

Systematic review

Effectiveness of vestibular exercises on balance impairment in patients affected with stroke - A systematic review

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*(Received: May 2021 Revised: December 2022 Accepted: March 2023)*Corresponding author: **Vignesh Srinivasan**. Email: vignesh.scpt@saveetha.com**ABSTRACT**

Introduction and Aim: The patients who have been suffered with stroke have severe balance problems, it is difficult to tell with certainty how balance performance in stroke patients is impacted by vestibular impairment. The study's purpose was to determine if oculomotor and gaze stability exercises may help post-stroke individuals improve their balance.

Materials and Methods: This study includes all articles of various databases from 2000 to 2020 was included for study selection. The google scholar, research gate databases were comprehensively studied. 100 articles were searched and out of which 60 articles were selected to be assessed for eligibility in full text. Finally, 9 articles were chosen for inclusion and for analysis, although 7 of them did not match our proposed inclusion criteria.

Results: Exercises for the vestibular system have been demonstrated to be effective for stroke patients whose balance has been compromised.

Conclusion: The study finds that more high -quality experimental research on vestibular exercises and balance impairment after stroke is necessary because there is very little evidence from earlier experimental studies to draw firm conclusions about their effects.

Keywords: Oculomotor; gaze stability; vestibular; stroke; balance; berg balance scale.

INTRODUCTION

Stroke is defined as a small vascular lesion in the brain that results in immediate neurological impairment. Stroke can be physiologically classified as a narrowing/blockage of blood vessel lumen known to be Ischemic stroke or Rupture in the blood vessel due to various factors known to hemorrhagic stroke and sometimes a silent stroke with minimal symptoms which is less noticed to known as transient ischemic stroke and all the three subtypes exists (1). The anterior inferior cerebellar artery provides blood flow to the entire labyrinth. Both anterior and posterior inferior cerebellar arteries supply the vestibular nucleus. Nearly 25% of patients who complain of vertigo the cause is vascular in nature (stroke). Tinnitus, hearing loss, facial paralysis are also signs of AICA involvement. These patients' complaints of vertigo difficulty in standing and walking (2). Balance problems and vertigo are also seen in large middle cerebellar artery strokes. Although isolated central vestibular impairments are unusual, patients with stroke sometimes present with symptoms of vestibular disorder along with other symptoms. It has been said that the goal of vestibular rehabilitation is to reduce fall and increase independence (3). Factors such as inability to walk, greater body sway have been associated with fall in the acute stage. In sub-acute, long term stages fall is not associated with specific stroke impairment but with reduced mobility and balance problems. For many stroke patients, maintaining balance is a

difficult endeavour. Long-term disability may result from poor balance and control. The change in balance performance before and after intervention will provide valuable information for clinical rehabilitation. People with stroke had more postural sway than age matched healthy people, according to studies on balance impairment (4). Reflex mechanism associated with vestibular function plays a crucial role in control (5). Stroke is the most common cerebellar vascular disease, with increased mortality, disability rates that brings a heavy economic burden to the families of the stroke population. Balance is the ability to maintain the centre of gravity within the base of support. 83 % of stroke survivors suffer from balance impairments after stroke. The fear of falling might contribute to a lethargic and dormant lifestyle with quality of life which directly affects the person's quality of life can lead to a longer hospital stay, which will directly or indirectly lead to increased economic losses. Results from randomised controlled trials have shown that vestibular rehabilitation improved postural balance in patients who had a stroke (6).

Postural stability and visual stabilisation are both aided by the vestibular system, which also aids in the vestibulo-ocular reflex and vestibular stabilisation. By inducing the eye to move in the same direction as the head movement, the vestibulo-ocular reflex stabilises the gaze during head movements to offer the best possible sharpness. As for maintaining postural stability, the vestibulo-spinal reflex helps to

initiate the contraction of muscles that resist gravity. The exercises for oculomotor control and gaze stabilisation are simple to carry out and come with a planned schedule that allows for convenient home use without supervision. The stroke survivors are most likely to experience balance issues as a residual complication after the acute phase of the attack due to vestibular dysfunction. Three times/day for a week exercise promotes more thorough and quicker recuperation, according to research (7).

MATERIALS AND METHODS

The articles were searched from electronic databases such as google scholar and research gate. The articles were selected from 2000 to 2020. Selection criteria were included by randomised controlled trials, Comparative studies and experimental studies. Studies written in English language were included. Studies focuses on medical intervention were excluded. The keywords used such as oculomotor and gaze stability exercise, stroke, balance. There were 100 articles were searched and out of which 60 articles were selected to be assessed for eligibility in full text, out of 60,16 articles were read in full text and remaining were duplicate and in untraceable. Finally, 7 articles don't meet the inclusion criteria

and of 9 articles were selected for inclusion and for analysis.

Study methods PRISMA recommendations were used as the basis for the systematic review.

Study selection

Vestibular exercises might help post stroke patients. The following databases were used to conduct the article search, Google Scholar, and PubMed. The study goal was to determine whether post stroke individuals improve their balance more effectively. Literature search was made using keywords such as: gaze stability, vestibular, oculomotor, stroke, balance, berg balance scale. Articles from the last 2000 - 2020 are selected.

Study eligibility criteria

Inclusion criteria

Patients with balance impairment, both male and female patients, age group between 30 to 80 have been included.

Exclusion criteria

Articles without full text, articles in other languages except English have been excluded.

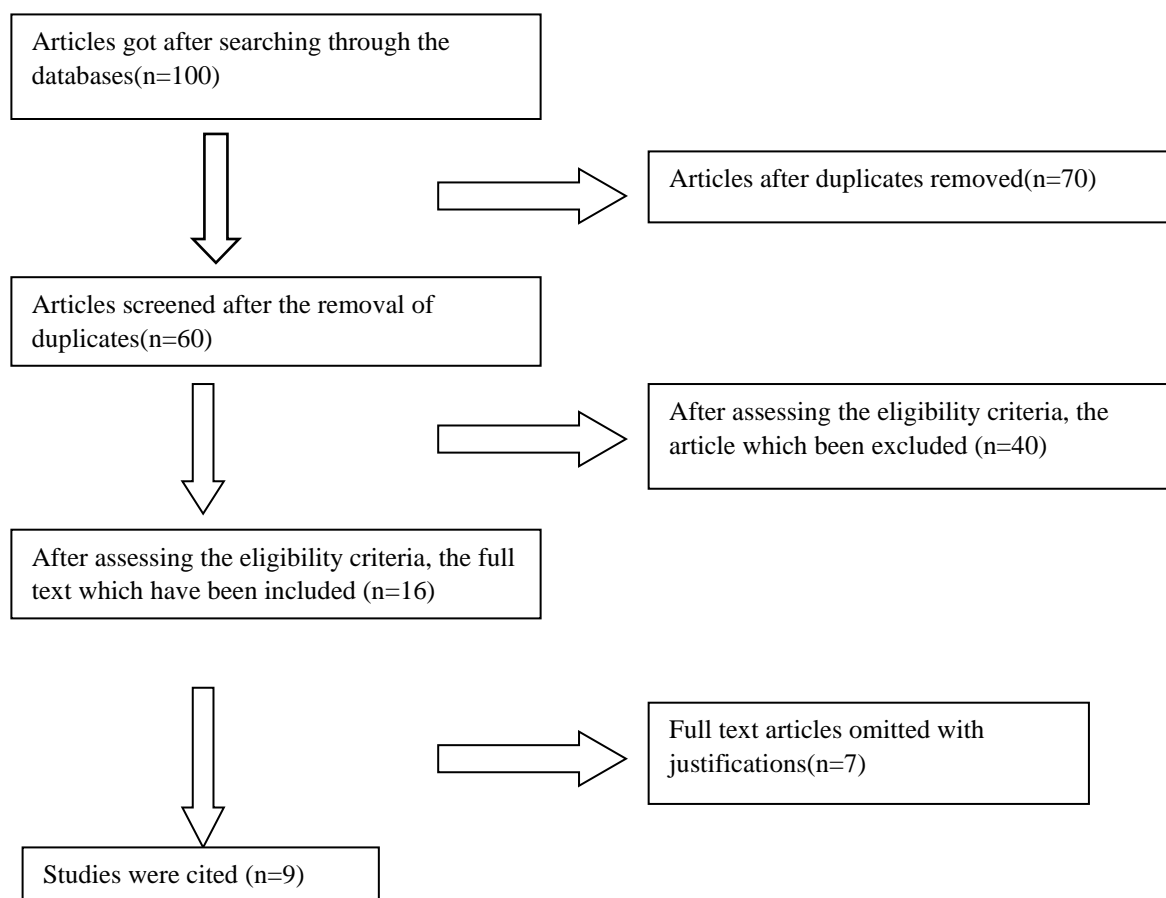


Fig. 1: Review of the PRISMA flowchart

Review of literature

Table 1: Vestibular exercises for post stroke patients

S.No.	Author Name	Title	Sample Size	Study Design	Outcome Measure	Study Description	Study Conclusion
1	Mitsutake et al., (8)	Effect of vestibular rehabilitation on gait performance in post stroke patients	n=28	Pilot randomized control trial	Dynamic gait index, gaze stabilization test, 10 m walk test, timed up and go test	Experimental Group: n=14 Intervention: Conventional therapy: 40 min Vestibular exercise: 20 min Duration: 3 weeks Control Group: n=14 Intervention: Conventional therapy: 60 min Duration: 6 weeks	Vestibular rehabilitation showed improved gait performance.
2	Saleem et al., (9)	Comparative study to evaluate the effectiveness of vestibular rehabilitation therapy versus dual task training on balance and gait in PCA stroke	n=30	Comparative study	Wisconsin Gait scale, Mini BEST test	Experimental Group: n=15 Intervention: Vestibular rehabilitation with conventional therapy 45 minutes in a day Duration: 4 weeks Control Group: n=15 Intervention: DT training balance task 45 minutes in a day Duration: 4 weeks	Patients recovering from a PCA stroke may benefit from VR therapy to regain their equilibrium.
3	Correia et al.,(10)	Better balance a randomized controlled trial of oculomotor and gaze stability exercises to reduce risk of falling after stroke	n=68	Non blinded, stratified randomized controlled trial	Berg balance scale timed up and go test	Experimental Group: n=33 Intervention: Oculomotor and gaze stability exercise for 3 weeks Duration: 3 weeks Control Group: n=35 Intervention: current rehabilitation program for stroke patients Duration: 3 weeks	The fear of falling down and its associated risk were minimised using the Gaze stabilisation exercises.
4	Tramontano et al., (11)	Vestibular rehabilitation training in patients with sub-acute stroke	n=25	Preliminary randomized controlled trial	10m walk test	Experimental Group: n=13 Intervention: Gaze stability exercise for 20 minutes Duration: 4 weeks Control Group: n=12 Intervention: balance exercises for 20 minutes Duration: 4 weeks	The balance in the unstable surfaces and in dynamic postures seem to be improved along with the gait by training the vestibular rehabilitation in stroke survivors.

Table 2: Vestibular exercises for other ailments

S.No.	Author Name	Title	Sample Size	Study Design	Outcome Measure	Study Description	Study Conclusion
1.	Career et al., (12)	Is customized vestibular rehabilitation in patients with Parkinson's disease	n=40	Comparative study	Unified Parkinson's disease rating scale, Parkinson's disease questionnaire -39, Activities specific balance scale, Berg balance scale	Experimental Group: n=29 Intervention: Adaptation exercises, substitution exercise, Habituation exercises Duration:30 -45 minutes one session for a week for 8 weeks Control Group: n=11 Intervention:	PD patients' balance improved with 8 weeks of vestibular exercises.

						conventional therapy Duration: 30-45 minutes	
2.	Marco et al., (13)	Vestibular rehabilitation has positive effects on balance, fatigue and activities of daily living in highly disabled patients with multiple sclerosis	n=30	Preliminary randomized controlled trail	Berg balance scale, fatigue severity scale, Tinetti balance gait scale	Experimental Group: n=30 Intervention: Gaze stability exercise, postural control exercise Duration:4 weeks Control Group: n=15 Intervention: PNF, active assisted mobilizations, balance training Duration: 4 weeks	VR training session enhances the patient balance and mobility
7	Hebert et al., (14)	Effects of vestibular rehabilitation on multiple sclerosis related fatigue and upright postural control	n=25	Single blinded stratified 6-block randomized controlled trail	Modified fatigue impact scale, post-urography, 6-minute walk test, Dizziness handicap inventory	Experimental Group: n=12 Intervention: Vestibular rehabilitation program consisting of eye movement, upright postural control for 55 minutes Duration:4 weeks Control Group: n=13 Intervention: Endurance and stretching exercises for 15 minutes Duration: 4 weeks.	In multiple sclerosis patients, vestibular rehabilitation reduced tiredness and impaired balance
8	Bhardwaj et al., (15)	Effectiveness of gaze stability exercises on balance in healthy elderly population	n=30	Randomized pre- test and post- test experimental design	Berg balance scale, Activities specific balance confidence scale	Experimental Group: n=15 Intervention: Gaze stability exercises 3 times daily not less than 30 minutes Duration: 6 weeks Control Group: n=15 Intervention: Placebo eye movements Duration: 6 weeks	Well tolerable balance control was achieved by training the gaze stability exercises with the ADL in healthy elderly populations.
9	Gulnurozogen et al., (16)	Is customized vestibular rehabilitation effective in patients with multiple sclerosis	n=40	Randomized control trial	Romberg test, tandem Romberg test, foam Romberg test, static Post-urography, 6-meter walk test, timed up and go test.	Experimental Group: n=20 Intervention: Adaptation exercise, substitution exercise, balance exercise, habituation exercise, static and dynamic balance exercise for 30-45 minutes Duration:8 weeks Control Group: n=20 Intervention: Conventional Therapy Intervention: Balance exercise 30-45 min Duration: 8 weeks	Patients with multiple sclerosis who undergo vestibular rehabilitation see improvements in balance and ADL.

RESULTS

Nine papers were ultimately recruited after the first selection of 100 research had been evaluated for eligibility according to the selection criteria. Most of the publications included in this evaluation came to the conclusion that various types of vestibular exercise, such as oculomotor and gaze stability training are beneficial. In stroke patients, the Cawthorne Cooksey exercise improved balance and decreased the risk of fall. Also, from this study apart

from stroke these vestibular exercises have been used in other ailments effectively in various neurological illnesses such as Parkinson’s disease, multiple sclerosis in elderly population.

DISCUSSION

This review addressed the issue of balance impairment in stroke and was clinically and scientifically relevant for researchers and clinicians. The only language examined was English. This may have overlooked some more significant studies. The

review covered papers that produced heterogeneity in the outcome measure. In an experimental investigation, done by Correia et al., (10) found that 3 weeks of vestibular exercises improved the stability and decreased both the risk and fear of falling among stroke survivors. In comparative research between vestibular therapy and DT training, Saleem et al., (9) found that vestibular rehabilitation was more effective at reducing gait disruption, improving balance and boosting patients' confidence when walking after PCA stroke.

CONCLUSION

The articles reviewed indicated that the vestibular rehabilitation program is successful in stroke patients and other illness such as Multiple sclerosis, Parkinson's illnesses, and the elderly population to improve balance. Further experiment investigation is needed to conclusively demonstrate that vestibular rehabilitation training improves equilibrium after stroke because there are not any studies with evidence to support this.

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CONFLICT OF INTEREST

The authors declare that there are no conflicts of interest disclosed.

REFERENCES

1. Gladys, S. R., Physiotherapy in neuro-conditions. Jaypee brother's First edition 2006; 20-59.
2. Gillen, G., Nilson, D.M., Stroke rehabilitation e-book: A functional based Approach, Elsevier Health Science 5th edition 2020; September 13: 405-413.
3. Smania, N., Picelli, A., Gandolfi, M., Fiaschi, A., Tinazzi, M., Rehabilitation of sensorimotor integration deficits in balance impairment of patients with stroke hemiparesis: a before/after pilot study. Neurological Sciences. 2008 DOI 10.1007/s10072-008-0988-0 <https://doi.org/10.1007/s10072-008-0988-0>
4. Matsugi, A., Ueta ,Y., Oku, K., Okuno ,K., Tamaru, Y., Nomura, S., et al.,Effect of gaze-stabilization exercises on vestibular function during postural control. Neuroreport. May 2017 24; 28(8):439-443.
5. Tyson, S.F., Hanley, M., Chillala, J., Selley, A., Tallis, R.C. Balance Disability After Stroke. Physical Therapy. 1 January 2006; 86 (1): 30-38.
6. Li, J., Zhong, D., Ye, J., He, M., Liu, X., Zheng, H., et al., Rehabilitation for balance impairment in patients after stroke: a protocol of a systematic review and network meta-analysis. BMJ open. 2019 Jul 1; 9(7): e026844.
7. Pimenta, C., Correia, A., Alves, M., Virella, D. Effects of oculomotor and gaze stability exercises on balance after stroke: Clinical trial protocol. Porto biomedical journal. 2017 May 1;2(3):76-80.
8. Mitsutake, T., Sakamoto, M., Ueta, K., Oka, S., Horikawa, E., Effects of vestibular rehabilitation on gait performance in post stroke patients: a pilot randomized controlled trial. International Journal of Rehabilitation Research. 2017 Sep 1; 40(3):240-245.
9. Saleem, S., Arora, B., Chauhan, P., Comparative Study to Evaluate the Effectiveness of Vestibular Rehabilitation Therapy versus Dual Task Training on Balance and Gait in

- Posterior Cerebral Artery (PCA) Stroke. Journal of Clinical & Diagnostic Research. 2019 Nov1;13(11). DOI: 10.7860/JCDR/2019/41828.13309
10. Correia, A., Pimenta, C., Alves M, Virella D. Better balance: a randomised controlled trial of oculomotor and gaze stability exercises to reduce risk of falling after stroke. Clinical Rehabilitation. 2021 Feb;35(2):213-221.
11. Tramontano, M., Bergamini, E., Iosa, M., Belluscio, V., Vannozzi, G., Morone, G., Vestibular rehabilitation training in patients with sub-acute stroke: A preliminary randomized controlled trial. Neurorehabilitation. 2018 Jan 1; 43(2):247-254.
12. Acarer, A., Karapolat, H., Celebisoy, N., Ozgen, G., Colakoglu, Z., Is customized vestibular rehabilitation effective in Parkinson's? Neurorehabilitation.2015 Jan 1;37(2):255-262.
13. Tramontano, M., Cinnera, A. M., Manzari, L., Tozzi, F.F., Caltagirone, C., Morone, G., et al., Vestibular rehabilitation has positive effects on balance, fatigue and activities of daily living in highly disabled multiple sclerosis people: A preliminary randomized controlled trial. Restorative Neurology and Neuroscience. 2018 Jan 1; 36(6):709-718.
14. Ozgen, G., Karapolat, H., Akkoc, Y., Yuceyar, N., Is customized vestibular rehabilitation effective in patients with multiple sclerosis? A randomized controlled trial. European Journal of Physical and Rehabilitation Medicine. 2016 Apr 6; 52(4):466-478.
15. Hebert, J.R., Corboy, J.R., Manago, M.M., Schenkman, M., Effects of vestibular rehabilitation on multiple sclerosis-related fatigue and upright postural control: a randomized controlled trial. Physical Therapy. 2011 Aug 1; 91(8):1166-1183.
16. Bhardwaj, V., Vats, M., Effectiveness of gaze stability exercise on balance in healthy elderly population. Int J Physiother Res. 2014; 2(4):642-647.