affected side trunk, upper limb and lower limb which tend to shift the center of mass to non-paretic side. This can be rehabilitated in a better way of balance training along with feedbacks in the form of visual, auditory, tactile and proprioceptive inputs.

Biofeedback, with its psycho physiological concepts, it makes the patient to actively participate via the feedback systems rather than passively receiving an intervention imposed on himself. Thus it enhances neural plasticity and cortical activation and reorganization.

Roland P. S. Van Peppen., et al and Kaur baljeet et al., in their studies, concluded that visual and auditory feedback training has an additional role in improving lower limb weight bearing symmetry and gait parameters in patients with hemi paresis respectively28.

To improve weight bearing through the involved lower extremities of hemi paretic patients, clinicians have described a number of techniques, including sophisticated equipments like force plateforms, limb load monitor, foot switches by sensors, and foot canes, which all may have their own considerable positive effect on training stance symmetry and standing balance.

The machines like balance master have their own disadvantage like lack of portability and need of a space occupying environment for keeping them, all which puts the patient under mechanophobia of huge machines and may hinders patients performance on it. This reason provokes us to look forward for a simple, less space-consuming, portable apparatus, which can afford the right, effective intervention for achieving better standing performance. And, in the field of rehabilitation there is always a need for new inventions and there comes the purpose of finding its effectiveness for its better utilization.

Quantification of the patients own performance and progression along with making the patient aware of their own effort by themselves makes a greater benefit in their function and performance rather than qualifying it by therapist or caretaker verbal feedbacks.

Hence in this present study concentration is given on simple kinetic feedback training of visual and auditory forms, by means of simple kinetic feedback equipment (SYMT FB Apparatus) which is cost effective and custom made for measuring and regaining stance symmetry in acute stroke .

The main purpose of the study is to find out the effect of simple kinetic feedback training on stance symmetry in individuals with acute hemi paretic stroke.

Review of literature

2. REVIEW OF LITERATURE

2.1. STANDING – POSTSTROKE

K. I. Ustinova et al., (2003) studied the characteristic features of upright posture maintenance and mechanisms of postural disorders in poststroke hemiparetic patients using a bilateral force platform. The following features of postural disorders were revealed in the patients when tested: an increase in the velocity and amplitude of the center-of-pressure (CP) sway as compared to in healthy subjects, an absolute decrease in the half-cycles of the CP sway, asymmetry of weight bearing by both feet, and a shift of the center of pressure of an affected foot towards the toe. The disturbance of stability of the vertical posture in such patients is to a greater extent associated with weight-bearing asymmetry[35].

N. Genthon et al., (2004) in their explorative study discussed that postural asymmetry in humans is generally associated with different pathologies. However, its specific influence on undisturbed upright stance is poorly understood[27].

EkaterinaB et al .,(1995) done a exploratory study on range of walking speeds in chronic hemiparetic patients is associated with their gait asymmetry and postural sway. In that they have discussed that hemiparetic patients walked slower, more asymmetrically, and swayed more laterally favoring their non affected leg than did healthy persons[10].

Eli Isakov et al.,(1997) done a evaluative study investigated in hemiparetics, below-knee amputees and healthy control subjects by measuring the foot-ground reactive forces in each limb separately and simultaneously. Forces in the anteroposterior and mediolateral directions were monitored by means of two force platforms. Values obtained from both legs were compared and their ratios were calculated. The anteroposterior forces were significantly larger in the sound limbs as compared to the affected limbs, both with the eyes open and closed. The anteroposterior/mediolateral force ratio in amputees and hemiparetics were smaller.

Therefore, amputees and hemiparetics should be trained in equilibrium exercises to improve the ability of the affected limb hence reduce load over the sound limb in the process of maintaining standing posture[11].

2.2. WEIGHT DISTRIBUTION, WEIGHT SHIFTING AND STANCE SYMMETRY

Ustinova et al., (2004) in their experimental study examined the learning of voluntary weight shifts based on visual Center of Pressure(COP) feedback in patients with different types of stroke in the territory of the middle cerebral addition to traditional rehabilitation. They first had to move their COP onto a randomly positioned target and then move this target into a designated basket. The other 39 patients only received traditional treatment. After the training period, the experimental group exhibited more reduction in weight bearing asymmetry than the control group and more improvement of postural stability (COP velocity) when standing in a forced symmetrical position[11].

Chih-Chieh Lin et al., (2003) in their experimental study, states that the symmetric standing training will be suitable for acute hemiplegic patients suffering from stroke. Sixteen patients with hemiparesis has taken and randomly assigned into two groups. The treatment group received biofeedback balance training and conventional physical therapy, while the control group received conventional physical therapy only. After training, both groups showed improvement in overall locomotor performance, gait pattern and interlimb coordination in most indices. However, this study's auditory and visual biofeedback training provided insignificant additional improvement to locomotor performance, gait pattern and interlimb coordination other than static performance[4].

Engardt M. et al., (1994) done a randomized controlled trial on long-term effects of auditory kinetic feedback on relearned symmetrical body weight distribution while rising and sitting down were studied in stroke patients. Thirty patients were re-tested on average 33 months after having trained with and without auditory feedback. Body weight distribution on the legs was measured with two force plates. At re-test there was a decrease from 48% to 39% of body weight distribution (%BWD) on the paretic leg in rising and in sitting down in the patients in the auditory feedback group. In the control group the decrease was from 44 to 39% BWD on the paretic leg in rising and from 44 to 42% WD in sitting down. The symmetrical body-weight distribution, acquired after auditory feedback training, was not consistent over time. Movement time, however, was significantly reduced in the auditory feedback group[12].

Mirjam de Haart et al., (2003) done a exploratory study with 37 in patients with a first hemispheric intra cerebral infarction or hematoma who were admitted to retrain standing balance and weight bearing asymmetry. Although weight-bearing asymmetry significantly improved during the first weeks of balance training, there was no improvement thereafter. The results showed that these patients suffer from severe postural instability as well as from several (both static and dynamic) aspects of postural asymmetry during quiet standing in the frontal and sagittal planes. Functional improvements during rehabilitation appear to be most prominent in the frontal plane, as indicated by a reduction in body sway, in visual dependency, and in weight-bearing asymmetry[8].

Kaur Baljeet et al., (2009) in their study of non-randomized control trial of 30 stroke patients (15 in experimental group and 15 in control group) assessed the effect of auditory feedback along with the conventional methods in improving the weight bearing symmetry of lower limbs and spatial temporal gait parameters in stroke patients. Conventional weight bearing exercises was given for control group while the same was supplemented with auditory feedback device called "Ped Alert" for the experimental group. Exercises were given one hour per day, five days a week for two weeks. Within group comparison showed significant improvement in weight bearing symmetry of both groups. Between groups comparison showed significant improvement in weight symmetry. Auditory feedback training has an additional role in improving certain gait parameters like unaffected step and stride lengths and gait velocity[49].

Vassilia Hatzitaki et al.,(2009) done a investigatory study to investigate the impact of two direction-specific, visually guided weight shifting (WS) training protocols on standing balance of 48 healthy elderly women. They were randomly assigned into: a group that practiced WS in the anterior/posterior direction (A/P group, n = 19), a group that practiced WS in the medio/lateral direction (M/L group, n = 15) and a control group (n = 14). Participants performed 12 training sessions of visually guided WS (3 sessions a week for 25 minutes per session). Static balance was measured before and after training and it is concluded that it is important to use the direction -specific WS tasks in balance training, in order to improve control of static balance in elderly women[36].

Pao-Tsai Cheng et al., (2004) performed a prospective study to assess the balance function of hemiplegic stroke patients and to investigate whether visual feedback rhythmic weight-shift training following acute stroke in static and dynamic balance performance and in falls among 52 hemiplegic stroke patients 28 in the training group and 24 in the control group. Intervention was given as conventional stroke rehabilitation programme plus visual feedback rhythmic weight-shift training. Measurement of static balance was taken in different sensory conditions; and dynamic balance performance including on-axis velocity and directional control during rhythmic weight-shift, occurrence of falls. Significant improvement in dynamic balance performance not in static balance function was found in hemiplegic patients in the training group[27].

Shumway-Cook et al.,(1988) suggested that "Visual feedback Therapy(VFT) is more effective than conventional therapy(CT) in reducing lateral sway and increasing load on the affected leg in re-establishing stance stability in post-acute stroke patients"[55].

Winstein et al.,(1989) in their experimental study investigated the effect of additional Visual feedback therapy compared with Conventional training for balance retraining in post-acute stroke patients with a standing feed-back trainer found significant improvement of static standing symmetry[55].

2.3.BALANCE TRAINING DEVICES IN STANDING REHABILITATION

M. Y. Lee et al., **(1997)** done a evaluative study for designing and clinical evaluation of a new biofeedback training device for static (postural steadiness) performance of the standing balance system. A new standing biofeedback training device, which includes a height-adjustable work table, weight-bearing sensors, and a real-time visual and auditory feedback system, has been developed for postural training . 60 persons with hemiplegia after acute stroke or traumatic brain injury were randomly divided into Group A (experimental) and Group B(control) . After a 4 weeks of training period, the results indicated that this device had a positive training effect on stance symmetry in hemiplegic subjects. The acute hemiplegic stroke patients, the static standing steadiness can be trained effectively through weight bearing biofeedback and a postural correction mirror in the clinical and home caring environments[22.]"

Marco Dozza et al., **(2005)** done a study on eight healthy subjects presented the effects of a portable prototype of an audio biofeedback (ABF) system on upright stance postural stability, in conditions of limited and unreliable sensory information. He outcome measures are stabilogram diffusion analysis, combined with traditional center of pressure analysis and surface electromyography, were applied to the analysis of quiet standing tasks on a Temper foam surface with eyes closed. These analyses provided the evidence that ABF may be used to treat postural instability. The examination of the electro myographic EMG activity supported the hypothesis that ABF does not induce an increased stiffness (and hence more co-activation) in leg muscles, but rather helps the brain to actively change to a more feedback-based control activity over standing posture[23].

I-Chun Cheng et al.,(2002) done a study to evaluate the delayed effects of balance training program on hemiplegic stroke patients.41 ambulatory hemiplegic stroke patients were randomly assigned into two groups, the control group and training group. Visual feedback balance training with the SMART Balance Master was used in the training group. Brunnstrom staging of affected limb scores and Functional Independent Measure (FIM) scores of each patient were recorded. Quantitative balance function was evaluated using the SMART Balance Master, before and 6 months after training. The results showed significant improvements in dynamic balance function measurements were found for patients in the trained group and insignificant difference was found in static balance functions[20].

Michael W. Kennedy et al., **(2000)** in their validity study described about the Nintendo Wii Balance Board that has the potential to enhance rehabilitation for patients with balance disorders and the validity was assessed. It provided the added benefit of visual biofeedback based on center of pressure location with normal rehabilitation exercises was given by the device. Patient improvement was tracked through objective analysis of trends both within a single session and from one session to the next. The device primarily uses a board display to directly indicate the subject's center of pressure and a bar display to indicate the right-left distribution of the patient's weight. It monitor the center of pressure of a subject standing on the Balance Board, providing visual feedback as to how his/her weight is distributed and the weight load placed on the board is also measured. Multiple display types can be used for visual feedback[57].

Haas BM et al., **(2000)** in their study used the Balance Performance Monitor (BPM), device which provides auditory and visual feedback on weight distribution and the magnitude of lateral and anterior-posterior sway during quiet standing. This study investigated the validity of the measurements provided by the BPM using a Kistler force plate (KFP) as the gold standard. Percentage weight distribution between the BPM foot plates was validated using both a series of calibration weights and the vertical component of ground reaction force, measured by the KFP, during normal standing in 18 young normal subjects. The lateral and anterior-posterior sway indices from the BPM were validated against the standard deviation of the position of the centre of pressure, again obtained using the KFP, during normal standing. The BPM may be used to provide a valid measure of the symmetry aspect, of postural control[19].

Ruth Ann Geiger et al., (2001) done a experimental study to investigate the addition of visual biofeedback/forceplate training could enhance the effects of other physical therapy interventions on balance and mobility following stroke on 13 patients. Subjects were assigned randomly to either an experimental group or a control group, both groups received physical therapy interventions designed to improve balance and mobility 2 to 3 times per week. The experimental group trained on the NeuroCom Balance Master for 15 minutes of each 50-minute treatment session. The control group received other physical therapy for 50 minutes. Although both groups demonstrated improvement following 4 weeks of physical therapy interventions, no additional effects were found in the group that received visual biofeedback/forceplate training combined with other physical therapy[31].

2.4. VISUAL AND/OR AUDITORY FEEDBACK IN STANDING

Stanton et al (2011)., done a systematic review with meta analysis of randomized trials to investigate the effect of biofeedback in lower limb activities. Intervention given as biofeedback during sitting standing, walking and measures were taken. Studies were selected b PEDro score, results showed that there is a significant improvement in lower limb activities following bio-feedback.it is concluded that augmenting feedback through the use of biofeedback is superior to usual or placebo therapy in lower limb activities[34].

Gunes Yavuzer et al (2006)., done a randomised controlled trial, investigated the effects of balance training, using force platform biofeedback, on quantitative gait characteristics of hemiparetic patients. In this study 41 patients were randomly assigned to an experimental or a control group. The control group (19) participated in a conventional stroke inpatient rehabilitation programme, whereas the experimental group (22) received 15 sessions of balance training (using force platform biofeedback) in addition to the conventional programme. The results indicate that experimental group shown significant improvement in gait characteristics mainly in vertical ground reaction forces. From the findings the clinical message is that balance training using force platform biofeedback, in addition to a conventional inpatient stroke rehabilitation programme is beneficial in improving postural control and weight-bearing on the paretic side while walking late after stroke[15].

Filipa Januario (2008) et al., done a study to assesses the postural stability and the effect of balance training using a force platform visual biofeedback among outpatients with postural disturbances following stroke. 38 outpatients with hemiplegia and/or ataxia after stroke has taken and postural training programme. A tilting multiaxial force platform was used to assess bilateral postural stability. The results suggest that a training program using force platform visual biofeedback improves objective measures of bilateral postural stability in patients with hemiplegia and/or ataxia after stroke. They also claimed that it may be important to associate biofeedback balance training to conventional programmes[13].

Barclay-Goddard RE et al.,(2009) had done a systemic review to determine if visual or auditory force platform feedback improves the clinical and force platform standing balance outcomes in clients with stroke. Standing balance deficits are common in individuals after stroke. The feedback can take visual and/or auditory form. Randomized controlled trials comparing force platform with visual feedback and/or auditory feedback to other balance treatments searched the Cochrane Stroke Group trials register. Force platform feedback did not improve clinical measures of balance when moving or walking. However, we did find a positive effect of force platform feedback training to train stance symmetry, but not sway, in standing[49].

Annick Ledebt et al(2005)., did an experimental study to examine the effects of balance training with visual feedback on stance and gait in school-age children with hemiplegic cerebral palsy. Ten participants between 5 and 11 years of age were assigned to either the training or the control group according to an aged-stratified randomization. The training corresponded to three sessions per week during six weeks 30 minutes each session. The force plate was displayed as a square on a vertical screen, situated at a distance of 1.3 m in front of the child standing at the center of the force plate. The COP was represented by a red dot they were asked to perform both static and dynamic tasks. Stance and gait parameters, based on force plate data, were assessed three times in both groups at the beginning, after six weeks, after ten weeks. The results suggest that balance training with visual feedback might be useful to decrease the amplitude of postural sway during quiet standing and increase the amplitude of the voluntary weight shifts during standing. In addition, the training resulted in a decrease of the asymmetry in step length during walking. The training group showed increases of the voluntary weight shifts in the forward and backward directions and toward the non-paretic leg whereas no increase was observed in the control group[1].

Dr. Rajendra Sharma et al.,(2OO1)conducted a study to find out the effectiveness of visual biofeedback training in reestablishing postural control in 20 patients undergoing balance rehabilitation with various balance problems. Quantitative assessment about balance problems was done using force plate system in regard to centre of gravity (COG) alignment, postural sway and dynamic balance measures within limits of stability (LOS). Visual biofeedback training to improve COG alignment, to reduce postural sway and to increase LOS was given for 3-6 weeks duration on alternate days. Improvement in static and dynamic balance was observed. The study suggests that visual biofeedback training facilitates appropriate balance strategies and enables in achieving improved postural control[29].

Nicolas Pinsault et al.,(2008) done a study with positive results on 12 healthy elderly subjects found out the effectiveness of the VFB system in improving postural control during quiet standing in elderly subjects depends on the scale display which implicates in clinical and rehabilitative areas[24].

Zuzana Halicka et al.,(2007) done a study to examine balance control performance in subjects of different age during the stance on different support surfaces with and without visual biofeedback (VBF). The study was performed on 20 young and 13 older subjects during stance on firm and foam surface in the conditions with and without VBF. Body sway was measured by force platform center of ppressure (CoP) and by two accelerometers located on the upper (Th4) and lower trunk (L5). Real-time visual biofeedback (VBF) is a voluntary control mechanism of postural activity using additional visual information of the centre of pressure (CoP) position. The results confirm knowledge about the stabilizing effect of additional VBF in stance control[38].

Deborah Nicholas et al., (1997) in their study used force platform using audio and visual feedback for balance control in hemiplegic stroke patients and found that feedback can be used to improve balance[49].

Chih-Chieh Lin et al.,(2002) did a study to investigate the effects of using a visual and auditory biofeedback system in a balance retraining program for 16 chronic post-stroke period. The patients were randomly divided into two groups with eight patients in each group. The treatment group received biofeedback balance training and conventional physical therapy, while the control group received conventional physical therapy only. Using a forceplate and motion analysis system, standing balance and locomotor performance parameters were recorded for each subject during evaluation sessions before and after the one-month treatment period. The results showed that both groups improved in overall locomotor performance, gait pattern, and interlimb coordination, however, the biofeedback group did not demonstrate a clinically significant improvement over the control group[4].

Culham, Elsie G et al.,(2000) done a study to explore the relative effectiveness of providing visual feedback of the CoG; position and conventional physical therapy, both offered in addition to regular therapy. Additional daily treatment sessions using either visual feedback of the CoG position or conventional balance training afforded no added benefit to the participants in rehabilitation[6].

Roland P. S. Van Peppen et al.,**(2006)** done a systemic review to establish whether bilateral standing with visual feedback therapy after stroke improves postural control compared with conventional therapy and to evaluate the generalization of the effects of visual feedback therapy on gait and gait-related activities. The methodological quality of each study was assessed with the Physiotherapy Evidence Database scale. Eight out of 78 studies were taken. The additional value of visual feedback therapy in bilateral standing compared with conventional therapy shows no statistically significant effects on symmetry of weight distribution between paretic and non-paretic leg, postural sway in bilateral standing, gait and gait-related activities[28].

2.4. OUTCOME MEASURE

Glanna M. Rodriguez et al ., (2002), in their experimental study to determine the effect of shoe wedges and lifts on symmetry of stance and weight bearing in hemiparetic individuals. Weight symmetry scores were taken as main outcome measure and analysed the weight symmetry ratio which reflects the subjects weight bearing status. In this study the balance master allowing independent measurement of vertical forces between the feet and surface of platforms. The weight bearing data on the weaker side were collected and averaged. Symmetry ratio reflecting the weight bearing status of the subjects were calculated as weight bearing of intact lower extremity divided by weight bearing of intact lower extremity[57].

Aim and objectives

3. AIMS AND OBJECTIVES

3.1. AIM OF THE STUDY

To find out the effect of simple kinetic feedback training on stance symmetry in individuals with acute hemiparetic stroke.

3.2. OBJECTIVES

- To evaluate the effect of simple kinetic feedback training on stance symmetry in individuals with acute hemiparetic stroke.
- To evaluate the effect of lateral weight shifting exercises on stance symmetry in individuals with acute hemiparetic stroke.
- To evaluate the difference between the effect of simple kinetic feedback training and lateral weight shifting exercises on stance symmetry in individuals with acute hemiparetic stroke.

Materials and methodology

4. MATERIALS AND METHODOLOGY

4.1. STUDY DESIGN

Pre test-Post test experimental study design

4.2. SAMPLING TECHNIQUE

Purposive sampling.

4.3. SAMPLE SIZE

15 subjects, satisfying the inclusion criteria.

Group A – 8 subjects

Group B – 7 subjects

4.4. STUDY SETTING

Department of physiotherapy,

Kovai Medical Centre and Hospital, Coimbatore.

4.5. CRITERIA FOR SELECTION

4.5.1. INCLUSION CRITERIA

- Age between 45 to 65.
- Both genders.
- Patients within 3 weeks post stroke.
- Medically stable patients.
- Ischemic and hemorrhagic stroke in the territory of the middle cerebral artery.
- Patients with MMSE (Mini mental status examination) > score 24.
- The Test for Upright motor control (Daniel and Worthingham)- Knee flexion component – Moderate(M).

  (Standing straight and lifting knee towards chest- actively completes an arc of knee flexion from 0 to between 30 and 60 three times within 10 secs)
- Patients with static standing balance – fair (Functional balance grade).

  (Patient able to maintain balance with handhold support, may require occasional minimal assistance)
- Patients with previous history of stroke without residual motor deficits.

4.5.2. EXCLUSION CRITERIA

- Medical conditions that could affect their ability or balance.
- Visual, hearing, perception, cognitive deficits and spatial disorders.
- Aphasic patients (Wernicke's alone).
- Sensory impairments (Superficial and Deep - touch and proprioception).
- Muscle tone ≥ 1 + in affected upper and lower limb. (Modified Ashworth Scale for Spasticity).

4.6. HYPOTHESIS

4.6.1. NULL HYPOTHESIS

H_{01}- There is no significant improvement with simple kinetic feedback training on stance symmetry in individuals with acute hemiparetic stroke.

H_{02}- There is no significant improvement with lateral weight shifting exercises on stance symmetry in individuals with acute hemiparetic stroke.

H_{03}- There is no significant difference between simple kinetic feedback training and lateral weight shifting exercises on stance symmetry in individuals with acute hemiparetic stroke.

4.6.2. ALTERNATE HYPOTHESIS

H_{a1}- There is a significant improvement with simple kinetic feedback training on stance symmetry in individuals with acute hemiparetic stroke.

H_{a2}- There is a significant improvement with lateral weight shifting exercises on stance symmetry in individuals with acute hemiparetic stroke.

H_{a3}- There is a significant difference between simple kinetic feedback training and lateral weight shifting exercises on stance symmetry in individuals with acute hemiparetic stroke.

4.7. STUDY METHOD

4.7.1. TREATMENT PROCEDURE

Totally 15 patients who fulfils the selection criteria were selected and randomly allocated 8 patients to experimental group and other 7 patients allocated to control group.

For both groups stance symmetry was measured before and after the treatment programme by using the weight bearing symmetry scores(WBBS). For the both the experimental and control group conventional physical therapy were given.

4.7.2. TREATMENT DURATION

2 sessions a day for 5 days.

- Experimental group received 15 minutes of simple kinetic feedback training along with conventional physical therapy.
- Control group received 15 minutes of lateral weight shifting exercises along with conventional physical therapy.

4.7.3. TRAINING FOR EXPERIMENTAL GROUP

Patients in experimental group received simple kinetic feedback training along with conventional exercises.

SYMT-FB APPARATUS

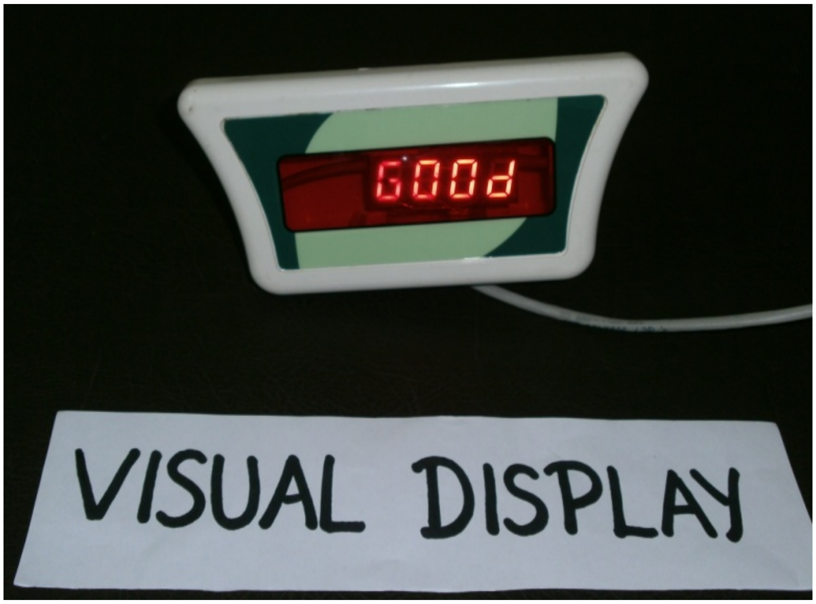
This is a custom-made, newly designed, portable simple kinetic feedback apparatus which serves both the values of evaluation and treatment training.

The purpose of designing the apparatus is to provide a cost effective apparatus for stance symmetry traning to the field of rehabilitation, to be beneficial in any clinical condition that is in need of lower limb symmetry.

It is designed keeping in mind the right time utilization of stance training which is a essential component in stroke rehabilitation. It is expected to give its benefits in the clinical setting in the standing component of stroke rehabilitation.

PHOTOGRAPHIC ILLUSTRATION OF KINETIC FEEDBACK TRAINING APPARATUS USED IN THE STUDY

PHOTOGRAPHIC ILLUSTRATION OF VISUAL DISPLAY:



STRUCTURAL CONFIGURATION :

The simple kinetic feedback apparatus is a battery charged device that consists of two rectangular shaped sensor platforms that measures the weight imposed on it. Weight will be displayed concurrently as a numerical reading in front display of apparatus by two digital meters which are connected to the two sensors respectively. This measurements is taken for weight bearing symmetry scores by taking the average of three outcomes.

BIOFEEDBACK COMPONENT :

It is in built inside the apparatus, by setting the range of needed value via the switch buttons, visual and auditory feedback outputs can be got.

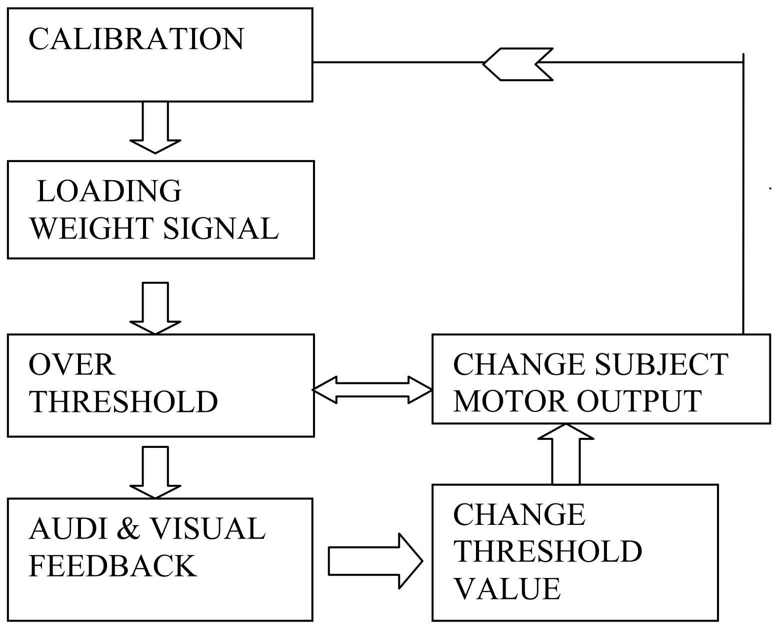
Visual display :

It is a constant electronic display of alphabets “GOOD” given by means of a light weight, detachable, wall mounted device. The device is connected to the apparatus before training and range is set.

Auditory Output :

It comes along with visual display, the hardware system for it is inbuilt in the apparatus. Both auditory and visual display starts when the feedback range is reached.

MECHANISM OF WORKING:



TRAINING:

Clear explanation with instruction and demonstration about the training procedure was given to the patient before starting simple kinetic feedback training.

Patient was made to stand from supine on to the plain floor for a 30 seconds with minimal assistance just prior to the treatment session.

Instructions and Demonstration

- Demonstration was given by the therapist by performing on his own.
- Patient was instructed to step the affected extremity first, on the marked area of the platform in the simple kinetic feedback equipment and then the normal side with the therapist assistance.
- After standing on it, he was instructed to stand upright comfortably to the maximum and as tall as possible.
- He was asked to look straight ahead and arms at sides comfortably.
- He was instructed to control his body from swaying for 30 seconds in order to measure the weight asymmetry from the equipment.
- Subject was practically exposed to the training session once as a trial.

- Maximum potential of the patient to bear weight over the paretic limb was found in kilograms.
- The threshold (according to the maximum potential) was set in the machine by calibration.
- Patient was asked to perform weight bearing over the paretic limb targeted till he gets a visual and auditory feed back. Then it was repeated till he masters.
- The visual and auditory feedbacks were given respectively in the form of electronic visual display of appreciatory message as “GOOD” and buzzer sound.
- Next threshold was set according to his performance, and the training continues until he gains symmetrical weight bearing in both the lower limbs.
- Proper education about the rationale behind the training was given to the patient and he was motivated to perform well.
- The duration was for 15 minutes excluding rest periods, with each weight bearing the patient is asked to bear weight for a maximum duration as much as he can, after reaching the target.

PHOTOGRAPHIC ILLUSTRATION OF A SUBJECT TRAINED BY SIMPLE KINETIC FEEDBACK TRAINING

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PHOTOGRAPHIC ILLUSTRATION OF SUBJECT FOCUSSING TO BIOFEEDBACK VISUAL DISPLAY

4.7.4. TRAINING FOR CONTROL GROUP

Patients in control group received lateral weight shifting exercises along with conventional exercises.

It consists of standing upright in the plain floor with feets apart and shifting weight to affected side to the maximum without compensatory movements, each weight bearing was for a minute and totally for 15 minutes excluding rest periods.

After intervention both the group were subjected to weight symmetry scores, thus the post test scores was taken.

4.7.5.CONVENTIONAL PHYSIOTHERAPY

Conventional exercises (twice a day, tailor made and individualised for each subject)

- Active assisted exercises to affected upper and lower limb.
- Bed mobility exercises

- **Supine to both side lying.**

    Rotation and flexion of neck.

    Hip and knee flexion.

    Flexion of shoulder and protraction of shoulder girdle.

    Rotation within the trunk.

- **Pelvic bridging**

    Flexion of hip and knee holds foot firmly on the bed

    Push down through his heels and lifts his buttocks.

- **Pelvic rotations**

    Rotating the knees to both the sides from pelvic bridging position.

- **Side lying to sitting.**

    Lateral flexion of neck.

    Lateral flexion of trunk.

    Leg lifted and lowered over side of bed.

- **Mobilisation to sit with required support.**

    Feet and knees close together.

    Weight evenly distributed.

    Flexion of hip with extension of trunk.

    Head balanced on level shoulders.

- **Mobilisation to stand with required support.**

    Feet a few inches apart.

    Hips in front of the ankle.

    Shoulders over hips.

    Head balanced on level shoulders.

    Erect trunk.

4.8. OUTCOME MEASURES:

Weight bearing symmetry scores

4.9. STATISTICAL ANALYSIS:

Pre-test and Post-test values of the study were collected and assessed for variation in improvement & their results were analyzed using Independent `t' test and Paired `t' test,

INDEPENDENT `t' TEST (between groups)

$$t = \frac{\overline{X1} - \overline{X2}}{S} \sqrt{\frac{n_1 n_2}{(n_1 + n_2)}} \qquad \text{Where, } S = \sqrt{\frac{\sum d_1^2 + \sum d_2^2}{n_1 + n_{2-}2}}$$

PAIRED `t'TEST (within groups)

$$t = \frac{\bar{d}\sqrt{n}}{S} \qquad \text{Where, } \mathbf{S} = \sqrt{\frac{\sum \boldsymbol{d^2} - [\bar{\boldsymbol{d}}]^2 \times \boldsymbol{n}}{\boldsymbol{n} - \mathbf{1}}}$$

S=combined standard deviation

d_1&d_2 =difference between initial & final readings in group A &group B respectively.

n_1&n_2=number of patients in group A & group B respectively.

$\overline{X}_1$&$\overline{X}_2$ =Mean of group A & group B respectively.

Data presentation

5. DATA PRESENTATION

5.1. DEMOGRAPHIC DATA

		EXPERIMENTAL GROUP	CONTROL GROUP
GENDER	MALE	3(37.5%)	4(57.14%)
	FEMALE	5(62.5%)	3(42.85%)
AGE	MALE	42.3±14.05	60±10.97
	FEMALE	39.6±7.31	45.3±5.55
TYPE OF STROKE	INFARCT	5(62.5)	5(71.42)
	HEMMORHAGE	3(37.5)	2(28.57)
SIDE OF WEAKNESS	RIGHT	5(62.5)	3(42.85)
	LEFT	3(37.5)	4(57.14)

5.2. TABULAR REPRESENTATION

5.2.1. TABLE 1:

PAIRED‘t’ TEST

Paired ‘t’ test values of weight bearing symmetry scores among experimental group :

SCALES	MEAN VALUES		Calculated ‘t’ Value	Table ‘t’ Value	Level of significance
	Pre-Test	Post-Test			
Weight bearing symmetry scores	6.7913	2.555	2.383	2.365	P>0.05 Significant

WEIGHT BEARING SYMMETRY SCORES

For 14 degrees of freedom and at 5% level of significance, the table‘t’ value is 2.383 and the calculated ‘t’ value is 2.365 Since the calculated ‘t’ value is greater than the table‘t’ value the null hypothesis is reject.

5.2.2. TABLE 2

GROUP II: CONTROL GROUP

Paired ‘t’ test values of Weight bearing symmetry scores (WBSS)among experimental group :

SCALE	MEAN VALUES		Calculated ‘t’ Value	Table ‘t’ Value	Level of significance p>0.05
	Pre-Test	Post-Test			
Weight bearing symmetry scores	**6.791**	**2.555**	**2.576**	**3.365**	**Significant**

WEIGHT BEARING SYMMETRY SCORES

For 12 degrees of freedom and 5% level of significance the table‘t’ value is 3.365 and the calculated’ value is 2.576. Since the calculated’t’ value is greater than the table‘t’ value the null hypothesis is rejected.

5.2.3. TABLE 3

INDEPENDENT‘t’ TEST:

Independent ‘ t’ test values for Weight bearing symmetry scores (WBSS) for pre test scores of experimental and control group.

SCALE	MEAN VALUES		Calculated ‘t’ Value	Table ‘t’ Value	Level of significance p<0.05
	Experimental Group	Control Group			
Weight bearing symmetry scores	**6.803**	**6.925**	**-.042**	**2.169**	**Not significant**

PRE TEST VALUES GROUP EXPERIMENTAL AND CONTROL

WEIGHT BEARING SYMMETRY SCORES

For 13 degrees of freedom and 5% level of significance, the table‘t’ value is 2.16 and the calculated ‘t’ value is -0.042. Since the calculated‘t’ value lesser than the table‘t’ value the null hypothesis is accepted.

5.2.4. TABLE 4

INDEPENDENT'‘t’ TEST

Independent ‘ t’ test values for Weight bearing symmetry scores (WBSS)for post test scores of experimental and control group.

SCALES	MEAN VALUES		Calculated ‘t’ Value	Table ‘t’ Value	Level of significance $p>0.05$
	Experimental Group	Control Group			
Weight bearing symmetry scores	2.555	3.5643	-0.716	2.169	Not Significant

POST TEST VALUES: EXPERIMENTAL AND CONTROL GROUP

WEIGHT BEARING SYMMETRY SCORES

For 13 degrees of freedom and 5% level of significance, the table‘t’ value is 2.160 and the calculated ‘t’ value is -0.716. Since the calculated‘t’ value lesser than the table‘t’ value the null hypothesis is accpted.

5.3. GRAPHICAL REPRESENTATION

Fig. 5.3.1: Graphical representation of mean values for Weight bearing symmetry scores (WBSS)among experimental group

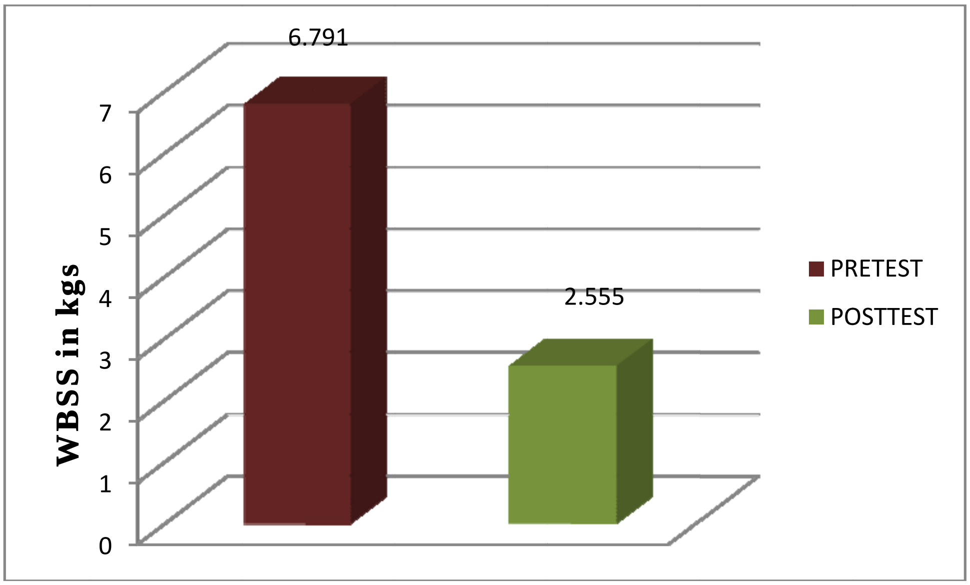


Fig.5.3.2 : Graphical representation of mean values for Weight bearing symmetry scores (WBSS)among control group

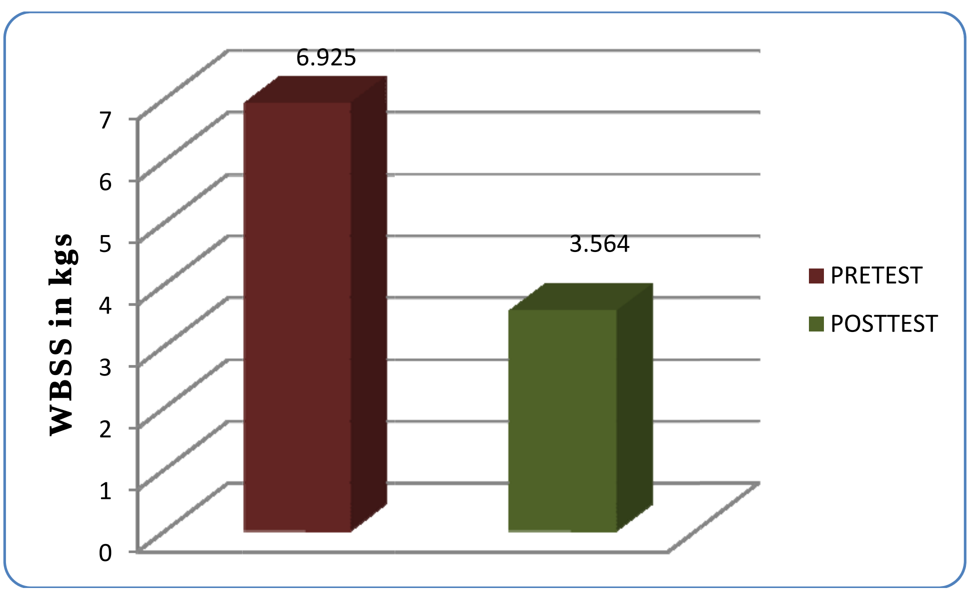


Fig.5.3.3: Graphical representation of pretest mean values for Weight bearing symmetry scores (WBSS) among experimental and control group

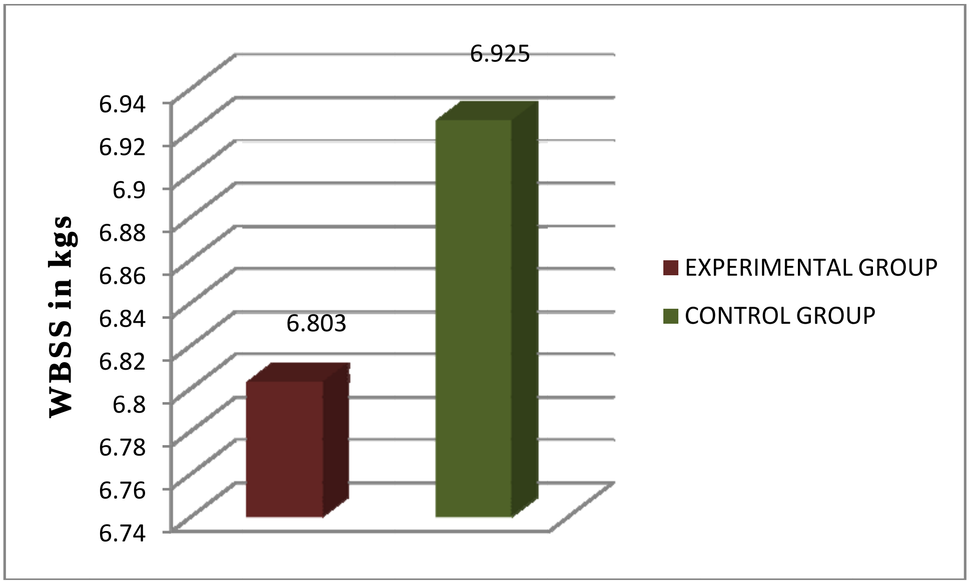
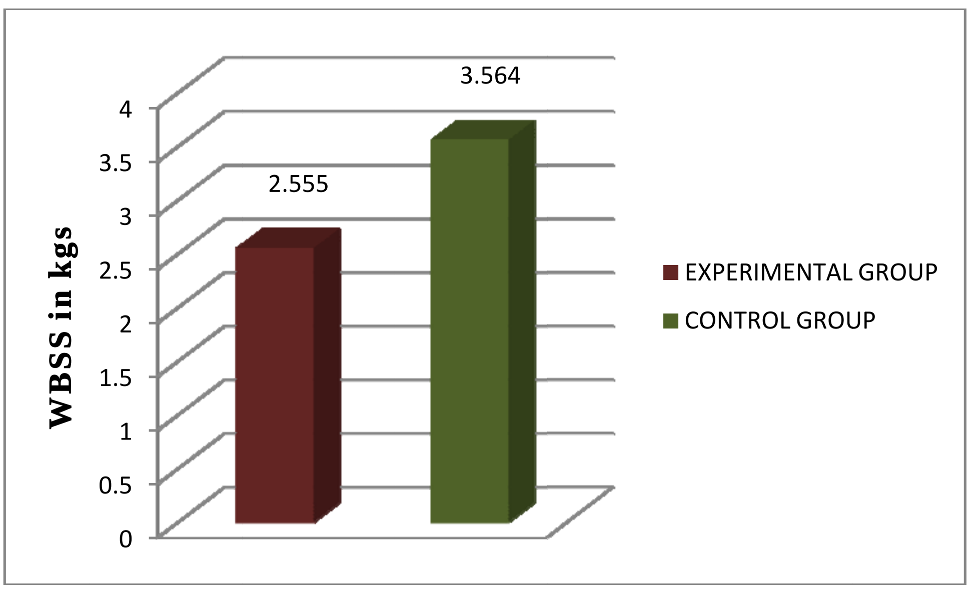


Fig.5.3.4:Graphical representation of post test mean values for Weight bearing symmetry scores (WBSS)among experimental and control group.



6. DATA ANALYSIS AND RESULTS

PAIRED’t’ TEST:

EXPERIMENTAL GROUP-WEIGHT BEARING SYMMETRY SCORES

For 14 degrees of freedom and at 5% level of significance, the table ‘t’ value is 2.365and the calculated ‘t’ value is 2.383. Mean difference between pre and post test value is 4.236. Since the calculated ‘t’ value is greater than the table ‘t’ value the null hypothesis is rejected. Thus, there is a significant improvement with kinetic feedback training in weight symmetry in individuals with acute stroke.

CONTROL GROUP- WEIGHT BEARING SYMMETRY SCORES

For 12 degrees of freedom and 5% level of significance the table ‘t’ value is 2.447 and the calculated ‘t’ value is 2.576. Mean difference between pre and post test value is 3.361. Since the calculated ‘t’ value is greater than the table ‘t’ value the null hypothesis is rejected. Thus, there is a significant improvement with lateral weight shifting in weight symmetry in individuals with acute stroke.

INDEPENDENT ‘t’ TEST:

PRE TEST VALUES OF EXPERIMENTAL AND CONTROL GROUP WEIGHT BEARING SYMMETRY SCORES

For 13 degrees of freedom and 5% level of significance, the table ‘t’ value is 2.447 and the calculated ‘t’ value is 0.042. Mean difference between pre test values of group I and group II -0.1212. Since the calculated ‘t’ value lesser than the table ‘t’ value the null hypothesis is accepted .Thus ,there is no significant difference exist between the groups. Hence there was homogeneity exists between both groups before the experiment on weight symmetry scores.

POST TEST VALUES OF EXPERIMENTAL AND CONTROL GROUP WEIGHT BEARING SYMMETRY SCORES

For 13 degrees of freedom and 5% level of significance, the table ‘t’ value is2.16 and the calculated ‘t’ value is -0.716.Mean difference between post test values of group I and group II is -1.009. Since the calculated ‘t’ value lesser than the table ‘t’ value the null hypothesis is rejected. Thus, there is a significant difference exist between simple kinetic feedback training and lateral weight shifting exercises on weight symmetry in individuals with acute hemiparetic stroke.

Discussion

7. DISCUSSION

Stroke as a neurological illness has third longest stay for rehabilitation and long term disability. Impaired stance symmetry is one of the major clinical problem encountered after stroke by patients.

Sacley, Lincoln et al., and Dickinson et al., in their studies assessed the absolute weight bearing and lateral stability in stroke patients and they found it to be improved and loading symmetry is found as an important clinical outcome[49].

M. Y. Lee (1997) et al., done a study for designing and clinical evaluation of a new biofeedback training device for static (postural steadiness) performance of the standing balance system and trained with a real-time visual and auditory feedback system and concluded that the static standing steadiness can be trained effectively through weight bearing biofeedback[22].

In the present study there was a significant improvement in both experimental and control groups but there was no significant improvement between the experiment and the control group. This shows that there is no statistically significant improvement found in the experimental group who received simple kinetic feedback training than the control group.

The insignificant results might be because of two major reasons, the one is because of small sample size and another is the less treatment duration only for 5 days. The insignificant results might also be due to many factors, that is variation in motivation level of the subjects, physical and mental fatigue hindering the performance, fear while stepping in the apparatus for initial days, wider range weight bearing symmetry scores at baseline.

There are also biomechanical factors such as varying stabilizing moment of forces by synergistic and compensatory components, ankle strategy mechanism, varying equilibrium forces and swaying which have an impact on weight bearing through paretic lower limb.

Ruth Ann Geiger et al., done a randomized controlled trial and found that both groups demonstrated improvement in stance and gait following 4 weeks after training, no additional effects were found in the group that received visual biofeedback/forceplate training[31].

Thus even there is clinical improvements found by simple kinetic feedback training, there is no statistically significant improvement found by comparing between the groups.

Summary and conclusion

8. SUMMARY AND CONCLUSION

The aim the study was to find out the effect of simple kinetic feedback training on stance symmetry in individuals with acute hemiparetic stroke. Fifteen acute hemiparetic stroke subjects were selected by purposive sampling method in which eight of them were underwent simple kinetic feedback training and another seven subjects lateral weight shifting exercises, both underwent conventional physical therapy for five days.

Stance symmetry was assessed using weight bearing symmetry scores. The pre and post test scores were analyzed by using‘t’ test. The results shows that there was no statistically significant improvement on stance symmetry by using weight bearing symmetry scores in between the experimental and control groups.

Thus it is concluded that there is no added benefit of simple kinetic feedback training in improving stance symmetry in individuals with acute hemiparetic stroke. Further studies with larger sample size and longer duration needs to be done to examine the effect of simple kinetic feedback training.

Limitations and suggestions

9. LIMITATIONS AND SUGGESTIONS

LIMITATIONS:

- Smaller sample size.
- Very short duration of treatment (5 days).
- Patient's attention span and concentration, motivation status, level of interest were not considered for inclusion criteria.
- Physical and mental fatigue was not considered for both assessment and treatment procedures.
- Study was only done on middle cerebral artery territory of stroke and the lesion side is not considered.
- Fear of fall and apprehension to stand on apparatus for initial few days of standing may hinder the performance in acute stage.
- No upper and lower limit range was fixed for weight symmetry ratio score in inclusion criteria.
- Weight transfer with the therapist while giving assistance during standing training was not able to keep in under a standard procedure.
- Visual display monitor is very small and only a constant display is provided, as cost factor for the apparatus is most considered.
- Since the apparatus is only a prototype and made as less expensive, it has got heavy weight. So the property of portability could not be used effectively throughout the study.
- Long term effect was not studied.

SUGGESTIONS:

- Larger sample size can be used.
- Treatment duration can be increased.
- Proper motivation session can be incorporated often before biofeedback treatment to enhance the recovery and to reduce the fear.
- Further carry over and transfer of training can be assessed.
- Interval based training and energy conservation training can be applied to reduce fatigue and for effective treatment approach.
- Treatment technique can also be studied in other types of stroke and considering the lesion side.
- Upper and lower limit range can be fixed for weight bearing symmetry score in inclusion criteria.
- Long term effect can be studied.

Technical suggestions

- Modifications in the apparatus such as less weight and easily portable, cost effective can be done further.
- Visual display can be done more of animated or tracking of weight distribution in bar or moving objects.
- New software or connection to the computer display can be made.
- Auditory cue can be done with voices or varying tones to make it more joyful.

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Appendix

11.1. APPENDIX I

INFORMED CONSENT TO PARTICIPATE IN THE RESEARCH STUDY

I ____________ voluntarily consent to participate in the research study "EFFECT OF SIMPLE KINETIC FEEDBACK TRAINING ON WEIGHT SYMMETRY AND STANDING BALANCE IN INDIVIDUALS WITH ACUTE HEMIPARESIS".

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

Signature of the applicant:

Signature of the researcher:

Signature of the witness:

11.2. APPENDIX II

ASSESSMENT FORM

Name: **Age/Sex:**

Occupation: **IP no:**

Address:

Date of admission:

Date of assessment:

History:

- ✓ Onset and course of present illness
- ✓ Major previous illness
- ✓ Associated problems and regularity of medications for it
- ✓ Risk factors
- ✓ Previous attacks of stroke
- ✓ Drug history
- ✓ Personal and psychological history
- ✓ History of medical conditions that could affect balance

  (painful conditions, giddiness, imbalance, sensory problems)

VITAL SIGNS:

- ✓ Blood pressure:
- ✓ Pulse rate:

- ✓ Respiratory rate:
- ✓ Temperature:

SELECTION CRITERIA :

- **Tests for vision :**
- **Test for hearing :**
- **Sensory assessment :**

Sensation	Right	Left
Pain **Touch** **Pressure** **Position sense** **Kinesthetic sense**		

- **Mini mental status examination score:**
- **Grading of spasticity :**

  Modified Ashworth Scale -0/ 1/ 1+/ 2/ 3/ 3+
- **The test for upright motor control :**

  Knee flexion component – Strong / Moderate / Weak
- **Functional balance grade :**

  Static standing balance : Normal / Good / Fair / Poor
- **Postural assessment :**

INVESTIGATION:

- CT SCAN:
- MRI scan

OUTCOME MEASURE

- WEIGHT SYMMETRY SCORES :