IJBPAS, March, Special Issue, 2025, 14(3): 39-52

ISSN: 2277–4998

International Journal of Biology, Pharmacy and Allied Sciences (IJBPAS)

'A Bridge Between Laboratory and Reader'

www.ijbpas.com

EFFECT OF VESTIBULAR REHABILITATION VERSUS CONVENTIONAL THERAPY FOR IMPROVING BALANCE AND GAIT IN POST STROKE PATIENTS

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Received 15th Dec. 2024; Revised 20th Dec. 2024; Accepted 1st Jan. 2025; Available online

https://doi.org/10.31032/IJBPAS/2025/14.3.1005

ABSTRACT

Aim:

The study aims to compare the effectiveness of vestibular rehabilitation therapy versus conventional therapy for improving balance and gait in post stroke patients.

Background of the study:

Stroke frequently produce severe neurological abnormalities, such as abrupt weakness or numbness on one side of the body, and are one of the main causes of long-term disability. Confusion, headaches, lack of coordination, and problems with balance are possible additional symptoms. Motor control deficiencies are frequently seen by stroke survivors, which can result in diminished mobility, balance, and postural control. More than 60% of stroke patients experience dizziness. Many methods have been investigated to address these issues, such as gait training and balance control. Two promising treatments are vestibular rehabilitation therapy and conventional therapy. Conventional therapy focuses on mobility issues, whereas vestibular rehabilitation tries to minimize balance loss. To help individuals with neurological impairment regain motor control and enhance their balance, both approaches are essential.

Methodology:

This experimental study was done in Faculty of Physiotherapy, involved 30 post-stroke patients aged 40-60. Patients underwent 4-week treatments of 20-30-minute sessions, three times daily, comparing vestibular rehabilitation and conventional therapy. Assessments included Berg Balance Scale, Wisconsin Gait Scale, Mini-BESTest, and Standing Balance Test. Inclusion criteria comprised acute hemiplegic stroke patients with specific cognitive abilities, while exclusion criteria included chronic hemiplegic stroke, cerebellar/brainstem lesions, and uncontrolled hypertension.

Results:

On comparing Pre-test and Post-test within Group A & Group B on Berg balance scale, Mini- BESTest, wisconsin gait scale and standing balance test group A shows a significant difference in the mean values at P ≤ 0.05 than group B.

Keywords: Stroke, balance, vestibular rehabilitation, conventional therapy, Gait

INTRODUCTION:

Stroke, also known as a "brain attack," is a serious global health issue that can have catastrophic effects on both individuals and civilizations **[1]**. The World Health Organisation (WHO) defines a stroke as the disruption of a blood artery in the brain or the restriction of blood flow to a portion of the brain. Strokes can result in a variety of neurological dysfunctions **[2]**. According to the American Heart Association (AHA), a stroke is a neurological dysfunction event brought on by a retinal, spinal, or brain infarction **[3]**. The American Stroke Association updated this definition in the twenty-first century to emphasize ischemia-induced central nervous system (CNS) infarction, which is backed by neuropathological, neuroimaging and clinical data **[4]**.

Stroke is a frighteningly common condition that affects almost one in four people over the age of 25 worldwide, with a major percentage of cases happening between the ages of 15 and 49 **[5, 6]**. Geographically, this incidence varies, with certain areas—like the Kiribati countries—experiencing especially high rates **[7]**. Stroke mortality have been shifting from developed to developing countries in recent decades; in these countries, 75% of stroke deaths and 81% of Disability-Adjusted Life Years (DALYs) are now documented **[8]**.

The prevalence of stroke varies considerably across rural and urban locations in India, indicating the intricate relationship between socioeconomic conditions and healthcare accessibility **[9]**. The risk of stroke is increased by several etiological factors, including high blood pressure, tobacco use, heart disease, diabetes, obesity and some drugs **[10]**. For prompt intervention, it is essential to recognize the tell-tale signs and symptoms of stroke, which include trouble speaking, paralysis or numbness, headaches, blurred vision and decreased coordination **[11]**.

The acronym "FAST" stands for face drooping, arm weakness, speech difficulty, and time to call emergency services **[12]**. It is a handy way to remember stroke symptoms and remember to get medical assistance right away. Acute care, reperfusion therapies, and rehabilitation are all part of stroke management techniques. Rehabilitation is particularly important in helping stroke patients recover and live better lives **[13]**.

This research focuses on vestibular rehabilitation and conventional treatment as rehabilitation strategies for individuals who have had a stroke **[14]**. These programs use a variety of exercises and evaluations to target balance and gait. Validated instruments such as the Wisconsin Gait Scale, Berg Balance Scale, Mini-BESTest and Standing Balance Test are used to assess the effectiveness of these interventions. These instruments provide important information about the results of rehabilitation following a stroke **[15]**.

In summary, stroke is still a major global public health concern that requires comprehensive approaches to care, prevention, and rehabilitation. Our goal is to lessen the effects of stroke on people, families and communities by doing thorough research and implementing focused treatments. This will ultimately improve outcomes and raise the standard of living for stroke survivors.

MATERIALS & METHODOLOGY:

The study was an experimental study with Comparative types of pre and post-type. Once the study gets approved by the institutional review board D-44/PHYSIO/IRB/2022-2023. The study included acute hemiplegic stroke patients (1-6 months), ability to follow two-step commands, ability to follow two step commands, cortical or subcortical lesions, no evidence of neglect (H – Cancellation Test), ability to give informed consent and excluded chronic hemiplegic stroke patients (> 6 months), uncontrolled hypertension, inability to give consent, lesion in brainstem and lesion in cerebellum. The subjects were fully explained about the benefits of participating in the study and after obtaining consent which is duly signed ensuring the confidentiality of their details. The subjects were randomly divided into Group A and Group B using a lottery method, with odd-numbered participants assigned to Group A and even-numbered participants assigned to Group B. Thirty participants who met the inclusion criteria were selected and allocated to the two groups, with 15 participants in each group. Group A received Vestibular Rehabilitation Therapy, while Group B received Conventional Therapy. The intervention consisted of 30-45 minutes per session, three days per week, for four weeks. Both Group A and Group B underwent testing using the Wisconsin Gait Scale, Mini-BESTest, Berg Balance Scale and Standing Balance Test.

GROUP A received Vestibular Rehabilitation Therapy intervention consisting of 45 minutes per day, three times a week for four weeks. It included two types of exercises: Adaptation exercises, were further divided into two types: The vestibule-ocular reflex (VOR) stimulating exercise: a) Head and eye in the same directions: For head movements with a target, the patient held a target at arm's length with eyes focused on the target, moving the head from side to side. The entire cycle was repeated 20-30 times, increasing speed with each progression and also transitioning from standing on a firm surface to a compliant surface. Head and eye in opposite directions: For head movement "out of phase" with the target, the patient held the target at arm's length with eyes focused on the target and moved the head to the right and the target to the left, and vice versa, while keeping the eyes focused on the target. The entire cycle was repeated 20-30 times, gradually increasing speed with each progression and transitioning from standing on a firm surface to standing on a compliant surface **[16]**.

Ocular motor exercises include: a) Smooth pursuit (visual tracking): The patient holds a target at arm's length, then moves the target left and right across the visual field, tracking with eye movement and keeping the head still. The entire cycle is repeated 20-30 times. b) Saccade latency (target in both hands): The patient holds the target in each hand approximately 15 inches apart at arm's length. Keeping the head still, the eyes are moved back and forth from target to target with 1 second per target **[17]**. The full cycle is repeated 20-30 times.

Balance exercises consist of: a) Standing with feet shoulder-width apart, arms across the chest. The difficulty level is raised as the patient progresses from bringing the feet closer together, closing their eyes, and standing on a cushioned sofa or foam. b) Practicing ankle sways, medial-lateral and anterior-posterior, later progressing to circle sways with closed eyes. c) Attempting to walk with the heel touching toe on a firm surface and progressing on carpet. d) Practicing walking five steps and turning 180 degrees (left and right) **[18]**. The difficulty level is raised by making smaller turns with closed eyes. e) Walking and moving the head side to side, up and down. f) Ball diagonal: Taking a ball in hand, lifting it, transferring it to the other hand,

and following the arch visually. g) Circle with the ball: Emphasizing the eyes on the ball and then moving it circularly in both directions with accelerating speed, while the head and body also move with the ball. The difficulty level is raised by progressing from sitting to standing to a narrower stance **[19]**.

Gait training involves: a) Walking in a straight line: The patient begins by walking next to a wall with the hand out for support. Gradually, the patient decreases the support and increases the number of steps. b) Walking with head in motion **[20]**. The patient walks with the head in motion, going from right to left with increasing speed. c) Sitting to standing, then return to sitting: The patient walks from one chair to another chair position 10 feet away. The difficulty level is raised by adding head movements, increasing walking speeds, and decreasing the width of gait. Additionally, gait training involves wide and sharp turns to the left and right **[21]**.

GROUP – B conventional therapy protocol included strengthening, stretching, coordination, postural training, lower limb weight-bearing exercises for 30 minutes. Participants received a conventional therapy program for 30 minutes a day, 3 days a week for 4 weeks. The program comprised limb stretching, strengthening, stability exercises, passive mobilization of joints, walking between parallel bars, manual dexterity exercises (grasp release, stacking cones), stretching, and weight-bearing exercises. During the sessions, the therapist provided necessary assistance to help the patients execute the exercises **[22]**.

Balance and gait exercises: Balance exercises: a) Stand with feet shoulder-width apart, arms across the chest. The difficulty level is raised as the patient progresses from bringing the feet closer together, closing eyes, and standing on a cushioned sofa or foam. b) Practice ankle sways, both medial-lateral and anterior-posterior, later progressing to circle sways with closed eyes. c) Attempt to walk with the heel touching toe on a firm surface, then progress to walking on carpet. d) Practice walking five steps and turning 180 degrees (left and right). Increase difficulty by making smaller turns with closed eyes. e) Walk and move the head side to side, up and down. f) Ball diagonal: Take a ball in hand, lift it up, transfer it to the other hand, and follow an arch visually. g) Circle with ball: Emphasize the eyes on the ball and then move it in a circular fashion in both directions with accelerating speed, while the head and body also move with the ball. Increase difficulty by progressing from sitting to standing to a narrower stance **[23]**.

Gait exercises: a) Walking on a straight line: Begin by walking next to a wall with the hand out for support. Gradually decrease the support and increase the number of steps. b) Walking with head in motion: Walk with the head in motion, going from right to left with increasing speed. c) Sitting to standing, then return to sitting: Walk from one chair to another chair position 10 feet away. Increase difficulty by adding head movements, increasing walking speeds, and decreasing the width of the gait. d) Gait with wide and sharp turns to the left and right **[24]**.

Data analysis

The collected data were tabulated and analysed using both descriptive and inferential statistics. All the parameters were assessed using Statistical Package for social science (SPSS) version 24, with a significance level of p-value less than 0.05 and a 95% confidence interval set for all analyses. The Shapiro-Wilk test was used to determine the normality of the data. In this study, the Shapiro-Wilk test showed that the data was normally distributed on the dependent values at P > 0.05. Hence parametric test was adopted. A paired t-test was adopted to find the statistical difference within the groups & Independent t-test (Student t-test) was adopted to find the statistical difference between the groups.

Table 1: Comparison of Wisconsin gait scale score between group – a and group - b in pre and post-test

TEST	GROUP – A		GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE TEST	37.46	2.35	37.93	2.25	-.555	28	.584*
POST TEST	26.06	3.43	31.93	3.89	-4.37	28	.000**

(*- P > 0.05 - Not Significant) & (- P ≤ 0.05 – Significant)**

Table 2: Comparison of mini-BESTest score between group – a and group - b in pre and post-test

TEST	GROUP - A		GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE-TEST	19.53	3.33	19.60	3.22	-.056	28	.956*
POST-TEST	25.80	1.61	22.80	2.73	3.66	28	.001**

(*- P > 0.05 - Not Significant) & (- P ≤ 0.05 - Significant)**

Table 3: Comparison of Berg balance scale score between group – a and group - b in pre and post test

TEST	GROUP - A		GROUP - B		t - TEST	df	SIGNIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE TEST	33.86	3.22	33.06	3.26	.675	28	.505*
POST TEST	49.26	3.65	38.33	3.79	8.04	28	.000**

(*- P > 0.05 - Not Significant) & (- P ≤ 0.05 - Significant)**

Table 4: Comparison of standing balance scale score between group – a and group - b in pre and post test

TEST	GROUP - A		GROUP - B		t - TEST	df	SINIFICANCE
	MEAN	S.D	MEAN	S.D			
PRE TEST	31.80	3.00	31.86	3.27	-.058	28	.954*
POST TEST	42.73	3.34	37.66	3.41	4.10	28	.000**

(*- P > 0.05 - Not Significant) & (- P ≤ 0.05 - Significant)**

RESULTS

On comparing the Mean Values of Group, A & Group B **(Table 1)** on Wisconsin Gait Scale score, it shows a significant decrease in the post test mean values in both groups, but (Group A - Vestibular Rehabilitation Therapy) shows 26.06 ± 3.43 which has the lower mean value is more effective than (Group B - Conventional Therapy) 31.93 ± 3.89 at $P \leq 0.05$. Hence the null hypothesis is rejected.

On comparing the Mean Values of Group, A & Group B **(Table 2)** on Mini Best Test score, it shows a significant increase in the post test mean values in both groups, but (Group A - Vestibular Rehabilitation Therapy) shows 25.80 ± 1.61 which has the higher mean value is more effective than (Group B - Conventional Therapy) 22.80 ± 2.73 at $P \leq 0.05$. Hence the null hypothesis is rejected.

On comparing the Mean Values of Group A & Group B (Table 3) on Berg Balance Scale score, it shows a significant increase in the post test mean values in both groups, but (Group A - Vestibular Rehabilitation Therapy) shows 49.26 ± 3.65 which has the higher mean value is more effective than (Group B - Conventional Therapy) 38.33 ± 3.79 at $P \leq 0.05$. Hence the null hypothesis is rejected.

On comparing the Mean Values of Group, A & Group B (Table 4) on Standing Balance Test score, it shows a significant increase in the post test mean values in both groups, but (Group A - Vestibular Rehabilitation Therapy) shows 42.73 ± 3.34 which has the higher mean value is more effective than (Group B - Conventional Therapy) 37.66 ± 3.41 at $P \leq 0.05$. Hence the null hypothesis is rejected.

On comparing Pre-test and Post-test within Group A & Group B on Wisconsin Gait Scale, Mini Best Test, Berg Balance Scale & Standing Balance Test score shows significant difference in the mean values at $P \leq 0.05$.

DISCUSSION

The present study investigated the effects of VRT versus conventional therapy specifically tailored to challenge balance and gait performance in post-stroke individuals. Both types of training elicited improvements in balance and gait performance, confirming the efficacy of well-designed exercises for stroke patients. In rehabilitation, specific forms of conventional therapy and VRT with adaptation, balance, and gait exercises have been demonstrated to benefit both gait and balance performance in patients' post-stroke. The results of this study are in accordance with Ng YS *et al.*, who concluded that visual, motor, and cognitive impairments are common in PCA stroke, and good functional gains are achievable after comprehensive rehabilitation. Many of the findings from this study were similar to those reported in the subacute PCA stroke literature (Deluca C *et al*., in 2007 and in 2011, Morton SM in 2010). Both groups demonstrated effective improvement in all parameters of gait and balance. The present findings of this study indicate that the VRT group showed significant improvement in balance and gait compared to conventional therapy in patients with PCA stroke.

The recovery of balance is considered of crucial importance, which can be affected by various mixed components like loss of strength or joint motion limitation or modification of tone, motor coordination, and sensory organization component. An important role is also played by the reflex mechanism related to vestibular function in postural contro. According to Ala'S A and Lamontagne A, individuals after a stroke have been described to exhibit abnormal coordination of axial segments and pelvic rotations during head rotations, which can contribute to changes in balance during gait. The decrease in instability of the head and trunk after a stroke causes impaired balance due to a lack of quality in visual information **[25]**.

It is based on the principle of completing and/or accelerating the physiological processes of central compensation when, for one reason or another, these processes cannot be put in place to offset a vestibular deficit. From a practical point of view, this compensation uses and reinforces the compensatory strategies that are activated spontaneously but incompletely by the patient, i.e., adaptation, substitution, and habituation strategies. These techniques call on physical exercises and/or instrumental techniques that should be adapted to the patient based on the clinical workup and paraclinical instrumental assessment done by a trained specialist, which will identify the side involved, the central or peripheral character of the disorder, the current degree of central compensation, and the patient's ability to use various sensory inputs. In addition to acute vestibular deficits, the best indications are chronic dizziness stemming from unilateral or bilateral peripheral vestibular deficit or a nonprogressive central but stabilized deficit, with incomplete compensation, whatever the patient's age. Measures should be applied to the disorder as the patient describes it, with the number of sessions specified **[26]**.

Vestibular rehabilitation is receiving increased interest for the treatment of patients with vestibular or without vestibular disorders and has become one of the main treatments. It is an exercise-based program primarily intended to lessen vertigo and dizziness, gaze instability, and/or imbalance and falls, influencing the amount of recovery that can be extended through compensation. Previous studies have shown that the Vestibulo-Ocular Reflex (VOR) function is significantly related to gait performance and VOR evaluation may be useful for people at risk of falling. The principle of VOR training is based on the sensory conflict that might lead to neurological rearrangements known as vestibular compensations, consisting of gaze stabilization exercises and balance exercises. Mitsutake T *et al*., showed that patients with subacute stroke also showed significant improvements in Balance and Gait after vestibular rehabilitation.

Whitney S *et al*., suggested that VRT is important to coordinate learning strategies in order to maximize adaptation, motor learning and avoid overstimulation. Therefore, it is essential for the clinician to pay more attention to not only common vestibular symptoms but also gait stabilization to avoid falls and to improve further balance. Eye and head movement exercises were performed for the improvement of gaze stability, whereas exercises performed during sitting, standing on the firm to cushion surface or on a narrow base to improve postural stability. Exercises containing stepping over obstacles with forward and backward walking further increase stride length, heel strike, and foot clearance **[27]**. The primary mechanisms for the recovery of posture are increased due to the increase in independency on visual and somatosensory cues for improving the vestibular responses. The goals for VRT for postural stability are: firstly, to use the remaining vestibular function; further, to use stable visual references and surface somatosensory information; and lastly, to identify effective and efficient alternative postural movement strategies.

Post-stroke individuals tend to show an elevation in postural perturbation because of under-stimulations in one of the sensory strategies. According to Bonan IV *et al*., hemiplegic patients cannot adequately utilize vestibular information and instead rely largely on visual input for stabilizing their postures. The significant result in the VRT group is in accordance with Marioni G *et al*., that Vestibular rehabilitation fosters the sensory reweight to coordinate vestibular input, and as a result, the patients showed improved walking performance after the VRT intervention program. VRT provides the necessary task-specific stimuli for neural reorganization, fostering central sensory integration and resulting in improved balance and gait. Ocular motor exercises play a key role in neuromuscular reorganization because visual feedback plays an important role in coordinated limb movements. So, it is possible that eye movement exercises included in the vestibular rehabilitation program contributed to the improved balance and gait **[28]**.

Ricci NA *et al*., explained in their systematic review that VRT helps in obtaining vestibular compensation through central mechanisms of neuroplasticity. Therefore, VRT has been considered a safe option with no side effects and also cost-effective and efficient. The improvement is thought to be brought by the exercises that are supposed to stimulate repetitive movements of eye, head, and trunk. WGS scores have a strong or very strong correlation with vestibular rehabilitation. The WGS may be recommended as a substitute tool to be used, as it is a useful ordinal scale, enabling simple and accurate observational assessment of gait in post-stroke. BESTest is the quantitative assessment tool that aims to identify the disordered systems underlying the postural control responsible for poor functional balance. By identifying the disordered systems underlying balance control, therapists can direct specific types of intervention for different types of balance problems. The BBS scores in the experimental group were higher than the corresponding scores in the control group ($P<0.05$). Meanwhile, the total effective rate and patient satisfaction in the experimental group were higher than they were in the control group ($P<0.05$). Although the gold standard for standing balance, these balance responses may be influenced in particular by responses from the vestibular which is part of the circuitry of the velocity storage integrator. Standing balance responses have been shown to involve higher involvement. Under those conditions, we have shown that with patients who have vertigo and stroke. According to Horak FB *et al*., the control of head and trunk orientation in space plays an important role in relation to the gravitational force for improving postural instability, as vestibular sensorial references are important for maintaining stability when high frequencies and velocities of body movement take place. Various researches done on vestibular rehabilitation have already shown significant improvement in balance and gait by vestibular exercises. So, the results of this study indicate the improvement in the patients with PCA stroke with balance and gait abnormalities after Vestibular Rehabilitation. So, this study extended previous findings and indicated that vestibular rehabilitation has a promising effect on balance gait performance in PCA stroke patients. Vestibular rehabilitation therapy is found to be very effective and beneficial in gaining confidence in walking by improving balance and alleviating gait disturbances with stroke patients. It is safe to perform, low cost, and without any side effects which can be easily used during rehabilitation **[28]**.

It can be prescribed as an additional tool during the stroke rehabilitation of these populations and also be used for the balance-impaired patients of various neurological disorders. It can also be given to the patients for a home program to improve balance and gait performance.

On comparing the pre-test and post-test with Group A and Group B on the Wisconsin gait scale, the Mini-BESTest, Berg balance, and Standing balance test show significant differences in the mean value at $p < 0.05$. The exact mean value of these outcome measures shows that the comparison of the pre-test and post-test of Group A and Group B has a major improvement in post-stroke patients in Group A than in Group B. The significant mean value is greater than or equal to 0.05 with p. Hence this study shows that there is a highly significant difference in post-test values of Group A and Group B, but there is a significant reduction in both groups. There is also an increase in the functional activity in Group A than Group B

CONCLUSION:

The results of this study are encouraging for the use of VRT as a part of the rehabilitation protocol by alleviating gait disturbances, improving balance, and instilling confidence in walking with post-stroke patients compared to conventional therapy. Based on the results of this study, vestibular rehabilitation is much more effective for balance and gait-impaired patients with stroke. Future studies might compare individuals who are subjected to a protocol with a greater frequency of weekly sessions, aiming to establish an ideal and sufficient number of treatment sessions. Hence, it is concluded that vestibular rehabilitation therapy is found to be more effective in improving balance and gait training than conventional therapy.

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