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WHOLE BODY VIBRATION AND WOBBLE BOARD TRAINING ON BALANCE IN POST STROKE HEMIPLEGIC PATIENTS: A COMPARATIVE STUDY

Neetika Katiyar, MPT

Mrs. Monalisa Pattnaik, MPT, Asst. Prof. (PT)

Dr. Patitapaban Mohanty, Ph. D., Assoc. Prof. (PT)

Swami Vivekanand National Institute of Rehabilitation Training and Research, Olatpur, Bairoi, Cuttack, India

ABSTRACT

Introduction: The balance and maintenance of postural control is a multisystem process incorporates the visual, vestibular and somatosensory input from afferent and efferent control strategies. Since stroke subjects often present with somatosensory deficits, stimulation of somatosensory system can be done by many ways to improve balance of stroke patients. There are many other researches in which results shows that whole body vibration and wobble board separately and in combination improve balance in stroke patients. So purpose of my study is to know that which is more effective in improving balance of stroke patients, whole body vibration or wobble board training.

Methodology: An experimental study design, 30 subjects with stroke randomly allocated into three groups. All the three groups received conventional exercises. In addition group 1 received wobble board training and group 2 received whole body vibration, 5 days in a week consecutively for 4 weeks. The balance measurements were taken by Berg Balance scale prior to the beginning of treatment and were repeated finally after the completion of treatment protocol.

Results: The overall result shows significant changes in balance in all the three groups and as mean value shows 20.05% improvement in wobble board group, 12.36% in whole body vibration group and 5.11% in conventional group.

Conclusion: Wobble board exercises are more beneficial than whole body vibration training for improvement of balance in post stroke hemiplegic patients and these two are better than conventional exercises.

KEYWORDS - berg balance scale, stroke, whole body vibration, balance, wobble board,.

INTRODUCTION - According to the World Health Organization (WHO)"stroke is considered as a clinical syndrome with rapid development of clinical signs of focal or global disturbance of cerebral function, of which origin is possibly vascular and lasting more than 24 hours".[1] The first global estimate on the burden of 135 diseases in which cerebrovascular diseases ranked as the second leading cause of death after ischemic heart disease.[2]

Impaired balance is a common problem in stroke patients. Many studies have shown that sitting and standing balance influences functional outcome after a stroke. Lisa A. Simpson, William C. Miller, Janice J. Eng did a study on individual with stroke and found out that stroke individuals fell 1.77 times more than the age and gender matched controls over the period of 13 months.[3]

Sarah F Tyson et al. did a research to investigate the frequency of balance disability; to characterize different levels of disability and impairments associated with balance disability. Result showed a total of 83% of the subjects had balance disability; of these, 27% could sit but not stand, 40% could stand but not step, and 33% could step and walk but still had limited balance. Subjects with the most severe balance disability had more severe strokes, impairments, and disabilities.[4]

The recovery of independence following stroke is a complex process requiring the reacquisition of many skills. Since controlling the body's position in space is essential part of functional skills, restoration of balance is a critical part of recovery of ability after stroke. Balance and maintenance of postural control is a multisystem process that incorporate the visual, vestibular and somatosensory input from afferent and efferent control strategies.[5] Proprioception which is one of the somatosensory input is a specialized sensory modality that includes the sensation of joint and muscle movement also known as kinesthesia and joint position sense.[6] An important cause of balance impairment in patients with stroke hemiparesis is a deficit of central integration of sensory input (somatosensory, visual and vestibular).

There are various physiotherapy treatment options available for balance impairments in stroke patients. Recently, whole-body vibration (WBV) exercise has been developed as a new modality for physical therapy.[7] Previous studies have suggested that WBV exercise increases muscle strength and improves muscular performance [8,9] and the positive effects of WBV on muscle performance should help to improve balance.[10,11]

The biomechanical ankle platform system training (balance training on wobble board and other unstable surfaces) is also most widely used by therapists in rehabilitation and athletic training for ankle injuries, proprioceptive and balance training. Wobble board helps to retrain the proprioceptive system in development of mechanoreceptors function thus help to return normal neuromuscular coordination.

Wobble board are constructed to allow varying motion which stimulates balance using both anticipatory and reactive balance mechanism. In this proprioceptive mechanism of the ankle joint is used for improving balance. Since, stroke subjects often present with somatosensory deficits, the adaptation of regular exercises with surface and vision manipulation to challenge balance could improve the process of somatosensory integration and have a positive effect on postural stability.[12]

Onigbind AT et al did a research to study the effect of 6 weeks wobble board exercises on static and dynamic balance of stroke survivors. The result showed that there was significant difference in the static balance (eye closed) ($F=7.49$, $P< 0.05$) and dynamic balance ($F3.20$, $P< 0.05$) between the groups. The study concluded that wobble board exercise improved both static (eye closed) and dynamic balance of stroke survivor used in this study.[13]

The aim of this study was to find out the difference between the effects of whole body vibration and wobble board training on the balance of hemiplegic patients due to stroke.

METHODOLOGY

STUDY DESIGN: A three group, pre-test post-test structured, comparitive study design.

A total of 30 subjects were recruited from Rehabilitation section of the Department of Physiotherapy, Swami Vivekanand National Institute of Rehabilitation Training and Research.

SAMPLING METHOD: By convenience sampling the subjects were selected from the stroke population according to the inclusion and exclusion criteria and were randomly divided into three groups after getting informed consent.

INCLUSION CRITERIA: Persons with hemiplegia due to stroke who were medically stable and able to understand and follow simple verbal instructions with duration of stroke 6 months to 2 years, Age

ranges between 30 - 60 years of age. Both the genders were included in the study and those who were able to stand without mobility aids for at least 15 minutes.

EXCLUSION CRITERIA: Patients with any cognitive deficit, neurological disease affecting balance other than stroke [such as cerebellar disorders, Parkinson's disease and/or Vestibular lesion], Patients with orthopedic problem [like fracture, severe osteoarthritis, any fixed hip, knee and ankle deformity], Patients with contraindication of vibration [like pregnancy, recent fracture, gall or kidney stone, malignancy, cardiac pacemaker, recent infectious disease etc] were not be taken in any group. Uncooperative patients, patients with sensory deficit and visual defect were not taken in any group.

PROCEDURE: All participants underwent an initial baseline assessment by berg balance scale. The **Berg Balance Scale** (or **BBS**) is a widely used clinical test to assess a person's static and dynamic balance abilities, named after Katherine Berg, one of the developers. For functional balance tests, the BBS is generally considered to be the gold standard. The test takes 15–20 minutes and comprises a set of 14 simple balance related tasks, ranging from standing up from a sitting position, to standing on one foot. The BBS has been shown to have excellent inter-rater (ICC = 0.98) and intra-rater reliability (ICC = 0.98), and is internally consistent (0.96).

Group 1 received conventional physiotherapy treatment along with wobble board training. Patients were asked to stand bare footed on wobble board and first trained. They were allowed to take support by holding the rails and bars. Then patients were instructed to do wobble movement in anterior posterior direction for 7.5 minutes and 7.5 minutes lateral movements. This 15 minute training was given once a day for 5 days in a week for 4 weeks.

Wobble board is a circular board having fulcrum of semi-sphere or smaller spherical cap shaped (or a shape that is approximately such) whose flat side is attached to the center of the board underside. This allows the board to pivot in all directions during the same ride: forward-backward, left-right and anywhere in between, i.e., toward 360 degrees.

Group 2 received conventional therapy along with whole body vibration. Contraindication for whole body vibration were checked. Frequency used for treatment was 30 hz. Patients were asked to stand bare footed on whole body vibrator. They were allowed to take support by holding any railing, bar and manual support if they had fear of fall. 15 minutes continue vibration was given once a day for 5 days in a week for 4 weeks.

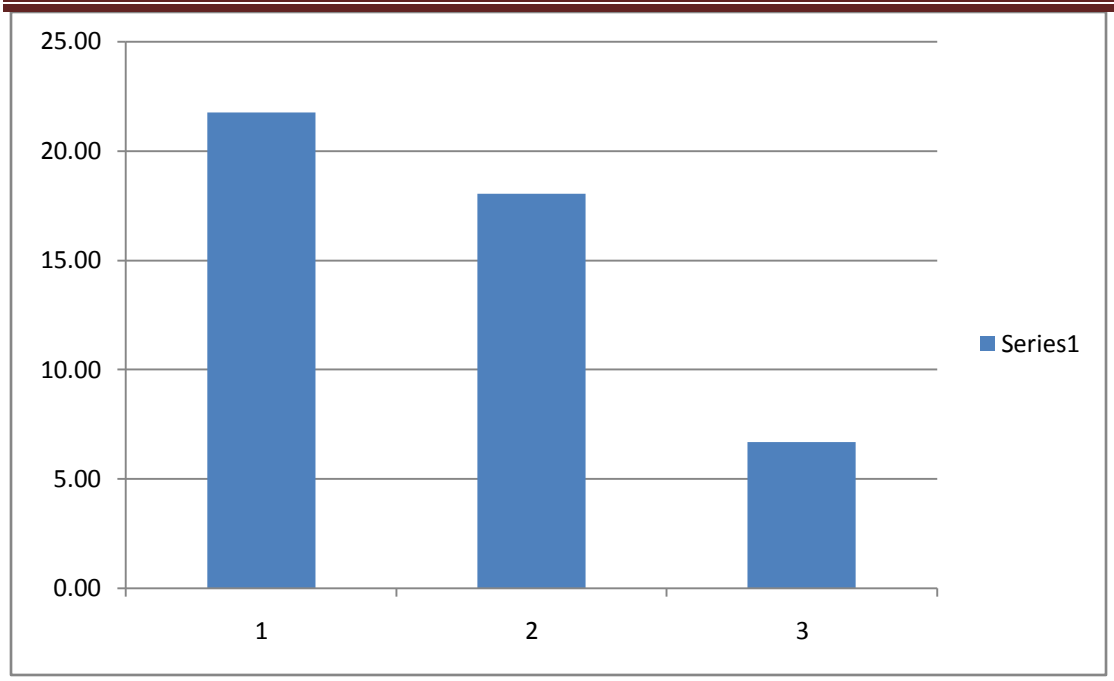
Whole body vibration (WBV) is a generic term used where any vibration of any frequency is transferred to the human body. Whole body vibration may refer to vibration training, also known as vibration therapy, biomechanical stimulation (BMS), and biomechanical oscillation (BMO), a training method employing low amplitude and low frequency mechanical stimulation to exercise musculoskeletal structures for the improvement of muscle strength, power, and flexibility. One type of somatosensory stimulation used in rehabilitation is WHOLE BODY VIBRATION THERAPY. It has been hypothesized that the transmission of mechanical oscillations from the vibrating platform may lead to physiological changes in muscle spindles, joint mechanoreceptors and produce tonic vibration reflex.

Group 3 only received conventional therapy which include stretching of tight structures, Range of movement exercises for the hemiplegic side, MRP for upper limb, Weight bearing of upper and lower limb, Bridging, single leg bridging, trunk rotation, quadruped, upper and lower limb weight shifting in quadruped position, side bridging, reaching activities in sitting position , stepping and stair climbing.

DATA COLLECTION- Balance Berg Scale measurements were taken prior to the beginning of treatment and were repeated finally after the completion of treatment protocol.

DATA ANALYSIS -Data analysis was done using Kruskal Wallis test by taking the change from pre to post. Analysis was performed by using SPSS package 23 version.

RESULTS - The Graph shows maximum improvement in wobble board group than in whole body vibration group and least in conventional group. Kruskal Wallis test showed that the chi square value = 16.170, df = 2 with p = 0.000, indicating a significant difference in change of scores between the groups.



Change in BBS

1= wobble board group, 2= whole body vibration group, 3= conventional therapy

Discussion

The overall result of the study showed that balance of hemiplegic patients improved as measured in berg balance scale after 4 weeks of intervention (wobble board, whole body vibration and conventional exercises). The changed berg balance score from pre to post is significantly different in all three groups. Mean value showed greater degree of improvement in wobble board group than whole body vibration group and least in control group.

CONVENTIONAL THERAPY GROUP- The improvement of balance in conventional group was 5.11%. The prime factor for improvement of balance in the control group could be an improved trunk stability and postural control as a result of increased core muscle strength. Balance is correlated to trunk muscle strength.[14] As conventional group include exercises such as bridging, single leg bridging, quadruped, trunk rotation, upper limb weight shifting and lower limb weight shifting in quadruped that lead to (a) improved length tension relationship of the upper and lower limb muscles which originate from the

girdles which in turn are linked to spine, (b) improved phasic contraction of spinal muscles, (c) decreased freezing and improved degree of freedom leading to smoother and more appropriate and purposeful movements.

EMG analysis of trunk and hip muscles was studied by Veerle KS et al during stabilization exercises in four-point kneeling in healthy volunteers. Thirty healthy volunteers were asked to perform three frequently prescribed stabilization exercises in four-point kneeling. The electromyographic activity of different trunk and hip muscles was evaluated. The results showed that exercises in four-point kneeling position, hip and trunk muscles seem to work together in a harmonious way. This shows that when relative activity of muscles is measured, both "global and local" muscles function together in order to stabilize the spine.[15]

Ryan et al studied effect of Trunk muscle exercises as a mean of improving postural stability in people with Parkinson's disease. Following baseline testing, participants were randomly assigned to one of three intervention groups, who received trunk muscle exercises similar to the present study, either once per week, 3 days/week, or education. This study showed that low-intensity and progressive trunk exercises can provide a effective means for maintaining or improving postural stability for people with PD.[16]

In support of this, a study was done by Moerchen V.A. et al to evaluate the effect of unstable and unilateral resistance exercises on trunk muscle activation. Six trunk exercises were performed on stable (bench) and unstable (Swiss ball) bases. Electromyographic activity of the upper lumbar, lumbosacral erector spinae, and lower-abdominal muscles were monitored. Result showed greater activation of the lower-abdominal stabilizer musculature (27.9%) with the trunk exercises. Regardless of stability, the superman exercise was found to be most effective trunk-stabilizer exercise for back-stabilizer activation, whereas the side bridge was the optimal exercise for lower-abdominal muscle activation. These exercises were also included in conventional exercises programme of the present study.[17]

Erkstrom et al did a research to identify exercises that could be used for strength development and for endurance or stabilization training for trunk and hip muscles. Surface EMG analysis was carried out in 19 males and 11 females while performing the following 9 exercises: active hip abduction, bridge, unilateral-bridge, side-bridge, prone-bridge on the elbows and toes, quadruped arm/lower extremity

lift, lateral step-up, standing lunge, and using the Dynamic Edge. EMG analysis of rectus abdominis, external oblique abdominis, longissimus thoracis, lumbar multifidus, gluteus maximus, gluteus medius, vastus medialis obliquus, and hamstring muscles were studied. Result showed that side-bridge exercise could be used for strengthening the gluteus medius and the external oblique abdominis muscles, and the quadruped arm/lower extremity lift exercise may help strengthen the gluteus maximus muscle. All the other exercises produced EMG levels less than 45% MVIC, so they may be more beneficial for training endurance or stabilization. Results suggest that these exercises could be used for a core rehabilitation or performance enhancement program.[18]

As these trunk exercises like bridging, single leg bridging, trunk rotation, may be the reason for increase in core muscle strength. Also reaching activity influences contraction of core muscles. This may contribute for improvement of components of berg balance mainly in sit to stand, pivot transfer, reaching forward with outstretch arm, retrieving objects from floor mainly because these activities needed contraction of core muscles.

Reason for improvement of score in conventional group may also be that exercises in conventional group also include stepping, stair climbing and reaching which can explain the increase in the score of some components of berg balance score those are, alternate stepping, forward reaching etc.

Whole body vibration group-The improvement of balance in group 2 who received WBV in addition to conventional exercises was 12.36%, which was 7.25% greater than the control group. The reason behind additional improvement of berg balance score in whole body vibration group could be that vibration stimulates the muscle spindles and the alpha motoneurons which initiates a muscle contraction according to the tonic vibration reflex. The reflex muscle contraction has been suggested to increase the synchronisation of the motor units when combined with a voluntary contraction. Many previous studies have suggested that WBV exercise increases muscle strength and improves muscular performance and balance.

Supporting study did by Roelants et al (2006), they conducted EMG studies recording EMG in Vastus Lateralis, Vastus Medialis, Rectus Femoris and Gastrocnemius and found significant increases in Maximal Voluntary Contraction% for all muscles after WBV training (vertical type, 35 Hz, 2.5 mm amplitude)

compared to baseline. Such a better recruitment of muscle fibers during voluntary contraction in the subjects of the present study would have contributed to improve balance.[19]

Following WBV training, significant improvement in knee extensors and/or plantarflexors strength as measured by peak torque using isokinetic or motor driven dynamometer has been demonstrated by many authors.[20]

Sung jen et al did a study to determine the effects of task-oriented training with whole body vibration (WBV) on the sitting balance of stroke patients. Subjects in the experimental group practiced an additional task-oriented training program with WBV, which was performed for 15 minutes, five times per week, for four weeks. The center of pressure (COP) path length and average velocity were used to assess subjects static sitting balance, and the Modified Functional Reach Test (MFRT) was used to assess their dynamic sitting balance. Result showed that following the intervention, the experimental group showed a significant change in MFRT. The results of this study suggest that WBV is feasible and efficacious for stroke patients.[21]

Also WBV acts through repetitive sensorimotor stimulation and therapies with WBV have been conducted for elderly patients as well as patients with cerebral palsy, multiple sclerosis, and stroke. As somatosensory system has important role in maintainance of balance and promotes brain plasticity. Studies regarding the functional recovery in stroke patients have suggested beneficial effect of somatosensory stimulation in terms of motor functions, balance and activities of daily living. This can be attributed to the strengthening effects of WBV on the postural muscles of trunk and lower limb.[22]

Marwa M. Ibrahim studied Effect of whole-body vibration on muscle strength, spasticity, and motor performance in spastic diplegic cerebral palsy children. Thirty spastic diplegic CP children (8–12 years) were randomized to two equal groups, control group and WBV group. The control group received a selected physical therapy treatment program for spastic diplegic CP and the WBV group received the same program in addition to WBV training. Measurements of isometric strength of knee extensors, spasticity, walking speed gross motor function were performed before and after 12 weeks of the treatment program. Result showed Isometric strength of knee extensors, spasticity and the walking speed were significantly improved only in the WBV group ($P < 0.05$). Growth motor function measure-88

(GMFM-88) (D%) was significantly increased ($P < 0.05$) in both groups in favour of the WBV group and GMFM-88 (E%) was significantly increased ($P < 0.05$) only in the WBV group.[23]

Ebersbach G et al found equilibrium and gait improved in patients with Parkinson's disease receiving WBV. Quantitative dynamic posturography only improved in patients with WBV whereas there was no significant change in controls.[24]

Other effects of vibration include modification of correcting movements and increased postural sway. The applications of vibration and predictability of stimuli can influence the physiologic effects.

Blottner et al compared the effect of WBV in bed rest subjects compared with static exercises. Results indicated a statistically significant reduction in maximum isometric voluntary plantar flexion force in the control group but not for the vibration group. The control group showed a reduction in Type I fibres in Soleus muscles whereas vibration group did not. Both Type I and II fibre size in VL muscles reduced in control, whereas only Type I in the vibration group. In the vibration group, type distribution was unchanged. Thus, there was preservation of muscle fibre phenotype in vibration group. It can be postulated that this effect of vibration would have been a contributing factor in improving balance in cerebral palsy subjects of the present study.[25]

Wobble board training group-Improvement of balance was maximum in wobble board group that was 20.05 % in which wobble board training was given along with conventional exercises. This improvement was 14.94% greater than improvement of balance in control group.

The reason for additional improvement may be that wobble board improves proprioception as by doing exercise on wobble board, tension of the lower limb muscles and position of joints changes and proprioception improves, mainly in lower limb and by improving proprioception patient can gain the balance skills necessary to maintain stability. Proprioceptors consist of both sensory and motor nerves that send and receive impulses to and from the central nervous system from stimuli within the skin, muscles, joints and tendons. These impulses transmit vital information, such as the amount of tension in a given muscle and the relative position of a body part during a given movement which in turn maintans balance. Proprioception includes balance, coordination and agility because the body's proprioceptors control all these factors.

Granacher U et al suggested that balancing exercises on an unstable surface sensitize the muscle spindle through gamma motor neurons, thereby improving motor output which influences the stability of joints.[26]

CG. Kim JH et al suggested that the improvement is believed to occur mainly due to the development of a compensatory posture strategy and neural plasticity. This improvement in postural strategy can explain improvement of score in mostly all components of berg balance.[27]

Reason for highest improvement in wobble board group may also be that exercises on wobble board increases lower limb weight shifting and many researches suggests that weight shifting induces postural control and balance.

Research was done by Adedovin et al to see the Effects of wobble board training on weight distribution on the lower extremities of sedentary subjects because inequality of weight distribution on the lower extremities affects the posture and gait performance of an individual. The purpose of this study was to investigate the effects of a six week wobble board exercise training program on the weight distribution in the lower extremities. The results showed that the wobble board exercise program could be used to improve the symmetry of weight distribution on the lower extremities in sedentary subjects. [28]

Another study in support done by cheng et al to see the Effects rhythmic weight-shift training on hemiplegic stroke patients. Aim of the study was to assess the balance function of hemiplegic stroke patients and to investigate whether visual feedback rhythmic weight-shift training following acute stroke can decrease falls among patients with hemiplegic stroke. Result showed that weight-shift training may improve dynamic balance function for hemiplegic stroke patients.[29]

The increase in lower limb weight shifting may be the reason for improvement of score of components of bbs mainly in placing alternate foot on stool, turning to look behind and turning 360◦.

Reason for heighest improvement in wobble board group may also be that it helps in increasing core muscle strength. Exercises on wobble board also needs contraction of core muscles. Various researches favours that in core strengthening program progression is made by emphasising on development of balance and coordination by doing exercises in standing position on various unstable surface like wobble board, balance board, bosu board etc.

Brennan j et al did a study to compare core muscle activity during resistance exercises performed on stable ground versus an unstable surface and to examine whether lifting at different relative intensities affects core muscle activity levels. Twelve trained men performed four different movements including the deadlift, back squat, military press, and curl. Surface electromyography (EMG) was utilized to assess the activity of the rectus abdominis, external oblique, transversus abdominis, and erector spinae muscles. Participants performed each movement under three separate conditions including standing on stable ground with 50% of their one repetition maximum (1RM), standing on a BOSU balance trainer with 50% of their 1RM and, standing on stable ground with 75% of their 1RM. The following muscles exhibited greater activity during the 75% 1RM condition than all other conditions: the transversus abdominis (TA) and external oblique muscles during the deadlift; the rectus abdominis (RA) during the squat; the TA, RA, and EO during the press, and TA and erector spinae (ES)during the curl. The ES muscle during the press movement and EO during the squat movement were more active during the BOSU 50% 1RM condition than the stable 50% 1RM condition. Healthy individuals might consider performing the military press, curl, squat and deadlift movements with higher intensity resistances while standing on stable ground to incur higher widespread muscle activity of the core region.[30]

Exercises on wobble board also influence the activation of ankle and hip strategy and these strategies are most important for postural control. Improvement in ankle and hip strategies can explain the increase in score of some components of berg balance scale which require these strategies. Those are forward reach, picking object from floor, standing with feet together, standing in one foot etc.

The over all result of the present study shows significant changes in all three groups and mean value shows 20.05% improvement in wobble board group, 12.36% in whole body vibration group and 5.11% in conventional group.

The results of this study i.e.more improvement in WBV group than conventional group is consistent with those of previous studies. Pollock et al. reported that, in an 8-week study of WBV exercise in participants over 80 years of age, there were significant improvements in the TUG test and BBS scores from the fourth week.[31] Bautmans et al. reported that, in a 6-week study of WBV exercise in individuals over 70 years of age, there was a significant improvement in the TUG test scores.[32] In addition, Bruyere et al reported a significant improvement in the TUG test scores after 6 weeks of WBV exercise in participants over 80 years of age.[33] Through WBV exercise, lower limb power and strength may increase, which may

improve balance and functional mobility. Improvements in such factors seem to have caused significant improvements in the BBS and TUG test scores, which assess dynamic balance.

The result of the study shows greatest improvement in wobble board group .The reason may be it improves proprioception, lower limb weight shifting, core muscle strength and also induces ankle and hip strategy, so that increases balance.this result is consistent with other studies. Research did by Sandesh Rayamajhi et al to see the effect of balance training program on rocker board in sitting for improving balance of stroke subjects. In the experimental group, the pre BBS score improved from 24 with sd of 1 to post BBS score of 31.2 with sd of 1.303 which was statistically significant(p value<0.05).this improvement is almost similar to present study.[34]

Onibigde et al see the effect of 6 weeks wobble board exercises on static and dynamic balance of stroke survivors. The subjects in the experimental group were trained on wobble board for six weeks while the control group received only the baseline treatment programs. The modified version of the timed balance test was used to assess balance while the foursquare step test was used to assess dynamic balance. The result showed that there was significant difference in the static balance (eye closed) ($F=7.49$, $P< 0.05$) and dynamic balance ($F3.20$, $P< 0.05$) between the groups.[13]

CONCLUSION-Wobble board, which is cost effective and easy to use is more beneficial than whole body vibration training for improvement of balance in post stroke hemiplegic patients and these two are better than conventional exercises.

Recommendations and Limitations of study- The relative small and selective group of patients included in this study challenges the generalizability of the outcome of the study. Future studies with a larger number of participants are therefore needed to confirm the results. As the present study is 4 weeks duration,long term follow up studies are required to know the carry over effects of intervention. Effect of different positions while receiving WBV should be evaluated. Further studies to determine optimum vibration training protocol (duration, frequency, amplitude of WBV) should be under taken.

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