

Effectiveness of Vestibular Rehabilitation for Diabetic Patients in Improving Balance and Quality of Life

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ABSTRACT

Background: Diabetes is commonly associated with complications such as retinopathy and peripheral neuropathy, which contribute to gait instability and increased fall risk. A less-recognized complication is diabetes-related vestibular dysfunction, which affects balance and spatial orientation. Emerging studies suggest that vestibular dysfunction in diabetic patients may exacerbate the risk of falls. This study investigates the impact of vestibular dysfunction in diabetic patients and evaluates the potential benefits of vestibular rehabilitation in improving balance and quality of life.

Methodology: In this experimental study, 30 diabetic patients with vestibular dysfunction were randomly assigned to two groups: the experimental group received vestibular rehabilitation, while the control group underwent conventional therapy. Pre- and post-treatment assessments were made using the Dizziness Handicap Inventory (DHI), Berg Balance Scale (BBS), and Dynamic Gait Index (DGI). The study aimed to compare improvements in balance and quality of life between the groups after six weeks of intervention.

Results: Both groups showed improvements in balance and quality of life, but the experimental group demonstrated significantly greater improvements in DHI, BBS, and DGI scores compared to the control group. The improvements were attributed to vestibular adaptation and substitution mechanisms.

Conclusion: Vestibular rehabilitation proved effective in improving balance and quality of life in diabetic patients with vestibular dysfunction. The findings support its inclusion as a valuable treatment to reduce falls and enhance postural stability.

KEYWORDS: Diabetes, Vestibular Rehabilitation, DHI, BBS, DGI.

INTRODUCTION

Diabetes is a chronic metabolic condition characterized by elevated blood glucose levels due to the body's inability to produce insulin or resist its action. (1) The prevalence is escalating, especially in low- and moderate-income countries. According to estimates, 347 million individuals had diabetes in 2008; by 2015, India had 69.2 million cases (8.7%), 36 million of which went undiagnosed.

Diabetic neuropathy, a common complication of both type 1 and type 2 diabetes, results from nerve damage caused by prolonged high blood sugar levels, poor circulation, and lifestyle factors like smoking and alcohol use. The symptoms of diabetic neuropathy appear gradually in most cases; the first sign is a feeling of pin and needles in your feet. Other common signs and symptoms of diabetic neuropathy include sensitivity to touch, loss of touch sensation, coordination difficulties, numbness, pain, muscle weakness, digestive issues, excessive sweating, erectile dysfunction, and foot ulcers.

Vestibular dysfunction, which causes dizziness and balance issues, is also common among diabetics. It results from multiorgan changes due to microvascular and macrovascular complications. (2) Peripheral neuropathy and retinopathy are common microvascular complications that contribute to increased postural sway and falls. (3) A recent epidemiological study reported that vestibular dysfunction was 70% more common in people with diabetes, especially those with poor glucose control and longer disease duration. (4)

The vestibular system is responsible for balance and eye movements, which include the inner ear and brain. It processes sensory signals from the eyes, inner ear, and body to maintain equilibrium. The inner ear contains three semicircular canals that detect rotational movements and two structures, the utricle and saccule, that detect head position and acceleration. This balance system is also known as the vestibular system.



This study examines the effectiveness of vestibular rehabilitation (VR) for diabetic patients in improving balance and quality of life. Thirty participants were divided into experimental and control groups, both receiving VR training. The outcomes were measured using the Berg Balance Scale, Dynamic Gait Index, and Dizziness Handicap Inventory.

Vestibular rehabilitation (VR) is an exercise-based therapy designed to address vestibular disorders by improving gaze stability, postural stability, vertigo, and daily activities. Key exercises in VR include head-eye movements, balance training with reduced support, and exposure to different sensory environments, promoting vestibular adaptation and substitution by other systems.

This study aims to assess the effectiveness of vestibular rehabilitation in improving balance and quality of life among diabetic individuals. By measuring outcomes such as balance (through the Berg Balance Scale) and dizziness impact (via the Dizziness Handicap Inventory), the study will explore how VRT may enhance daily function and reduce dizziness in this population. The hypothesis suggests that vestibular rehabilitation will significantly improve balance and quality of life among diabetic patients, while the null hypothesis posits no significant changes

METHODOLOGY

This experimental study was conducted at the Diabetic Clinic, Indira Gandhi Government General Hospital and Post Graduate Institute, Puducherry, with a total sample size of 30 participants—15 in the control group and 15 in the experimental group. Participants were selected through convenient sampling and randomly allocated into groups. The study was carried out over a duration of six weeks. The inclusion criteria comprised diabetic patients of both genders aged between 45 to 75 years, presenting with vestibular symptoms as confirmed by the Dix-Hallpike Test, Roll Test, and Caloric Test. Patients were excluded if they were below 45 or above 75 years of age, or if they had conditions such as cervical radiculopathy, pacemaker implantation, a history of cardiac surgery, malignant tumors, chemotherapy or HIV-related complications, other neurological diagnoses, or were uncooperative. The outcome measures used to evaluate the effectiveness of vestibular rehabilitation included the Dizziness

RESEARCH PROCEDURE

Participants who met the inclusion criteria were selected for the study, and informed consent was obtained after explaining the procedure in detail. They were randomly divided into two groups: Group A received vestibular rehabilitation, while Group B underwent conventional therapy. Pre-intervention assessments were conducted using the Dizziness Handicap Inventory, Berg Balance Scale, and Dynamic Gait Index Score. The intervention was administered four days per week over a period of eight weeks. Post-intervention assessments were conducted using the same tools, and the difference between pre- and post-test scores was analyzed to evaluate the effectiveness of vestibular rehabilitation in improving balance and quality of life among diabetic individuals.

Cawthorne Cooksey Exercises:

The vestibular rehabilitation exercises were structured progressively, starting with movements in bed or sitting, including slow to fast eye movements (up-down, side-to-side) and focusing exercises. This was followed by slow to quick head movements, later with eyes closed, involving forward-backward bending and side-to-side turning. In sitting, participants continued eye and head movements, added shoulder shrugs, and practiced bending to pick up objects. In standing, exercises included transitioning from sitting to standing (with eyes open and closed), ball-handling tasks above eye level and under the knee, and turning while standing. Finally, mobility-based activities were introduced, such as walking across a room, on slopes, and stairs (with eyes open and closed), as well as engaging in games that involve stooping, stretching, and aiming, like bowling and basketball, to enhance dynamic balance and coordination.

Gaze Stabilization Exercises:

Gaze stabilization exercises aim to enhance visual focus on a stationary object while the head is in motion. The exercise involves looking straight ahead at a target, such as a letter "E" held at eye level, and moving the head side to side while maintaining focus. Speed is gradually increased, ensuring the letter remains clear; if dizziness occurs, the speed should be reduced. The exercise should last up to one minute and be repeated three to five times daily. It can also be performed with up-and-down head movements. Progressions include placing the target on a busy background and altering foot positions, starting from sitting to standing, to challenge balance further. A numerical rating scale can help track symptom changes. Repeat 3-5 times daily.

Canalith Repositioning (CRP):

The aim of **Canalith repositioning procedures (CRP)** is to treat people with **benign paroxysmal positional vertigo (BPPV)** by moving particles or otoliths trapped in the posterior semicircular canals in the inner ear (labyrinth) causing dizziness. CRP involves a series of head and upper body movements performed by a trained specialist health professional. The two main CRP treatments are the **Epley maneuver** and the **Semont (Semont Liberatory) maneuver**. Repeat 3 times at night.

Semont Maneuver: This exercise, similar to the Epley maneuver, is used to treat dizziness, particularly from benign paroxysmal positional vertigo (BPPV) affecting the left ear. The individual begins by sitting on the edge of the bed and turning the head 45 degrees to the right. They then quickly lie down on the left side and remain in that position for 30 seconds. Next, without changing head direction, they roll to lie on the right side while keeping the head at a 45-degree angle, facing downward, and stay in this position for another 30 seconds. Afterward, they return slowly to a sitting position and rest for a few minutes. The sequence is reversed for treating dizziness from the right ear.

DATA ANALYSIS & RESULTS

Baseline characteristics of the groups: Table: 1

characteristics	Experimental	control
Total participants	15	15
Age (years) Mean ± SD	56± 7	55± 7
Gender F:M	7:8	9:5
Duration of condition	6 weeks	6 weeks
DHI score	71.4± 6.17	62.1± 8.15
Berg balance score	44.6± 1.80	45.8± 1.47
Dynamic gait index score	16± 2.87	16.8± 18.5

TABLE:2: WITH IN THE GROUP ANALYSIS-BERG BALANCE SCALE

Sl.No	GROUP	ANALYSIS	MEAN ± SD	P-VALUE	WILCOXON VALUE	SIGNIFICANCE
1	A Experimenta l Group	Pre test	44.6±1.80	<0.0001	120	****
		Post test	50.47±1.30			
2	B Control Group	Pre test	45.8±1.47	0.0001	105	***
		Post test	47.2±1.38			

RESULT: The result of this study from the above table 2 indicate that within group analysis of berg balance scale shows extremely significant improvement in group A (p < 0.0001) & (p 0.0001) group B in both the group ie., experimental group and control group.

WITHIN GROUP ANALYSIS OF BERG BALANCE SCALE EXPERIMENTAL & CONTROL GROUP

FIGURE-1

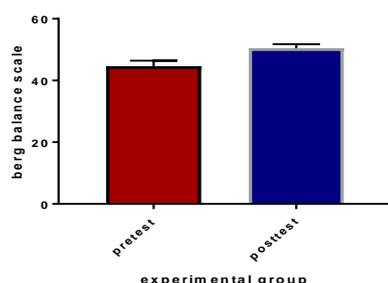


FIGURE-2

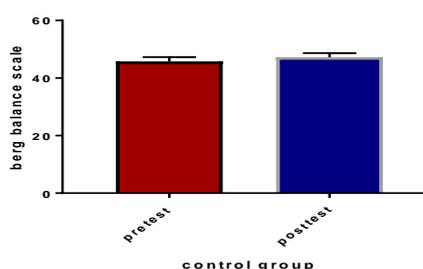


TABLE-3 BETWEEN THE GROUP ANALYSIS-BERG BALANCE SCALE

S.NO	GROUP	ANALYSIS	MEAN ±SD	MANN-WHITNEY U	SIGNIFICANCE
1	Experimental Group	Pre test	44.6±1.80	10	****
		Post test	50.47±1.30		
2	Control group	Pre test	45.8±1.47		
		Post test	47.2±1.38		

RESULT: The result of this study from the above table indicate that, in group analysis of berg balance scale is shows extremely significantly improved ($p < 0.0001$) in the individuals in experimental group and individual in control group.

BETWEEN GROUP ANALYSIS OF BERG BALANCE SCALE
FIGURE-3

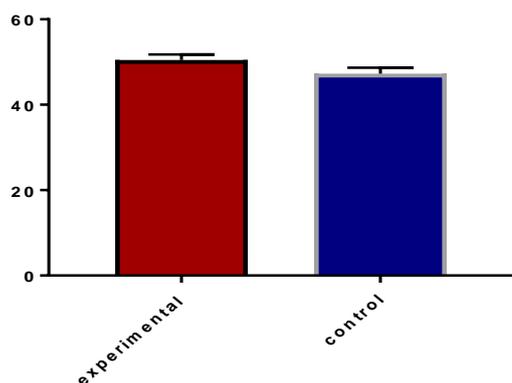


TABLE-4 WITHIN GROUP ANALYSIS OF DYNAMIC GAIT INDEX SCORE

S.NO	GROUP	ANALYSIS	MEAN +SD	P-VALUE	WILCOXON VALUE	SIGNIFICANCE
1	A Experimental	Pre test	16.8±1.74	0.0001	105	***
		Post test	18.53±1.45			
2	B Control	Pre test	16±2.79	<0.0001	120	****
		Post test	20.33±1.39			

RESULT: The result of this study from above the table 4 indicates that within group analysis of dynamic gait index score shows extremely significant improvement Group A ($p < 0.0001$) & group B ($p < 0.0001$) in both the group ie., experimental and control group.

WITHIN GROUP OF ANALYSIS OF DYNAMIC GAIT INDEX SCORE EXPERIMENTAL GROUP & CONTROL GROUP

FIGURE-4

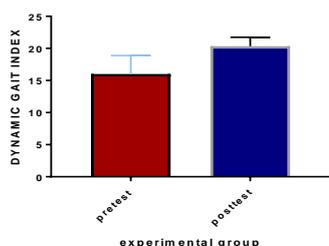


FIGURE-5

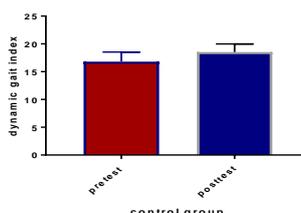


TABLE-5 BETWEEN THE GROUP ANALYSIS- DYNAMIC GAIT INDEX SCORE

SL. NO	GROUP	TEST	MEAN ±SD	P-VALUE	MAAN-WHITNEY U	SIGNIFICANCE
1	Experimental Group	Pre test	16.8±1.74	0.0017	40.5	**
		Post test	18.5±1.45			
2	Control Group	Pre test	16±2.79			
		Post test	20.33±1.39			

RESULT: The result of this study from the above the table indicate that, in group analysis of dynamic gait index score is shows very significantly improved (p-0.0017) in the individuals in experimental group and individual in control group.

BETWEEN GROUP ANALYSIS OF DYNAMIC GAIT INDEX

FIGURE-6

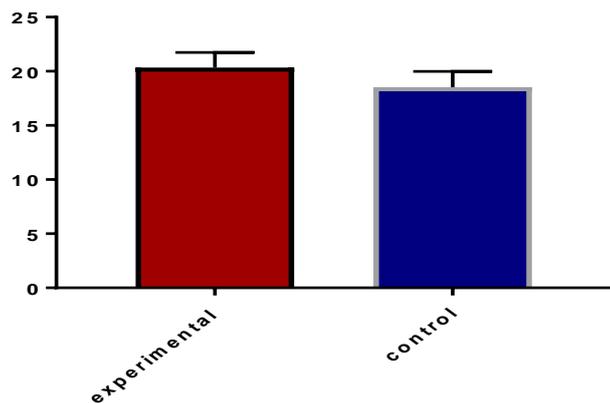


TABLE -6 WITHIN IN GROUP ANALYSIS OF DIZZINESS HANDICAP INVENTORY SCORE

SL.NO	GROUP	ANALYSIS	MEAN ±SD	p VALUE	WILCOXON VALUE	SIGNIFICANCE
1	A Experimental	Pre Test	62.13±8.15	<0.0001	-120	****
		Post Test	52±7.52			
2	B Control	Pre Test	71.47±6.17	0.0002	-91	***
		Post Test	52.67±8.26			

RESULT: The result of this study from the above table 6 indicates that within groups analysis of dizziness handicap inventory score shows significant improvement Group A ($p < 0.0001$) & group B ($p = 0.0002$) in both the group ie experimental and control group.

FIGURE-7

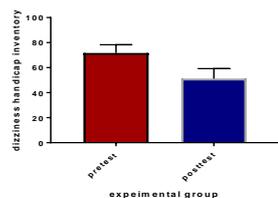


FIGURE-8

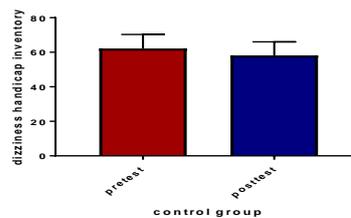


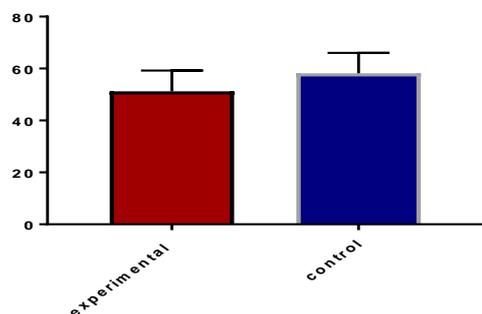
TABLE - 7 BETWEEN THE GROUP ANALYSIS- DIZZINESS HANDICAP INVENTORY EXPERIMENTAL & CONTROL GROUP

SL. NO	GROUP	ANALYSIS	MEAN +SD	P VALUE	MANN-WHITNEY U	SIGNIFICANCE
1	Experimental Group	Pre test	62.13±8.15	0.0481	65	*
		Post test	52±7.52			
2	Control Group	Pre test	71.47±6.17			
		Post test	52.67±8.26			

RESULT: The result of this study from the above table indicate that, in group analysis of dynamic gait index score is shows significantly improved ($p = 0.0481$) in the individuals in experimental group and individual in control group.

BETWEEN GROUP ANALYSIS OF DIZZINESS HANDICAP INVENTORY SCORE

FIGURE-9



RESULT: The results show significant improvements in both groups across all measures. The P-value for the Berg Balance Scale was < 0.0001 for both Group A (experimental) and Group B (control), indicating substantial improvement, with Group A showing a greater change. Similarly, the P-value for the dynamic gait index was < 0.0001 for Group A and 0.0017 for Group B, demonstrating significant improvements in both, again with Group A showing more progress. Finally, the P-value for the Dizziness Handicap Inventory was < 0.0001 for Group A and 0.0002 for Group B, indicating significant improvements in both groups, with a more pronounced improvement in Group A.



DISCUSSION

Diabetes is a known risk factor for vestibular dysfunction, contributing to impaired balance and an increased risk of falls. Several studies have shown that both peripheral and central vestibular structures are affected by diabetes. Morphological changes such as hair cell degeneration and disruptions in the vestibulocochlear nerve have been reported in diabetic animal models (Myers et al., 1987). Additionally, Perez et al. (2001) demonstrated delayed evoked potential responses in diabetic mice, which further suggests impaired vestibular function. These changes lead to reduced sensory feedback from the vestibular system, contributing to difficulties in balance and an increased risk of falls in diabetic individuals.

The present study investigated the effects of vestibular rehabilitation therapy (VRT) in diabetic patients with vestibular dysfunction. The experimental group that received VRT, showed significant improvements in balance and quality of life compared to the control group, which received conventional therapy. These findings are consistent with studies by Deshpande et al., who reported that VRT is effective in improving functional independence and reducing dizziness in patients with balance disorders. The results also align with those of Ricci et al. (2013), who highlighted the role of VRT in stimulating neuroplasticity, thus helping patients recover from vestibular damage.

The improvement observed in the experimental group may be due to the mechanisms of vestibular adaptation and vestibular substitution, both of which are central to vestibular rehabilitation (Cohen et al., 2013). Vestibular adaptation involves readjusting the gain of the vestibulo-ocular reflex (VOR), while vestibular substitution relies on alternative strategies to compensate for the loss of vestibular function. These mechanisms play a significant role in restoring balance, particularly in diabetic patients, who may experience both vestibular and proprioceptive deficits (Cohen-Schwartz et al., 2005).

The findings from Myers et al. (1987) and Yoda et al. (2001) further support the idea that diabetes leads to significant structural changes in the vestibular system. For instance, Yoda et al. (2001) found a higher prevalence of otoconia deposits in the semicircular canals of diabetic individuals, which may contribute to balance problems. Moreover, Degerman et al. (2011) observed that chronic hyperglycemia and insulin resistance can disrupt ion homeostasis in the saccule, further impairing vestibular function. These morphological and physiological changes highlight the complex relationship between diabetes and vestibular dysfunction.

In the current study, both groups (experimental and control) showed improvements in balance, as assessed by the Berg Balance Scale (BBS) and Dynamic Gait Index (DGI). However, the experimental group exhibited greater improvement, suggesting that VRT is a more effective intervention. This is in line with previous studies, such as that by Bressi et al. (2015), which demonstrated that VRT is an effective and low-cost treatment for vestibular disorders. Furthermore, Martellucci et al. found that incorporating regular physical activities post-treatment can help reduce residual dizziness, a factor that may explain the superior outcomes observed in the experimental group.

Vestibular rehabilitation has long been considered a safe and effective treatment for improving balance and quality of life in individuals with vestibular dysfunction (Ricci et al., 2013). In this study, the Cawthorne-Cooksey protocol was used, which is based on repetitive exercises to enhance neuroplasticity and improve balance control. These exercises, which focus on head, eye, and body movements, have been shown to accelerate compensation and adaptation of the vestibular system (Caovilla, 2013).

The findings of this study emphasize the importance of vestibular rehabilitation as a first-line treatment for diabetic patients with vestibular dysfunction. By addressing both the mechanical and functional components of vestibular impairment, VRT provides a comprehensive approach to managing balance disorders. Given its effectiveness, VRT should be considered as an integral part of the therapeutic regimen for diabetic patients at risk of falls and balance-related issues. In conclusion, this study supports the use of VRT as a more effective treatment option than conventional therapy for diabetic patients with vestibular dysfunction.

CONCLUSION

The subjects of this study showed a significant improvement in their quality of life and balance after the vestibular rehabilitation. So, it is concluded that vestibular rehabilitation is effective in improving their quality of life and balance after vestibular rehabilitation training.

LIMITATIONS & RECOMMENDATIONS

The study had certain limitations, including a relatively small sample size, which may affect the generalizability of the results. Additionally, the research was conducted over a short duration, limiting the ability to observe long-term outcomes. Furthermore,

the study focused exclusively on diabetic patients with vestibular system involvement, which restricts its applicability to the broader diabetic population. Future studies can benefit from increasing the sample size and including a wider age range, particularly older populations, to enhance the applicability of the findings. Additionally, assessing the recurrence of symptoms and extending the study duration would provide more comprehensive insights. Further research could also explore the effects of vestibular rehabilitation in patients with diabetic neuropathy to broaden clinical understanding.

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