

A Prospective Study of the Significance of Audio-Vestibular Assessment in Patients with Diabetes Mellitus**Khushbu Rani¹, Ajit Kumar²**¹Assistant Professor, Department of ENT, Radha Devi Jageshwari Memorial Medical College & Hospital, Turki, Muzaffarpur, Bihar.²Senior Resident, Department of ENT, Radha Devi Jageshwari Memorial Medical College & Hospital, Turki, Muzaffarpur, Bihar.

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Conflict of interest: Nil

Abstract

Background: It is estimated that by 2035, the number of Indians affected by diabetes mellitus (DM) will have nearly doubled. Divergent views exist on the audio-vestibular system's involvement due to ongoing study on the microvascular issues associated with it. Thus, this study was carried out to assess the audio-vestibular capabilities in patients with diabetes mellitus and ascertain their association with the course and management of the condition.

Methods: This prospective, cross-sectional study comprised 97 DM patients who underwent clinical evaluation, the Dix-Hallpike maneuver, and investigations such as videonystagmography (VNG) and pure tone audiometry (PTA).

Results: Of the 97 patients, 64 reported sensorineural hearing loss in varied degrees on PTA, and 16 had vestibular hypofunction on the VNG caloric test. When 5 years of DM was used as the cutoff, it was found that the occurrence of bilateral hearing loss and vestibular hypo-functioning were statistically significant (p value 0.028 and <0.001, respectively). After analyzing the symptoms with PTA and VNG, it was shown that there was a strong link between tinnitus and hearing loss (p values of 0.03 and <0.001, respectively) and aberrant findings in both examinations. This suggests that the vestibular dysfunction is subclinical. But no meaningful associations were discovered with DM's glycaemic control.

Conclusion: Larger studies in other populations are required to further confirm the correlation, but it is recommended to consider audio-vestibular evaluation with PTA and VNG as screening tests for long-term DM patients with or without symptoms of giddiness and hearing loss as a step towards early identification of microvascular complications of the inner ear.

Keywords: Diabetes mellitus, hearing loss, vestibular dysfunction, Pure tone audiometry (PTA), Videonystagmography (VNG).

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Introduction

Diabetes mellitus (DM) is a chronic metabolic disorder marked by elevated blood glucose levels. Patients, families, and institutions are deemed to bear a personal, social, and financial burden due to this condition. India is regarded as the global hub for diabetes. [1] Yesudian et al. [2] described the economic cost of diabetes in India. They analyzed 19 research conducted in various regions of the country and predicted that the number of Indians affected by the disease will climb sharply from 65. One million in 2013 to 109 million by 2035, making it a national health concern.

Consequently, DM and its complications have been the subject of an enormous amount of ongoing research. Diabetes-related microvascular and macrovascular problems frequently result in multiorgan anatomical and functional alterations in affected individuals. [3] Recent research suggests that patients

with diabetes may have altered audio-vestibular (AV) systems. [4] It is hypothesized that hearing loss and auditory system failure are caused by microvascular anomalies in complex diabetes mellitus. Nonetheless, the outcome is still unclear because of discrepancies in the research. A small number of studies [5,6] indicated a positive link between DM and hearing loss, while the majority reported no correlation at all. [7-9]

In order to find the morphological evidence of vestibular pathology in long-term experimental diabetes mellitus II, Myers SF, Ross MD performed an animal model study on Sprague-Dawley rats in 1987. [10] The study revealed an increased incidence of secondary lysosomes within the connective tissue cells as well as an accumulation of intracellular lipid droplets that increased with the level of hyperglycemia. Numerous clinical investigations have been

carried out to investigate the connection between vestibular function and diabetes; some relied on questionnaires, while others employed VEMP. [11-12]

Based on a thorough medical history that includes balance issues and a recent history of falls, audio-vestibular (AV) dysfunction in diabetic mellitus (DM) is diagnosed. [13] To validate the condition, videonystagmography (VNG) and pure tone audiometry (PTA) are crucial in addition to the clinical assessment. The most effective method for assessing vestibular impairment is VNG. [14] With the aforementioned context in mind, the current investigation was designed with the goal of determining whether AV dysfunction is present in DM patients and whether screening for it is necessary.

Materials and Methods

The study was an observational, prospective, cross sectional study at Department of ENT, Radha Devi Jageshwari Memorial Medical College and Hospital, Turki, Muzaffarpur, Bihar with 97 patients in the study group. It included all adult patients presenting with diabetes mellitus to Dept. of ENT, both in-patients and out-patients. Patients with middle ear/external ear disease, head injury or trauma to ear, patients on or having history of consumption of ototoxic drugs and patients with cervical radiculopathy were excluded. The

objectives of the study were explained to the participants, following which written informed consent was taken. Institutional ethics committee approval was obtained prior to commencement of the study. Detailed history of these patients regarding the duration of the disease, medications were noted and history of any recent falls or balance disorders or other systemic diseases along with detailed clinical otolaryngology examination which include ear, nose, throat examination and Dix Hallpike maneuver was done. Patients' blood glucose status was established by checking their glycosylated Hemoglobin levels and fasting and post prandial blood glucose levels. All the patients were subjected to Videonystagmography (VNG) and Pure tone audiometry (PTA).

Results

The data were tested for its distribution using the Shapiro–Wilk test of normality using Statistical Package for Social Sciences (version 22.0). The results showed that the data were not normally distributed. Hence, non-parametric tests were used for within- and between-group comparisons. Chi square test was used to check the association between the parameters. $p < 0.05$ was considered significant. Table 1 summarizes the demographic characteristics of participants.

Table1: Demographic characteristics of patients

Patient parameters	Value (%)
Age–Mean (in years)	54.68 (\pm 10.68)
Male	54 (55.67%)
Female	43 (44.33%)
Diabetes Mellitus	
Duration:	
<5 years	77 (79.38%)
>5 years	20 (20.62%)
Diabetes Control :	
HbA1C<7	46 (47.42%)
HbA1C>7	51(52.58%)

On analysing the data, when duration of diabetes mellitus of 5 years was used as a cut off, it was identified that the occurrence of bilateral hearing loss and hypo functioning noted on caloric test of VNG were statistically significant with chi square test (p value 0.028 and <0.001 respectively). On assessing individually as well, there was a significant correlation with duration of diabetes and caloric test performed on right and left ear respectively (p value <0.001 for both ears). The

above details are tabulated in table 2. However, there was no association noted with gaze, saccades and optokinetic nystagmus.

There was no correlation with control of diabetes and hearing loss (bilateral/unilateral). Also, there was no correlation with control of diabetes and videonystagmography- caloric test, gaze, saccades and optokinetic nystagmus.

Table2 : Comparison of symptoms, PTA, VNG results with diabetes duration

Symptoms	Duration of DM				p value
	≤5years	Percentage	>5 years	Percentage	
HEARINGLOSS	19	55.88%	15	44.11%	
TINNITUS	24	68.57%	11	31.43%	
GIDDINESS	38	77.55%	11	22.45%	
PTA					
U/L	7	100%	0	0	0.687
B/L	39	68.42%	18	31.58%	0.028*
NORMAL	31	93.94%	2	6.06%	
VNG(caloric-normal)	71	88.89%	10	11.11%	<0.001*
VNG(caloric-hypo)	6	37.5%	10	62.5%	

*signifies statistically significant values

Table 3 describes the correlation of symptoms with results of PTA and VNG. It shows that the patients who presented with hearing loss and tinnitus had objective hearing loss measured by pure tone audiometry (p value <0.001) than those who presented with giddiness. It was also identified that VNG showed hypofunction in patients who presented with hearing loss or tinnitus without complaints of giddiness (p value <0.001).

Table3 : Correlation of symptoms with investigations

Symptoms (No. of patients)	Investigation				p value
	PTA U/L	PTA B/L	VNG (Caloric-U/L)	VNG (Caloric-B/L)	
HEARINGLOSS(34)	0	32	1	13	<0.001*
TINNITUS(35)	2	27	0	11	0.03*
GIDDINESS(49)	4	30	1	12	0.433

*signifies statistically significant values

Discussion

Several studies have proposed that DM may exacerbate hearing loss and vestibular dysfunction and extensive investigations have been conducted in order to identify the pathophysiology. The proposed mechanisms in AV dysfunctions found in DM are probably an effect of angiopathy, neuropathy or both, as of the anatomic studies in animals conducted by Myers et al (1985 & 1998) and Costa OA (1967).15-17 Microangiopathy of the vascular striae seems to be the major cause as supported by all related studies, mentioned earlier.

The results of the present study of 97 patients reveals mean age of 54.68±10.687 (from 30-77 years) among whom 54 were males. 64 of the 97(66%) DM patients examined had some degree of SNHL, which is consistent with other studies. [5,9,18-20] Tay et al [18] in 1994 reported a higher incidence of hearing loss among DM patients as compared to non-diabetics with a significance of P < 0.001. In a meta-analysis, Akinpelu et al (2014) reported a significant incidence (44-69.7%) in type 2 DM patients. [20] Karkarlapudi et al, in 2003[21] reported a 13.3% of hearing loss in diabetes mellitus patients than the subjects without DM. Among the patients with hearing loss in the present study, 89% had bilateral SNHL indicating that the hearing complications implicated in DM have a bilateral distribution. This result is consistent with similar studies; however, the proportion of the population with bilateral SNHL

was highest in our study in comparison to others. [9,19,21]

The possible factors that influence the worsening of hearing thresholds in diabetics were evaluated. Presbycusis was ruled out by the nature of the audiological curves in PTA, which were mostly involving both the lower and higher frequencies in our patients, whereas in presbycusis, higher frequencies are commonly affected earlier in the process of hearing loss. [22] In correlation studies, we found that the duration of the DM and hearing loss was found to be statistically significant (p<0.001) when 5 year duration was considered as cut off. Some studies support this, by stating that the hearing threshold increases with increase in duration of diabetes, [23,24] while others state no relation between hearing threshold and the duration. [19,25,26]

There was no correlation between the glycemic control and hearing loss. This was in consistency with studies by Cullen R et al [26] and Deviprasad et al. [27] Although it was found to be significant in Type 1 DM patients in a study by Okhovat SA et al [28] and Panchu P. [19] We also observed no gender differences regarding hearing loss. This finding was consistent with other studies, where no gender differences were observed amongst participants, but there are reports of male diabetics having a greater deterioration of hearing as compared to females. [26]

However, relatively few studies have focused on the effects of DM on the vestibular functions. There are clinical studies demonstrating balance disorders in patients with DM [11,29,] which have a positive correlation of vestibular dysfunction with duration and control of DM. In Insulin-dependent-diabetes mellitus patients, Alessandrini et al [30] noted significantly longer saccadic eye movement latency. Nicholson et al [31] observed that both IDDM and NIDDM patients had abnormal gaze-holding, vestibulo-ocular reflex (VOR) and optokinetic nystagmus. Whereas, Di Nardo et al [32] found normal findings in electronystagmography (ENG) in DM (Insulin dependent) patients with and without peripheral neuropathy. Klagenberg et al [33] reported that vestibular assessment was within normal limits in patients with IDDM. Results of the present study have demonstrated that statistically significant alterations were present in VNG in DM patients when considering the caloric test whereas the gaze, saccade, and optokinetic nystagmus were normal. [34]

Another surprise correlation, in the present study was that of the symptoms and the PTA-VNG findings. Even though giddiness was the most common symptom followed by tinnitus and hearing loss, the latter complaints had a statistically significant correlation with positive VNG and PTA findings. This may be attributed to the subclinical vestibular dysfunction in patients who have symptoms of tinnitus and hearing loss. Among 49 patients with giddiness, only 26.53% had positive VNG finding which is like the study by Fonseca AS et al [29] which had 40%. Similar disparity was observed by Klagenberg et al [33] where only 16.6% of total patients had giddiness and 60% of them were positive for VNG.

Conclusion

The statistically significant correlation between hearing loss and vestibular dysfunction in chronic DM patients of more than 5 years duration which is attributed to the microvascular complications of angiopathy in the inner ear makes it worthy to consider audio-vestibular evaluation as a screening tool along with other screening tests regularly used in practice. The subclinical nature of vestibular dysfunction in these patients is notable as it may lead to significantly increased risk of fall. With a projected sharp rise of the DM affected population in the Indian subcontinent, it becomes more important to take remarkable steps to prevent the complications by implementing a regular audio-vestibular evaluation in these patients. However, large scale studies in various populations needs to be conducted to overcome the confusions that exists regarding the correlation.

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