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Original Research Article

An Analytical Cross Sectional Assessment of Sensorineural Hearing Loss in Type 2 Diabetes Mellitus

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Abstract

Aim: To investigate the association between diabetes and sensorineural hearing loss **(**SNHL).

Material & Methods: In this cross-sectional study, we evaluated 100 type 2 diabetes mellitus patients coming to the Department of ENT, MP Birla Hospital & Priyamwada Birla Cancer Research Institute, Satna (MP), India.

Results: Audiometry testing at 250–8,000 Hz, SRT, and SDS were significantly worse in participants in the D than ND group. The differences between groups were not significant when the models.

Conclusion: We found no association between the duration of diabetes and worsening of hearing thresholds after models were adjusted for age, gender, and the presence of hypertension.

Keywords: Diabetes Mellitus Type II; Hearing Loss Sensorineural; Audiometry.

Introduction

Hearing is one of the important sense involved in development of human skills which has been known to be affected by many diseases since. The available records suggest that hearing loss has been identified around 1500 BC in ancient Egyptian era. It was reported by Jardao in 1857 that diabetes mellitus causes hearing loss in a case series of diabetic coma. [1] Almost 278 million people around the world have hearing loss ranging from mild to severe hearing loss and more than half of them is preventable by early diagnosis, management and treatment, in which diabetes mellitus takes a major part. India has a diabetic population of 50 million people which is expected to be doubled by 2030.[2]Diabetes mellitus (DM) is a metabolic disorder, due to relative or absolute lack of insulin resulting in elevated blood glucose levels associated with long term vascular and neurological complications.3 Apart from glucose metabolism disorders, diabetes mellitus is the one most commonly related with auditory disorders. Various studies have been shown that diabetes mellitus causes different types of hearing loss, One of them is progressive, gradual bilateral sensorineural loss, affecting especially high frequencies and the elderly. Similar to that of presbyacusis, but with more severe losses than those expected by aging but the relationship between the two has been highly controversial.

[3]In addition to the cardiovascular outcomes and the long-term damage to the

kidneys, eyes, and nervous system caused by diabetes [4], this disease was also associated with alterations in hearing function in a meta-analysis of 18 clinical and epidemiological studies [5].

The pathological support to this association may be related to an increase in capillary lesions in the cochlea, more specifically in the stria vascularis and basilar membrane. Other studies have also reported a reduction in the number of spiral ganglion neurons. These differences could be related to the duration of diabetes and to comorbidities that could affect the inner ear [6].

In this study, we investigated the association between diabetes and SNHL. We evaluated the influence of other factors such as age, gender, exposure to noise, hypertension diagnosis, and duration of diabetes on this association.

Material & Methods:

In this cross-sectional study, we evaluated 100 type 2 diabetes mellitus patients and 100 patients without diabetes mellitus, coming to the Department of ENT, MP Birla Hospital & Priyamwada Birla Cancer Research Institute, Satna (MP), India.

Participants aged 35–74 years were eligible for the study. The baseline assessment consisted of a 7-hour examination, which took place over a period of one year. Blood samples were taken after an overnight fast, and an oral 75 g glucose tolerance test and glycated hemoglobin measurements were performed (20).

Hearing examination:

After otological inspection, an audio logical assessment was conducted. Screening acoustic immittance measurements (Arphi R36M) were performed to exclude middle ear disorders.

Pure-tone audiometry was performed using air conduction at octave frequencies from 250-8,000 Hz and bone conduction at 500-4,000 Hz.

Speech tests included the Speech Reception Threshold (SRT) and the Speech Discrimination Score (SDS). The SRT assesses people’s ability to hear and understand standardized three syllable words (threshold in decibel hearing level (dBHL)), and the SDS evaluates people’s ability to hear and understand standardized one-syllable words (percentage of words correctly identified).

All tests were performed using an Arphi Proton DX 5audiometer in a sound-proof room.

Statistical analysis:

Continuous variables were expressed as means ± SD, and categorical variables were expressed as proportions. The chisquare and Kruskal-Wallis tests and one-way analysis of variance (ANOVA) were used whenever applicable. We constructed linear regression models using the hearing threshold values, SRT, and SDS for each frequency as dependent variables to evaluate their association with diabetes. The significance level was set at 0.05.

Results:

Table 1 shows that participants in the D group were older and included more men and more participants with hypertension compared to the ND group. In addition, glucose, HbA1c, systolic and diastolic blood pressure, triglycerides, and creatinine levels were significantly higher in the D than the ND group. Results for audiometry testing at 250–8,000 Hz, SRT, and SDS were significantly worse in participants in the D than ND group.

Table 2 shows the number of participants with HL in each frequency range (low-middle and high). The number of participants with HL was significantly higher in the D group than the ND group. The OR for both frequency ranges showed a difference between the groups (crude model). However, in the adjusted model, this difference between groups was lost.

Table 3 shows the beta coefficients for the association between audiometric measurements and a diagnosis of diabetes. In this analysis (crude model), all audiometric measurements and speech test variables were significantly worse in the D group than the ND group. However, the differences between groups were not significant when the models.

Table 1: Baseline characteristics of study participants

	Without diabetes (ND) N = 100	With diabetes (D) N = 100	p
Age (years) (Mean ± SD)	50.3± 8.0	57.4 ± 9.0	o0.001
Glucose (mmol/l)	5.39± 0.31	7.97 ± 2.76	o0.001
HbA1c (%) (mmol/mol)	6.6± 0.5 (33± 6.8)	6.5 ± 1.3 (48 ± 14.3)	o0.001
Hypertension (%)	32	63	o0.001
Systolic BP (mmHg)(Mean ± SD)	115.7± 14.3	125.7± 19.2	o0.001
Diastolic BP (mmHg)(Mean ± SD)	76.3± 10.4	79.4 ± 11.6	o0.001
Dyslipidemia (%)	58	65	0.285
Total cholesterol (mmol/l) (Mean ± SD)	5.37± 0.90	5.30± 1.3	0.112
LDL cholesterol (mmol/l) (Mean ± SD)	3.21± 0.88	3.29± 0.83	0.291
HDL cholesterol (mmol/l) (Mean ± SD)	1.68± 0.47	1.93± 0.32	o0.001
Triglycerides (mmol/l) (Mean ± SD)	1.23± 1.11	1.74± 1.17	o0.001
Creatinine (mg/dl) (Mean ± SD)	0.80± 0.37	0.80± 0.22	0.001
250 Hz (dBHL)(Mean ± SD)	13.5± 7.5	14.5± 8.90	0.001
500 Hz (dBHL)(Mean ± SD)	11.8± 8.3	13.8± 9.03	o0.001
1000 Hz(dBHL)(Mean ± SD)	10.5± 9.3	13.4± 10.3	o0.001
2000 Hz(dBHL)(Mean ± SD)	12.5± 11.4	16.4± 12.4	o0.001
3000 Hz(dBHL)(Mean ± SD)	14.1± 13.7	20.5± 14.9	o0.001
4000 Hz(dBHL)(Mean ± SD)	17.8± 15.3	25.4± 16.6	o0.001
6000 Hz(dBHL)(Mean ± SD)	25.3± 16.8	32.5± 18.2	o0.001
8000 Hz(dBHL)(Mean ± SD)	25.6 ± 18.9	31.8± 20.5	o0.001
SRT (dBHL)(Mean ± SD)	13.5± 8.2	16.4± 9.7	o0.001
SDS (%) (Mean ± SD)	96.1± 4.4	94.0± 6.5	0.001

Table 2: Individuals (n) with hearing impairment in each range frequencies (low-middle or high) for both groups (N and ND), odds-ratio and p-value in crude and adjusted model

	Low-middle range frequencies n (%) hearing impairment	High range frequencies n (%) hearing impairment
Without diabetes(ND) N = 100	7%	28%
With diabetes(D) N = 100	12%	49%
Crude model(OR; 95% CI)	1.82 (1.32 – 3.30)	2.42 (1.60 – 3.21)
p-value	0.010	o0.001

Adjusted model(OR; 95% CI)	1.11 (0.66 – 1.90)	1.20 (0.81 – 1.70)
p-value	0.782	0.510

Table 3: Beta-coefficients for the association between mean audiometric measurements and diabetes mellitus in crude and adjusted models.

	Crude	Adjusted for age	Full adjusted
250 Hz	1.73 (0.74 to 3.31; p=0.001)	0.38 (-0.20 to 1.89; p=0.219)	0.60 (p=0.271)
500 Hz	2.63 (1.29 to 3.40; po0.001)	0.86 (-0.30 to 2.20; p=0.110)	0.67 (p=0.390)
1000 Hz	2.28 (0.39 to 3.62; p=0.005)	0.40 (-1.30 to 1.53; p=0.527)	0.23 (p=0.770)
2000 Hz	3.52 (1.70 to 5.50; po0.001)	0.29 (-1.26 to 2.07; p=0.773)	0.28 (p=0.369)
3000 Hz	5.10 (2.70 to 7.39; po0.001)	0.59 (-1.10 to 3.04; p=0.280)	0.70 (p=0.603)
4000 Hz	6.33 (3.28 to 8.20; po0.001)	1.40 (-0.80 to 3.70; p=0.192)	0.90 (p=0.517)
6000 Hz	7.29 (4.64 to 9.90; po0.001)	1.20 (-1.40 to 3.89; p=0.494)	1.27 (p=0.692)
8000 Hz	7.38 (4.39 to 10.83; po0.001)	0.10 (-2.73to 2.89; p=0.832)	0.21 (p=0.880)
SRT	2.47 (1.30 to 3.70; po0.001)	0.30 (-1.23 to 1.49; p=0.638)	0.09 (p=0.904)
SDS	-1.28 (-2.20 to -0.51; p=0.004)	-0.33 (-1.33 to 0.49; p=0.293)	-0.63 (p=0.416)

Discussion:

The results of present study are comparable to studies conducted by Rajendran et al with prevalence 73.3% and Hlayisi et al with prevalence 74%. [7-8] However, low prevalence was seen in study by Nagoshi et al (54%) and Friedmann et al (55%).[9-10] Variation may seen in prevalence because of the different study period, sample size, inclusion and exclusion criteria.

A positive correlation was seen in the current study when extrapolating the severity of the SNHL with the duration of DM. As the duration of the disease increased, higher proportions of patients were found to have SNHL, except in the group which had diabetes for >12 years where the number of samples was very low, i.e., only 4. This propensity of worsening of hearing loss with duration of disease follows the logic that exposure to the basic pathological processes that result in SNHL (microangiopathy and neuropathy) is greater in the patients that have been suffering from the disease for a longer time. Similar results have been reported by other authors.[11-12]

Uchida et al. [13] argued that the association between diabetes and HL could not be strongly supported because many confounding variables may affect this association, including noise exposure and presbycusis. Indeed, other studies that investigated the effects of diabetes on hearing function did not remove confounding factors such as exposure to noise [14], gender [15], age [16], and hypertension [17].

Thus, we attempted to control for these possible confounding factors in our study and determine whether the differences observed in the initial analyses (Tables 1 and 2 – crude analysis) were also present (i.e., D participants had lower hearing thresholds than ND participants) after models were adjusted for age, gender, hypertension diagnosis, and exposure to noise.

Pure tone audiometry shows bilateral, progressive and high frequency SNHL. Same results were found in the study by Rózańska-Kudelska. [18]

Kakarlapudi et al. [19] found that increasing serum creatinine levels correlated with worse hearing in a subject with diabetes who had SNHL likely as a result of microangiopathy in the inner ear. Similarly, Agarwal et al. [20] reported that subjects with good glycemic control had significantly better hearing thresholds than those with poor glycemic control (HbA1c 458 mmol/mol). [21]

Conclusion:

We found no association between the duration of diabetes and worsening of hearing thresholds after models were adjusted for age, gender, and the presence of hypertension.

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