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Role of Diabetes Mellitus on Sensorineural Hearing Loss in Patients Attending a Tertiary Care Health Center: A Clinical Audit of Four and a Half Years

ABSTRACT

Objective: The current study aimed to analyze the occurrence of sensorineural hearing loss (SNHL) among diabetes mellitus (DM) patients and to correlate the degree of hearing loss with the duration and type of DM.

Methods: This was a hospital-based retrospective observational study, using data collected from 7382 hearing-impaired patients from January 1, 2016 to July 30, 2020. The data collected were blood glucose levels and hearing thresholds through pure-tone audiometry (PTA). The association between SNHL type/severity and the types of diabetes mellitus (DM) were measured.

Results: Diabetic SNHL was observed in 2786 (37.74%) of the patients. Of the 2786 patients with diabetes, 315 (11.3%) had type 1 DM and 2471 (88.7%) had type 2 DM. According to the PTA readings, SNHL was recorded in 2786 DM patients (37.74%) and 4596 non-diabetic patients (62.25%) ($P < .001$). The mean duration of DM was significantly high in the diabetic patients with SNHL [11.7 ± 7.6 years] than in those without SNHL [7.3 ± 5.4 years] ($P = .001$). The mean fasting blood glucose was higher in the diabetic patients with SNHL than in those without SNHL [175.3 ± 83.3mg/dL vs. 157.7 ± 54.9 mg/dL] ($P = .247$). A lower age at DM onset ($P = .042$) and a longer duration of diabetes were related to a higher severity of SNHL ($P = .007$). The age at onset and the duration of diabetes were associated with SNHL.

Conclusion: The study reveals high prevalence of SNHL in type 2 DM. Diabetes mellitus acts as a more significant initiating and progression factor of hearing loss than other factors. By using PTA, the early detection of hearing loss in type 2 DM may help to avoid the deafness or its further progression.

Keywords: Pure-tone audiometry, sensorineural hearing loss, type 2 diabetes mellitus, vestibulocochlear

INTRODUCTION

Worldwide, 422 million people are affected by diabetes mellitus (DM). Approximately 5% of the population suffers from DM in India.[1,2] The disease's long-term complications can be macrovascular or microvascular in nature. Hearing loss in DM may be bilateral sensorineural.[3] The microvascular complications of DM and diabetic neuropathy affect hearing in the diabetic population.[4,5]

The root cause of sensorineural hearing loss (SNHL) lies in the cochlea and its associated structures, the vestibulocochlear nerve-cranial nerve VIII, or the central auditory processing centers in the brain. While early detection of SNHL may not be possible by conventional audiometry, it can be achieved with high-frequency pure-tone audiometry. Diabetes mellitus is a risk factor for SSNHL, possibly due to microangiopathy. The severity of hearing loss is classified as mild, moderate, severe, and profound. The PTA results are good indicators of hearing impairment, and can differentiate between conductive hearing loss, sensorineural hearing loss, and auditory and mixed hearing loss.

The current study aimed to analyze the occurrence of sensorineural hearing loss among patients with DM and find a correlation between the degree of hearing loss and the duration and type of DM.

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METHODS

This was a hospital-based retrospective observational study. Data was gathered from 7382 hearing-impaired patients from January 1, 2016 to July 30, 2020, for 4 years 7 months.

Setting

The District Hospital and Apollo Institute of Medical Sciences and Research, Chittoor.

History

Otoscopic examination and pure-tone audiometry (PTA) had been performed for all the patients.

Procedure

All the patients in the study, who had come to the OPD of the ENT department, had hearing loss with type II DM,. Data including age, sex, occupation, weight, history of smoking, alcoholism, diabetes, hypertension, and hypothyroidism were noted. Investigations such as hemoglobin level, fasting blood sugar and post prandial blood sugar (FBS/PPBS), and HbA1c were done as routine investigations. The results of these investigations were collected from the IP/OP charts of the patients.

Hearing loss was examined using pure-tone average (PTA). The patients were exposed to pure tones, the intensity of which can be increased/decreased in 5dB steps. The amount of increase in intensity above the normal level is a measure of the degree of hearing loss at that frequency. It is charted in the form of a graph audiogram. The threshold of bone conduction is a measure of cochlear function.

We defined the hearing loss as having a pure-tone average (PTA) > 25dB in the worse ear, at 0.5, 1, 2, and 4 kHz frequencies. The audiometer was so calibrated that the hearing of a normal person, both for air and bone conduction, was at zero dB, and there was no air-bone (A-B) gap. The degree of hearing loss ranged from none to profound, according to the WHO[6] criteria (Table 1), and according to Biswas.[7] The latter is widely used in India.

Independent Variables: Duration of illness, etiological factors.

Outcome Variable: Sensorineural hearing loss.

Statistical Analysis

Statistical analysis were performed using the Statistical Package for the Social Sciences (SPSS) version 22.0 (IBM SPSS Corp.; Armonk, NY, USA). Mean, frequency, percentage, median, and range values were determined with the data analysis. Differences were tested by the analysis of variance, chi-square test, Fisher's exact test, the independent samples *t*-test, logistic regression analysis, and the Mann–Whitney *U*-test. Statistical significance was set at $P < .05$.

RESULTS

Over the duration of the study period (4 years 7 months), there were a total of 7382 cases of deafness recorded among the total OPD population. The mean age was 45.0 ± 9.9 years in the DM group and 45.1 ± 9.8 years in the healthy controls ($P = .990$), in the age range of 40–60 years. In both the DM and control groups 4710 individuals (63.8%) were female and 2672 individuals (36.2%) were male ($P = .95$).

Of the 7382 hearing-impaired patients, 2786 (37.74%) had diabetes. Of the 2786 patients with diabetes, 315 (11.3%) had type 1 DM and 2471 (88.7%) had type 2 DM.

Based on the PTA readings, SNHL was identified in 2786 DM patients (37.74%) and 4596 non-diabetic patients (62.25%) ($P < .001$). The odds ratio of DM for the presence of SNHL was 3.5 (95% CI, 1.6-6.6, $P < .001$). However, the type of involvement (one-sided or two-sided) and the severity of SNHL were not related to the presence of DM ($P = .771$ and $P = .644$ respectively).

The mean age of DM patients with SNHL was 47.7 ± 8.07 years and in diabetic patients without SNHL was 42.3 ± 10.12 years. There was statistically significant association between SNHL and the age in DM patients ($P < .05$). However, the type and severity of SNHL were not related to the patient's age ($P = .804$ and $P = .217$, respectively).

The mean duration of diabetes was significantly longer in the SNHL patients with DM (11.7± 7.6 years) than in those without DM (7.3 ± 5.4 years) ($P = .001$). However, the age at onset of DM and fasting blood glucose level were not associated with the

Table 1. WHO Grading of Hearing Impairment as Modified in 1991

Grades of Impairment	Audiometric ISO Values (500, 1000, 2000, 4000 Hz)	Impairment Description	Number of Patients With Hearing Loss	40-50 years	50-60 years
No impairment	≤25 dB HL	No or very slight hearing problems. Able to hear whispers	189	110	79
Slight impairment	26-40 dB HL	Able to hear and repeat words spoken in normal voice at 1 m distance	995	457	538
Moderate impairment	41-60 dB HL	Able to hear and repeat words using raised voice at 1 m distance	1023	396	627
Severe impairment	61-80 dB HL	Able to hear some words when shouted into better ear	480	159	321
Profound impairment	≥80 dB HL	Unable to hear and understand even with shouting	99	30	69
Total			2786	1152	1634

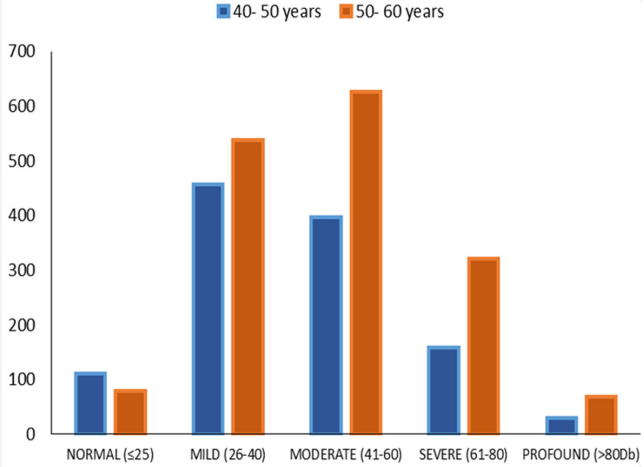

Figure 1. Frequency based on pure-tone audiometry.

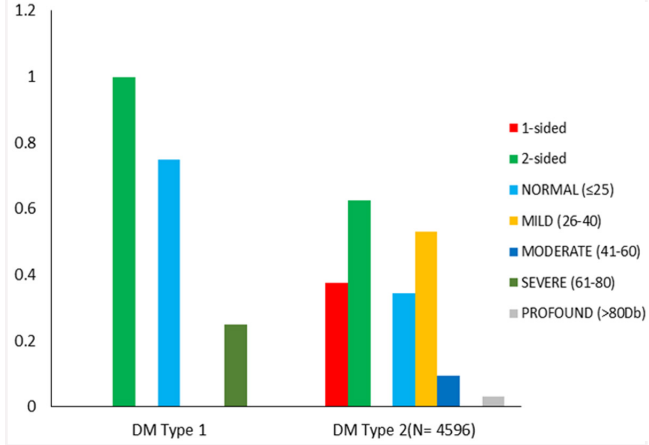

Figure 2. Association of sensorineural hearing loss (SNHL) type and severity with diabetes mellitus type.

presence of SNHL (Figure 1). The mean FBS levels were higher in DM patients with SNHL than DM patients without SNHL (175.3± 83.3 mg/dL vs. 157.7± 54.9 mg/dL), though there was no statistical significance ($P = .247$). The FBS level was not significantly related to the severity of SNHL, but a lower age at diabetes onset and a longer duration of diabetes were related to higher severity of SNHL ($P = .042$ and $P = .007$, respectively) (Table 2) (Figure 2).

The type and severity of SNHL were not associated with glycemic control in the diabetic patients (Table 2). The SNHL frequency, severity, or type also showed no significant association with the presence of DM complications. SNHL severity was related to the type of DM; with 25% of type 1 DM patients with SNHL had grade 5 SNHL, compared with 0% of the type 2 DM subject with SNHL ($P = .032$) (Table 3).

DISCUSSION

In this study, the SNHL rate was compared both in the DM and healthy groups. The findings showed the relationship between

Table 3. Association of Sensorineural Hearing Loss (SNHL) Type and Severity with Diabetes Mellitus Types

Variables	Type 1 DM	Type 2 DM
	N (%)	*N* (%)
SNHL type		
One-sided	0	926 (37.47)
Two-sided	315 (100)	1545 (62.5)
	$P = .278$	
SNHL severity		
1	236 (74.9)	850 (34.4)
2	0	1312 (53.1)
3	0	232 (9.38)
4	79 (25.07)	0
5	0	78 (3.15)
	$P = .032$	

Table 2. Comparison of Sensorineural Hearing Loss Type and Severity Between Diabetic Patients and Non-Diabetic Healthy Controls. Association of Sensorineural Hearing Loss Type and Severity With Diabetes Mellitus-Related Characteristics Among Patients With DM

Variable	Non-diabetic Patients ($N = 4596$)	No. of Diabetic Patients ($N = 2786$)	DM Duration (Years) Mean ± SD	Age at Onset (Years) Mean (SD)	Fasting Blood Glucose Level (mg/dL) Mean (SD)
SNHL type	*N* (%)	*N* (%)			
One-sided	1723 (37.5)	928 (33.3)	9.3 ± 6.6	39.3 ± 11.2	161.7 ± 56.2
Two-sided	2873 (62.5)	1858 (66.7)	12.9 ± 7.9	33.8 ± 10.4	182.1 ± 85.3
			$P = .064$	$P = .203$	$P = .343$
SNHL severity	*N* (%)	*N* (%)			
Normal (≤25)	2588 (56.3)	189 (6.78)	10.1 ± 7.1	35.1 ± 8.4	169.1 ± 78.4
Mild (26-40)	1724 (37.51)	995 (35.71)	10.7 ± 7.2	39.0 ± 11.1	173.9 ± 60.2
Moderate (41-60)	284 (18.7)	1023 (36.71)	20.1 ± 12.9	29.3 ± 6.2	227.3 ± 97.2
Severe (61-80)	0	480 (17.27)	19.0 ± 15.2	16.0 ± 4.5	115.0 ± 55.2
Profound (>80)	0	99 (3.55)	12.5 ± 11.2	38.0 ± 19	190.0 ± 40.5
			$P = .007$	$P = .042$	$P = .496$

the various aspects of SNHL and DM. These results were similar to the study reported by Kakarlapudi et al.[8]

The prevalence of the diabetic SNHL population was 37.74% of a total of 7382 patients with hearing loss. Malucelli et al.[9] found the prevalence to be 76%, Rajendran et al.[10] as 73.3% and Krishnappa and Naseeruddin found the prevalence of SNHL among type-2 diabetic patients to be 73%.[11]

DM does not show significant correlation with SNHL severity. Hence, it is suggested that DM only acts as an initiating and progression factor in hearing loss, than other effects.

Both FBS and glycemic control were not associated with the incidence or severity of SNHL. The FBS levels were higher in diabetic patients with SNHL (175.3 vs. 157.7 mg/dL), and the proportion with SNHL was higher among patients with uncontrolled DM (55.9% vs. 44.1%). These differences were not statistically significant. This demonstrates that glucose metabolism may not be the most important issue for the development of SNHL, and perhaps only acts as an aggravating factor.

Despite the small number of patients with type 1 DM in the current study, there was a significantly high proportion of these patients with a severe grade of SNHL, than of patients with type 2 DM and SNHL. However, there was no significant correlation between the type of DM and the presence of SNHL.

The previous studies carried out involved patients across all age groups, whereas the current study was performed only in subjects aged >40 years. Sakuta et al.[12] reported a statistically significant higher prevalence of hearing loss among diabetic and non-diabetic middle aged men (60.2% and 45.2% respectively). Dalton et al.[13] showed a higher incidence of hearing loss among diabetic subjects compared with a control group, but they reported null significant association between hearing loss and DM type 2.

We found that age of onset and duration of DM were associated with the occurrence of SNHL. Therefore, the role of DM progression and aging should be considered more carefully.[8,14] In our study, the age of diabetic patients was associated with the severity of SNHL ($P = .042$), suggesting that aging is a factor in SNHL patients with DM, and that the role of disease progression should be investigated more precisely. The patients' sex was matched with controls in our study to diminish its confounding role. All these factors allowed us to eliminate some possible confounding factors in the role of DM in SNHL development.

Since many people worldwide are living in communities with a high rate of undiagnosed DM, and since hearing loss can be considered to be a consequence of diabetes, a metabolic assessment may be useful to the patients with hearing loss.[15] On the other hand, routine screening for hearing loss in diabetic patients may also be helpful to diminish comorbidities among these patients, with a consequent improvement in their quality of life.

CONCLUSION

It is confirmed that there is a high prevalence of SNHL in type-2 DM. Diabetes mellitus is an independent risk factor for hearing loss, apart from age and smoking. Diabetes mellitus pays a greater role as an initiating and progression factor of hearing loss, than other factors. Determining the cause of SNHL in diabetic patients may lead to the development of better treatment options. The early detection of hearing loss in type 2 diabetes mellitus, using PTA, may help to avoid deafness and its further progression.

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