ORIGINAL ARTICLE

Effects of Vestibular vs. Somatosensory Rehabilitation on Balance and Quality of Life of Sub-acute Stroke Patients with Vestibular Syndrome

Munaish Kumar[1], Namra Sarwar[2], Khushbakht Imtiaz[3], Arooj Malik[4], Muneeba Aziz Choudhry[5], Aniqa Inam[6]

Assistant Professor, Islamabad Institute of Health Sciences[1], Neuro-Physiotherapist, Rayan Medical Center, Gujrat[2], Senior Physical Therapist, Ali Ahmad Physiocare[3], Family Medicine Specialist, MKD Clinics Peshawar[4], Clinical Attachee, Huddersfield Royal Infirmary, United Kingdom[5], General Physician, Allied Hospital, District HQ Teaching Hospital, Faisalabad, Pakistan[6]

Corresponding Email: *munaishkumar9@gmail.com*

Abstract

Background: Stroke is a leading cause of disability worldwide, affecting millions of people annually and leading to significant healthcare utilization. Survivors of stroke often experience balance impairments in the early subacute phase, mainly due to sensory and vestibular deficits, which can greatly impact their quality of life.

Methods: To evaluate the effectiveness of vestibular and somatosensory interventions on balance and quality of life, a double-blind, randomized controlled trial was conducted on early subacute stroke patients with vestibular syndrome. 52 patients were randomly assigned to either a vestibular or somatosensory rehabilitation group or a control group that received standard care. The trial was completed by 49 patients who were assessed at baseline and 12 weeks post-intervention using the Berg Balance Scale and the Vestibular Quality of Life Questionnaire.

Results: Both vestibular and somatosensory rehabilitation interventions demonstrated significant improvements in balance, as measured by the Berg Balance Scale scores, and quality of life based on the scores from the Vestibular Quality of Life Questionnaire at $p<0.05$, compared to the control group. There were no significant differences between the two intervention groups in terms of their impact on balance or quality of life outcomes.

Conclusion: Vestibular and somatosensory rehabilitation interventions are both effective strategies for improving balance and quality of life in patients at the early subacute stage of stroke with vestibular syndrome. These results highlight the necessity of implementing targeted rehabilitation approaches in stroke care protocols to achieve the best possible functional outcomes and long-term recovery.

Keywords
Balance, Stroke, Quality of Life, Vestibular Symptoms.

Cite as: Kumar M, Sarwar N, Imtiaz K, Malik A, Choudhry MA, Inam A. Effects of Vestibular vs. Somatosensory Rehabilitation on Balance and Quality of Life of Sub-acute Stroke Patients with Vestibular Syndrome. Allied Med Res J. 2024;2(2):149-157. Available from: https://ojs.amrj.net/index.php/1/article/view/148/92.

DOI: https://doi.org/10.59564/amrj/02.02/017 **Received:** 18th February 2024, Revised: 20th April 2024, Accepted: 3rd June 2024

Introduction

Stroke is a leading cause of death and disability globally, affecting millions of people and putting immense pressure on healthcare systems[1]. It occurs when a part of the brain is deprived of oxygen and nutrients due to a problem with blood supply, causing brain cells to die[2]. This leads to various impairments such as motor issues, cognitive deficits, and balance problems, significantly reducing the quality of life[1-2].

The World Stroke Organization (WSO) considers stroke a significant global public health issue, with over 100 million people having experienced a stroke worldwide[3]. In 2019 alone, there were 12.2 million new cases of stroke, leading to 6.6 million deaths and 143 million years of life lost due to disability-adjusted life years (DALYs). The risk of having a stroke has increased by 50% from 1990 to 2017, and the prevalence of stroke has risen by 102% from 1990 to 2019[3]. In Pakistan, with a population of around 225 million, the burden of stroke is substantial. While comprehensive studies to determine the true incidence of stroke in the country are lacking, estimates suggest an annual incidence of 250 cases per 100,000 individuals[4]. Some regional studies have reported stroke prevalence rates of 1.2% among adults in certain areas and 4.8% in specific communities[5]. The mean age of stroke patients in Pakistan tends to be younger compared to patients in Western countries, and stroke-related mortality ranges from 11% to 30%[4-5].

Individuals who have experienced a stroke are at high risk of falls due to motor and higher cerebral function impairments. Sensory, vestibular, and perceptual dysfunctions following a stroke can further increase this risk[6]. Recognizing and managing vestibular symptoms early on is crucial in preventing falls and maximizing recovery in stroke survivors. Neurorehabilitation to enhance postural stability and balance has gained significant attention in clinical practice. Effective management of vestibular dysfunction can lead to significant improvements in balance, mobility, and quality of life for patients following a stroke[7]. Vestibular rehabilitation is an exercise-based approach that targets gaze stability, improves postural stability, and aids in sensory integration. Research has shown that it can enhance balance in individuals with peripheral vestibular dysfunction and those with vestibular hypofunction[8].

It also improves balance and postural recovery in several forms of damage to the central nervous system, including conditions such as Parkinson's disease, multiple sclerosis, concussion, and cerebral palsy. Somatosensory rehabilitation is another effective method of improving proprioceptive functions and somatosensory integration to enhance coordination and balance for vestibular symptoms[9]. These two rehabilitation methods have been promising in enhancing balance, mobility, and quality of life among such patients[10]. The efficacy of vestibular and somatosensory interventions for post-stroke vestibular symptoms remains significant in the literature. The evaluation of the effectiveness of such interventions in patients with vestibular syndrome and early subacute stroke will provide partial insight into the development of best practices at the clinical level and the optimization of outcomes for patients with such conditions. This study would fill a literature gap and thus improve care among stroke survivors.

Methodology

Study Design and Setting

This was a double-blind, randomized controlled trial conducted at the University Hospital, Gujrat, in the Neurology and Rehabilitation Departments. The effectiveness of vestibular and somatosensory interventions on balance in patients with early subacute stroke with vestibular syndrome was measured.

Sample Size Calculation

This study initially enrolled 52 participants, with a statistical power of 0.8, to detect significant differences between the groups regarding balance improvement at a significance level of 0.05 and an effect size of 0.8.

Sampling Technique

Participants were consecutively sampled from admissions to a neurological ward. The attending neurologist and rehabilitation therapist performed an eligibility assessment, and participants were included if they fulfilled the following criteria:

Inclusion Criteria

- Age between 50-80 years.
- Diagnosed with early subacute stroke, 7 to 14 days post-stroke.
- The patient can follow simple commands and perform exercises as required by the rehabilitation process.
- The patient has medical clearance for PT.
- MMSE > 24.
- Presence of symptoms of vestibular syndrome such as vertigo, dizziness, imbalance, or nystagmus.

Exclusion Criteria

- MMSE score less than 24.
- Severe loss in vision and severe hearing disability.
- Past vestibular disorders.
- Other neurological and musculoskeletal diseases affect balance.
- Unstable cardiovascular conditions.

Outcome Measures

The study used two primary measures to denote the outcome for assessing the effectiveness of interventions:

Berg Balance Scale (BBS)

The participants' balance was assessed using the Berg Balance Scale, which consists of 14 items that evaluate functional tasks such as sitting, standing, reaching, and turning. The scores on the scale range from 0 to 56, with higher scores indicating better balance. The reliability of the BBS is satisfactory in stroke populations[11].

Vestibular Quality of Life Questionnaire

Quality of life (QOL) in individuals with vestibular disorders is evaluated using the Vestibular Disorders Quality of Life (VQOL) questionnaire. This questionnaire covers vestibular symptoms' physical, functional, emotional, and social aspects. Higher scores on the VQOL indicate better quality of life. The VQOL has demonstrated good internal consistency and test-retest reliability in populations with vestibular disorders[12].

Therapist Role and Blinding

Interventions were given under supervision by trained rehabilitation therapists. Participants were blinded to group allocations, and outcome assessors (blinded to the delivery of the interventions) measured outcomes without bias.

Intervention Protocols

- **Vestibular Rehabilitation Group (n=17)**
  Participants performed Cawthorne-Cooksey exercises to enhance vestibular-ocular and vestibulospinal reflexes. It involved exercises of eye movements, head movements, and balance exercises done in a sitting position twice a day for 15 minutes each session.

- **Somatosensory Rehabilitation Group (n=17)**
  Participants performed Frenkel's exercises to enhance proprioceptive functions and somatosensory integration. The exercises were performed in slow, repetitive movements to improve coordination and accuracy, twice a day for 15 minutes per session.

- **Control Group (Usual Care) (n=18)**
  The subjects remained under usual medical and rehabilitation treatment as ordered by their treating physicians, but no specific vestibular or somatosensory interventions were delivered under this study protocol.

All subjects continued their prescribed pharmacological treatment by the treating physicians. Any modification or alteration in medication was documented and duly considered during data analysis.

Ethical Considerations

The Declaration of Helsinki principles were strictly adhered to. The institutional ethics committee obtained the approval for the study design. Written informed consent was sought from all the participants. Data confidentiality and participant anonymity were maintained rigorously throughout the study.

Statistical analysis

Data analysis was done using SPSS version 25. A summary of the baseline characteristics and outcome measures was presented through descriptive statistics, which included means, standard deviations, frequencies, and percentages. Within-group comparisons were made with paired t-tests, while between-group comparisons were conducted using an independent t-test with $p<0.05$ set as the significance level.

Results

The original sample size was 52, divided into experimental and control groups. Throughout the study, there were drop-outs totaling about 5%, resulting in a post-intervention sample size of 49. Analysis of the demographic characteristics revealed that the average age of the respondents was 65.3 ± 8.2 years, with 53% being male and 47% female. The groups were matched for age, gender distribution, and other relevant demographic variables, as indicated in Table 1, ensuring a homogeneous study population.

Table-1 Demographic characteristics of participants

Variables	Vestibular Rehabilitation (n=16)	Somatosensory Rehabilitation (n=16)	Control (Usual Care) (n=17)	Total (n=49)
Mean Age (years)	66.1±8.0	64.9±8.4	65.0±8.2	65.3±8.2
Gender (Male/Female)	8/8	8/8	10/7	26/23
Mean Duration Post-Stroke (days)	10±2	9±3	10±2	10±2
MMSE Score (Mean±SD)	27.5±1.2	27.3±1.1	27.4±1.3	27.4±1.2

The Shapiro-Wilk test has shown that data for both outcome measures, BBS and VQOL scores, are usually distributed in both groups, hence permitting parametric tests ($p>0.05$).

Participants undergoing vestibular rehabilitation exhibited significant changes from the baseline to the 12-week follow-up assessment for balance and VQOL. The average BBS score improved from 30±4 to 36±3 after the intervention, while the corresponding VQOL score changed from 70±10 to 75±8. Participants undergoing somatosensory rehabilitation also significantly improved BBS and VQOL scores. The average BBS score was increased from 29±3 at baseline to 34±4 post-intervention, with a concomitant improvement in VQOL score from 68±8 to 73±7. The control group receiving usual care had no significant changes in BBS or VQOL scores at 12 weeks. The mean BBS score was 28 ± 5 at baseline and 29 ± 5 post-intervention, with a $p > 0.05$ compared to the VQOL score of 65±12 at baseline versus 66±11 post-intervention (Table-2).

Table-2 Baseline and Post-Intervention Scores for BBS and VQOL

Group	Baseline BBS (Mean±SD)	Post-Intervention BBS (Mean±SD)	Baseline VQOL (Mean±SD)	Post-Intervention VQOL (Mean±SD)
Vestibular Rehabilitation	30±4	36±3	70±10	75±8
Somatosensory Rehabilitation	29±3	34±4	68±8	73±7
Control (Usual Care)	28±5	29±5	65±12	66±11

No statistically significant differences in either the BBS or VQOL scores were found between the vestibular and somatosensory rehabilitation groups ($p>0.05$). The findings indicate that both vestibular and somatosensory rehabilitation were equally effective in enhancing balance and quality of life in individuals with early subacute stroke with vestibular syndrome.

Discussion

This randomized controlled trial was conducted to establish the efficacy of vestibular and somatosensory rehabilitation intervention on balance and quality of life in patients with early sub-acute stroke with vestibular syndrome. The study's primary findings have proven that a significant effect was noticed in balance and quality of life using these interventions compared to the usual care. Both vestibular and somatosensory rehabilitation resulted in significant improvement in the BBS-measured balance. These results support prior research that has shown this same advantage of vestibular rehabilitation in improving postural control and thereby reducing the risk of falls for stroke victims[13]. Interventions targeting somatosensory functions also improved proprioception and the patient's tactile sensitivity, culminating in improved balance outcomes. Participants in both intervention groups reported improved quality of life, as measured with the VQOL. Improvements in subjective well-being are consistent with previous literature where vestibular rehabilitation improves stroke survivors' general quality of life.

When compared to the studies by Abasi et al.[14] and Hebert et al.[15] it is stressed that vestibular rehabilitation will impact much more globally than just on balance alone, prompting improvements in fatigue and independence in daily activities. Although these were conducted on different patient populations, the multidimensional benefits of vestibular rehabilitation in neurological disorders are apparent. The improvement in balance and quality of life could be due to enhanced sensory integration and motor control by interventions of both the vestibular and somatosensory nature. The interventions promote neuroplasticity and sensorimotor reorganization, which are essential in stroke recovery. Vestibular and somatosensory rehabilitative intervention can be included in the physiological early subacute stroke care protocol for providing maximum functional outcomes and long-term recovery[16-17]. These interventions must be patient-specific to pursue maximum potential and optimize overall rehabilitation outcomes[18].

Limitations and Future Directions

The limitations of this study were a relatively small sample size of participants and the short-term follow-up period. Future studies are warranted to examine larger cohorts with longer-term outcomes to investigate the durability of the rehabilitation effect and allow the examination of additional outcomes of interest, such as fatigue and depression, which impact recovery trajectories.

Conclusion

The findings revealed the effectiveness of vestibular and somatosensory interventions on improved balance and quality of life among individuals with early subacute stroke and vestibular syndrome. If clinicians focus more on such individualized rehabilitation ideas, that is, cortical reorganization after brain damage, functional outcomes could be optimized and quality of life enhanced for stroke survivors.

Acknowledgments

None.

Conflict of Interest

None.

Grant Support and Funding Disclosure

None.

References

1. GBD 2019 Stroke Collaborators. Global, regional, and national burden of stroke and its risk factors, 1990–2019: a systematic analysis for the Global Burden of Disease Study 2019. The Lancet. Neurology. 2021 Oct;20(10):795.

2. Orellana-Urzúa S, Rojas I, Líbano L, Rodrigo R. Pathophysiology of ischemic stroke: role of oxidative stress. Current pharmaceutical design. 2020 Sep 1;26(34):4246-60.
3. Thayabaranathan T, Kim J, Cadilhac DA, Thrift AG, Donnan GA, Howard G, Howard VJ, Rothwell PM, Feigin V, Norrving B, Owolabi M. Global stroke statistics 2022. International Journal of Stroke. 2022 Oct;17(9):946-56.
4. Khan M, Sana FA, Ali Y. Strokes Outcome Determinants in Pakistan Primary Stroke Center. Annals of the Romanian Society for Cell Biology. 2022 Jul 8;26(01):2015-24.
5. Sherin A, Ul-Haq Z, Fazid S, Shah BH, Khattak MI, Nabi F. Prevalence of stroke in Pakistan: Findings from Khyber Pakhtunkhwa integrated population health survey (KP-IPHS) 2016-17. Pakistan journal of medical sciences. 2020 Nov;36(7):1435.
6. Donovan J, De Silva L, Cox H, Palmer G, Semciw AI. Vestibular dysfunction in people who fall: A systematic review and meta-analysis of prevalence and associated factors. Clinical rehabilitation. 2023 Sep;37(9):1229-47.
7. Bonanno M, De Nunzio AM, Quartarone A, Militi A, Petralito F, Calabrò RS. Gait analysis in neurorehabilitation: from research to clinical practice. Bioengineering. 2023 Jun 30;10(7):785.
8. Tramontano M, Russo V, Spitoni GF, Ciancarelli I, Paolucci S, Manzari L, Morone G. Efficacy of vestibular rehabilitation in patients with neurologic disorders: a systematic review. Archives of Physical Medicine and Rehabilitation. 2021 Jul 1;102(7):1379-89.
9. Sidarta A, Lim YC, Wong RA, Tan IO, Kuah CW, Ang WT. Current clinical practice in managing somatosensory impairments and the use of technology in stroke rehabilitation. PLoS One. 2022 Aug 11;17(8):e0270693.
10. Calisgan E, Talu B. The effect of vestibular and somatosensory rehabilitation in addition to early rehabilitation on balance after stroke: a randomized controlled trial. Topics in Stroke Rehabilitation. 2024 Feb 21:1-0.
11. Miyata K, Hasegawa S, Iwamoto H, Otani T, Kaizu Y, Shinohara T, Usuda S. Comparing the measurement properties and relationship to gait speed recovery of the Mini-Balance Evaluation Systems Test and the Berg Balance Scale in ambulatory individuals with subacute stroke. Physical Therapy Research. 2020 Jun 20;23(1):72-8.
12. Schuhbeck F, Strobl R, Conrad J, Möhwald K, Jaufenthaler P, Jahn K, Dieterich M, Grill E, Zwergal A. Determinants of functioning and health-related quality of life after vestibular stroke. Frontiers in Neurology. 2022 Sep 8;13:957283.
13. Meng L, Liang Q, Yuan J, Li S, Ge Y, Yang J, Tsang RC, Wei Q. Vestibular rehabilitation therapy on balance and gait in patients after stroke: a systematic review and meta-analysis. BMC medicine. 2023 Aug 25;21(1):322.
14. Abasi A, Raji P, Friedman JH, Hadian MR, Hoseinabadi R, Abbasi S, Baghestani A. Effects of vestibular rehabilitation on fatigue and activities of daily living in people with Parkinson's disease: a pilot randomized controlled trial study. Parkinson's Disease. 2020;2020(1):8624986.

15. Hebert JR, Filley CM. Multisensory integration and white matter pathology: Contributions to cognitive dysfunction. Frontiers in Neurology. 2022 Nov 2;13:1051538.
16. Hall CD, Herdman SJ, Whitney SL, Anson ER, Carender WJ, Hoppes CW, Cass SP, Christy JB, Cohen HS, Fife TD, Furman JM. Vestibular rehabilitation for peripheral vestibular hypofunction: an updated clinical practice guideline from the academy of neurologic physical therapy of the American Physical Therapy Association. Journal of neurologic physical therapy. 2022 Apr 1;46(2):118-77.
17. Hazelton C, Thomson K, Todhunter-Brown A, Campbell P, Chung CS, Dorris L, Gillespie DC, Hunter SM, McGill K, Nicolson DJ, Williams LJ. Interventions for perceptual disorders following stroke. Cochrane Database of Systematic Reviews. 2022(11).
18. Whitney SL, Sparto PJ, Furman JM. Vestibular rehabilitation and factors that can affect outcome. InSeminars in neurology 2020 Feb (Vol. 40, No. 01, pp. 165-172). Thieme Medical Publishers.

AUTHORS' CONTRIBUTION

The following authors have made substantial contributions to the manuscript as under:

Conception or Design: Kumar M, Sarwar N, Imtiaz K

Acquisition, Analysis or Interpretation of Data: Kumar M, Malik A, Choudhry MA

Manuscript Writing & Approval: Sarwar N, Choudhry MA, Inam A

All the authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.