Original Article

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Effects of Progressive Gaze Stability Exercises on Balance and Gait in Vestibular Neuritis Patients: A Quasi-experimental Study

Physiotherapy Section

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ABSTRACT

Introduction: Gaze stability exercises are the exercises that are used effectively to improve gaze stability during head movement in various vestibular disorders patients, and to improve balance in static and dynamic movements of the same.

Aim: To compare the effectiveness of progressive gaze stability exercises to improve balance and gait in patients with vestibular neuritis.

Materials and Methods: This quasi-experimental study was conducted at Outpatient Department of SGT hospital, Gurugram, Haryana, India, from November 2018 to March 2019. A total of 26 subjects were randomly assigned into two groups, group A received progressive gaze stability exercises with conventional therapy (n=13) and group B received conventional therapy (n=13). Group A received Vestibular Rehabilitation Therapy (VRT) for 25 minutes a day five times a week for four weeks. group B conventional training which consisted of balance exercises. Participants were assessed with Mini Balance Evaluation Systems Test (Mini-BESTest) and dizziness handicap inventory to access the performance of balance and functional limitation, respectively. Data was analysed by using the Statistical Package for the Social Sciences (SPSS) version 20.0 for statistical analysis. A level of significance was set at p-value <0.05.

Results: The finding of the study showed no significant change for baseline parameters between the experimental and conventional groups with respect to age (p-value=0.097), gender (p-value=0.573), height (p-value=0.682), weight (p-value=0.945), duration of illness (p-value=0.579). Both the groups showed significant improvement with in group, when measured using dependent t-test for Mini-BESTest and Wisconsin Gait Scale. The comparison of postintervention scores of Mini-BESTest and WGS between group A and group B showed significant difference (p-value=0.001) and (p-value=0.002) respectively.

Conclusion: The present study has provided preliminary evidence that progressive gaze stability exercises when coupled with conventional balance exercises may improve gait and balance in patients with vestibular neuritis.

Keywords: Adaptation exercises, Postural training, Substitution exercises, Vestibular rehabilitation

INTRODUCTION

Vestibular neuritis is a disorder resulting most commonly from a viral infection that inflames the inner ear or the nerves connecting the inner ear to the brain [1]. This inflammation results in disruption of the transmission of sensory information from the ear to the brain which leads to sudden, severe vertigo (a spinning sensation) caused by altered processing of information from both the ears. Other symptoms include dizziness, nausea, vomiting, imbalance, leading to significant difficulty in walking [2]. The average annual incidence of vertigo varied from 11.7 per 1,00,000 in the year 2012 to 16.1 in the year 2017, with the mean age at the onset of the disease as 52.3 years and male to female ratio as 1.1:1 [3].

Balance is the ability to maintain equilibrium, the input from different receptors, including labyrinthine, somatosensory, and visual are fed to the feedback circuits which are responsible for body balance. To correct internal and external balance perturbations, these inputs have to be adequately integrated within the central nervous system in order to produce appropriate changes in motor output and if any input gets impaired, the balance gets hampered. Vestibular neuritis affects the vestibular organs which includes the three loop-shaped semicircular canals affecting the sac-shaped utricle and saccule. They provide signal to the brain via the vestibulocochlear nerve (eighth cranial nerve). This nerve has two branches. First branch which is known as the cochlear nerve transmits messages from the hearing organ, while the second known as the vestibular nerve transmits messages from the balance organs [4]. Vestibular neuritis occurs due to sudden decrease in the function of one set of vestibular organs mainly from one inner ear. It is believed that our two ears constantly send information to the brain about the status of our balance. The brain which integrates those signals sent from the right and the left ear so when one ear stops sending the signals, the brain receives signals from the healthy side and interprets rotating movement of the body. As a compensation for this false sense of rotation, the brain generates eye and body movements in the opposite direction, which causes a strong sensation of spinning, nausea and a tendency to fall to one side [5].

Numerous interventions such as optokinetic training and sensitisation have been used to treat various vestibular disorders there is insufficient research on interventions for vestibular neuritis, which causes patients to lose their balance [6]. There are various rehabilitation techniques that have been adopted to improve gait and balance parameters in vestibular neuritis patients. Progressive gaze stability exercises are the exercises that focus on the plasticity of the balance system by promoting vestibular adaptation and substitutions to improve compensations [7]. No study documented the effectiveness of progression of gaze stability exercises on postural stability and dizziness occurring due to viral infections leading to acute neuritis. Hence, the aim of this study was to investigate the effect of progressive gaze stability exercises compared with conventional balance training on balance and gait in patients with vestibular neuritis.

MATERIALS AND METHODS

This quasi-experimental study was conducted at Outpatient Department of SGT hospital, Gurugram, Haryana, India, from November 2018 to March 2019. This study was approved by the Institute Ethics Committee (SGTU/ FMHS/D/108), and the review board of SGT University, Gurugram, Haryana, India.

Inclusion criteria: The inclusion was typically based on clinical history and physical examination in accordance to the four established criteria for vestibular neuritis: 1) acute or sub-acute onset of vertigo; 2) horizontal spontaneous nystagmus with a fast-phase component toward the unaffected ear; 3) hyporesponsive biothermal caloric test results in the affected ear (with greater than 25% asymmetry between the sides, as measured with Jongkees's formula [8]; and 4) displacement of verticality as perceived with eyes when rotated toward the affected ear without any vertical divergence of an eye above other [9,10].

Exclusion criteria: Patients having labyrinthitis, retrocochlear lesion, Meniere's disease, migraine associated vertigo, transient ischemic attack, and infarction or haemorrhages of either the inner ear or the brain stem, or with other neurological or psychiatric illness were excluded from the study.

A total of 26 patients were included who were diagnosed with vestibular neuritis by physicians, computed tomography, and/or an Magnetic Resonance Imaging (MRI) scan of the brain with contrast can show enhancement of the vestibular nerve fibres within the internal auditory canal with the labyrinth of the inner ear often intact.

Study Procedure

Each participant provided their written informed consent. A total of 26 subjects were randomly assigned into two groups,

- Group A vestibular rehabilitation with conventional therapy (n=13);
- Group B placebo along with conventional therapy (n=13) only.

Each group received Vestibular Rehabilitation Therapy (VRT) or placebo training 25 minutes in a day five times in a week for four weeks. Patients were assigned randomly to the experimental and control groups using computer-generated random number system.

Experimental procedure (group A): The vestibular rehabilitation program consisted of 25 minutes of vestibular adaptation exercises which consist of gaze stability exercises. It comprised of various exercises that are performed rapidly with active head rotations. The visual target was fixed or moving depending on the type of exercises to be performed. The individual was asked to perform the head movements. The patients were asked to do head motions with a fixed visual target, which were referred to as X1 viewing exercises. The X2 viewing exercises were defined as those in which the visual target moved in the opposite direction of the head [11].

Placebo procedure (Group B): The placebo program consisted of exercises that were performed to be vestibular neutral exercises. It comprised of exercises in which the participants performed saccadic eye movements, with the head stationary without holding on visual targets against a plain white wall. The time taken to perform these placebo eye exercises was equated with the time spent by Group A in performing gaze stability exercises. All the participants were instructed to perform the exercises over a period of four weeks 25 minutes in a day for five days over a four week period. After fourth week, postintervention data was collected again to analyse the statistical differences [12].

Wisconsin Gait Scale (WGS) is an observational tool for the evaluation of gait. It is divided into four subscales. which assess a total of fourteen spatiotemporal and kinematic parameters of gait observed during the consecutive gait phases [13].

Participants were assessed with Mini Balance Evaluation Systems Test (Mini-BESTest) and dizziness handicap inventory to access the performance of balance and functional limitation, respectively. The Mini-BESTest was used to assess balance in several neurological conditions. It was widely used in both clinical practice and research. It includes 14 items and maximum score of 28 points. Each score from 0-2 [14].

Conventional Training

Both the groups received a conventional therapy program for 45 minutes a day, five days in a week for four weeks, along with experimental and placebo training. Conventional training consisted balance and gait exercises.

Balance exercises:

(a) Standing with feet shoulder width apart arms across the chest and the patient was asked to bring the feet closer together with closed eyes on cushion sofa or foam;

(b) Practiced ankle sways, medial-lateral and anterior-posterior later on with circle sways with closed eyes;

(c) Attempted to walk with heel touching toe on firm surface and then on carpet;

(d) Practiced walking five steps and turning 180 (left and right);

(e) Walked and moved the head side to side, up and down;

(f) Touched the wall;

(g) Took a ball in hand, lifted it up, transferred to other hand followed arch visually.

Gait exercises:

(a) Walking on straight line;

(b) Walking with head in motion;

(c) Walking with head turns;

(d) Sit to stand;

(e) Standing with one foot;

(f) Standing on cushion;

(g) Standing and throwing;

(h) Standing with heel together;

(i) Standing on one feet, all exercises were performed under the supervision of a physiotherapist [15].

STATISTICAL ANALYSIS

Data was analysed by using the Statistical Package for the Social Sciences (SPSS) version 20.0 for statistical analysis. After the descriptive analysis of the data the Shapiro-Wilk test was used to assess the normality of the data distribution. As variables were shown to be parametric, student t-test was used to compare variables within each group and for comparisons between the groups paired t-test was used to analyse within group differences. A level of significance was set at p-value ≤0.05.

RESULTS

The general characteristics of the study participants are summarised in [Table/Fig-1]. There was no significance difference found between characteristics of participants in group A and group B in terms of age (p-value=0.097), height (p-value=0.682), weight (p-value=0.945), duration of illness (p-value=0.579), gender score at baseline.

Variables	Group A Mean (SD)	Group B Mean (SD)	p-value (paired t-test)
Age (years)	58.15 (7.9)	57.00 (7.8)	0.097
Height (cm)	168.31 (7.4)	165.18 (8.02)	0.682
Weight (kg)	69.54 (11.8)	70.18 (9.59)	0.945
Duration of illness (months)	3.23 (1.2)	5.24 (0.4)	0.579
Gender			
Male	9	10	0.573
Female	4	3	

[Table/Fig-1]: Baseline characteristics of participants.

On comparing the pre-intervention scores of group A and B for Mini-BESTest (p-value=0.132) and WGS (p-value=0.215) no significant difference was seen. However, the comparison

of postintervention scores of Mini-BESTest and WGS between group A and group B showed significant difference (p-value=0.001) and (p-value=0.002) respectively as measured by students t-test shown in [Table/Fig-2].

Groups	Mini-BESTest		p-value	Wisconsin gait scale		p-value
	Pretest Mean±SD	Post-test Mean±SD		Pretest Mean±SD	Post-test Mean±SD	
Group A	37.46±7.87	28.46±7.93	0.001	28.43±7.62	22.36±3.99	0.012
Group B	40.76±6.56	35.12±6.90	0.001	20.0±1.16	22.01±2.47	0.056
p-value	0.132	0.001		0.215	0.002	

[Table/Fig-2]: Comparison of pre and postintervention score of Mini-BESTest and Wisconsin Gait Scale in Group A and Group B.

DISCUSSION

The present study findings indicate that gaze stability exercises can bring about a significant improvement on balance in patients with vestibular neuritis. This study is in accordance with the study conducted by Goudakos JK et al., who reported the benefit of various vestibular exercises to facilitate reflex mechanism related to vestibular function [16]. Vestibular Rehabilitation focuses on utilising the plasticity of the balance system to improve the natural compensation process. Decreased gain of vestibular response to head movements gives rise to gaze instability in patients with vestibular dysfunction [17]. Inducing retinal slip by horizontal or vertical head movements while maintaining visual fixation on a target, increases the gain of the vestibular response [18,19]. For vestibular adaptation to occur, retinal slip needs to be induced repeatedly.

The findings of this study are similar to thar conducted by Macias JD et al., in which there was a statistical significant improvement on the scores of Berg Balance Scale (BBS) after vestibular rehabilitation therapy [20]. Another study by Giray M et al., also showed improvement in BBS scores after vestibular rehabilitation in chronic unilateral vestibular dysfunction [21].

In a similar study, Gans RE concluded that there are various compensatory responses of the central nervous system which are based on plasticity of the brain therefore when we use motion sensitive exercises their occurs habituation a repetitive stimuli which in turn leads to a rebalance in the tonic activity within the vestibular nuclei. He also suggested that sensory conflict might lead to neurological rearrangements known as vestibular compensation on which vestibular training is based [22].

Cohen HS et al., suggested that VRT is important to co-ordinate learning strategies to maximise adaptation, motor learning and avoid overstimulation. Therefore, it is critical for a clinician to pay more attention to not only the common vestibular symptom but also gait stabilisation to avoid fall, and further to improve balance. Eye and head movements exercises are performed to improve the gaze stability, whereas exercises performed while sitting, standing on firm or cushion or on narrow base to improve postural stability [23].

The Vestibulo-Ocular Reflex (VOR) is activated while gazing on a target during head rotation and to maintain one's posture. The VOR function directly affects gait performance and its evaluation can assess the people who are at higher risk of falling. The principle of VOR training is also based on sensory conflict which might lead to various neurological rearrangements, commonly called as vestibular compensations, which consists of gaze stabilisation and balance exercises [24-27]. Gaze stability exercises increase gain of vestibular response to head movements thus in turn gives rise to stability. They also induce retinal slip thereby inducing vestibular adaptation by horizontal and vertical head movements while focusing on fixed target and in turn increases vestibular responses [28].

Limitation(s)

The present study was a preliminary investigation which involved a small sample population. Further studies which involve higher sample size are needed to confirm these results. Furthermore, the duration of treatment was four weeks which might have been insufficient to promote an optimal response for gait for our participants. It remains unknown that whether additional benefits can be obtained when this study is carried out with a longer treatment period. Future studies can be done to investigate the possible carryover effects of the therapy.

CONCLUSION(S)

The present study has provided preliminary evidence that progressive gaze stability exercises when coupled with conventional balance exercises may improve gait and balance in people with vestibular neuritis. Improvements were shown in Mini-BESTest and WGS scores.

REFERENCES

[1] Thomas WB. Vestibular dysfunction. Veterinary Clinics: Small Animal Practice. 2000;30(1):227-49.
[2] Chawla N, Olshaker JS. Diagnosis and management of dizziness and vertigo. Medical Clinics. 2006;90(2):291-304.
[3] Yardley L, Redfern MS. Psychological factors influencing recovery from balance disorders. J Anxiety Disord. 2001;15(1-2):107-19. Doi: 10.1016/s0887-6185(00)00045-1. PMID: 11388354.
[4] Taylor RL, McGarvie LA, Reid N, Young AS, Halmagyi GM, Welgampola MS. Vestibular neuritis affects both superior and inferior vestibular nerves. Neurology. 2016;87(16):1704-12.
[5] Böhmer A, Rickenmann J. The subjective visual vertical as a clinical parameter of vestibular function in peripheral vestibular diseases. J Vestib Res. 1995;5(1):35-45.
[6] Pavlou M, Bronstein AM, Davies RA. Randomized trial of supervised versus unsupervised optokinetic exercise in persons with peripheral vestibular disorders. Neurorehabil Neural Repair. 2013;27(3):208-18.
[7] Han BI, Song HS, Kim JS. Vestibular rehabilitation therapy: Review of indications, mechanisms, and key exercises. Journal of Clinical Neurology. 2011;7(4):184-96.
[8] Furman JM, Jacob RG. Jongkees' formula re-evaluated: Order effects in the response to alternate binaural bithermal caloric stimulation using closed-loop irrigation. Actaoto-Laryngologica. 1993;113(1):03-10.
[9] Brandt T, Dieterich M, Strupp M. Peripheral vestibular forms of vertigo. Vertigo and Dizziness: Common Complaints. 2005:41-87.
[10] Liu GT, Volpe NJ, Galetta SL. Neuro-Ophthalmology E-Book: Diagnosis and Management, Book with DVD-ROM. Elsevier Health Sciences; 2010 Aug 27.
[11] Clendaniel RA. The effects of habituation and gaze-stability exercises in the treatment of unilateral vestibular hypofunction–preliminary results. J Neurol Phys Ther. 2010;34(2):111.
[12] Hall CD, Heusel-Gillig L, Tusa RJ, Herdman SJ. Efficacy of gaze stability exercises in older adults with dizziness. J Neurol Phys Ther. 2010;34(2):64-69.
[13] Rodriquez AA, Black PO, Kile KA, Sherman J, Stellberg B, McCormick J, et al. Gait training efficacy using a home-based practice model in chronic hemiplegia. Arch Phys Med Rehabil. 1996;77(8):801-05.
[14] Di Carlo S, Bravini E, Vercelli S, Massazza G, Ferriero G. The Mini-BESTest: A review of psychometric properties. Int J Rehabil Res. 2016;39(2):97-105. Doi: 10.1097/MRR.0000000000000153.
[15] Bhardwaj V, Vats M. Effectiveness of gaze stability exercises on balance in healthy elderly population. Int J Physiother Res. 2014;2(4):642-47.
[16] Goudakos JK, Markou KD, Psillas G, Vital V, Tsaligopoulos M. Corticosteroids and vestibular exercises in vestibular neuritis: Single-blind randomized clinical trial. JAMA Otolaryngol Head Neck Surg. 2014;140(5):434-40.
[17] Shepard NT, Telian SA, Smith-Wheelock M. Habituation and balance retraining therapy: A retrospective review. Neurologic Clinics. 1990;8(2):459-75.
[18] Herdman SJ. Advances in the treatment of vestibular disorders. Physical therapy. 1997;77(6):602-18.
[19] Herdman SJ. Role of vestibular adaptation in vestibular rehabilitation. Otolaryngol Head Neck Surg. 1998;119(1):49-54.
[20] Macias JD, Massingale S, Gerkin RD. Efficacy of vestibular rehabilitation therapy in reducing falls. Otolaryngology—Head and Neck Surgery. 2005;133(3):323-25.
[21] Giray M, Kirazli Y, Karapolat H, Celebisoy N, Bilgen C, Kirazli T. Short-term effects of vestibular rehabilitation in patients with chronic unilateral vestibular dysfunction: A randomized controlled study. Arch Phys Med Rehabil. 2009;90(8):1325-31.
[22] Gans RE. Vestibular rehabilitation: Critical decision analysis. Seminars in Hearing 2002;23:149-59.
[23] Cohen HS, Gottshall KR, Graziano M, Malmstrom EM, Sharpe MH, Whitney SL. International guidelines for education in vestibular rehabilitation therapy. J Vestib Res. 2011;21(5):243-50.

[24] Herdman SJ. Role of vestibular adaptation in vestibular rehabilitation. Otolarynolaryngology Head and Neck Surg. 1998;119(1):49-54.
[25] Gauthier GM, Robinson DA. Adaptation of the human vestibuloocular reflex to magnifying lenses. Brain Res. 1975;92(2):331-35.
[26] Herdman SJ, Hall CD, Schubert MC, Das VE, Tusa RJ. Recovery of dynamic visual acuity in bilateral vestibular hypo function. Arch Otolaryngol Head Neck Surg. 2007;133(4):383-89.
[27] Yardley L, Barker F, Muller I, Turner D, Kirby S, Mullee M, et al. Clinical and cost effectiveness of booklet based vestibular rehabilitation for chronic dizziness in primary care: single blind, parallel group, pragmatic, randomized controlled trial. BMJ. 2012;344.
[28] Johansson M, Akerlund D, Larsen HC, Andersson G. Randomized controlled trial of vestibular rehabilitation combined with cognitive-behavioral therapy for dizziness in older people. Otolaryngol Head Neck Surg. 2001;125(3):151-56.

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