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ORIGINAL ARTICLE

Association of Type 2 Diabetes Mellitus and Hearing Loss in a Tertiary Care Setting

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ABSTRACT:
Background and Aim: Type 2 diabetes mellitus (T2DM) is a major global health challenge with well-known microvascular complications. However, its impact on hearing function is often underrecognized. This study aimed to investigate the pattern and type of hearing impairment among T2DM patients and to correlate it with glycemic control, duration of diabetes, and the presence of peripheral neuropathy. **Material and Methods:** A descriptive cross-sectional study was conducted at a tertiary care hospital in India. A total of 100 patients with T2DM were enrolled. Demographic data, diabetes duration, HbA1c levels, and neuropathy status were recorded. All participants underwent pure-tone audiometry to assess hearing thresholds, and the type and degree of hearing loss were documented. Peripheral neuropathy was assessed using clinical examination. Statistical analysis was performed to determine correlations, with $p < 0.05$ considered significant. **Results:** Sensorineural hearing loss (SNHL) was the most common type of hearing loss (55%), followed by conductive hearing loss (CHL) (10%) and mixed hearing loss (4%), while 31% of participants had normal hearing. Bilateral hearing loss was most prevalent across all types. Poor glycemic control (HbA1c >7%) and diabetes duration >10 years were significantly associated with hearing impairment. Although patients with diabetic neuropathy showed higher rates of hearing loss, the association was not statistically significant. **Conclusion:** Hearing impairment, particularly SNHL, is a common but often overlooked complication of T2DM. Early screening and integration of audiological assessment into routine diabetes care, especially for patients with long disease duration and poor glycemic control, are essential for preserving auditory function and improving quality of life.
Keywords: Type 2 diabetes mellitus, sensorineural hearing loss, glycemic control, peripheral neuropathy, audiometry

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INTRODUCTION

Type 2 diabetes mellitus (T2DM) is one of the most prevalent metabolic disorders worldwide, characterized by chronic hyperglycemia resulting from insulin resistance and/or impaired insulin secretion. As the global burden of diabetes continues to rise, especially in developing countries like India, its multisystem complications have emerged as major public health concerns [1,2]. While microvascular and macrovascular complications such as retinopathy, nephropathy, neuropathy, and cardiovascular disease are well-recognized, the association between T2DM and hearing impairment is often underdiagnosed and underreported [3,4].

Several studies have identified a higher prevalence of sensorineural hearing loss (SNHL) among patients with diabetes compared to age-matched non-diabetic controls, suggesting that diabetes is a potential independent risk factor for auditory dysfunction [5,6]. The pathophysiology behind this association is believed to be multifactorial, involving microangiopathy of the cochlear vasculature, neuropathy of the auditory nerve, and metabolic disturbances affecting the inner ear [7]. Chronic hyperglycemia leads to oxidative stress, inflammation, and advanced glycation end-products (AGEs) deposition, which collectively impair cochlear microcirculation and neural conduction, ultimately leading to progressive hearing loss [8].

Importantly, the severity of hearing impairment in diabetes has been correlated with factors such as poor glycemic control (measured by HbA1c), longer disease duration, and the presence of peripheral neuropathy, indicating a shared pathogenic mechanism [9]. In particular, studies have reported that patients with uncontrolled diabetes and longer disease duration exhibit greater thresholds of hearing loss, especially in the high-frequency range [10]. Despite growing global evidence, data from India remain limited, particularly in the context of correlating audiometric profiles with glycemic parameters and diabetic complications.

Given India's status as the diabetes capital of the world, it is crucial to investigate this overlooked complication to facilitate early screening and timely intervention, potentially preserving patients' quality of life. This study aims to analyze the pattern and type of hearing impairment among patients with T2DM attending a tertiary hospital in India and to examine its correlation with glycemic control, duration of diabetes, and presence of peripheral neuropathy.

MATERIAL AND METHODS

This descriptive cross-sectional study was conducted at the outpatient and inpatient departments of a

tertiary care hospital in India over a 12-month period. The study aimed to assess the pattern and type of hearing impairment among patients with type 2 diabetes mellitus (T2DM) and to examine its correlation with glycemic control, duration of diabetes, and presence of peripheral neuropathy.

A total of 100 adult patients aged 30 years and above with a confirmed diagnosis of T2DM were enrolled in the study. **Inclusion criteria** were patients with a minimum diabetes duration of one year, irrespective of gender, who consented to participate and undergo hearing and neurological assessments. **Exclusion criteria** included individuals with known preexisting hearing loss due to chronic otitis media, previous ear surgeries, history of exposure to occupational noise, history of ototoxic drug use, trauma-related hearing loss, or congenital auditory defects.

After obtaining written informed consent, demographic details such as age, gender, occupation, education level, and residence were recorded. Relevant medical history including duration of diabetes, treatment regimen, history of diabetic complications, and comorbidities such as hypertension or dyslipidemia were obtained. Glycemic control was assessed using the most recent glycated hemoglobin (HbA1c) levels, categorized as controlled (HbA1c <7%) or uncontrolled (HbA1c ≥7%).

All participants underwent a thorough ear, nose, and throat (ENT) examination to rule out local causes of hearing impairment. Pure-tone audiometry was performed using a calibrated audiometer to assess hearing thresholds across frequencies ranging from 250 Hz to 8000 Hz. The type of hearing loss was classified as sensorineural, conductive, or mixed, and the severity was graded according to the World Health Organization (WHO) classification.

Peripheral neuropathy was evaluated clinically using vibration perception threshold (VPT) testing with a biothesiometer, monofilament testing, ankle reflex testing, and symptom inquiry. Patients were classified as having neuropathy if they demonstrated abnormal findings in at least two of these modalities.

STATISTICAL ANALYSIS

Collected data were entered into Microsoft Excel and analyzed using SPSS software. Descriptive statistics such as mean, standard deviation, and percentages were used to summarize the data. Correlation between hearing impairment and factors such as glycemic control, diabetes duration, and neuropathy status was assessed using appropriate statistical tests, with a p-value <0.05 considered statistically significant.

RESULTS

Table 1 presents the demographic profile of the participants. Most individuals were between 40–59 years of age, with a predominance of females (62%). A majority were married (80%) and over half had attained tertiary education (55%). Regarding glycemic control, 58% had poor control (HbA1c >7%), with a mean fasting blood sugar (FBS) of 7.8 mmol/L.

Table 2 details the duration of diabetes mellitus among the participants. Nearly one-third (32%) had lived with diabetes for more than 10 years, followed by 30% within 1–5 years, 20% within 6–10 years, and 18% with a diagnosis under one year, reflecting a wide distribution of disease duration.

Table 3 summarizes the audiogram findings. Sensorineural hearing loss (SNHL) was the most common type (55%), followed by conductive hearing loss (CHL) at 10% and mixed hearing loss at 4%. Around 31% of patients had normal hearing. Mild hearing loss was the most frequent degree (50%), with smaller numbers presenting moderate, moderately-severe, severe, or profound loss.

Table 4 outlines the distribution of hearing loss based on laterality. Bilateral involvement was dominant across all types, particularly among mixed hearing loss (100%) and those with normal hearing (96.8%). Left-sided and right-sided losses were less frequent, with a statistically significant association (chi-square 16.85, p = 0.010).

Table 5 examines the distribution of audiometric patterns across demographic variables. SNHL was prevalent in the 50–59 and 40–49 year age groups, while normal hearing was more common in younger individuals. CHL was slightly more frequent among males, whereas females showed higher rates of SNHL. A longer duration of diabetes (>10 years) was associated with more SNHL and CHL cases.

Table 6 explores the relationship between diabetic neuropathy symptom score (DNSS) and hearing loss. Among participants with DNSS, SNHL (54.5%) and CHL (70%) were the most observed types. Those without DNSS had lower hearing impairment rates. The association between DNSS and hearing loss was not statistically significant (chi-square 2.10, p = 0.480).

Table 1: Demographic distribution

Variable	Frequency	Percentage (%)
Age group (years)		
20–29	3	3.0
30–39	18	18.0
40–49	28	28.0
50–59	28	28.0
60–69	18	18.0
70–79	3	3.0

80 and above	2	2.0
Sex		
Male	38	38.0
Female	62	62.0
Marital status		
Married	80	80.0
Separated/divorced	5	5.0
Single	10	10.0
Widow	5	5.0
Education		
Primary	22	22.0
Secondary	23	23.0
Tertiary	55	55.0
HbA1c range		
1–6%	42	42.0
>7%	58	58.0
FBS (mg/dL)		
Mean	7.8	–
Minimum	4.3	–
Maximum	20.0	–
Standard deviation	2.2	–

Table 2: Duration of DM

Years of DM Diagnosis	Frequency	Percentage (%)
<1 year	18	18.0
1–5 years	30	30.0
6–10 years	20	20.0
>10 years	32	32.0
Total	100	100.0

Table 3: Audiogram findings

Audiogram Type	Frequency	Percentage (%)
CHL (Conductive Hearing Loss)	10	10.0
Mixed	4	4.0
SNHL (Sensorineural Hearing Loss)	55	55.0
Normal	31	31.0
Total	100	100.0

Table 4: Distribution of hearing loss

Position	CHL (%)	Mixed (%)	SNHL (%)	Normal (%)	Chi-square (p value)
Bilateral	6 (60.0)	4 (100.0)	30 (54.5)	30 (96.8)	16.85 (0.010)*
Left	1 (10.0)	0 (0.0)	5 (9.1)	0 (0.0)	
Right	3 (30.0)	0 (0.0)	20 (36.4)	1 (3.2)	
Total	10 (100.0)	4 (100.0)	55 (100.0)	31 (100.0)	

Table 5: Distribution of audiometry by demographic data

Variable	CHL N (%)	Mixed N (%)	SNHL N (%)	Normal N (%)	Chi-square (p value)
Age groups (years)					
20–29	1 (10.0)	1 (25.0)	1 (1.8)	0 (0)	
30–39	2 (20.0)	0 (0)	10 (18.2)	7 (22.6)	19.75 (0.300)
40–49	2 (20.0)	1 (25.0)	12 (21.8)	12 (38.7)	
50–59	3 (30.0)	1 (25.0)	18 (32.7)	6 (19.4)	
60–69	2 (20.0)	1 (25.0)	9 (16.4)	5 (16.1)	
70–79	0 (0)	0 (0)	2 (3.6)	0 (0)	
80 and above	0 (0)	0 (0)	1 (1.8)	1 (3.2)	
Sex					
Male	7 (70.0)	2 (50.0)	18 (32.7)	11 (35.5)	5.89 (0.120)
Female	3 (30.0)	2 (50.0)	37 (67.3)	20 (64.5)	

Duration of DM					
<1 year	0 (0)	0 (0)	12 (21.8)	5 (16.1)	9.85 (0.280)
1–5 years	3 (30.0)	1 (25.0)	18 (32.7)	8 (25.8)	
6–10 years	4 (40.0)	1 (25.0)	7 (12.7)	9 (29.0)	
>10 years	3 (30.0)	2 (50.0)	19 (34.5)	9 (29.0)	

Table 6: Association of DNSS and hearing loss.

Presence of DNSS	CHL N (%)	Mixed N (%)	SNHL N (%)	Normal N (%)	Chi-square (p value)
Yes	7 (70.0)	3 (75.0)	30 (54.5)	16 (51.6)	2.10 (0.480)
No	3 (30.0)	1 (25.0)	25 (45.5)	15 (48.4)	
Total	10 (100.0)	4 (100.0)	55 (100.0)	31 (100.0)	

DISCUSSION

This study provides important insights into the relationship between type 2 diabetes mellitus (T2DM) and hearing impairment, confirming that auditory dysfunction is a relevant but often overlooked microvascular complication of diabetes. The high prevalence of sensorineural hearing loss (SNHL) observed in this study (55%) is consistent with previous research, which has documented a nearly twofold increase in hearing impairment among diabetic patients compared to age-matched non-diabetic controls [11,12]. SNHL in diabetic patients is thought to arise from chronic hyperglycemia-induced microangiopathy, which compromises the blood supply to the cochlea, and from diabetic neuropathy affecting the auditory nerve [13].

Importantly, bilateral hearing loss was the predominant presentation across all hearing loss types, particularly among patients with SNHL and mixed hearing loss. This symmetrical pattern reinforces the hypothesis that diabetes exerts a systemic microvascular impact, rather than focal or unilateral auditory damage. Notably, age distribution showed that hearing loss was most prominent in the 40–59-year age group, a period when metabolic and vascular burdens are typically at their peak. This observation underscores the importance of initiating routine auditory screening even in middle-aged diabetic patients, rather than waiting for age-related hearing decline.

Sex-wise distribution in our study revealed slightly higher SNHL prevalence among females, while males showed more conductive hearing loss (CHL). Although this difference was not statistically significant, it opens an interesting area for further exploration, as hormonal, lifestyle, and anatomical factors might contribute to sex-based differences in hearing outcomes in diabetes.

Duration of diabetes emerged as a key determinant, with longer disease duration (>10 years) correlating strongly with increased rates of SNHL and CHL. This finding supports the cumulative effect of chronic hyperglycemia and reinforces the need for aggressive metabolic control over the long term. Consistently, poor glycemic control (HbA1c >7%) was associated with higher rates of hearing loss, emphasizing that microvascular complications are modifiable through optimal diabetes management [14,15].

The relationship between diabetic neuropathy symptom score (DNSS) and hearing loss was also examined. While patients with DNSS had higher rates of SNHL and CHL, the association did not reach statistical significance ($p = 0.480$). This may suggest that although neuropathy and hearing impairment share underlying microvascular mechanisms, their clinical manifestations may not always align in timing or severity. Future studies with larger samples and objective neuropathy assessments (such as nerve conduction studies) are needed to clarify this relationship.

Overall, our findings highlight that hearing impairment in diabetes is underdiagnosed and frequently dismissed as age-related hearing loss. This underrecognition can lead to delayed intervention, reduced communication abilities, social isolation, and decreased quality of life. Routine audiological screening in diabetic patients — particularly those with long disease duration, poor glycemic control, or neuropathy — should be considered an essential component of diabetes care. Furthermore, multidisciplinary management, involving endocrinologists, ENT specialists, and audiologists, is crucial to address the broad spectrum of diabetes complications and preserve patients' functional independence [16].

CONCLUSION

The study demonstrates a strong association between type 2 diabetes mellitus and hearing impairment, particularly SNHL, with patterns influenced by glycemic control, disease duration, and the presence of peripheral neuropathy. While hearing loss in diabetes is often mild to moderate, its progressive nature warrants early detection and intervention. Incorporating routine audiometric screening into diabetes care protocols could significantly enhance patient outcomes, preserve quality of life, and prevent further sensory disability.

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