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COMPARISON OF THE EFFECTIVENESS OF WOBBLE BOARD EXERCISES VS STATIC AND DYNAMIC WEIGHT SHIFT BALANCE STRATEGIES ON SENSORIMOTOR FUNCTION OF LOWER LIMBS AND BALANCE IN SUBJECTS WITH ACUTE ISCHEMIC STROKE

Physiotherapy

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ABSTRACT

This study compared the effectiveness of wobble board exercises and static/dynamic weight shift strategies on balance and sensorimotor function in individuals with acute and subacute stroke. Researchers recruited 30 stroke subjects (aged 45-60, both men and women) with specific inclusion criteria for a randomized controlled trial. They assigned Group 1 to wobble board exercises and Group 2 to static and dynamic weight shift strategies. Both groups participated in 30-minute sessions, five days a week, for six weeks. The researchers assessed balance using the Berg Balance Scale and sensorimotor function with the Fugl-Meyer Lower Extremity Scale. Analysis showed significant improvements in Group 1 compared to Group 2 ($p < 0.005$). These findings indicate that wobble board training proves more effective than static and dynamic weight shift strategies in improving balance and sensorimotor function in stroke patients, demonstrating its potential in stroke rehabilitation.

KEYWORDS

Stroke, balance, wobble board, static and dynamic weight shift strategies

INTRODUCTION

A stroke is a sudden loss of brain function, caused by a disruption in blood flow, lasting over 24 hours or leading to death, with no clear cause other than vascular issues.[1]

Stroke causes include atherosclerotic thrombosis, transient ischemic attacks, embolism, hypertensive hemorrhage, aneurysms, arteritis, thrombophlebitis, and hematologic disorders like clotting issues, sickle cell disease, and anticoagulant use etc.[2]

Stroke is predicted to cause 12 million cases and 7 million deaths globally in 2024. Major risk factors include high blood pressure, tobacco use, and heart conditions. It's the second leading cause of death worldwide, with varying incidence rates across countries. In the U.S., 7 million people have had a stroke, with 795,000 new cases annually. Recurrence rates are high, and hemorrhagic strokes have higher mortality. In India, stroke is the fourth leading cause of death and the fifth leading cause of disability, with significant case fatality rates.[3,4]

Ischemic stroke occurs due to blocked blood flow, often from thrombosis, embolism, or hypoperfusion, leading to brain tissue damage. Hemorrhagic stroke results from a ruptured blood vessel, causing more severe damage. Chronic hypertension is a major risk factor for both types, causing vessel degeneration, necrosis, and micro-aneurysms.[5,6]

In stroke, the ischemic cascade is a chain of cellular processes caused by impaired blood flow to the brain. This includes oxygen deprivation, loss of energy, accumulation of toxic metabolites, calcium buildup, and activation of harmful enzymes, all resulting in brain cell injury and inflammation.[7,8]

Stroke risk factors include hypertension, atrial fibrillation, diabetes, smoking, hyperlipidemia, contraceptive use, hypercoagulable states, atheromatous plaques, anaemia, and low left ventricular ejection fraction. Environmental and genetic factors, especially in developing countries, also contribute. Low night-time heart rate variability and CKD further increase stroke risk.[9,10,11,12]

Balance is regulated by four systems: the visual system, which stabilizes gaze and posture during movement; the somatosensory system, which sends sensory information from the body to the brain; the cognitive system, which affects balance, particularly in patients with neglect or attention issues; and the vestibular system, which manages postural, ocular, and visceral responses to head movements.[13,14]

Sensorimotor function coordinates sensory input and motor responses, enabling the body to detect and react to stimuli. It integrates sensory systems, like touch and sight, with motor control to support movement, balance, and fine motor skills necessary for daily activities. These systems work together to maintain stability, relying on each other for precise movement and posture control.[5,15,14,16]

NEED OF THE STUDY

Stroke survivors often face challenges with sensorimotor function and balance, with limited research comparing various balance training regimens. While wobble board exercises have shown improvement in balance, studies suggest that seated wobble board training enhances balance by activating the motor system. Rocker board training has also proven effective for trunk balance and gait. Regular wobble board practice promotes neural plasticity, enhancing compensatory strategies. Studies, like Onibigde et al.'s, show significant improvements in balance after six weeks of wobble board training. Building on previous research, the current study compares wobble board exercises with static and dynamic exercises to assess treatment effectiveness.[15,17]

AIM

The aim of the study "To compare the effectiveness of wobble board exercises vs static and dynamic weight shift strategies on sensorimotor function of lower limb, balance in subjects with acute stroke".

OBJECTIVES

- To evaluate the effect of wobble board exercises on Sensorimotor function assessed with Fugl Meyer scale- Lower extremity [LE]
- To evaluate the effect of wobble board exercises on Balance assessed with berg balance scale (BBS)
- To evaluate the effect of static and dynamic weight shift strategies on sensorimotor function assessed with Fugl Meyer scale- Lower extremity [LE]
- To evaluate the effect of static and dynamic weight shift strategies on Balance assessed with berg balance scale (BBS)
- To evaluate and compare the effect of wobble board exercises vs static and dynamic weight shift strategies on balance by berg balance scale (BBS) and sensorimotor function by Fugl Meyer scale -LE.

MATERIALS AND METHODOLOGY

MATERIALS

1. Wobble board
2. Chair
3. Couch
4. Parallel bar with mirror
5. stepper

METHODOLOGY

Study Method

Study Design: Simple randomized control trail

Study Setup: SVIMS (In the following departments) College of physiotherapy, General ward, Neurology, Sri Venkateswara Ayurvedic Hospital, Tirupati.

Sampling Method: simple random sampling by lottery method

Sample Size: 30 samples

Study Duration: 6 months

Treatment Duration: 6 weeks

Inclusion Criteria:
- Stroke subjects of age 45-60 years.
- Stroke subjects with acute ischemic stroke.
- No visual and sensory deficits
- Both the genders
- MMSE (mini mental scale examination): 24 – 30
- VCG (voluntary control grading) :GRADE 4 and above 4
- BBS (Berg balance scale) :35-38/56(moderate risk of fall)
- NIHSS **:5-15**

Exclusion Criteria:
- Any other neurological deficits as multiple sclerosis, Parkinson's disease
- Any musculoskeletal disorders like Osteoarthritis (OA), ligament injuries of lower limb.
- No cognitive deficits
- Recurrent hemiplegia
- Bilateral hemiplegia

Outcome Measures:
1. Berg balance scale (BBS)
2. Fugl Meyer Assessment -LE (FMA-LE)

Study Procedure:
The study was conducted at SVIMS Hospital, Tirupati, with ethical clearance obtained from the institutional ethics committee (CODE: 1750). Participants who met the inclusion criteria were included after providing informed consent. The Berg Balance Scale and Fugl-Meyer Assessment-LE were measured at both baseline and after 6 weeks of the protocol.

EXPERIMENTAL GROUP- 1:
WOBBLE BOARD TRAINING:
Experimental Group 1 participated in wobble board training, with subjects instructed to perform the activities in front of a posture mirror.

WEEK1:
1.Seated Balance: The subject sat in a chair with their feet on the wobble board, which was shifted forward, backward, and side to side, engaging the leg and core muscles.
2. Weight Shifting: The subjects stood on a wobble board with support and shifted their weight from one foot to the other, starting with small shifts and gradually increasing as their balance improved.

Weight Shifting

WEEK 2:
3. Heel-to-Toe Balance: A wobble board was placed in front of a stable surface for support, and subjects were instructed to step on the board with one foot in front of the other while maintaining balance. After a few seconds, they were asked to switch feet.

Heel -To- Toe balance

4. Single-Leg Stance: The subjects stood on the wobble board with support, lifted their unaffected leg, and held the position for increasing durations as their balance improved.

WEEK 3:
5. Side-to-Side Tilts: The subjects were instructed to stand on the wobble board and tilt it side to side, maintaining slow and controlled movements, and were advised to seek help if needed.
6. Forward-Backward Tilts: The subjects were instructed to stand on the wobble board and tilt it forward and backward, maintaining control and seeking assistance if needed.

WEEK 4:
7. Figure of Eight: Subjects were instructed to stand on the wobble board and move it in a figure-eight pattern, with support initially provided and gradually reduced.
8. Squats on Wobble Board: Subjects were instructed to stand shoulder-width apart on the wobble board and perform shallow squats while maintaining balance, with support provided initially.

Week 5 And Week 6:
9. Tandem Stance: Subjects were instructed to stand on the wobble board with one foot in front of the other (heel to toe) and switch feet after a few seconds.
10. Reaching Exercises: Subjects were instructed to stretch forward, to the side, and overhead with one hand while maintaining balance, and to alternate hands during the exercises.[15]

Experimental Group -2:
The Experimental Group 2 was given static and dynamic weight shift strategies.

Static And Dynamic Weight Shift Strategies:
WEEK 1: **Statical sitting weight shift plan**
Subjects performed forward, backward, and side-to-side reaching, along with arm raises, for 15 minutes per session, 5 repetitions, five times a week.

WEEK 2: Supportive Positioning At The Bed's Edge.
Subjects stood at the bed's edge and performed reaching, side shifts, and arm raises for 15 minutes per session, 5 repetitions, five times a week.

Supportive Positioning At The Bed's Edge

Week 3: Training On A Single Step (floor markings)
Subjects performed forward and backward reaching with a step, side shifts with a step, and arm raises while stepping, for 15 minutes per session, 5 repetitions, five times a week.

Week 4: Dual Step Training
Subjects engaged in 25-minute step-up training and one-leg stands three times a week, along with 15-minute sessions five times a week, using previous interventions.

Week 5 And 6: Increase Of Progression
Subjects performed one-leg stands with minimal support, step-ups on varying block heights, and brief walks with turns, for 15 minutes per session, five times a week, using previous interventions.[16]

Conventional Physiotherapy:
Both experimental groups performed conventional exercises, including correcting muscular imbalances, range of motion exercises for the hemiplegic side, and motor relearning for the upper limb. Weight-bearing exercises for both limbs were encouraged, along with trunk rotation, pelvic bridging, side bridging, quadruped position, reaching in sitting, stepping, and stair climbing.

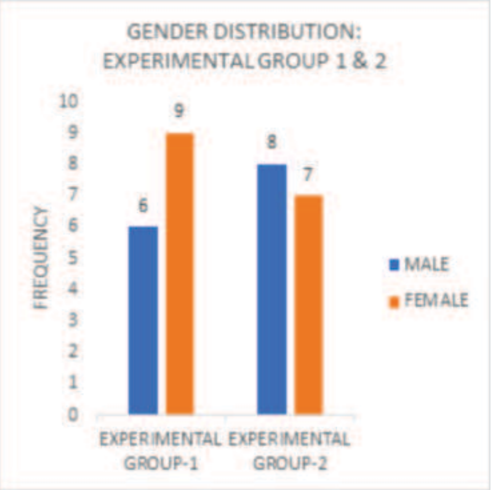
Statistical Analysis
The statistical analysis was performed using the "SPSS 20.0 version software

- The data was first entered into a Microsoft Excel spreadsheet, tabulated, and then subjected to statistical analysis.
- All the descriptive statistical data were presented in the form of mean and standard deviation and was graphically represented. All 30 participants completed the study protocol within six weeks of treatment sessions.
- The Paired t-test was used within groups to compare pre- and post-treatment values, as the sample was normally distributed. The Mann-Whitney U test was used to compare between the two groups due to non-normal distribution. A p-value of < 0.05 was considered significant for all statistical analyses.

RESULTS
Baseline evaluation was done for the subjects in Groups 1 and 2 by using the Berg balance scale and FMA-LE. Subjects have undergone the intervention for 6 weeks and post-test evaluation was done by using the above measures and documented the findings.

Table 1: Comparison Of Demographic Variables Between Experimental Group-1 And Experimental Group-2 Subjects.

variables	Experimental group-1	Experimental group-2
Mean age: years	53.00 ± 5.732	47.87 ± 5.592
Gender: male,female	6:9	8:7



Graph- 1 Graphical representation Gender distribution in Experimental Group-1 and Experimental Group-2

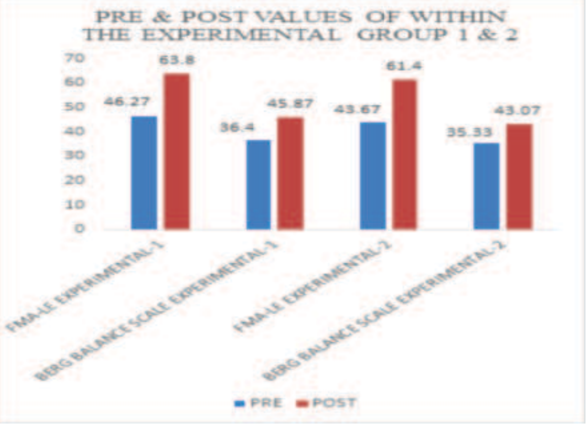
Interpretation:
In experimental group 1, the mean age of the subjects was 53, while in experimental group 2, the mean age was 47.87.

Table 2: Within Group Analysis Of Experimental Group-1 Between Pre And Post Test Values Of FMA-LE, BBS.

Experimental group-1		Mean	SD	t-value	p-value
FMA-LE	Pre	46.27	4.26	16.76	<0.0001
	Post	63.80	2.70		
	Mean difference	17.53			
BBS	Pre	36.80	1.24	17.75	<0.0001
	Post	45.87	1.80		
	Mean difference	9.07			

Table- 3: Within Group Analysis Of Experimental Group-2 Between Pre And Post Test Values Of FMA-LE And BBS:

Experimental group-2		Mean	SD	t-value	p-value
FMA-LE	Pre	43.67	2.469	23.56	<0.0001
	Post	61.40	2.063		
	Mean Difference	17.73			
BBS	Pre	35.33	2.225	7.986	<0.0001
	Post	43.07	2.738		
	Mean difference	7.74			

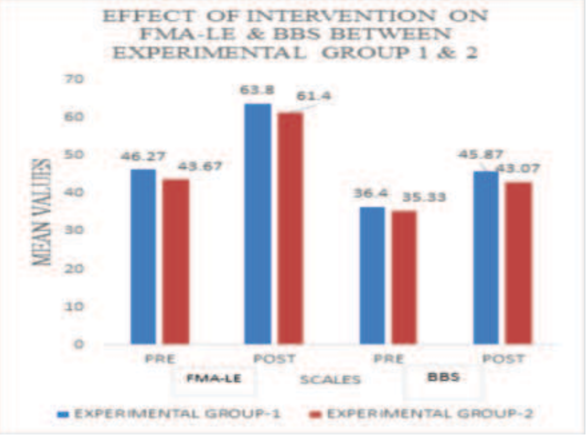


Graph 2: Graphical representation of pre and post test mean values for FMA-LE and BBS for Experimental group -1 and Experimental group2:

RESULT:
In Group 1, the FMA-LE score increased from 46.27 to 63.80, and the BBS score improved from 36.40 to 45.87. In Group 2, the FMA-LE score rose from 43.67 to 61.40, while the BBS score increased from 35.33 to 43.07. Both groups showed significant improvements in FMA-LE and BBS scores after treatment.

Table 4: Comparison Between Experimental Group-1 And Experimental Group-2:

Group	MANN WHITNEY U Value	P Value
Pre FMA LE	68	0.0603
Post FMA LE	55.50	0.0156
Pre BBS	79	0.1632
Post BBS	48.50	0.0063



Graph 3: Graphical representation of intervention effect on FMA-LE & BBS between experimental group 1 & 2

The Mann-Whitney U test revealed no significant difference in FMA-LE scores between Experimental Groups 1 and 2 before treatment ($U = 68$, $p = 0.0603$). After treatment, however, a significant difference was observed ($U = 55.50$, $p = 0.0156$), with Group 1 scoring 2.4 points higher on average. For the BBS score, no significant difference was found before treatment ($U = 79$, $p = 0.1632$), but after treatment, Group 1 had a significantly higher mean score ($U = 48.50$, $p = 0.0063$), with a 2.8-point difference.

DISCUSSION

Balance is vital for mobility, and improving gait is a key recovery goal. Wobble board training effectively enhances balance, strengthens core muscles, promotes neuroplasticity, and aids motor learning in stroke patients.[11]

The study involved 30 participants with acute hemiplegic stroke, aged 40-60 years, divided into two groups. One group performed Wobble board exercises with conventional therapy, while the other practiced weight-shifting strategies alongside conventional therapy. Both groups received 6 weeks of treatment, with 6 sessions per week. Assessments showed significant improvements in both groups, with the Wobble board group showing more notable progress.

The study found significant progress with the addition of static and dynamic weight shift techniques to conventional physiotherapy. The mean BBS score improved from 35.33±2.469 to 43.07 ±2.738, while the FMA-LE score increased from 43.67±2.469 to 61.40±2.063. These improvements in balance and sensorimotor function are attributed to the shifting of body weight, which enhances stability by activating postural, proprioceptive, and core muscles. Additionally, dynamic weight shifts involve quick adjustments and reflexive muscle responses.

The findings of this study are consistent with previous research, which found that static and dynamic weight shift strategies improved the mean difference in FMA-LE scores. The previous study also reported that these strategies enhanced balance, reflex activity, and postural control in both static and dynamic positions. (43)

The study shows that wobble board exercises are more effective than static and dynamic weight shifts in improving balance and sensorimotor function in stroke patients. BBS scores increased from 36.40 ±1.242 to 45.87± 1.807, and FMA-LE scores improved from 46.27± 4.267 to 63.80 ±2.704,suggesting enhanced sensorimotor function and balance.

Wobble board exercises improve the sensorimotor system by activating proprioceptors in muscles, ligaments, and joints, enhancing feedback to the CNS. They promote reflexive balance corrections, postural control, and muscle co-contraction, helping stroke subjects address postural asymmetry. These exercises also support neuroplasticity and motor learning by simulating real-life balance challenges, encouraging functional brain reorganization and helping stroke survivors adapt their balance techniques to daily activities through error-based learning. (32,34,36)

The Berg Balance Scale (BBS) and the Fugl-Meyer Assessment for Lower Extremity (FMA-LE) are tools used to evaluate motor function, balance, and recovery in people recovering from a stroke. The BBS examines overall balance through 14 activities, while the FMA-LE specifically assesses motor function and postural control in the lower limbs. Both assessments take into account neuromuscular and sensory systems, providing a thorough understanding of motor recovery and balance in individuals with neurological disorders.[38]

Research shows a positive correlation between the two, suggesting that improved motor control (FMA-LE) is linked to better postural control (BBS), offering a comprehensive assessment of recovery in stroke survivors.[19]

A previous study supports the current findings, showing significant improvements in BBS scores after wobble board training, with mean differences of 31.93 and 51.33 between pre- and post-test scores. Wobble board exercises enhance balance and sensorimotor function by offering a dynamic, multisensory approach that strengthens muscle contractions, improves neuromuscular coordination, reflexes, and mental focus.[19]

The current study's findings are consistent with previous research. One study showed that wobble board training enhanced FMA-LE scores by improving proprioception, neuromuscular adaptation, muscle strength, coordination, and postural control. Jen-Wen Hung and Chiung-Xia Chou found that combining exergaming with weight-shifting exercises improved balance in post-stroke individuals. Hoffman et al. emphasized wobble boards in neuromuscular training to enhance proprioception and balance, particularly in young adults. Additionally, Sandesh Rayamajhi et al. demonstrated that rocker board training improved balance in stroke patients.

Hence the study indicates that adding wobble board exercises to conventional physiotherapy improves balance and sensorimotor function in individuals with acute stroke, supporting the alternate hypothesis.

Limitations And Recommendations

1. The 6 weeks treatment period is limited, to explain the long-lasting effects of treatment.
2. As the current study's sample size was small (n=30), studies with large sample size are recommended.
3. Further follow up for the studies are recommended to know the long-lasting effects.
4. Comparison of the current protocol in the other neurological balance impairments can be done to know the potential benefits of each protocol.

CONCLUSION

The present study concluded that Wobble board exercises along with Conventional treatment was found to be more effective compared to Static and dynamic weight shift strategies on balance and sensorimotor function in Subjects with acute hemiplegic stroke.

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