Original Research Article

Impact of glycemic control and duration on hearing impairment in diabetics

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Abstract

Background: Diabetes mellitus is a non-communicable chronic disease with numerous complications, hearing impairment is one of the less known complications. The biggest impact of the disease is on adults of working age. The present study is planned to evaluate hearing loss in subjects with type 2 diabetes mellitus (controlled and uncontrolled) and the resulting audiometric pattern in the present population. **Material and method:** This was a prospective observational study done for 2 years (2015-2017) in 128 Type 2 diabetes mellitus patients according the inclusion and exclusion criteria of the study. The blood investigation for diabetes mellitus included fasting blood sugar, random blood sugar, postprandial blood sugar, and HbA1C. The disease was graded as controlled and uncontrolled, depending on the HbA1C value. The duration of diabetes mellitus was also categorized into three subgroups: < 5 years, 5-10 years, and > 10 years. Hearing impairment was measured using Pure Tone Audiometry (PTA). The statistical analysis was done using SPSS (Statistical packages for Social Sciences) Version 18.0 software. **Result:** The mean age of the study population was 44.48± 5.47 years. Total prevalence of SNHL is 71.09% in diabetics, of which patient's aged between 40-50 showed maximum prevalence. The uncontrolled group has more prevalence of SNHL (80.68 %) than the well-controlled group (50%) and prevalence was also high in those patients who presented with duration of more than 10 years (100%) while less in those with less than 5 years (50.7%). **Conclusion:** The study emphasizes importance of metabolic assessment for patients presenting with hearing loss so as to reduce the high rate of undiagnosed diabetes mellitus in the community. And also the need of early evaluation of auditory impairment in diagnosed diabetes mellitus cases and use of audiological tests to monitor diabetic patients should be considered a routine procedure.

Keywords: Diabetes mellitus, Hearing loss, SNHL.

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Received Date: 07/09/2020 Revised Date: 23/10/2020 Accepted Date: 11/11/2020
DOI: https://doi.org/10.26611/10161635

Access this article online	
Quick Response Code:	Website: www.medpulse.in
	Accessed Date: 24 December 2020

INTRODUCTION

The relationship between diabetes mellitus (DM) and sensorineural hearing loss (SNHL) has been a subject of debate since Jordao (1857) reported a case of hearing impairment with incipient diabetic coma[1]. Edgar in 1915 was the first to report a high-frequency SNHL in a diabetic patient[2]. Till now, the most widely accepted concept is the hyperglycemia-induced oxidative stress and nitrosative stress. This stress results in dysfunction at the endothelium and destruction of DNA at the cellular level and may lead to vascular ischemia in the neural tissue leading to demyelination and organ dysfunction. The microangiopathic changes are also studied in animal models to detect the auditory system's failure in diabetes mellitus[3]. The typical hearing loss in diabetes is a progressive bilateral sensorineural type deafness of gradual onset, which affects predominantly higher frequencies. The prevalence and its adverse health effects have increased more rapidly in South Asia than in any other world region[4]. Untreated hearing loss can negatively

impact the social and emotional wellbeing of individuals, thus hampering the economy of developing countries[5]. The effects of different variables such as duration of diabetes, blood sugar control, and the presence of end-organ damage on hearing loss have not yet been clarified, despite several studies on this topic. Furthermore, the most extensive studies in this area as described in the medical literature have examined several patients but still limit the conclusion because of insufficient statistical power[6].Hence, the present study evaluates hearing loss in subjects with type 2 diabetes mellitus (controlled and uncontrolled) and the resulting audiometric pattern in central India's population.

MATERIAL AND METHODS

This prospective observational study was conducted in the Department of Otorhinolaryngology at Jawaharlal Nehru Hospital and Research Centre, Bhilai, from June 2015 to May 2017. About 128 patients attending ENT OPD (outpatient department) with a history of hearing loss and diabetes mellitus were enrolled in the study, fulfilling inclusion and exclusion criteria. The ethical and scientic society of the institution has given the ethiical clearance for the study. After a patient has given written informed consent, a detailed history was taken regarding diabetes mellitus and hearing loss along with the detailed physical examination of the external ear, tympanic membrane, and eighth cranial nerve examination. The audiometric evaluation included Pure Tone Audiometry (PTA), using a calibrated Interacoustics Clinical Audiometer ELKON eda 3 N 3 multi with RadioEar B 71 bone vibrator to assess the hearing loss. The blood investigation for diabetes mellitus included fasting blood sugar, random blood sugar, postprandial blood sugar, and HbA1C. The disease was graded as controlled and uncontrolled, depending on the HbA1C value. The duration of diabetes mellitus was also categorized into three subgroups: < 5 years, 5-10 years, and > 10 years.

Inclusion Criteria:

1. Patients diagnosed with Type 2 diabetes mellitus as per The National Diabetes Data Group and the World Health Organization issued diagnostic criteria.
2. Patients Random blood glucose concentration >200 mg/Dl, Fasting plasma glucose >126 mg/dL
3. Patients greater than 18 and less than 55 years old.

Exclusion criteria:

The patients with the following features were excluded from the study-

1. Subjects with history of chronic exposure to noise, trauma to the ear, any chronic ear disease, family history of hearing loss.
2. Subjects with hypertension, hyperlipidemia, any other chronic liver, and kidney diseases.
3. Subjects with the history of ototoxic drugs intake and cranial nervous system sedatives in the past 2 month.

Analysis of data (statistical methods employed):

The statistical analysis was done using SPSS (Statistical packages for Social Sciences) Version 18.0 software. Pearson chi-square value and p-value has been estimated in our study and tried to find the correlation between different variables of diabetes mellitus and SNHL.

RESULTS

The characteristics of the study cohort have been shown in table 1,graph 1. Age group 40 to 50 years was in the majority comprising 66.41%, while patients in the age group < 40 years were only 20.31 % and > 50 years were 13.28 %. The mean age of the study population was 44.48± 5.47 years. There were 54.69 % males, and 45.31 % were females in our study. The duration of diabetes in our cohort was analyzed; a maximum of 71 (55.47%) patients presented with < 5 years duration, 49 (38.28%) patients with 5- 10 years duration, and 8 (6.25%) patients with >10 years duration. The mean duration of the DM in the study population was 4.70 ± 3.65 years. In the present study, the mean random blood sugar was 250.008 ± 43.28 mg/dL, the mean fasting blood glucose level was 158.07 ± 31.27 mg/dL, and the mean postprandial blood glucose level was found to be 228.93 ± 48.73 mg/dL. The mean HbA1C was 7.05 ± 1.071 in our study. In this study, a family history of diabetes was present in 31.25 % of the patients, while most of the patients (68.75 %) had no family history. The severity of hearing loss was minimal in 23.44 %, mild in 32.81 %, moderate in 8.59%, and moderately severe in 6.25%. When we analyzed the prevalence of SNHL in patients, it was found to be 71.09% of which patients age between 30-35 years, 35-40 years, 40-45 years, 45-50 years, 50-55 years were 22.22%, 58.82%, 76%,83.33%, 58.82% respectively and it was found to be statistically significant ($p<0.01$)(table 2, graph 2). We tried to evaluate the association between different diabetes parameters as random blood sugar (RBS) and fasting blood sugar (FBS) with hearing loss. As shown in the table and figure(table ,Graph 3a,3b), the maximum number of patients with RBS >250 mg/dL had 81.82 % hearing loss, and patients with RBS <200 mg/dL, the hearing loss was only 65.48%, which was not significant ($p=0.27$). Patients with the FBS >150mg/dL had hearing loss in 81.03% compared to 62.86% with FBS 126-150mg/dL which was also not statistical significant ($p <0.09$). These observations suggest that these values of the sugar estimation do not correlate with hearing loss. When we took HbA1C as a variable and assessed the correlation with hearing loss, we found that the uncontrolled group has more prevalence of SNHL (80.68 %) than the well-controlled group (50%). This result was highly significant ($p=0.0036$) in our study,

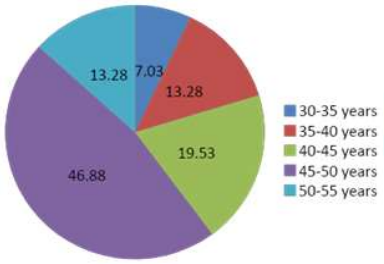
shown in Table 4 and Graph 4. The other variable which was found significant was the duration of diabetes and the prevalence of SNHL. Prevalence was high in those patients who presented with a duration of more than ten years (100%) while less in those with less than five years (50.7%). (table 5,Graph 5) This difference was statistically significant ($p<0.001$). (Table 6) The prevalence of SNHL was also significantly high in patients with a family history of diabetes (77.5 %) compared to those with no family history (68.18 %) ($p=0.12$).

Table 1

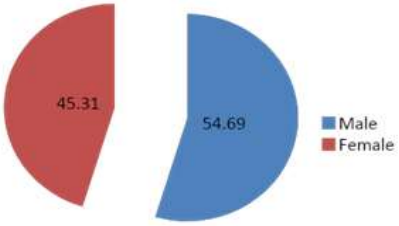
Age Group (years)	N	%
30-35	9	7.03
35-40	17	13.28
40-45	25	19.53
45-50	60	46.88
50-55	17	13.28
Total	**128**	**100**
Mean ± SD in years	44.48±5.47	

(*) 30-35 does not include 35 ie upper limit

GRAPH -1



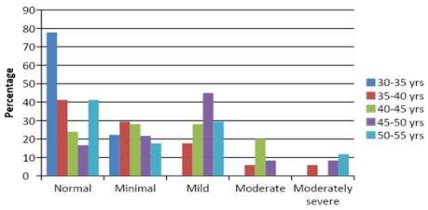
Graph 1: Percentage age distribution



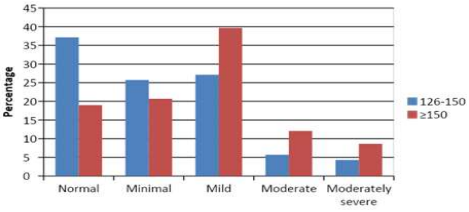
Graph 2: Percentage gender distribution

TABLE 2: Association of age with SNHL

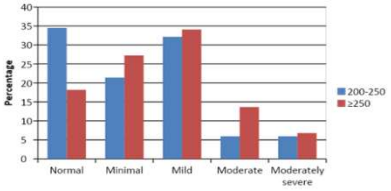
Age Group (in years)	Hearing Loss					Total	Pearson's Chi square value(DF)	P value
	Normal	Minimal	Mild	Moderate	Moderatey severe			
30-35	7 (77.78%)	2 (22.22%)	0(0%)	0(0%)	0(0%)	9		
35-40	7 (41.18%)	5 (29.41%)	3 (17.65%)	1(5.88%)	1(5.88%)	17		
40-45	6(24%)	7(28%)	7(28%)	5(20%)	0(0%)	25		
45-50	10 (16.67%)	13 (21.67%)	27 (45%)	5(8.33%)	5(8.33%)	60	**29.97 (16)**	**0.018***
50-55	7 (41.18%)	3 (17.65%)	5 (29.41%)	0(0%)	2(11.76%)	17		
Total	37 (28.91%)	30 (23.44%)	42 (32.81%)	11 (8.59%)	8 (6.25%)	128		



GRAPH 2: Distribution of hearing loss according to age



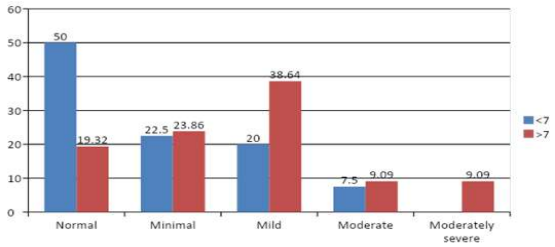
GRAPH-3 a: Association of SNHL with RBS



GRAPH 3b: Association of SNHL with RBS

TABLE 4: Association of SNHL with HbA1c

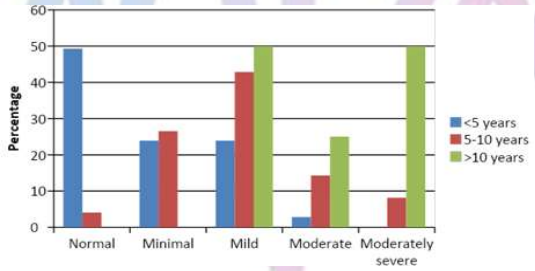
HbA1c	Hearing Loss					Total	Pearson's Chi square value (DF)	P value
	Normal	Minimal	Mild	Moderate	Moderately severe			
<7	20(50%)	9(22.5%)	8(20%)	3(7.5%)	0(0%)	40(100%)		
>7	17(19.32%)	21(23.86%)	34(38.64%)	8(9.09%)	8(9.09%)	88(100%)	**15.60(4)**	**0.0036***
Total	37(28.91%)	30(23.44%)	42(32.81%)	11(8.59%)	8(6.25%)	128(100%)		



GRAPH 4: Association of SNHL with HbA1c

TABLE 5 : Association of duration of diabetes with SNHL

duration	Hearing Loss					Total	Pearson's Chi square value (DF)	P value
	Normal	Minimal	Mild	Moderate	Moderately severe			
<5 years	35 (49.3%)	17 (23.94%)	17 (23.94%)	2(2.82%)	0(0%)	71(100%)		
5-10 years	2(4.08%)	13 (26.53%)	21 (42.86%)	7 (14.29%)	4(8.16%)	49(100%)	**59.05 (8)**	**<0.001***
>10 years	0(0%)	0(0%)	4(50%)	2(25%)	4(50%)	8(100%)		
Total	**37 (28.91%)**	**30 (23.44%)**	**42 (32.81%)**	**11 (8.59%)**	**8(6.25%)**	**128 (100%)**		



GRAPH 5: Distribution of hearing loss according to duration in years

Table 6: Association of SNHL with family history of diabetes

Family History	Hearing Loss					Total	Pearson's Chi square value (DF)	P value
	Normal	Minimal	Mild	Moderate	Moderately severe			
Present	9(22.5%)	9(22.5%)	18(45%)	4(10%)	0(0%)	40(100%)		
Absent	28 (31.82%)	21 (23.86%)	24 (27.27%)	7(7.95%)	8(9.09%)	88(100%)	**7.25(4)**	**0.12**
Total	**37 (28.91%)**	**30 (23.44%)**	**42 (32.81%)**	**11 (8.59%)**	**8(6.25%)**	**128 (100%)**		

Graph 6

DISCUSSION

Diabetes mellitus is a non-communicable chronic disease with numerous complications. One of the less known complications is hearing impairment, leading to a decreased quality of life among those affected.[7] In the present study, 12.5% of diabetic subjects have reduced hearing on ABC tuning fork test and higher hearing threshold with SNHL found in 71.09%, which is of gradual onset and progressive type with minimal to moderately severe degree of hearing loss. None of the patients had severe and profound hearing loss based on Clark's criteria for hearing impairment[8]. According to most studies, the increased incidence of hearing impairment related to age and gender is between 13 to 95 %[9-11]; however, individual studies have denied a relationship of these variables with diabetes [12,13,18]. Patients with different diabetes types as insulin-dependent diabetes mellitus (IDDM) and non-insulin-dependent diabetes mellitus (IDDM) may be added to the study and should be considered a factor in causing variability[14,15]. In the present study, the total prevalence of SNHL is 71.09%, of which patients age between 45-50 years, 40-45 years, showed a maximum prevalence of SNHL 83.3% and 76%, respectively. Our study has shown that age is an essential predictor for SNHL and was highly statistically significant ($p<0.01$), but it did not prove that there is an increase in hearing impairment with an increase in age. We could exclusively correlate the relationship of diabetes mellitus and hearing loss, as the cases with the co-existence of hypertension and other chronic disorders were excluded from the study. Also, people with diabetes of fewer than 55 years of age were included to avoid audiological derangements owing to presbycusis. It has been seen in many studies that elderly diabetics are more prone to develop deafness than the younger ones and the duration of diabetes has a vital role in causing the SNHL[7,16,17]. However, the type and severity of SNHL were not related to the patient's age, suggesting that diabetes mellitus act only as an initiating factor, and the progression of hearing loss is related to other factors. Our study has shown slight male preponderance, 54.69% of the patients were males, and 45.31% were females, of which SNHL was seen slightly higher among females (72.41%) compared to males (70%); however, this difference was statistically not significant ($p=0.36$), unlike Cullen and Cinnamond [15] reported that male diabetics were deafer than female diabetics. They summarized that this might have been due to occupational noise exposure. Many studies have noted no gender differences in audiological impairment in diabetics[9,10,18]. Our study categorized patients according to diabetes duration into three categories and a mean duration of 4.70 ± 3.65 years. The prevalence of SNHL was higher in those patients who presented with more than 10 years of diabetes (100%), while it reduced in those who had less than 5 years duration (50.7%). This difference was statistically significant ($p<0.001$). Our findings were similar to many studies suggesting that the increased diabetes duration directly correlated with the SNHL[7,10,14,19]. Harkare *et al.*.[18] and Rajendran *et al.*.[19] study state that diabetes duration less than or more than 10 years does not affect hearing loss incidence. Variations in the study population and diagnostic tools are the possible reason for such differences in the observation. In this study family history of diabetes was present in 31.25% of patients, and the prevalence of SNHL was significantly high in these patients (77.5%) compared to those without a family history of diabetes (68.18%) ($p=0.12$). These results suggest that patients with a positive family history of diabetes are at increased risk of developing SNHL, unlike Taylor and Irwin[6]. HbA1C was considered in our study since it directly explains the patient's blood sugar control over the past three months. In our study, the prevalence of SNHL in an uncontrolled group was found to be more (80.68%) than the well-controlled group (50%), which is highly statistically significant ($p=0.0036$). Our results are similar to a few authors [18,10,9] bit contradictory to others[17,19]. Kakarlapudi *et al.*.[9] showed that in patients with diabetes with the worsening microvascular disease led to the worse hearing. Interestingly Axelsson *et al.*.[20] observed that age-matched patients with diabetes treated with insulin had better hearing than those patients treated with oral medications. Wackym and Linthicum *et al.*.[21] observed that diabetic patients treated with di*et al.*.one had more severe hearing loss than patients on oral hypoglycemic agents, who had even worse hearing than the patients taking insulin. As diabetes's treatment modality was not

effectively evaluated in the present study, we cannot highlight the association between hearing loss and treatment. This concept lends itself to the belief that aggressive therapy of diabetes leads to less hearing loss. The limitations of the study were the small cohort of the study group and no randomization. We have not used other modalities such as Brain Evoked Response Audiometry , Otoacoustic Emissions , which could have refined our results and thus a limiting factor.

CONCLUSION

Two essential variables as glycemic control (based on HbA1C) and increased diabetes duration have shown a strong correlation with hearing impairment. Hence metabolic assessment becomes necessary for patients presenting with hearing loss to reduce the high rate of undiagnosed diabetes mellitus in the community. Also, with early detection of diabetes, auditory impairment due to uncontrolled/ undetected diabetes mellitus can be prevented to an extent. It is advisable to screen for SNHL in all diabetics, even at a younger age. Thus, use of audiological tests to monitor diabetic patients should be considered a routine procedure so that it helps to diminish co-morbidities among patients and improve their quality of life.

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Source of Support: None Declared
Conflict of Interest: None Declared