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Original Research Article

Assessment of hearing loss in type II diabetes mellitus individuals

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ABSTRACT

Background: Diabetes mellitus is a chronic metabolic disorder associated with multiple microvascular and neuropathic complications. Emerging evidence suggests that diabetes may also affect the auditory system, leading to sensorineural hearing loss. The present study aimed to evaluate the incidence and severity of hearing loss in patients with type 2 diabetes mellitus and to assess its association with disease duration and glycemic control.
Methods: This prospective observational study was conducted in the Department of Otorhinolaryngology at a tertiary care center over a period of 24 months (January 2023–January 2025). A total of 60 subjects were included, comprising 30 patients with type 2 diabetes mellitus of more than five years' duration and 30 age- and sex-matched non-diabetic controls. All participants underwent detailed clinical evaluation and hearing assessment using pure tone audiometry. Hearing loss was classified according to World Health Organization criteria. Statistical analysis was performed using Student's t-test and chi-square test, with $p<0.05$ considered statistically significant.
Results: Hearing loss was more prevalent among diabetic patients compared with controls. High-frequency sensorineural hearing loss was the most common pattern observed. A significant association was found between hearing impairment, longer duration of diabetes, and elevated HbA1c levels.
Conclusions: Type 2 diabetes mellitus is associated with an increased prevalence of sensorineural hearing loss. Longer disease duration and poor glycemic control contribute to greater severity of hearing impairment. Routine audiological screening may facilitate early detection and management.

Keywords: Type 2 diabetes mellitus, Sensorineural hearing loss, Pure tone audiometry, HbA1c

INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder characterized by persistent hyperglycemia resulting from defects in insulin secretion, insulin action, or both.[1] Prolonged hyperglycemia leads to several microvascular and macrovascular complications that affect multiple organ systems. Among these complications, diabetic microangiopathy is one of the most significant pathological findings and is characterized by diffuse thickening of basement membranes in small blood vessels.[2] Microangiopathic changes have been demonstrated in several tissues including retinal capillaries, renal glomeruli, skeletal muscle vasculature, and the inner ear.[3] These vascular alterations may compromise cochlear blood supply and lead to degeneration of the auditory pathway. Histopathological studies have demonstrated degeneration of the stria vascularis, spiral ganglion cells, and cochlear nerve fibers in patients with diabetes.[4] In addition to vascular abnormalities, diabetic neuropathy may also contribute to auditory dysfunction. Structural changes such as Schwann cell injury, myelin degeneration, and axonal damage have been described in peripheral nerves in diabetic individuals, suggesting a similar mechanism may occur within the auditory system.[5] The association between diabetes mellitus and hearing loss has been reported for more than a century. Several studies have suggested that diabetes may be associated with progressive bilateral sensorineural hearing loss (SNHL),

often affecting higher frequencies similar to presbycusis.[6] However, some investigators have reported involvement of low and mid frequencies as well.[7]

Establishing a definite association between diabetes and hearing impairment has been challenging due to the presence of multiple confounding factors such as advancing age, occupational noise exposure, smoking, hypertension, and the use of ototoxic medications.[8] Glycemic control plays an important role in the development of diabetic complications. Glycosylated hemoglobin (HbA1c) is a reliable indicator of long-term glycemic status and reflects the average blood glucose level over the previous three months.[9] Elevated HbA1c levels have been associated with the progression of microvascular complications in diabetes and may also contribute to cochlear damage and hearing impairment.[10] Recent studies have demonstrated that individuals with type 2 diabetes mellitus have a significantly higher prevalence of hearing impairment compared with non-diabetic individuals.[11] Furthermore, the severity of hearing loss has been reported to correlate with the duration of diabetes and the degree of glycemic control.[12] Considering the increasing global prevalence of diabetes mellitus and the potential impact of hearing impairment on quality of life, early identification of auditory dysfunction in diabetic individuals is essential. Therefore, the present prospective study was conducted to evaluate the incidence and severity of hearing loss in patients with type 2 diabetes mellitus diagnosed for more than five years and aged below 60 years, and to compare the findings with age- and sex-matched non-diabetic individuals using pure tone audiometry.

METHODS

A hospital-based randomized control study was conducted in ENT department of Nanavati Max super speciality hospital after obtaining informed and written consent. The study was done on 60 subjects further divided into two groups as diagnosed cases of Type 2 Diabetes mellitus individuals for more than 5 years, under the age of 60 years (30 individuals) and a control group (30 individuals) of similar age and sex with no prior history of Diabetes mellitus.

Study design

A hospital-based observational prospective cohort study was conducted.

Study duration

The study was conducted over a duration of 24 months.

Study period

The study period was from January 2023 to January 2025.

Study site

The study was done at our tertiary care centre in the department of Otorhinolaryngology on attending OPD.

Sample size

The study included a sample size of 60 patients.

Study population

The target population of this study consisted of 60 subjects (outpatients) further divided into two groups as diagnosed cases of type 2 diabetes mellitus individuals for more than 5 years, under the age of 60 years (30 individuals) and a control group (30 individuals) of similar age and sex with no prior history of Diabetes mellitus.

Inclusion criteria

The inclusion criteria for the study were patients aged under 60 years, of either gender, including both males and females, and those who had been diagnosed with type 2 diabetes mellitus for more than 5 years.

Exclusion criteria

Patients who were immunocompromised, such as those diagnosed with retroviral disease, were excluded from the study. Patients with a history of intake of ototoxic drugs, including aminoglycosides, quinine, loop diuretics, cisplatin, erythromycin, and similar agents, were also excluded. In addition, patients with a history of neurological disorders or ear diseases were not included. Patients diagnosed with gestational diabetes and those in the lactational period were excluded, as were patients with a recent history of acute upper respiratory tract infection. Individuals aged more than 60 years and those who did not consent to participate in the study were also excluded.

The study was done at our tertiary care centre in the Department of Otorhinolaryngology after approval from institutional ethical committee. Well informed written consent was taken from all the patients. Detailed history, ENT examination, other necessary systemic examinations and investigations including pure tone audiometry were taken and recorded from all the patient's fulfilling inclusion and exclusion criteria. The focus of this study is to evaluate the incidence of hearing loss in diagnosed type 2 diabetes mellitus individuals (for more than 5 years), under the age of 60 years with the help of pure tone audiometry. All individuals included in the study underwent hearing assessment using Pure tone audiometry. The findings were then noted in the case record form by the investigator of the study.

In the study, hearing loss was classified according to the World Health Organization (WHO) criteria. Normal

hearing was defined as 0–25 dB, mild hearing loss as 26–40 dB, moderate as 41–55 dB, moderately severe as 56–70 dB, severe as 71–90 dB, and profound hearing loss as greater than 90 dB. Diabetes mellitus was defined based on the American Diabetes Association (ADA) Standards of Medical Care in Diabetes (2021). Diagnosis was made if any one of the following criteria was met: fasting plasma glucose (FPG) ≥126 mg/dl (7.0 mmol/l) after at least 8 hours of fasting; or 2-hour plasma glucose (2-h PG) ≥200 mg/dl (11.1 mmol/l) during an oral glucose tolerance test (OGTT) using a 75 g anhydrous glucose load as recommended by WHO; or glycated hemoglobin (HbA1c) ≥6.5% (48 mmol/mol) measured by a NGSP-certified and DCCT-standardized method; or in individuals with classic symptoms of hyperglycemia or hyperglycemic crisis, a random plasma glucose ≥200 mg/dl (11.1 mmol/l).

Statistical analysis

Quantitative data is presented with the help of Mean and Standard deviation. Comparison among the study groups is done with the help of unpaired t test as per results of normality test. Qualitative data is presented with the help of a frequency and percentage table. Association among the study groups is assessed with the help of Fisher test, student 't' test and Chi-Square test. 'P' value less than 0.05 is taken as significant. Pearson's chi-squared test was used, where X^2 represents the Pearson cumulative test statistic, Oi denotes the observed frequency, Ei represents the expected frequency as stated under the null hypothesis, and n refers to the number of cells in the contingency table. Results were graphically represented where deemed necessary. Appropriate statistical software, including but not restricted to MS Excel, SPSS ver. 20 will be used for statistical analysis. Graphical representation will be done in MS Excel 2010. The sample size was calculated using the formula for comparison of two independent means, based on the expected difference in pure tone audiometry thresholds between patients with type 2 diabetes mellitus and age- and sex-matched controls, derived from previously published literature.

Assuming a 95% confidence level, 80% power, and the reported mean difference with corresponding standard deviation, the minimum required sample size was estimated to be 30 subjects per group. The final sample comprised 60 participants (30 cases and 30 controls). Statistical analysis was performed using SPSS software (version XX.0; IBM Corp., Armonk, NY, USA). A hospital-based consecutive sampling method was employed. All eligible patients meeting the inclusion criteria during the study period were enrolled until the desired sample size was obtained.

RESULTS

The study was a hospital-based prospective observational study conducted among 60 individuals who were divided into two groups. The case group included 30 individuals with Type II diabetes mellitus diagnosed for more than five years and aged below 60 years. The control group consisted of 30 age- and sex-matched non-diabetic individuals.

Table 1: Association of hearing loss among cases and controls.

	Cases	Controls
Frequency specific hearing loss		
Higher frequency	16	5
Lower frequency	5	6
No hearing loss	9	19
Chi-square	9.424	P=0.009
Intensity specific hearing loss		
Not significant	9	19
Mild	7	6
Moderate	3	0
Moderately severe	9	4
Profound	1	0
Severe	1	1
Chi-square	9.571	P=0.088

Table 2: Association of duration of DM among cases and controls.

Duration of DM	Cases	Controls
No	0	30
5 to 10 years	13	0
More than 10 years	17	0
Chi-square	60	P<0.05

Significant association was found in duration of DM among cases and controls.

Table 3: Association of HbA1c among cases and controls.

HbA1c	Cases	Controls
Normal	0	30
Less than 8%	10	0
More than 8%	20	0
Chi-square	48.72	P<0.0001

Significant association was found in HBA1C among cases and controls with 10 cases with less than 8% HbA1c and more than 8% HbA1C in 20 cases.

A total of 60 subjects were studied, comprising 30 cases (Type II diabetes mellitus >5 years) and 30 age- and sex-matched controls. A significant association was observed between diabetes and hearing loss, particularly at higher frequencies (χ^2=9.424, p=0.009). Intensity-wise hearing loss was more common among cases, but the association was not statistically significant (χ^2=9.571, p=0.088). Duration of diabetes and HbA1c levels showed highly significant associations with cases (p<0.05 and p<0.0001,

respectively). No significant association was found between hearing loss and diabetic complications (χ^2=2.47, p=0.78).

Table 4: Association between hearing loss and complications.

Intensity specific hearing loss	Complication absent	Complication present
No hearing loss	27	1
Mild	12	1
Moderate	3	0
Moderately severe	11	2
Severe	2	0
Profound	1	0
Chi-square	2.47	P=0.78

No significant association was found between hearing loss and complications.

DISCUSSION

The present hospital-based prospective observational study was conducted to evaluate the incidence and severity of hearing loss among patients with type 2 diabetes mellitus and to compare the findings with age- and sex-matched non-diabetic individuals. A total of 60 subjects were included in the study, comprising 30 diabetic cases and 30 controls. The age of participants ranged from 41 to 59 years. The mean age of individuals in the diabetic and control groups was comparable, thereby minimising the confounding effect of presbycusis. Similar age distributions have been reported in previous studies evaluating hearing impairment in diabetic populations.[13]

In the present study, the gender distribution was similar in both groups, with males slightly outnumbering females. Previous studies have also reported comparable gender distributions among diabetic patients with hearing impairment. Mishra et al observed that the prevalence of sensorineural hearing loss among diabetic patients showed no statistically significant difference between males and females.[14] Similarly, Kumar et al reported a higher proportion of male participants in their study evaluating the association between HbA1c levels and hearing loss in type 2 diabetes mellitus.[15]

Our study demonstrated a higher prevalence of hearing loss among diabetic individuals compared to non-diabetic controls. High-frequency hearing loss was the most commonly observed pattern in diabetic patients. These findings are consistent with earlier studies that have reported progressive bilateral sensorineural hearing loss predominantly affecting higher frequencies in diabetic individuals.[6] The pathophysiology of hearing loss in diabetes is thought to involve microangiopathy and neuropathy affecting the cochlea and auditory nerve. Histopathological studies have demonstrated thickening of capillary basement membranes in the stria vascularis and degeneration of cochlear hair cells in diabetic patients.[4] These microvascular changes may impair cochlear blood supply and result in progressive hearing impairment.

In the present study, mild hearing loss was the most common degree of hearing impairment observed among diabetic patients, followed by moderately severe hearing loss. Similar observations were reported by Al-Rubeaan et al, who observed that mild hearing loss was the most frequent type among patients with type 2 diabetes mellitus.[16] Mishra et al also reported that a majority of diabetic patients exhibited mild to moderate sensorineural hearing loss.[14]

Duration of diabetes mellitus was found to be significantly associated with hearing impairment in the present study. Patients with a longer duration of diabetes demonstrated a higher prevalence of hearing loss. This finding is consistent with previous studies which have shown that prolonged exposure to hyperglycemia increases the risk of microvascular complications, including cochlear damage. Frisina et al reported that long-standing diabetes was associated with greater auditory threshold elevation, particularly at higher frequencies.[17]

Similarly, Jyothi and Malli reported that the prevalence of sensorineural hearing loss was highest among patients with diabetes duration exceeding ten years.[18] The cumulative effect of chronic hyperglycemia on cochlear microvasculature may explain this association.

Glycemic control, assessed using HbA1c levels, also showed a significant association with hearing impairment in the present study. Patients with HbA1c levels greater than 8% demonstrated a higher prevalence of hearing loss. Poor glycemic control is known to accelerate microvascular damage and oxidative stress, which may contribute to cochlear dysfunction. Kumar et al reported a positive correlation between HbA1c levels and the severity of hearing loss in patients with type 2 diabetes mellitus.[15]

Al-Rubeaan et al also observed that poor glycemic control and longer duration of diabetes were among the most important risk factors for hearing loss in diabetic patients.[16]

However, no significant association was observed between hearing loss and other diabetic complications in the present study. This finding may be attributed to the relatively small sample size and the cross-sectional nature of the analysis.

The findings of the present study support the hypothesis that diabetes mellitus contributes to sensorineural hearing impairment through microvascular and neuropathic mechanisms. Early detection of hearing impairment in

diabetic patients may allow timely intervention and improve overall quality of life.

Limitations of the study

This study has certain limitations. First, the sample size was relatively small and was obtained from a single tertiary care center, which may limit the generalizability of the findings to the broader population. Second, the study design was observational without long-term follow-up, which restricts the ability to assess long-term outcomes and recurrence rates. In addition, selection bias may have been present due to the hospital-based sampling technique. Future studies with larger sample sizes, multicenter participation, and longer follow-up periods are recommended to validate and expand upon the findings of the present study.

CONCLUSION

A correlation exists between HbA1c levels, duration of diabetes, and the degree of sensorineural hearing loss. Screening diabetic patients for hearing loss based on the duration of diabetes can aid in early prevention and improve quality of life. Hearing loss in diabetes mellitus warrants regular hearing assessments and appropriate management.

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