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Original Research Article

Effects of Different Types of Vestibular Rehabilitation Exercises on Improvement of Quality of Life in Patients with Vertigo of Vestibular Origin: A Comparative Study

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Abstract

Background: Vertigo is a prevalent and disabling symptom in patients with vestibular disorders, exerting a negative impact on physical, functional and emotional domains of quality of life. Vestibular Rehabilitation Therapy (VRT) is an exercise rehabilitation therapeutic strategy aimed at central compensation and improved functional recovery. But few comparative data are available about the efficacy of various kinds of vestibular rehabilitation exercises, especially in low-resources countries.

Methods: This single-blind randomised controlled trial was carried out in the Department of Physical Medicine and Rehabilitation at Patna Medical College and Hospital between April 2021 and March 2022. Eighty patients were enrolled, and 40 completed the study. Patients diagnosed with central or peripheral vestibular disorders were randomly assigned into four groups: adaptation, habituation, substitution and combined tailored exercise group. All patients were prescribed betahistine 100 mg three times daily for two weeks plus supervised vestibular rehabilitation exercises for six weeks. Primary outcome measures were the Dizziness Handicap Inventory (DHI) and Visual Vertigo Analog Scale (VVAS), measured at baseline and after six weeks. Paired t-test and ANOVA were applied for statistical analysis.

Results: DHI and VVAS scores of all four groups improved significantly (p 0.05). Between-group comparison using ANOVA showed no statistically significant difference among the exercise modalities (p > 0.05). Combined tailored exercise group showed clinically better improvement.

Conclusion: Vestibular Rehabilitation (VR) increases the quality of life in patients with vestibular dysfunction. All regimens provide a benefit, with the combined individualised approach providing the largest clinical benefit. Structured OPD-based VRT is applicable easily without complicated sophisticated equipment.

Keywords: Adaptation Exercises, Habituation Exercises, Substitution Exercises, Vertigo, Vestibular Rehabilitation.

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Introduction

Vertigo is a sensation of motion, usually the sense of spinning when there is no actual movement [1]. It is a primary clinical manifestation of diseases involving the vestibular system which includes the peripheral labyrinth and vestibular nerve, as well as the central pathways in the brain stem and cerebellum. Vestibular disorders constitute a heavy clinical load around the world, occupying a large fraction of outpatient services in neurology and otolaryngology [2,3]. The estimated 1-year prevalence of vertigo is ~4–5% and lifetime prevalence approaches 7–8%, the latter being even higher in women or elderly [4]. In addition to its physical symptoms, vertigo may have a profound impact on quality of life and can result in disability, limit activities of daily living, cause emotional distress, fear of falling and induce social isolation [5,6]. Symptoms are associated with difficulties in the activities of daily living, impaired work productivity, and decreased independence [7,8]. Thus, there is need for comprehensive rehabilitation programs aimed not only at

symptom management but also restoration of function. VRT is an exercise-based program of treatment intended to facilitate central vestibular compensation and enhance normal function [9]. Vestibular compensation represents neuroplastic processes within the central nervous system, which restore balance and gaze stability following vestibular injury [10,11]. Adaptation exercises study seeks to enhance vestibulo-ocular reflex (VOR) gain by repetitive head movements that generate retinal slip. Habituation techniques decrease motion sensitivity through systematic, repeated exposure to provocative stimuli [12]. Substitution activities encourage the utilization of visual and somatosensory inputs to help balance a deficient vestibular system. One tailored approach combines aspects of all three, individualized according to patient deficits. Pharmacotherapy, especially betahistine, is often employed as an adjuvant to promote vestibular compensation and diminish acute manifestations, leading to increased tolerance to rehabilitation exercises.

Despite growing evidence supporting VRT, comparative trials for exercise modalities types remain limited. The VRT is mostly analyzed as a single construct, without distinguishing the adaptation, habituation and substitution strategies. In addition, affordable OPD-based rehabilitation models should be replicable even in minimum resource environments and with simple equipment. In the Indian scenario, particularly in eastern regions, published data regarding structured vestibular rehabilitation and comparison to exercise protocol are rare.

Objectives

1. To assess the efficacy of vestibular rehabilitation exercises on improvement of quality of life in patients with vestibular dysfunction.
2. To evaluate the effect of adaptation, habituation, substitution, and combined exercises using DHI and VVAS.
3. To compare effects of these exercises with each other.

Materials and Methods

Study Design: This study was conducted as single-blinded randomized controlled trial to evaluate and compare the efficacy of different approaches of vestibular rehabilitation exercises in enhancing quality of life for patients with vestibular vertigo. The evaluator who assessed the outcome was blind to group assignment, thus reducing assessment bias.

Study Setting: The research was conducted in the Department of Physical Medicine and Rehabilitation (PM&R) at Patna Medical College and Hospital, a tertiary care teaching hospital of eastern India. Patients were included from the PM&R outpatient department (OPD) and Department of ENT on referral basis. The research study was conducted spanned over one year, ranging from April 2021 to March 2022.

Sample Size: The sample size was estimated using the OpenEpi software (Version 3) based on findings from a comparable study carried out in Udaipur, Rajasthan in the year 2020 reporting clinically relevant improvement among patients receiving vestibular rehabilitation. Assuming 95% ($\alpha = 0.05$) and a power of 80% ($\beta = 0.2$), the minimum sample size was found to be n = 74. For practical purposes and to allow for dropout, 80 patients were recruited in the first instance. However, second-wave of COVID-19 pandemic along with high loss to follow-up, only 40 patients completed the study and were analyzed.

Inclusion Criteria: Patients aged 18 or older who had central or peripheral vestibular disorders were included. Patients were either referred from the ENT department after vestibular pathology was confirmed or direct reporting to PM&R OPD with symptoms of vertigo. Written informed consent was obtained from all subjects before enrolment.

Exclusion Criteria: The study excluded patients that were below 18 years of age. Pregnant or lactating women were excluded. Participants with cervical spondylosis, acute cardiac diseases and other clinical neurologic conditions except for central vestibular disorders were also excluded to eliminate the potential confounding effects on balance. Patients who did not provide informed consent were also excluded.

Randomization and Group Allocation: After initial evaluation, eligible patients were randomly divided into 4 groups with simple randomization. Regarding the type of vestibular rehabilitation protocol, Adaptation Exercise Group, Habituation Exercise Group, Substitution Exercise Group and Combined Tailoring Exercise Group. The two groups together underwent an individualized exercise programme and received adaptation, habituation and substitution exercises in accordance with the patients' deficits.

Intervention Protocol: All patients were treated with pharmacotherapy (Betahistine 100 mg three times daily) for two weeks before the exercises. The Patients was instructed on specific vestibular rehabilitation exercises in the PM&R gymnasium or ward under supervision after pharmacotherapy. Patients were educated to practice the exercises given for 15 min twice daily at home over a period of six weeks. During follow-up visits, adherence was reinforced.

Outcome Measures: The DHI and the VVAS were the primary outcome measures. Baseline

evaluation was performed at Day 0 before intervention. Post-intervention testing took place at the end of 6 weeks active therapy.

Statistical Analysis: Statistical method was used for data analysis. Demographics were compared by the chi-square test. Pre and post intervention scores were compared in-group using the paired t- test. Comparisons between groups were made using an analysis of variance (ANOVA). A value of p less than 0.05 was considered significant.

Results

Demographic Characteristics: A total of 40 patients completed the study and were analysed. Between these two, female gender 28 cases (70%) dominated the study population compared to male 12 cases (30%), which suggested a higher prevalence of vestibular dysfunction in women within the study group.

The average age of the participants was 44.02 ± 3.42 years, indicating that majority of patients fell within middle age group.

There were no statistically significant differences in the baseline demographic characteristics of the four intervention groups, suggesting comparability at pretest. The demographic characteristics of the study population are shown in Table 1.

Table 1: Demographic Characteristics of Study Participants (n = 40)

Variable	Frequency (n)	Percentage (%)
Gender		
Male	12	30%
Female	28	70%
Age (years)	Mean ± SD	
Overall Mean Age	44.02 ± 3.42	

Within-Group Analysis: Within-group comparison of pre- vs post intervention comparison showed that all four groups achieved statistically significant changes for the two outcome measures: DHI and VVAS. However, with the Paired t-test, all adaptation habituation substitution and combined tailored group revealed significant improvements of their DHI scores after six weeks of VR exercise (P<0.05). Also, VVAS scores significantly decreased in all groups with reduced visual vertigo and improvement in functions. These results imply that both types of vestibular rehabilitation exercises were effective in improving quality of life for patients with vestibular disorder. The within-group comparison is summarized in Table 2.

Table 2: Within-Group Comparison of Pre- and Post-Intervention Scores

Group	Pre-DHI (Mean ± SD)	Post-DHI (Mean ± SD)	p-value	Pre-VVAS (Mean ± SD)	Post-VVAS (Mean ± SD)	p-value
Adaptation Group	62.4 ± 5.2	41.3 ± 4.8	<0.05	7.8 ± 1.1	4.9 ± 0.9	<0.05
Habituation Group	60.8 ± 6.1	40.7 ± 5.0	<0.05	7.6 ± 1.2	4.7 ± 1.0	<0.05
Substitution Group	61.2 ± 5.5	42.1 ± 4.9	<0.05	7.7 ± 1.0	5.0 ± 0.8	<0.05
Combined Tailored Group	63.1 ± 4.9	38.2 ± 4.3	<0.05	7.9 ± 1.1	4.2 ± 0.7	<0.05

Between-Group Comparison: One-way ANOVA was conducted for the between-group comparison to identify whether any certain form of exercise had superior in improving outcomes. Although the group in which both types of therapy was tailored showed a greater reduction in DHI and VVAS scores, there was no statistically significant difference between groups after ANOVA testing (p > 0.05). It suggests that all exercise modalities were effective and no one form of exercise was superior to others in the sample selected.

The comparison between the two groups is presented in Table 3.

Table 3: Between-Group Comparison of Mean Improvement Scores (ANOVA Analysis)

Group	Mean DHI Improvement	Mean VVAS Improvement
Adaptation Group	21.1	2.9
Habituation Group	20.1	2.9
Substitution Group	19.1	2.7
Combined Tailored Group	24.9	3.7
ANOVA p-value	>0.05	>0.05

Overall, the results demonstrate that vestibular rehabilitation has a positive impact on patients' quality of life among those with vertigo of vestibular origin, with the combined tailored

approach showing the highest clinical improvement though no superior differences were found between these exercise modalities.

Discussion

The present study evaluated the impact of various vestibular rehabilitation exercise types on quality of life in patients with vertigo of vestibular origin. The results indicated that all four modes of exercise adaptation, habituation, substitution, and combined tailored exercises had significantly improved the DHI and VVAS scores at six weeks. This suggests that VRT, regardless of the exercise used, is efficacious in decreasing dizziness-related disability and increasing functional gain.

Although between-group comparison using ANOVA did not reach statistical significance, the combination of exercise tailored to the individuals had the highest numbers for clinical improvement in DHI and VVAS scores. This implies that a multimodal approach combining several vestibular interventions could be of further functional benefit.

Comparison with Previous Studies: The results of this study are similar to study 1 [13], which observed marked improvement in vertigo symptoms and QoL with well-designed VR. The above-mentioned findings have also been found in various Randomized Control Trials (RCTs) investigating VRT as an efficacious non-pharmacological treatment for vestibular dysfunction.

Preliminary groundwork for graded head and eye movement exercises to encourage vestibular compensation was laid by study 2 [14]. Subsequent trials have confirmed that structured exercise therapy reduces dizziness handicap and improves balance ability. In addition, study 3 [15] examines concomitant betahistine and VRT use have demonstrated that concurrent therapy may bring about greater symptom amelioration and speed up recovery than monotherapy. These results corroborate these findings and suggest that pharmacotherapy with early supervised exercise therapy has a clinically relevant benefit.

Possible Mechanisms: The improvement in all groups may also be attributed to central vestibular compensation, which consists of neuroplastic changes at a central level. Repeated exposure to intentional head and body motion contributes to recalibration of vestibulo-ocular reflex and increased effectiveness of postural control mechanisms. Neuroplasticity helps in adaptation to vestibular deficits by strengthening alternative neural pathways. VOR retraining is the main effect of adaptation exercises, and they work to enhance gaze stability, while habituation exercises work to reduce motion sensitivity through repeated exposure to provocative stimuli. Substitution exercises induce the use of visual and somatosensory cues to compensate for a loss of vestibular information. The combined tailored approach maximizes these mechanisms simultaneously. Moreover, betahistine can improve circulation of the vestibule and help central compensation of vestibular function, which were synergistic effect when combined with rehabilitation exercises.

Clinical Implications: The findings of the present study demonstrate the clinical utility of vestibular rehabilitation as a relatively simple and natural intervention. The exercise protocols were used with a lack of necessity for expensive equipment and high technology, enabling the work to be implemented in resource- limited institutions. An OPD-based rehabilitation program with trained personnel from PM & R personnel is sufficient to achieve significant improvement in quality of life.

This is especially relevant in the developing regions where sophisticated vestibular laboratories are often not available.

Limitations: The overall sample size was very small (n = 40), mainly because of a high rate of loss to follow-up during the second wave of the COVID-19 pandemic. The follow-up period of six weeks is too short a time to assess the long-term sustainability of improvement. Furthermore, subjective measures of vestibular function were not included in the former study and outcomes with respect to VOR performance were limited to reported findings.

Future Recommendations: Larger, multicenter randomized controlled trials with longer follow-up are required to validate these findings in the future. The addition of a formal vestibular testing (e.g., videonystagmography or posturography) would improve the outcome assessment. Comparisons to isolated exercise therapy without pharmacotherapy would provide additional information about the independent contribution of vestibular rehabilitation exercises.

Conclusion

The results of the present study confirm that VRT significantly improves the quality of life in individuals with vertigo of vestibular aetiology. The statistical analyses showed significant improvement in dizziness-related disability and visual vertigo symptoms using DHI and VVAS for all three individual exercise types of adaptation, habituation, and substitution. These data validate that structured vestibular stimulation has an important part to play in optimizing functional recovery and reducing the physical, emotional and functional impact of vestibular dysfunction.

Although no statistically significant differences were found between the groups, the comprehensive tailored exercise intervention showed the most clinical benefit. This implies that a combination of several vestibular rehabilitation techniques could improve global therapeutic results by simultaneously addressing mechanisms of VOR adaptation, motion desensitization, and sensory substitution.

Short-term pharmacotherapy with betahistine before rehabilitation could promote intracortical homeostasis to a greater extent and enhance patient adherence to exercise protocols.

The study highlights that efficacious vestibular rehabilitation can be easily carried out in an OPD without any sophisticated machinery and technical support. A formal program provided by a rehabilitative PM&R team is enough to achieve significant improvements in patient-reported outcomes. Thus, combined pharmacotherapy and subsequently tailored vestibular rehabilitation exercises are a practical, resource-effective and cost-effective approach in treating vertigo in patients with vestibular disorders, especially in resource constrained healthcare system.

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