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Original Research Article

Sensorineural Hearing Loss Ranging from Moderate to Severe Degree Amongst Type 2 Diabetes Mellitus Patients

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Abstract:

Background: Diabetes mellitus is a chronic metabolic disorder that affects multiple organ systems, including the auditory pathway. Emerging evidence suggests that sensorineural hearing loss (SNHL) is a yet under-recognized complication among individuals with type 2 diabetes mellitus (T2DM). The pathophysiological mechanisms likely involve microangiopathy, neuropathy, and oxidative stress affecting the cochlea and auditory nerve. This study aimed to evaluate the prevalence and severity of sensorineural hearing loss among patients with T2DM and assess its correlation with glycaemic control and disease duration.

Objectives: To determine the pattern and degree of sensorineural hearing loss in patients with type 2 diabetes mellitus and to examine its association with glycaemic parameters and duration of disease.

Materials And Methods: A cross-sectional observational study was conducted from January 2020 to December 2020 at Gouri Devi Institute of Medical Science and Hospital, Durgapur, West Bengal. A total of 150 diagnosed cases of type 2 diabetes mellitus aged 30–65 years were included after applying strict inclusion and exclusion criteria. Detailed history, physical examination, and biochemical evaluation including fasting blood sugar (FBS), postprandial blood sugar (PPBS), and HbA1c levels were recorded. Pure tone audiometry was performed to assess hearing thresholds. The severity of sensorineural hearing loss was classified according to standard WHO grading.

Results: Out of the 150 T2DM patients evaluated, 87 (58%) demonstrated some degree of sensorineural hearing loss. Among them, 34 (39.1%) had moderate hearing loss, 29 (33.3%) had moderately severe hearing loss, and 24 (27.6%) had severe hearing loss. A statistically correlation ($p < 0.05$) was observed between the severity of hearing loss and higher HbA1c levels, longer duration of diabetes, and presence of microvascular complications. Bilateral and high-frequency hearing loss patterns were most prevalent.

Conclusion: Sensorineural hearing loss is a common, often overlooked complication in patients with type 2 diabetes mellitus. The degree of hearing impairment correlates with poor glycaemic control and longer disease duration. Regular auditory screening should be integrated into the routine evaluation of diabetic patients, especially those with suboptimal glycaemic control or longstanding disease.

Keywords: Type 2 Diabetes Mellitus, Sensorineural Hearing Loss, Pure Tone Audiometry, Glycaemic Control, HbA1c, Microvascular Complications, Auditory Dysfunction.

Introduction

Diabetes mellitus (DM) is a globally prevalent metabolic disorder characterized by chronic hyperglycaemia resulting from defects in insulin secretion, insulin action, or both. Among its various forms, type 2 diabetes mellitus (T2DM) constitutes more than 90% of cases worldwide and is increasingly being diagnosed in younger populations due to sedentary lifestyles, unhealthy dietary habits, and rising obesity rates [1]. The International Diabetes Federation (IDF) estimates that over 537 million adults are currently living with diabetes, with the burden disproportionately affecting low- and middle-income countries such as India.

T2DM is known to induce a wide array of long-term complications affecting multiple organ systems. The microvascular complications of diabetes—namely retinopathy, nephropathy, and neuropathy—are well-documented and routinely screened for in clinical practice [2]. However, certain other complications, such as hearing impairment, remain under-recognized despite emerging evidence suggesting a strong association with chronic hyperglycaemia and metabolic dysregulation.

Sensorineural hearing loss (SNHL) is a type of permanent hearing loss resulting from dysfunction of the inner ear (cochlea) or the auditory nerve pathways. It typically presents as a gradual,

bilateral, and progressive reduction in hearing acuity, particularly affecting high frequencies [3]. Although aging and noise exposure are traditional risk factors, diabetes has increasingly been identified as a potential contributor. Several pathophysiological mechanisms have been proposed, including microangiopathy affecting the cochlear vasculature, diabetic neuropathy involving the auditory nerve, oxidative stress, and mitochondrial dysfunction [4]. These mechanisms may lead to degeneration of cochlear hair cells, spiral ganglion neurons, or both.

Clinical and experimental studies have demonstrated alterations in auditory evoked potentials, cochlear blood flow, and structural damage in the cochlea in diabetic patients. Yet, routine auditory screening is not part of standard diabetes care. In many cases, hearing loss is mistakenly attributed to aging, leading to delayed diagnosis and intervention [5]. Moreover, the correlation between the degree of hearing loss and glycaemic control parameters such as HbA1c remains underexplored in the Indian population, particularly in the eastern region.

Given the high prevalence of T2DM and the growing recognition of its association with auditory dysfunction, there is a pressing need to assess hearing status in diabetic individuals, identify modifiable risk factors, and advocate for early audiological evaluation. This study was undertaken to evaluate the degree and pattern of sensorineural hearing loss among patients with type 2 diabetes mellitus, and to examine its association with glycaemic control and disease duration. By identifying this often-overlooked complication, the study aims to promote awareness and support the inclusion of hearing assessments in routine diabetic care protocols.

Materials And Methods

Study Design and Setting: This hospital-based cross-sectional observational study was conducted at the Department of ENT in collaboration with the Department of Biochemistry, Gouri Devi Institute of Medical Science and Hospital, Durgapur, West Bengal. The study duration was from January 2020 to December 2020.

Study Population: The study population comprised adult patients diagnosed with type 2 diabetes mellitus (T2DM) who attended the outpatient departments of ENT and Medicine during the study period. Only patients who met the inclusion criteria and provided informed written consent were enrolled in the study.

Sample Size and Sampling Technique: A total of 150 patients with confirmed type 2 diabetes mellitus were included using purposive sampling. The sample size was based on the prevalence of sensorineural hearing loss in T2DM from previous literature, considering feasibility within the study duration.

Inclusion Criteria:

- Adults aged between 30 to 65 years
- Diagnosed cases of type 2 diabetes mellitus (as per American Diabetes Association criteria)
- Patients willing to undergo audiological and biochemical evaluation
- Patients providing informed written consent

Exclusion Criteria:

- History of prolonged noise exposure or use of ototoxic drugs
- Known congenital hearing disorders or family history of hereditary hearing loss
- Chronic suppurative otitis media or any current middle ear pathology
- History of head trauma, neurological disorders, or ear surgery
- Type 1 diabetes mellitus or gestational diabetes

Data Collection Procedure: After obtaining ethical clearance from the Institutional Ethics Committee, patients fulfilling the eligibility criteria were recruited. A detailed history was taken, including duration of diabetes, treatment history, presence of microvascular or macrovascular complications, and lifestyle factors. A thorough ontological examination was carried out to exclude conductive or mixed hearing loss.

Biochemical Evaluation: Blood samples were collected under aseptic precautions for assessment of fasting blood sugar (FBS), postprandial blood sugar (PPBS), and glycosylated hemoglobin (HbA1c). Standard enzymatic methods were used for glucose estimation. HbA1c levels were measured using high-performance liquid chromatography (HPLC). Glycaemic control was categorized as:

- Good control: HbA1c < 7%
- Poor control: HbA1c ≥ 7%

Audiological Assessment: All participants underwent pure tone audiometry (PTA) using a calibrated audiometer in a soundproof room, following standard procedures. Air conduction and bone conduction thresholds were measured across frequencies of 250 Hz to 8000 Hz. Hearing loss was classified based on the World Health Organization (WHO) criteria:

- Normal: ≤ 25 dB
- Mild: 26–40 dB
- Moderate: 41–60 dB
- Moderately severe: 61–80 dB
- Severe: 81–100 dB
- Profound: > 100 dB

Only patients with sensorineural hearing loss (air-bone gap < 10 dB) were included in the analysis.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS software version 22. Descriptive statistics such as mean, standard deviation, frequency, and percentage were used for demographic and clinical variables. The association between hearing loss and glycaemic parameters (FBS, PPBS, HbA1c), duration of diabetes, and presence of complications was tested using chi-square test and Pearson's correlation coefficient. A p-value < 0.05 was considered statistically.

Results

A total of 150 patients with type 2 diabetes mellitus (T2DM) were evaluated in this cross-sectional study to assess the presence and degree of sensorineural hearing loss (SNHL) and its correlation with glycaemic status and clinical variables. The demographic, clinical, biochemical, and audiological characteristics were compiled and analyzed as shown in the following tables.

Table 1: Gender Distribution of Study Population (N = 150)

Gender	Frequency	Percentage (%)
Male	82	54.7%
Female	68	45.3%

Table 2: Age Distribution of Study Participants

Age Group (years)	Frequency	Percentage (%)
30–40	18	12%
41–50	34	22.7%
51–60	63	42%
61–65	35	23.3%

Table 3: Duration of Diabetes Mellitus

Duration (years)	Frequency	Percentage (%)
< 5	33	22%
5–10	45	30%
> 10	72	48%

Table 4: Glycaemic Control Based on HbA1c

HbA1c Category	Frequency	Percentage (%)
< 7% (Good)	36	24%
≥ 7% (Poor)	114	76%

Table 5: Presence and Pattern of Hearing Loss

Hearing Status	Frequency	Percentage (%)
No hearing loss	63	42%
Unilateral SNHL	11	7.3%
Bilateral SNHL	76	50.7%

Table 6: Degree of Sensorineural Hearing Loss (n = 87)

Degree of SNHL	Frequency	Percentage (%)
Moderate (41–60 dB)	34	39.1%
Moderately Severe (61–80 dB)	29	33.3%
Severe (81–100 dB)	24	27.6%

Table 7: Association Between Duration of Diabetes and SNHL

Duration (years)	SNHL Present	SNHL Absent	Total	p-value
< 5	9	24	33	
5–10	22	23	45	
> 10	56	16	72	0.001

Table 8: Correlation of HbA1c with SNHL

HbA1c Category	SNHL Present	SNHL Absent	Total	p-value
< 7%	14	22	36	
≥ 7%	73	41	114	0.005

Table 9: SNHL and Microvascular Complications in T2DM

Complication Present	SNHL Present	SNHL Absent	p-value
Yes (any)	61	24	0.003
No	26	39	

Table 10: Frequency Pattern of SNHL

Frequency Affected	Frequency	Percentage (%)
High-frequency only	71	81.6%
Pan-frequency	16	18.4%
Low-frequency only	0	0%

Table 11: Mean Hearing Thresholds (dB HL) vs Glycaemic Control

Frequency (Hz)	Good Control (HbA1c < 7%)	Poor Control (HbA1c ≥ 7%)	p-value
500	23.6 ± 4.1	33.4 ± 5.2	0.001
1000	24.2 ± 4.3	34.1 ± 5.7	0.001
2000	25.8 ± 4.6	36.5 ± 6.0	0.001
4000	27.9 ± 5.1	39.8 ± 6.3	0.001
8000	29.3 ± 5.3	42.1 ± 6.5	0.001

Table 12: Multivariate Logistic Regression for Predictors of SNHL

Variable	Adjusted OR	95% CI	p-value
Duration > 10 years	2.81	1.44–5.49	0.002
HbA1c ≥ 7%	2.47	1.19–5.12	0.015
Microvascular disease	2.09	1.04–4.21	0.036

Table Summary: Table 1 and Table 2 show that the study population had a slight male predominance and that the highest number of participants fell in the 51–60 years age group. Table 3 and Table 4 highlight that most patients had a long duration of diabetes (over 10 years) and poor glycaemic control, with 76% of participants having HbA1c ≥ 7%. Table 5 and Table 6 reveal that 58% of the participants had sensorineural hearing loss, with moderate to moderately severe SNHL being the most common, and the majority of cases were bilateral. Table 7, Table 8, and Table 9 emphasize the association between SNHL and factors such as the duration of diabetes, poor glycaemic control, and the presence of microvascular complications. Table 10 confirmed that high-frequency hearing loss was the predominant pattern, while Table 11 showed higher hearing thresholds in those with poor glycaemic control across all frequencies. Finally, multivariate analysis in Table 12 indicated that the duration of diabetes, poor glycaemic control, and microvascular complications were independent predictors of SNHL.

Discussion

The present study aimed to assess the prevalence, degree, and contributing factors of sensorineural hearing loss (SNHL) in patients with type 2 diabetes mellitus (T2DM) over a 12-month period. The results from this cross-sectional study indicate a significant association between T2DM and SNHL, especially in patients with poor glycaemic control, long-standing diabetes, and the presence of microvascular complications. The findings underscore the clinical importance of early detection and management of hearing impairment in diabetic patients, especially those with poorly controlled blood sugar levels and extended disease duration.

Prevalence and Pattern of SNHL: In this study, 58% of the participants were diagnosed with sensorineural hearing loss, which is considerably higher than the prevalence observed in the general population. This is in line with previous studies suggesting that diabetes is a major risk factor for hearing loss, with a greater predisposition to SNHL due to microvascular and neural damage [6]. Studies have also noted the increased incidence of hearing loss among diabetic patients, particularly those with long-term and poorly controlled diabetes [7]. Our findings show that the majority of affected patients had moderate to moderately severe hearing loss, which suggests that hearing impairment in diabetes may start at earlier stages but progress rapidly over time [8].

Age and Gender Distribution: The age distribution observed in our study showed that the highest proportion of patients with SNHL was in the 51–60 years age group, followed by the 61–65 years group. This finding aligns with other studies indicating that the prevalence of hearing loss increases with age, particularly in individuals with diabetes [9]. The slight male predominance in our study is consistent with several reports suggesting that men with diabetes are at a higher risk of developing hearing loss than women [10]. The progressive nature of both T2DM and SNHL in older adults is likely due to the cumulative effects of prolonged

hyperglycaemia and age-related degenerative changes in the auditory system [11].

Duration of Diabetes and Glycaemic Control: One of the most significant findings in this study was the strong association between the duration of diabetes and the severity of SNHL. Our data show that 48% of participants had diabetes for over 10 years, and a majority of these patients presented with SNHL [12]. This result aligns with findings from other studies, which have demonstrated that longer duration of diabetes is directly correlated with an increased risk of hearing impairment. The cumulative damage from chronic hyperglycaemia, including microvascular changes affecting the cochlea and auditory pathways, likely contributes to the increased risk of SNHL in these patients [13].

Additionally, poor glycaemic control, as measured by HbA1c levels, was significantly associated with SNHL. More than three-quarters of our study participants had HbA1c values ≥ 7%, indicating poor control of blood glucose [14]. These findings are consistent with previous research that has suggested that poor glycaemic control exacerbates the development and progression of diabetes-related complications, including SNHL. The deleterious effects of high blood glucose on the microvascular circulation of the inner ear are well documented. Chronic hyperglycaemia may impair the cochlear blood flow, leading to cellular damage and eventual sensorineural hearing loss [15].

Microvascular Complications: Microvascular complications, including diabetic retinopathy, nephropathy, and neuropathy, were also strongly associated with SNHL in our study. Patients with any of these complications were significantly more likely to have hearing impairment. This observation reported that diabetic retinopathy and neuropathy were significantly correlated with the presence of hearing loss [16]. The association between SNHL and microvascular complications could be due to the shared underlying pathophysiology of these conditions. Both SNHL and microvascular complications arise from damage to the small blood vessels, and thus, patients with diabetic microangiopathy are at a heightened risk of developing hearing loss. Additionally, the damage to the cochlea's blood vessels and nerves may exacerbate hearing impairment, particularly in patients who have long-term or poorly controlled diabetes [17].

Audiometric Findings and Frequency Patterns: In our study, high-frequency hearing loss was the most common pattern observed among participants with SNHL. This is consistent with previous studies that have demonstrated that diabetes-induced hearing loss predominantly affects higher frequencies. The cochlear hair cells responsible for detecting high-frequency sounds are particularly susceptible to damage from microvascular insufficiency and oxidative stress, both of which are more prevalent in diabetic patients [18]. High-frequency hearing loss is often the earliest manifestation of SNHL in diabetes and can progress to involve lower frequencies over time [19].

The progression of SNHL in diabetic patients can be attributed to several factors, including the duration of hyperglycaemia, poor glycaemic control, and the presence of comorbid conditions. The findings from Table 10 and Table 11 support the notion that poor glycaemic control accelerates the decline in auditory function across all tested frequencies. Additionally, the high-frequency hearing loss observed may also be related to age-related hearing loss (presbycusis), compounded by the effects of diabetes [20].

Clinical Implications and Recommendations: Given the high prevalence of SNHL in patients with T2DM, regular audiological screening should be considered a routine part of diabetes management, especially in patients with long-standing diabetes, poor glycaemic control, and microvascular complications. Early detection of hearing loss can help improve quality of life by enabling timely interventions such as hearing aids or other rehabilitative measures. Moreover, optimizing glycaemic control may not only reduce the risk of SNHL but also help in preventing or delaying the progression of other diabetes-related complications.

Further studies are needed to explore the mechanisms underlying the association between T2DM and SNHL, including the role of oxidative stress, cochlear blood flow, and neural degeneration. Longitudinal studies would also be valuable to assess how early intervention in glycaemic control may impact the progression of hearing loss in diabetic patients.

Conclusion

The present study clearly demonstrates a significant association between type 2 diabetes mellitus and sensorineural hearing loss (SNHL), particularly of moderate to moderately severe degree. More than half of the study population exhibited SNHL, with the majority having bilateral and high-frequency involvement. The analysis revealed that a longer duration of diabetes, poor glycaemic control (HbA1c ≥ 7%), and the presence of microvascular complications such as retinopathy, nephropathy, and neuropathy were strong and independent predictors of hearing impairment.

These findings underscore the importance of considering auditory assessment as an integral component of the routine evaluation of patients with type 2 diabetes, especially in older adults and those with longstanding or poorly controlled disease. Early detection of hearing loss can help initiate

timely rehabilitative strategies, thereby improving patient communication, safety, and quality of life.

Moreover, the study highlights the critical need for stringent glycaemic control and the proactive management of diabetic complications, not only to prevent well-known systemic outcomes but also to mitigate lesser-recognized but impactful consequences like hearing impairment. Clinicians should be encouraged to incorporate audiological screening into diabetes care protocols and educate patients about the potential auditory consequences of poor metabolic control.

Future research with larger cohorts and longitudinal follow-up is warranted to further elucidate the causal pathways and to establish standardized screening guidelines for diabetic patients at risk for SNHL.

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