

Vestibular Disorders and Their Impact on Balance and Mobility

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ABSTRACT

Background: Our sense of balance and spatial orientation is reliant on intricate network of structures in the inner ear called the vestibular system. Any disruption or damage to this system can result in various vestibular disorders that significantly affect an individual's balance and mobility.

Objectives: The study highlighted the impact of vestibular disorders on balance and mobility of the body, its importance of early detection and outcome.

Methods: The research was conducted at Mufti Mehmood Memorial Teaching Hospital, Dera Ismail Khan, from September 2021 to December 2022, comprising 86 participants having trouble in body balance and mobility diagnosed with vestibular disorders. They were investigated through a balance questionnaire including questions about their history of dizziness and falls for 01 year and a balance test through modified Romberg Test.

Results: Mean age of patients was 54.22+10.47 years. It was seen that out of 86 patients, 17 had a history of falling (19.76%), 23 (26.74%) reported experiencing dizziness, 63 (73.26%), 8 (9.3%) patients reported having a history of fainting, while 38 (44.18%) reported mild vertigo, 13 (15.11%) reported moderate vertigo, and 7 (8.13%) reported severe vertigo. The impact of vestibular disorders on balance and mobility measured through Modified Romberg Test revealed that only 15 (17.44%) patients passed Romberg Test and 71 (82.55%) were failed and ranked positive cases for loss of body balance and mobility.

Practical implication: Overall, research on vestibular disorders and their impact on balance and mobility has important practical implications for healthcare providers and patients. Early detection, targeted interventions, education, assistive devices, and a multidisciplinary approach can all help improve balance and mobility and reduce the risk of falls.

Conclusion: Vestibular disorders can have a significant impact on an individual's balance and mobility. The presence of vestibular dysfunction significantly raises chances of falls, which are among the most debilitating and expensive health conditions affecting elderly individuals.

Keywords: Fall injuries; Romberg test; Vertigo; Vestibular dysfunction.

INTRODUCTION

The inner ear houses the vestibular system, responsible for crucial functions necessary for survival. These functions embrace detection of head movement and the orientation of head in relation to gravity. Even though Aristotle did not consider the vestibular system to be one of the fundamental five senses, discovery of vestibular organ during mid-1800s established its role in providing sensory information to brain concerning head movement. For this reason, it has been referred to as the "sixth sense"¹⁻². Vestibular system is a complex network in the inner ear, responsible for our sense of balance as well as spatial orientation. When this system is disrupted or damaged, can cause vestibular disorders bearing significant influence on individual's balance and mobility³.

Dizziness, a recurrently reported symptom is prevalent in approximately 20-30% of overall population. This complaint is particularly common in older adults, and its incidence increases with advancing age. The majority of reported cases (around 85%) are related to problems with the vestibular system, either peripherally or centrally. Other causes of dizziness can be attributed to cardiovascular, psychological, visual, proprioceptive, or neurological factors. Data analysis has revealed that roughly 85% of dizziness cases can be attributed to peripheral origin, resulting from issues with the vestibular system⁴⁻⁵.

Familiar vestibular disorders embrace vestibular neuritis, Benign Paroxysmal Positional Vertigo (BPPV) and Meniere's disease. BPPV is the most common and account for 20-30% of all cases of dizziness and vertigo. It is caused by dislodged small crystals in inner ear and semicircular canals, rendering rotational head movements. This can cause episodes of intense vertigo that can last from seconds to minutes⁶⁻⁸. Meniere's disease is another common vestibular disorder, characterized by episodes of vertigo, tinnitus (humming in the ears), and hearing loss. It results owing to fluid accumulation in the inner ear, influencing the vestibular system functioning⁹. Vestibular neuritis and labyrinthitis are caused by viral infections, leading to inflammation and damage to the vestibular system. They can cause symptoms such as vertigo, dizziness, and difficulty with balance and mobility⁶.

The impact of vestibular disorders on balance and mobility can be significant. Individuals with vestibular disorders may experience symptoms such as dizziness, vertigo, imbalance, and unsteadiness, which can make it difficult to perform everyday activities such as walking, standing, and driving. They may also be at an increased risk of falls and injuries¹⁰⁻¹¹. The management of dizziness and balance problems often involves the implementation of vestibular rehabilitation, which encompasses various interventions such as balance training and compensation following a vestibular lesion. This approach is also employed in the treatment of other causes of vertigo, dizziness, and balance issues. Several original studies have shown that patients with balance problems can benefit significantly from vestibular rehabilitation, with positive outcomes reported¹².

The objectives of this study thus included the impact of vestibular disorders on balance and mobility of the body and highlighting its importance of early detection and treatment of vestibular disorders to prevent complications and improve outcomes.

MATERIAL AND METHODS

This cross-sectional research was conducted at Mufti Mehmood Memorial Teaching Hospital, Dera Ismail Khan, from September 2021 to December 2022. The study comprised 86 patients of different age and sex groups with the history of problem in body balance and mobility diagnosed with vestibular disorders.

Participants were investigated through a balance questionnaire prior to the balance testing, which included questions about their history of dizziness and falls in the past 01 year. To assess the presence of vertigo, dizziness, and falls, standardized questions were asked in face-to-face interviews. If a participant answered affirmatively to the initial question regarding lifetime vertigo, they were subsequently asked about vertigo during past 12 months and falls. Participants who reported moderate or severe vertigo and dizziness in the past 12 months were tested using Head Impulse Test (HIT) to determine the presence or absence of vestibular hypofunction. To estimate the prevalence of vestibular hypofunction in asymptomatic individuals, a random sub-

sample of participants' representative of the general population who reported no vertigo in the past 12 months were also tested. The balance testing involved the modified Romberg Test of Standing Balance on Firm and Compliant Support Surfaces, which consisted of four test conditions designed to assess the sensory inputs contributing to balance, including the vestibular system, vision, and proprioception (Table 1). The fourth test condition was exclusively designed to test vestibular function, where participants had to maintain balance on a foam-padded surface with their eyes closed. Balance testing was scored on a pass or fail basis, with failure defined as needing to open their eyes, moving their arms or feet to achieve stability, or beginning to fall or requiring operator intervention to maintain balance within a 30-second interval. The prevalence of vestibular dysfunction in the population was calculated and categorized.

Inclusion criteria were as follows ^{21,22} : participants aged 18 and above who reported experiencing moderate or severe dizziness, as measured by visual analog scale (VAS). The exclusion criteria were individuals affected by central nervous system diseases, non-vestibular causes of imbalance, degenerative or tumors, acute infection, lower limb anomalies, cervical or suboccipital spine morphological alterations, neuromuscular disease, or trauma that hindered exercising. Additionally, participants taking medication affecting auditory functions were not included in the study.

After obtaining ethical approval from the institution's Ethical Review Board, the study was conducted with the patients being informed of the research procedure and data analysis. The patients were also ensured that their participation was voluntary.

Statistical analysis was conducted using IBM's statistics program for SPSS versions 23.0. Hypothesis testing was performed using a significance level of $p < 0.05$.

Table 1: Modified Romberg Test of Standing Balance

Test condition	Surface	Eyes	Time	Result
1	Firm	Open	30 sec	Normal if person can withstand for 30 seconds, or otherwise result would be positive
2	Firm	Closed	30 sec	
3	Foam	Open	30 sec	
4	Foam	Closed	30 sec	

RESULTS

Our study comprised 86 patients of different age and sex groups with the history of problem in body balance and mobility and was diagnosed with vestibular disorders. The statistical analysis comparing demographic variables among the study patients revealed mean age of patients to be 54.22+10.47 years. The analysis showed that there was a statistically significant association ($p < 0.05$) between gender and outcome being studied (p -value = 0.0068). The other demographic variables analyzed

Table 6: Stratification of patients regarding complaint of vertigo

S. No	Number of patients (n)	Patients with no complaint of vertigo n(%)	Mild vertigo n(%)	Moderate vertigo n(%)	Severe vertigo n(%)	F- value	p-value
1	86	28	38	13	07	49.75	0.00001*

*indicated that the value is significant at $p < 0.05$

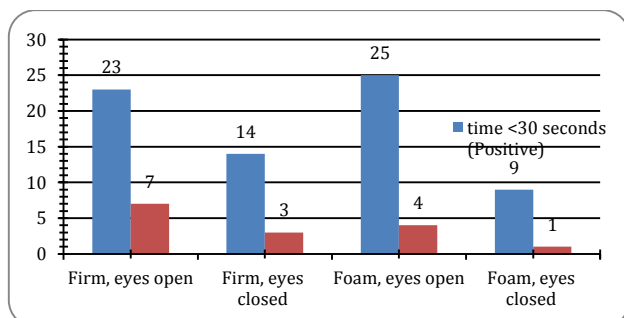


Figure 1: Results of Modified Romberg Test of Standing Balance on Firm and Compliant Support Surfaces

(age, education level, and residence) did not show a statistically significant association with the outcome being studied ($p \geq 0.05$). The education level found that 51 patients (59.30%) were educated and 35 patients (40.69%) were uneducated. Most of the participants belonged to urban population (56.97%) than rural areas (43.02%) (Table 2).

It was seen that out of 86 patients, 17 had a history of falling (19.76%) and 69 did not have a history of falling (80.23%). The chi-square value is 20.606, which is a relatively large value, indicating a strong association ($p < 0.05$) between the history of falls and the outcome being studied (Table 3). Table 4 presented the results of a stratification analysis based on the patients' self-reported dizziness. Our findings suggested that out of the 86 patients, 23 (26.74%) reported experiencing dizziness, while 63 (73.26%) did not report dizziness ($p < 0.05$). The stratification analysis based on the patients' history of fainting was also studied and it was found that out of 86 patients, 8 (9.3%) reported having a history of fainting, while 78 (90.7%) did not report a history of fainting ($p < 0.05$) (Table 5).

Table 2: Demographic data of participants

S. No	Demographic value	Patients data n(%)	Chi-square value	p-value
1	Age (Mean+SD) years	54.22+10.47	-	-
2	Number of patients (n)	86	-	-
3	Education level n(%)		1.636	0.2008
	Educated	51 (59.30)		
	Uneducated	35 (40.69)		
4	Gender n(%)		7.323	0.0068*
	Male	59 (68.60)		
	Female	27 (31.39)		
5	Residence n(%)		0.8565	0.3547
	Urban	49 (56.97)		
	Rural	37 (43.02)		

*indicated that the value is significant at $p < 0.05$

Table 3: Stratification of patients according to the history of fall

S. No	Number of patients (n)	Patients with history of fall n(%)	Patients without history of fall n(%)	Chi-square value	p-value
1	86	17	69	20.606	0.000 01*

*indicated that the value is significant at $p < 0.05$

Table 4: Stratification of patients regarding report of dizziness

S. No	Number of patients (n)	Self-reported dizziness n(%)		Chi-square value	p-value
		Yes	No		
1	86	23	63	11.773	0.00060*

*indicated that the value is significant at $p < 0.05$

Table 5: Stratification of patients regarding consciousness and fainting

S. No	Number of patients (n)	History of fainting n(%)		Chi-square value	p-value
		Yes	No		
1	86	08	78	39.264	0.00001*

*indicated that the value is significant at $p < 0.05$

The stratification analysis based on the patients' complaint of vertigo was critically analyzed and the results of the analysis revealed that out of the 86 patients in the study, 28 (32.56%) did not report any complaint of vertigo, while 38 (44.18%) reported mild vertigo, 13 (15.11%) reported moderate vertigo, and 7 (8.13%) reported severe vertigo. The p-value is less than 0.05 ($p = 0.00001$), which is statistically significant, confirming that the difference between the means is statistically significant (Table 6). Figure 1 revealed that impact of vestibular disorders on balance and mobility measured through Modified Romberg Test of Standing Balance on Firm and Compliant Support Surfaces. Patients were divided into 04 categories i.e. 02 categories of firm and foam surfaces each with open and closed eyes (Table 1). The patients were supposed to stand for 30 seconds in balanced state. The patients who stood for 30 seconds or more were ranked

normal and who failed to do so was termed as positive cases. Only 15 (17.44%) patients passed Romberg Test and 71 (82.55%) were failed and ranked positive cases for loss of body balance and mobility (Figure 1).

DISCUSSION

It was seen that out of the 86 patients, 17 had a history of falling (19.76%), 23 (26.74%) reported experiencing dizziness, 63 (73.26%), 8 (9.3%) patients reported having a history of fainting, while 38 (44.18%) reported mild vertigo, 13 (15.11%) reported moderate vertigo, and 7 (8.13%) reported severe vertigo. The impact of vestibular disorders on balance and mobility measured through Modified Romberg Test revealed that only 15 (17.44%) patients passed Romberg Test and 71 (82.55%) were failed and ranked positive cases for loss of body balance and mobility.

A study discovered that initially, there were no discernible group discrepancies in terms of personal characteristics, clinical attributes, or outcome measures according to a study. Nevertheless, during the first follow-up, significant differences were observed in favor of the intervention in both primary and secondary outcomes. However, during the second follow-up, there were no significant differences between the two groups. The study discovered that the intervention accelerated the recuperation of patients with dizziness and balance problems following a traumatic brain injury, but the advantages had vanished two months after the intervention concluded¹². Another study of the same kind found that a significant number of patients suffering from traumatic brain injury demonstrated positive responses to vestibular rehabilitation within eight weeks. The intricacy of dizziness and balance issues experienced after a traumatic brain injury necessitated interventions that were individually tailored, with many patients requiring a gradual pace of advancement. The various causes of post-traumatic dizziness respond differently to vestibular rehabilitation techniques¹³⁻¹⁴. It was also reported that there was a decrease in vestibular-ocular reflex gain and age-related degeneration of the vestibular system, leading to a prevalence of visual hallucinations in approximately 25% of symptomatic older adults¹⁵⁻¹⁶.

A study strongly supported our findings, which suggested that vertigo was a symptom that specifically arose due to inner ear dysfunction or issues with immediate connections in the brainstem and cerebellum¹⁷. On the other hand, dizziness could result not only from non-acute vestibular disorders but also from various other causes, including metabolic, cardiovascular, or psychiatric disorders, contrary to the traditional view¹⁸⁻²⁰.

CONCLUSION

In conclusion, vestibular disorders can have a significant impact on an individual's balance and mobility. The presence of vestibular dysfunction significantly raises the chances of falls, which are among the most debilitating and expensive health conditions affecting elderly individuals. These findings emphasize the significance of identifying, treating, and potentially screening for vestibular impairments to decrease the impact of fall-related injuries and fatalities. If someone experiences symptoms of dizziness, vertigo, or unsteadiness, he must be properly diagnosed and treated, to manage the symptoms of vestibular disorders, allowing individuals to improve their balance and mobility and maintain their independence.

Conflict Of Interest: None.

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