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Original Research Article

The clinical study of audiologic manifestations of type 2 diabetes mellitus in association with other diabetic microvascular complications: an observational study

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ABSTRACT

Background: Sensorineural hearing loss (SNHL) is a major clinical and public health problem. Diabetes mellitus (DM) is characterized by various microvascular and macrovascular complications. DM is associated with thickening of basal membrane of the stria vascularis capillaries on the lateral wall of cochlea and neuropathic changes which leads to SNHL.
Methods: This is an observational study involving 160 participants grouped into diabetics and non-diabetics. DM was diagnosed using standard American Diabetes Association (ADA) criteria. All the participants were subjected to pure tone audiometry to detect SNHL which was graded into mild, moderate, severe and profound based on degree of decibel loss. The occurrence of SNHL was compared with the occurrence of microvascular complications among diabetics.
Results: In our study, 34 (42.5%) cases and 8 (10%) of controls had SNHL. The occurrence of SNHL was higher among diabetics than non-diabetics ($p < 0.0001$) with majority (88.23%) of cases having bilateral SNHL. Among diabetics, 26 (32.5%) had neuropathy, 23 (28.75%) had retinopathy, 21 (26.25%) had nephropathy. There was no statistically significant relationship between occurrence of SNHL and microvascular complications among diabetics ($p=0.8614$). The occurrence of SNHL correlated with the levels of HbA1c ($p = 0.017$). The occurrence of SNHL among diabetics was 42.5% as compared to only 10% among non-diabetics which was statistically significant. The occurrence of SNHL correlated with the levels of HbA1c among diabetics suggesting an association between DM and SNHL ($p=0.017$).
Conclusions: There was increased occurrence of sensorineural hearing loss among the individuals with diabetes mellitus with significant relationship with the glycaemic index.

Keywords: Complications, Diabetes mellitus, Hearing loss, Microvascular, Sensorineural

INTRODUCTION

Approximately 5% of the world's population, equivalent to over 360 million population has disabling hearing loss, according to the World Health Organization (WHO).[1] Type 2 diabetes mellitus accounts for 80-90% of all diabetes cases. According to the Diabetes Atlas 2009, there are about 51 million diabetic individuals and it is estimated that, by year 2025, the total number would be 69.92 million.[2,3] Microvascular complications in DM

include retinopathy, nephropathy and neuropathy. These complications occur due to metabolic injuries caused by altered blood flow and endothelial permeability resulting in organ dysfunction.[4,5] DM is associated with thickening of the basal membrane of the stria vascularis capillaries on the lateral wall of the cochlea and other microvascular and neuropathic changes that could induce hearing loss.[6,7]

The association of hearing loss with DM, however, is still controversial. Several studies have observed no association between DM and hearing loss.[8] A longitudinal study of association between DM and SNHL, it was found that DM was associated with increased prevalence of SNHL but did not correlate with the increased incidence.[9]

This study was conducted to study the occurrence of sensorineural hearing loss in patients with type 2 diabetes mellitus and to find the relationship between the occurrence of SNHL with the occurrence of microvascular complications in patients with type 2 diabetes mellitus.

Aims and objectives was to study the occurrence of SNHL among patients with DM, to study the relationship between the level of glycaemic control with the occurrence of SNHL and to find the association between the occurrence of SNHL with the microvascular complications of DM.

METHODS

This is an observational study was conducted on patients attending the department of General Medicine in Vydehi Institute of Medical sciences and Research Centre (VIMS & RC), Bengaluru. The study population (n=160) were divided into two groups based on their diabetic status. Group one (diabetic) consisted of 80 patients diagnosed with type 2 diabetes (T2DM) and group two (non-diabetic) consisted of 80 non-diabetic patients attending the out-patient clinic. This study was conducted from January 2018 to December 2018.

Sampling technique

Consecutive adult patients attending the department of General Medicine either as outpatient or as inpatient were explained about the study and those who consented were included in the study.

Inclusion criteria

Adult diabetic patients aged ≥20 years with a confirmed diagnosis of T2DM based on the any 2 of the following 3 criteria (American Diabetes Association (ADA) diagnostic criteria); Fasting Plasma Glucose (FPG) ≥126 mg/dL, Post-Prandial Plasma Glucose (PPG) ≥200 mg/dL and glycated haemoglobin (HbA1c) ≥6.5% were regarded as diabetics (group one). Also, individuals who were already diagnosed and treated as DM were also included in the group one irrespective of their glycaemic control. Those with normal FPG <100 mg/dL and normal PPG <140 mg/dL and normal HbA1c (<5.6%) were regarded as non-diabetics (group two).

Exclusion criteria

- History of ototoxic drugs (Aminoglycoside antibiotics, Aspirin, Furosemide, Chloroquine, Hydroxychloroquine) in the last three months.
- Previous ear surgeries.
- Recent ear/nose/throat infections.
- Recent or prolonged exposure to noise (Occupational / accidental exposure).
- Presence of conductive hearing loss on Pure Tone Audiometry (PTA).

Fasting plasma glucose levels were measured by drawing venous blood (2ml) after an overnight (8 to 12 hours) fasting followed by postprandial plasma glucose measurement after 2 hours of food. Group one was subjected for glycated haemoglobin (HBA1c) test to assess the glycemic control. HBA1c <7% was considered as good glycemic control and HBA1c >7% as poor glycemic control.

Otologic examination was carried out by ENT specialist and the findings of outer ear, external auditory canal and the status of the tympanic membrane were recorded. Mobility of the tympanic membrane was tested by pneumatic otoscope.

All subjects and controls were subjected to Pure Tone Audiometry (PTA) which was performed in a sound proof booth with ambience noise <45dB. Air conduction thresholds were measured at frequencies 250, 500, 1000, 2000, 4000, 6000 and 8000 Hertz while the Bone conduction thresholds were measured at 250, 500, 1000, 2000 and 4000 Hertz.

The degree of hearing loss is graded based on the degree of decibel (dB) loss as follows:

- Mild: 26 to 40 dB
- Moderate: 41 to 55 dB
- Moderately severe: 56 to 70 dB
- Severe: 71 to 91 dB
- Profound: More than 91 dB

All the data were recorded in a Microsoft office excel 2007 and SPSS version 21 was used for analysis of data. Frequencies, percentages, mean and standard deviation was used to depict the data.

The occurrence of SNHL among diabetics and non-diabetics were calculated compared with respect to age and gender.

The occurrence of SNHL was compared with the occurrence of microvascular complications like neuropathy, nephropathy, retinopathy among diabetics.

Among the diabetics, the degree of SNHL was compared with the serum HbA1c levels.

Chi-square test, degree of freedom, and p values were used for statistical analysis. p value less than 0.05 is considered statistically significant.

RESULTS

Authors studied 80 diabetic patients and 80 non-diabetic patients to assess their audiological status. The demographic details are shown in Table 1.

The mean age among diabetics was 49.88 with a standard deviation of 10.82 and the mean age among non-diabetics was 47.77 with a standard deviation of 8.66 (p=0.1752). Among diabetics males were 76.25% as compared to females who were 23.75%.

Among non-diabetic group, males were 51.25% as compared to females who were 48.75%. Most of the participants were in the age group of 50 to 59 years in both groups.

With respect to gender, there was a male preponderance in both the groups which was statistically significant with a p value of 0.001.

Pattern of hearing loss

Table 2 shows, 34 (42.5%) diabetics and only 8 (10%) of non-diabetics had SNHL. 46 (57.5%) diabetics and 72 (90%) non-diabetics did not have hearing loss. Majority of the participants in both the groups had mild to moderate sensorineural hearing loss.

Among those who had hearing loss, diabetic patients had a more chance of having sensorineural hearing loss when compared to non-diabetic individuals and this was found to be statistically significant with a p value of less than 0.0001.

Among those with SNHL, most of the participants (88.24%) in the diabetes group had bilateral sensorineural hearing loss as compared to non-diabetic group (75%) (p=0.336).

Table 1: Age and sex distribution of the study population.

Age distribution	Diabetics		Non-diabetics	
	Male No. (%)	Female No. (%)	Male No. (%)	Female No. (%)
20 - 29 years	3 (3.75%)	0 (0%)	0 (0%)	0 (0%)
30 - 39 years	8 (10%)	6 (7.5%)	3 (3.75%)	11 (13.75%)
4 - 49 years	14 (17.5%)	2 (2.5%)	14 (17.5%)	15 (18.75%)
50 - 59 years	22 (27.5%)	7 (8.75%)	19 (23.75%)	12 (15%)
60 - 69 years	14 (17.5%)	4 (5%)	5 (6.25%)	1 (1.25%)
Total	61 (76.25%)	19 (23.75%)	41 (51.25%)	39 (48.75%)

Table 2: Pattern of hearing loss in both the groups.

Hearing loss	Diabetics	Non-diabetics	Chi square value	Degree of freedom	p value
No hearing loss	46 (57.5%)	72 (90%)	21.8	1	<0.0001*
Mild sensorineural hearing loss	23 (28.75%)	6 (7.5%)			
Moderate sensorineural hearing loss	9 (11.25%)	2 (2.5%)			
Severe sensorineural hearing loss	1 (1.25%)	0 (0%)			
Profound sensorineural hearing loss	1 (1.25%)	0 (0%)			

Table 3: Relationship between presence of microvascular complications and hearing loss among diabetics.

Microvascular complications	No hearing loss	Mild hearing loss	Moderate hearing loss	Severe hearing loss	Profound hearing loss
Nil	17	11	3	1	0
Nephropathy	9	7	5	0	0
Neuropathy	14	8	3	0	1
Retinopathy	11	8	4	0	0

Chisquare=0.75 DF=3 p=0.8614

Prevalence of microvascular complications and relationship with the occurrence of sensorineural hearing loss among diabetics

In the diabetic group, 32 (40%) of participants had no microvascular complications. Among those with microvascular complications, 26 (32.5%) participants had neuropathy, 23 (28.75%) had retinopathy, 21 (26.25%) had nephropathy (Table 3).

Statistically 14 out of 26 (53.84%) diabetic participants with neuropathy had no hearing loss. 11 out of 23 (47.83%) diabetic participants with retinopathy had no hearing loss. 9 out of 21 (42.86%) diabetic participants with nephropathy had no hearing loss. There was no statistically significant relationship between the occurrence of hearing loss and microvascular complications in diabetic individuals.

All three microvascular complications were seen in 10 diabetic individuals. Among them 4 patients had sensorineural hearing loss which was statistically insignificant. The mean FBS, mean PPBS and mean HbA1c were 195.46±98.47, 271.52±146, 8.69±2.77 respectively. The occurrence of sensorineural hearing loss correlated well with the degree of HbA1c with a p value of 0.017 (Table 4). There is a statistically significant relationship between the occurrence of sensorineural hearing loss with the increasing levels of HbA1c levels.

Table 4: Relationship between Hba1c and degree of hearing loss among diabetics.

HbA1c levels	No hearing loss	Mild hearing loss	Moderate hearing loss	Severe hearing loss	Profound hearing loss
<5.6	4 (5%)	0 (0%)	0 (0%)	1 (1.25%)	0 (0%)
5.6 - 6.5	11 (13.75%)	7 (8.75%)	3 (3.75%)	0 (0%)	0 (0%)
>6.5	27 (33.75%)	19 (23.75%)	7 (8.75%)	0 (0%)	1 (1.25%)

DISCUSSION

In the study, we compared the occurrence of SNHL in individuals with DM and without DM. The occurrence of SNHL among diabetics was 42.5% as compared to only 10% among non-diabetics which was statistically significant. Similar observation has been made by many other studies.[10,11]

The occurrence of SNHL correlated with the levels of HbA1c among diabetics suggesting a possible significant association between diabetes and increased hearing loss as compared to the observation made by Kim MB et al in which they found that the risk of hearing loss increased progressively with increasing HbA1c levels above 5%.[10] 5 individuals among cases had well controlled HbA1c (<5.6%), among whom only 1 had SNHL. So, the physician taking care of patients with DM should screen and monitor the hearing ability to detect the early signs of hearing loss. Also, strict glycemic control is essential to prevent or retard the onset of hearing loss.

In this study, authors tried to compare the occurrence of SNHL with microvascular complications like neuropathy, nephropathy, and retinopathy among diabetics.

Authors did not find any significant relationship. However, larger cohort and case control studies are required to refute this association. The possible mechanism of increased risk of hearing loss in diabetes include microangiopathy in the blood vessels of striae vascularis due to cumulative effects of advanced glycation end products.[12,13] Kurien et al, demonstrated that significant hearing loss in all frequencies were found in patients with DM whose blood sugars were poorly controlled.[14] However, few longitudinal studies failed to find an association between DM and hearing loss.[9,15]

Some of the limitations of our study are, authors did not analyse the hearing loss occurrence with respect to frequency specific. Also authors did not find the confounding effects of anti-diabetic medications on the occurrence of hearing loss.

CONCLUSION

There was increased occurrence of sensorineural hearing loss among the individuals with diabetes mellitus with significant relationship with the glycaemic index, suggesting the need for strict glycaemic control to prevent this microvascular complication.

Recommendations

Authors recommend considering screening for SNHL in patients with DM as part of screening for end organ damage and we recommend for early measures for strict glycaemic control.

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