Section: ENT

Original Research Article

AUDIOLOGICAL CHANGES IN PATIENTS SUFFERING FROM TYPE II DIABETES MELLITUS A PROSPECTIVE COMPARATIVE STUDY

Bhagavatula Annapurna Rao[1], Sukumar Sannidhiboina[2], Iytha Sai Mourya[3]

[1]Professor & HOD, Department of ENT, ACSR Government Medical College, Nellore, India
[2]Assistant Professor, Department of ENT, ACSR Government Medical College, Nellore, India
[3]Senior Resident, Department of ENT, ACSR Government Medical College, Nellore, India

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Corresponding Author:
Dr. Iytha Sai Mourya
Email: i.saimourya08@gmail.com

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Abstract

Background: Diabetes is a chronic condition which is becoming very common in both rural and urban India and all over the World. Uncontrolled diabetes frequently results in hyperglycaemia, or elevated blood sugar. The characteristic finding in Diabetes Mellitus is a bilateral symmetrical sensorineural hearing loss (SNHL) particularly in higher frequencies. Further, hearing impairment seems to be dependent upon severity and duration of diabetes. Small blood vessels & nerves in inner ear can be damaged due to prolonged high blood sugar levels. Over time, low blood sugar levels can damage nerve signals that travel from inner ear to brain. This study compares the hearing loss and duration of diabetes mellitus along with comparison between diabetic and non-diabetic patients of same age group. The aim of the study is to study the correlation between the severity of audiological changes and the duration of diabetes mellitus and to compare the occurrence of hearing loss in non-diabetic patients with the diabetic patients. **Materials and Methods:** 50 diabetic and 50 non diabetic patients were selected for a prospective study attending the Department of ENT, Government Medical College and Hospital, Nellore, Andhra Predesh between Feb 2023 to January 2024. Audiometric evaluation was conducted to analyse the hearing status and also HbA1c was performed to identify the diabetic status of the patient. Statistical analysis was done to observe the final outcome. **Result:** Among the 100 patients 48% were males & 52% were females. The overall Male to Female ratio is 0.92: 1. The age of the youngest patient was 31 years and all the patients were below 60 years. From this study it can be concluded that there will be statistically more risk of hearing loss among diabetics than non-diabetics. Major type of hearing loss among diabetics is Sensorineural. **Conclusion:** Most of the diabetics suffered moderate and severe hearing loss compared to non-diabetics where normal hearing & mild hearing loss was more. This finding implies that diabetics are at more risk for hearing loss. Sensorineural hearing loss was present in 60% diabetics, conductive hearing loss in only 4%.

INTRODUCTION

There is an increasing number of persons with diabetes mellitus (DM) due to a variety of factors, such as aging populations, urbanization, and rising rates of obesity and physical inactivity. Calculating the prevalence of diabetes and the total number of people afflicted by the disease both now and in the future is necessary for rational resource allocation and planning. In the 20–70 years age range, type 2 diabetes (T2DM) is a complicated disease that affected approximately 285 million people globally in 2010. By the end of 2030, it is expected to affect 438 million people.[1,2]

The primary causative reasons for hearing loss, tinnitus, and vertigo in diabetic population has been identified as the effects of glycosides, lipids, and metabolic disorders on the vestibular and auditory systems.[3,4] As a result, those with diabetes are more likely to experience hearing issues. While the majority of research found bilateral progressive high-frequency sensorineural hearing loss (SNHL) in diabetic patients, some studies,[5,6] found no effect on hearing in diabetic individuals. In diabetic individuals, one measure of their level of glycaemic control is glycosylated haemoglobin (HbA1C). But

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there isn't any conclusive evidence linking its high concentrations to higher hearing thresholds. Therefore, it is still unclear whether there is concrete proof that having diabetes with poor metabolic control leads to a higher level of SNHL.[7]

Studying the connection between T2DM and hearing loss is important since both conditions are serious health issues. The current study set out to investigate potential relationships between glycaemic control (measured by HbA1C levels) and other diabetes-related variables and the degree of hearing loss among individuals with diabetes. Correlating the audiological results with variables like gender, comorbidities, duration of diabetes, and the existence of additional diabetes complications was the second goal.

MATERIALS AND METHODS

50 diabetic and 50 non diabetic patients were selected for a prospective study attending the Department of ENT, Government Medical College and Hospital, Nellore, Andhra Pradesh between Feb 2023 to January 2024. Audiometric evaluation was conducted to analyse the hearing status and also HbA1c was performed to identify the diabetic status of the patient. Patients were selected using a systematic random sampling technique (every other patient who met the inclusion criteria was chosen) and referred to the Ear, Nose, and Throat (ENT) clinic of our hospital for a hearing assessment.

All investigations were performed in accordance with the Declaration of Helsinki on biomedical studies involving human subjects, and informed consent was obtained from all participants. The study was approved by Institutional Ethics Committee.

Patients who satisfied the following requirements were considered well-controlled: fasting blood sugar (FBS) <130 mg/dl, 2-hour postprandial blood sugar (2hrPPBS)˜180 mg/dl, and HbA1c <7%. Participants in the study were those between the ages of 20 and 60 who had been diagnosed with T2DM based on World Health Organization guidelines and had no prior history of ear illness. In order to eliminate the impact of age-related alterations in hearing status, this investigation was conducted on DM individuals who were below 60 years of age, with age matching between the groups.

History of ototoxic drug intake (gentamycin, quinidine, high dose aspirin, and furosemide) within the previous three months, abnormal otoscopic and tympanometric examinations, heavy smokers (more than one pack per day), occupational noise exposure, severe or uncontrolled diabetes mellitus, heavy alcohol consumption, and neurologic disorders like multiple sclerosis were the exclusion criteria.

Methodology: A complete detailed medical history (retinopathy, nephropathy, neuropathy, angiopathy, diabetic ketoacidosis, and diabetic hyperosmolar coma) was taken. Biochemical tests including postprandial blood sugar (PPBS), triglyceride, FBS, HbA1c, total cholesterol, and low-density lipoprotein were performed on each individual (LDL). An ENT and clinical examination was performed, and a history of otologic conditions, including hearing loss and tinnitus, was obtained. In every case, an audiological examination was conducted to rule out middle-ear diseases, including tympanometry and acoustic reflex. In order to determine the hearing threshold at each frequency, pure tone audiometry (PTA) was measured at 0.25, 0.5, 1, 2, 4, and 8 kHz as well as high-frequency PTA at 10, 12, 14, and 16 kHz using an AC40 clinical audiometer (Madsen, Denmark)[7] in a sound-isolated room that was standardized in accordance with the manufacturer's instructions. Hearing loss was defined as any frequency >20 dB HL at which PTA thresholds were reached. Using one- and two-syllable words of equal stress (Spondees), the speech reception threshold (SRT) and speech discrimination score (SDS) were measured; thresholds greater than 25 dB HL and SDS lower than 75% were deemed abnormal.

The main outcome variable was to profile the PTA findings in diabetic subjects with Non-diabetics. However, there were many variables of interest such as age, gender, glycaemic control (HbA1C level), glycaemic status (FBS and 2hrPPBS), and duration of disease, tinnitus, and vertigo and comorbid disease.

Statistical Analysis

The Statistical Package for Social Sciences (SPSS) version 22 was used for statistical analysis following data collection. The Kolmogorov-Smirnov test was employed to assess the data's normality of distribution. To compare the data in the groups, we employed Chi-square Fisher Exact, and Mann-Whitney tests. We employed multivariable analysis to control the effects of several characteristics, such age and the length of the disease, for example. It was determined that the significance threshold was less than 0.05.

RESULTS

As per [Table 1] the study included 100 subjects with a mean age of 53.74±4.8 years (range, 39–60 years), among whom 52% were female. The participants were divided into two groups according to HbA1c level (diabetic and Non-diabetic). Age distribution and HbA1c level, FBS and 2hrPPBS according to diabetes's status. There is a significant mean difference in HbA1C in comparison to both groups ($p<0.05$) which is also seen in 2hr PPBS (197 vs 269) and it was also statistically significant. Among gender distribution out of 100 total participants (27/50 are diabetic females and 25/50 are non-diabetic).

As per [Table 2] Chi-square and Fisher Exact Tests revealed statistically significant differences in hearing loss at the 9-kHz frequency between non-diabetic and diabetic groups (P=0.02). However, at frequencies of 0.25 and 0.5 kHz in the left ear, two

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patients in the diabetic group and twelve patients in the Non-diabetic group had hearing loss; however, due to the small sample size, this difference cannot be considered significant. According to level of HbA1c, in the diabetic group, hearing loss was more significant at the 8, 9, 10, and 11 kHz frequencies compared with the non-diabetic group (P<0.02).

As per [Table 3] to evaluate the association between hearing loss and existence of other complications related to diabetes (such as diabetic, nephropathy, neuropathy, diabetic foot, for example), patients were divided into two groups: with or without complications. In this study, 57 patients (54.8%) had comorbidities such as hypertension, thyroid dysfunction, and rheumatological diseases, for example; of these 24 (42.6%) were in the well-controlled group and 33 (63.5%) were in the poorly controlled group. No significant difference was observed (P<0.07). Mostly hearing loss was sensorineural hearing loss present in 60% diabetics, conductive hearing loss in only 4%.

Table 1: Comparison of age and markers between Diabetics and Non-Diabetics

Variables	Diabetes's status	Mean	Standard deviation	P-value
Age (year)	Non-Diabetic	54.25	5.85	0.87
	Diabetic	54.06	5.79	
HbA1C (%)	Non-Diabetic	7.03	0.80	0.01*
	Diabetic	9.93	1.03	
FBS (mg/dl)	Non-Diabetic	147.04	26.09	
	Diabetic	165.89	73.29	0.09
2hrPPBS (mg/dl)	Non-Diabetic	197.25	62.54	0.01*
	Diabetic	269.79	92.95	

Table 2: Hearing status in different frequencies according to PTA test in the study groups

Frequency (Hz)	Hearing status		Diabetes status			P-value	
		Non-Diabetic		Diabetic			
		Right ear, No. (%)	Left ear, No. (%)	Right ear, No. (%)	Left ear, No. (%)	Right ear	Left ear
250	Normal	41 (82.7%)	44 (88.5%)	48 (96.2%)	49 (94.2%)	0.02	0.24
	Abnormal	9 (17.3%)	6 (11.5%)	2 (3.8%)	1 (5.8%)		
500	Normal	43 (82.7%)	44 (88.5%)	48 (96.2%)	49 (94.2%)	0.02	0.24
	Abnormal	7 (17.3%)	6 (11.5%)	2 (3.8%)	1 (5.8%)		
1,000	Normal	44 (84.6%)	47 (90.4%)	42 (80.8%)	45 (86.5%)	0.60	0.53
	Abnormal	6 (15.4%)	3 (9.6%)	8 (19.2%)	5 (13.5%)		
2,000	Normal	36 (69.2%)	40 (76.9%)	38 (73.1%)	38 (73.1%)	0.66	0.65
	Abnormal	14 (30.8%)	10(23.1%)	12 (26.9%)	12 (26.9%)		
4,000	Normal	29 (55.8%)	29 (55.8%)	29 (55.8%)	33 (63.5%)	0.99	0.42
	Abnormal	21 (44.2%)	21 (44.2%)	21 (44.2%)	17 (35.5%)		
8,000	Normal	28 (53.8%)	28 (53.8%)	29 (55.8%)	17 (32.7%)	0.84	0.02
	Abnormal	22 (46.2%)	22 (46.2%)	21 (44.2%)	33 (67.3%)		
9,000	Normal	19 (36.5%)	22 (42.3%)	17 (32.7%)	15 (28.8%)	0.08	0.01
	Abnormal	11 (21.2%)	8 (15.4%)	21 (40.4%)	23 (44.2%)		
10,000	Normal	13 (25%)	19 (36.5%)	15 (28.2%)	14 (26.9%)	0.24	0.02
	Abnormal	17 (32.7%)	11 (21.2%)	23 (44.2%)	24 (46.2%)		
11,000	Normal	7 (13.5%)	12 (23.1%)	9 (17.3%)	5 (9.6%)	0.25	0.01
	Abnormal	23 (44.2%)	18 (34.6%)	29 (55.8%)	33 (63.5%)		
12,000	Normal	1 (1.9%)	0 (0%)	1 (1.9%)	2 (3.8%)	0.25	0.10
	Abnormal	29 (55.8%)	30 (57.7%)	37 (71.2%)	36 (69.2%)		

[a]Pure tone audiometric

Table 3: Frequency of diabetic comorbidities according to diabetes status

Comorbidities	Diabetes status			
	Non-diabetic, No. (%)	Diabetic, No. (%)	Total No. (%)	P-value
+	26 (53.8%)	17 (36.5%)	43 (45.2%)	
_	24 (46.2%)	33 (63.5%)	57 (54.8%)	0.07

DISCUSSION

The link between diabetes mellitus (DM) and hearing loss was initially reported, and it continues to be a contentious topic of discussion. A review of the literature reveals that many studies have been published evaluating the impact of diabetes mellitus (DM) on hearing acuity. However, to the best of our knowledge, relatively few studies have evaluated the relationship between hearing loss and glycaemic control status, or have compared a wide range of other variables in patients with poorly controlled and well-controlled diabetes.[7]

These results in the present study showed that high-frequency PTA is more accurate than the usual PTA test for early screening, and it may be helpful for the diagnosis of subclinical cases. Some studies revealed that higher frequencies were affected more in diabetic patients,[8,9] which is consistent with our study. On

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the other hand, other studies have reported that all the frequencies are similarly affected.[10,11]

In the present study at frequencies of 0.25 and 0.5 kHz in the left ear, two patients in the diabetic group and twelve patients in the Non-diabetic group had hearing loss; however, due to the small sample size, this difference cannot be considered significant. According to level of HbA1c, in the diabetic group, hearing loss was more significant at the 8, 9, 10, and 11 kHz frequencies compared with the non-diabetic group ($P<0.02$). When compared to individuals with strong glycaemic control, Panchu et al. observed that the degree of hearing loss at all frequencies demonstrates a positive link with the lack of glycaemic control.[12]

In our study there was no discernible relationship between the state of diabetes management and the occurrence of tinnitus. In line with our research, Gibrin et al. likewise found no statistically significant variations in tinnitus between DM patients and the control group.[13] According to certain writers, DM and hyperinsulinemia can cause secondary vestibulocochlear abnormalities. Small differences in glucose and plasma insulin affect the labyrinth, according to experimental research, and the hair cells and central vestibular system are sensitive to changes brought on by diabetes mellitus.[14,15] According to our research, patients with diabetes problems experienced statistically significant increased hearing loss at frequencies of 8 kHz and 11 kHz in the left ear when compared to patients without issues. Patients with diabetes problems experienced a 42% hearing loss at high frequencies, according to Naini et al,[16] in contrast, patients without issues had normal hearing at all frequencies. According to our findings, patients with and without comorbidities differ significantly at frequencies of 10 and 11 kHz in the right ear and 8 kHz in the left ear. In line with our findings, Swaminathan et al. observed a higher risk of hearing loss in those with high levels of LDL, high triglycerides, and total cholesterol.[17] According to Fukushima et al,[18] these problems in hearing status may be caused by alterations in the cochlea, such as thicker stria-vascularis arteries, atrophy, and loss of outer hair cells without loss of spiral ganglion cells.

CONCLUSION

On performing pure tone audiometry, most of the diabetics suffered moderate and severe hearing loss compared to non-diabetics where normal hearing & mild hearing loss was more. This finding implies that diabetics are at more risk for hearing loss. Sensorineural hearing loss was present in 60% diabetics, conductive hearing loss in only 4%. We also propose more comprehensive and detailed studies with a greater sample size to further clarify these associations.

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