

To Study the Effect of Type II Diabetes Mellitus and Its Duration on Hearing

¹Ankit Gulati, ²Vikas Kakkar, ³Sameer Aggarwal, ⁴Chandni Sharma, ⁵Vineet Panchal, ⁶Mohit Pareek, ⁷Surender Bishnoi

ABSTRACT

Objective: This study has been undertaken to study the effect of type II diabetes mellitus (T2DM) and its duration on hearing.

Materials and methods: The present study was conducted on 100 persons of age group 20 to 45 years. All subjects included in the study were divided into two groups. Group I: 50 patients suffering from T2DM (fasting blood sugar \geq 126 mg/dL and postprandial \geq 200 mg/dL) of either sex, in the age group of 20 to 45 years. Group II: 50 healthy volunteers in the age group of 20 to 45 years, of either sex were included in control group. Hearing assessment was done by using pure tone audiometry (PTA).

Results: In diabetic patients, the mean threshold in the PTA was higher at all frequencies as compared with healthy controls, and there was a positive correlation between the duration of diabetes and hearing loss.

Conclusion: Various audiological investigations have revealed that there is a strong association of diabetes with sensorineural part. The prevalence of sensorineural hearing loss (SNHL) in type II diabetics observed was 64%. In the majority of the patients, the hearing loss was bilateral, affecting mid and higher frequencies from 2 to 8 kHz. Hence, to conclude, we can say that the high prevalence of hearing loss in T2DM supports the importance of audiometric evaluation in such patients.

Keywords: Pure tone audiometry, Sensorineural hearing loss, Type II diabetes mellitus.

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INTRODUCTION

Diabetes mellitus (DM) is a syndrome characterized by disordered metabolism and inappropriate hyperglycemia due to either a deficiency of insulin secretion or a combination of insulin resistance and inadequate insulin secretion to compensate. The DM is classified into type I DM and T2DM.¹ The T2DM is the more prevalent form and results from insulin resistance with a defect in compensatory insulin secretion.²

According to the Diabetes Atlas published by the International Diabetes Federation, there were an estimated 40 million persons with diabetes in India in 2007, and this number is predicted to rise to almost 70 million by 2025, by which every fifth diabetic subject in the world would be an Indian.³ Chronic complications associated with DM are microvascular complications, i.e., nephropathy, neuropathy, retinopathy, and macrovascular complications, such as coronary artery disease and peripheral vascular disease.⁴

In DM, the hearing impairment is predominantly bilateral SNHL, mainly affecting high-frequency tones with a gradual onset and progression.⁵ Suggested pathogenesis for this DM-associated SNHL includes cochlear microangiopathy, hyperglycemia of the cerebrospinal fluid or perilymph, auditory neuropathy, and diabetic encephalopathy.⁶ Changes in central auditory and cognitive processing have also been documented in subjects with diabetes.⁷

With this background, the present study was undertaken to study the effect of T2DM on hearing and assess the relationship between hearing impairment and the duration of the disease.

MATERIALS AND METHODS

The present study was conducted in the Department of Otorhinolaryngology in collaboration with the Department of Medicine, Pt. Bhagwat Dayal Sharma Post Graduate Institute of Medical Sciences, Rohtak, India, in 100 persons of age group 20 to 45 years. All subjects included in the study were divided into two groups.

Group I: 50 patients suffering from T2DM (fasting blood sugar \geq 126 mg/dL and postprandial \geq 200 mg/dL) of either sex, in the age group of 20 to 45 years.

Group II: 50 healthy volunteers in the age group of 20 to 45 years of either sex were included in control group.

¹Senior Resident, ²Senior Professor, ³Associate Professor
^{4,5}Assistant Professor, ⁶Junior Resident, ⁷Medical Officer

^{1,5,6}Department of ENT, Adesh Medical College & Hospital
Ambala, Haryana, India

^{2,4}Department of ENT, Pt. Bhagwat Dayal Sharma Post Graduate
Institute of Medical Sciences, Rohtak, Haryana, India

³Department of Medicine, Pt. Bhagwat Dayal Sharma Post
Graduate Institute of Medical Sciences, Rohtak, Haryana, India

⁷Haryana Civil Medical Services, Rohtak, Haryana, India

Corresponding Author: Ankit Gulati, Senior Resident
Department of ENT, Adesh Medical College & Hospital, Ambala
Haryana, India, e-mail: gulati.ankit07@gmail.com

The age of cases and controls was between 20 and 45 years, with most of them between 31 and 35 years. The difference in sex distribution between the two groups was insignificant ($p > 0.05$).

Inclusion Criteria

Patients in the age group of 20 to 45 years having T2DM for more than 1 year.

Exclusion Criteria

- Patients <20 years or >45 years.
- Subjects having conductive hearing loss, otitis externa, and tympanic membrane perforation.
- History of any ear discharge, ototoxic drug intake, impairment of hearing and family history of deafness, meningitis, encephalitis, head injury, and patients having congenital anomalies of auricle or external auditory meatus.

All patients underwent detailed evaluation based on history, general physical examination as well complete ear–nose–throat examination. Pure tone audiometry was done for assessing the effect of T2DM on hearing. An informed consent was taken to participate in the study.

AUDIOLOGICAL ASSESSMENT

The PTA was conducted using ALPS AD 2000 + audiometer to measure the air conduction thresholds at the octave frequencies between 250 and 8,000 Hz with a 10 dB up- and 5 dB downthreshold-seeking procedure. Bone conduction thresholds were measured at 250 to 8,000 Hz using the same procedure.

STATISTICAL ANALYSIS

The data collected in the study were compiled and analyzed by using unpaired and paired students t-test and chi-squared test.

p-value > 0.05 was considered as not significant

p-value < 0.05 was considered as significant

p-value < 0.01 was considered as highly significant (HS)

p-value < 0.001 was considered as very highly significant (VHS)

RESULTS

The difference in hearing threshold at frequency ranging from 500 Hz to 8 kHz of both right and left ears for air conduction between groups I and II was statistically HS ($p < 0.001$). The difference in hearing threshold at frequency ranging from 500 Hz to 8 kHz of both right and left ears for bone conduction between groups I and II was statistically VHS ($p < 0.001$; Table 1).

Table 1: Comparison of hearing threshold intensity at various frequencies of air and bone conduction of right and left ears between groups I and II

Parameter (Hz)	Group I (dB) (Mean \pm SD)	Group II (dB) (Mean \pm SD)	p-value
<i>Air conduction</i>			
250	24.80 \pm 6.1	22.20 \pm 2.29	<0.01
500	24.80 \pm 5.64	20.80 \pm 1.98	<0.001
1,000	24.85 \pm 5.49	20.50 \pm 1.88	<0.001
2,000	28.35 \pm 7.04	20.85 \pm 2.50	<0.001
4,000	34.45 \pm 10.45	22.00 \pm 2.52	<0.001
8,000	36.10 \pm 11.95	22.05 \pm 2.93	<0.001
<i>Bone conduction</i>			
250	17.15 \pm 7.07	12.70 \pm 3.34	<0.01
500	17.70 \pm 6.97	10.80 \pm 2.33	<0.001
1,000	18.35 \pm 6.93	12.60 \pm 3.23	<0.001
2,000	21.05 \pm 7.62	13.10 \pm 3.44	<0.001
4,000	24.75 \pm 9.83	11.80 \pm 2.81	<0.001
8,000	26.35 \pm 10.90	10.80 \pm 2.33	<0.001

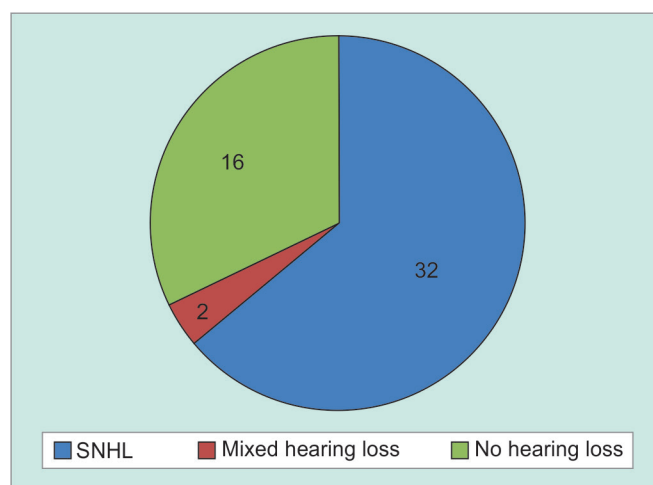
There was mild hearing loss at 2, 4, and 8 kHz frequencies.

Hearing Loss

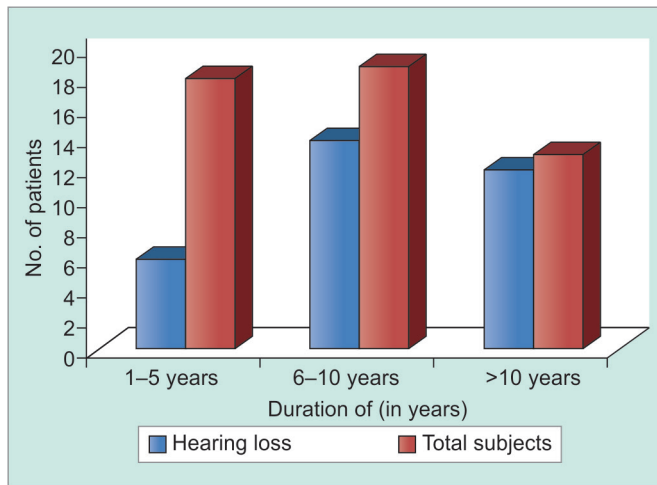
In group I, 32 (64%) subjects had bilateral sensorineural hearing loss with an average air conduction threshold of 31.78 dB in right ear and 31.95 dB in left ear, average bone conduction threshold of 24.75 dB in right ear and 24.76 dB in left ear with average A–B gap 6.5 dB in right ear and 6.4 dB in left ear. Two patients had unilateral mixed hearing loss (4%) while 16 (32%) had no hearing loss, while in group II, no hearing loss was observed (Graph 1).

Sensorineural Hearing Loss and Duration of Diabetes (Group I)

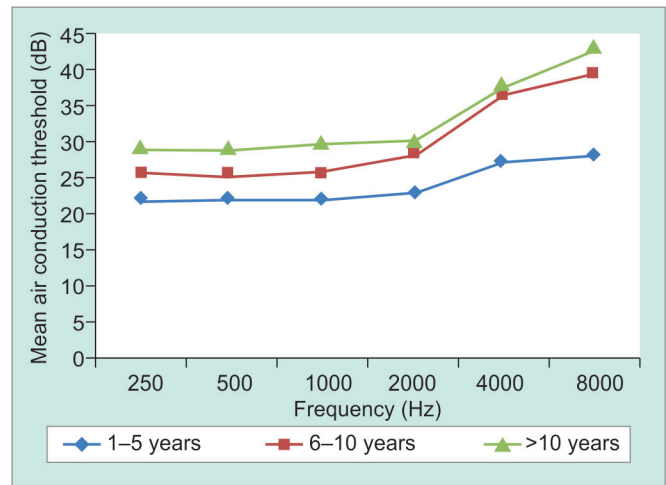
Six patients (33.3%) out of 18 had diabetes for 1 to 5 years, 14 patients (73.7%) out of 19 had diabetes for 6 to 10 years, while 12 patients (92.3%) out of 13 had diabetes for more



Graph 1: Hearing loss in group I



Graph 2: Sensorineural hearing loss and duration of diabetes (group I)



Graph 3: Mean air conduction threshold of right and left ears and duration of diabetes

Table 2: Mean air conduction threshold of right and left ears and duration of diabetes

Frequency (Hz)	Duration		
	1-5 years (dB)	6-10 years (dB)	>10 years (dB)
250	21.6	25.5	28.8
500	21.8	25.1	28.6
1,000	21.8	25.8	29.5
2,000	22.8	27.8	30
4,000	27.1	36.4	37.3
8,000	27.9 dB	39.3 dB	42.6 dB

than 10 years with bilateral SNHL (Graph 2). There was positive and very significant ($p < 0.01$) correlation between SNHL and duration of diabetes.

Mean Air Conduction Threshold of Right and Left Ears and Duration of Diabetes

Mean air conduction threshold at various frequencies increases with increase in the duration of the diabetes showing a positive correlation between duration of diabetes and hearing loss (Table 2 and Graph 3).

DISCUSSION

The relationship between DM and hearing loss is complex and under debate. Since many years it has been supported by the bulk of conflicting literature. The crux about the effect of diabetes on hearing loss lies centered around the cochlea and the neural pathways, which have been studied through the years in relation to age, sex, and duration.

HEARING LOSS IN T2DM

In our study involving 50 subjects of T2DM, the prevalence of hearing loss was found to be 68% out of which 64% had bilateral SNHL while 4% had unilateral mixed hearing

loss. The results approximate to those of Friedman et al⁸ (55%) and Aggarwal et al⁹ (64.86%), while Pani et al¹⁰ reported a higher incidence of hearing loss (80%). There is wide variation of results regarding the prevalence of SNHL in diabetics due to different inclusion and exclusion criteria, methodology, and diagnostic approaches.

Effect of T2DM on PTA

As shown in Table 1, the cases showed gradual increase in hearing threshold starting at 250 Hz and becoming pronounced as the frequency increased, whereas all the controls had normal hearing threshold. Frisina et al¹¹ also observed that with increasing frequency, threshold sound intensity increases in diabetic subjects. The results of our study also support Austin et al⁶ who observed that individuals with T2DM have significantly worse hearing (higher mean pure tone thresholds) than those with no DM across all test frequencies.

Mild hearing loss was observed for frequencies 2, 4, and 8 kHz. The results approximate with that of Pani et al¹⁰ and Tay et al,¹² who also observed hearing loss in mid and high frequencies. In contrast, Kurien et al¹³ and Cullen and Cinnamon¹⁴ observed hearing loss in higher frequencies. Fangcha et al¹⁵ observed hearing loss only at 500 Hz. Salvenelli et al¹⁶ did not find hearing loss in the diabetic subjects. The possible pathophysiological basis for this reduction in auditory acuity may be microangiopathy of the inner ear, neuropathy of the cochlear nerve, or a combination of both. Several studies have attempted to locate the site of any possible pathological processes causing hearing loss in diabetics. Thickened capillaries in the stria vascularis, basilar membrane, and endolymphatic sac were also observed. They also proposed that these changes were responsible for diabetic SNHL.¹⁷ Similar microangiopathic mechanisms were proposed by Kakarlapudi et al¹⁸ and Zelenka and Kozac,¹⁹ who

found SNHL in all the frequencies tested in their diabetic subjects.

Diabetes Duration and Hearing Loss

There was a strong and statistically highly significant ($p < 0.01$) correlation between the duration of diabetes and SNHL in our study where diabetics with more than 10 years of disease were found to be more affected as compared with the younger diabetic age groups. This is supported by the study carried out by Mehra et al,²⁰ Mitchell et al,²¹ and Sunkum and Pingile,²² while contradicting the other studies by Axelsson et al²³ and Pani et al.¹⁰ Prolonged diabetes leads to increased generation of advanced glycation end products, which initiates a metabolic cascade that could disrupt the cochlea and auditory nerve both anatomically and physiologically. This could be a possible reason for increase in hearing threshold with increasing duration of diabetes.

SUMMARY AND CONCLUSION

The DM is an endocrine disorder affecting multiple organ systems, especially the neural component. Various audiological investigations have revealed that there is a strong association of diabetes with the sensorineural part. The prevalence of SNHL in type II diabetics observed was 64%. In the majority of the patients, the hearing loss was bilateral, affecting mid and higher frequencies from 2 to 8 kHz. Hence, to conclude, we can say that the high prevalence of hearing loss in T2DM supports the importance of audiometric evaluation in such patients.

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