

Original Article

Evaluation of Hearing loss by Pure Tone Audiometry in Type 2 Diabetes Mellitus

Gita Khakurel¹, Nayan Bahadur Mahato²

¹Assistant Professor, Department of Physiology, Kathmandu Medical College, Bhaktapur, Nepal,

²Assistant Professor, Department of ENT, Kathmandu Medical College, Kathmandu, Nepal,

ABSTRACT

Introduction: The association of hearing loss and diabetes has been under research for many years. The hearing loss in diabetes in our population has not been studied extensively. The objective of this study was to compare the hearing threshold between type 2 diabetic patients and age- and sex-matched controls.

Materials and Methods: A comparative study was done in the Department of ENT, Kathmandu Medical College from October 2019 to February 2020. The hearing threshold, of 40 type 2 diabetics patients, and 40 age- and sex-matched healthy controls in the age group of 35 to 55 years, were assessed by pure tone audiometry. The hearing threshold was compared between the two groups by using the student's unpaired t-test.

Results: Among 40 diabetes patients, 29 (72.5 %) had bilateral, mild to moderate sensorineural hearing loss. The hearing threshold in diabetes patients was significantly higher than the healthy controls in all the frequencies except at 250 Hz. When comparing the threshold according to the duration of diabetes, it was found to be significantly higher only at higher frequencies (4000 and 8000 Hz) in diabetes with more than 5 years duration.

Conclusions: The hearing loss was common in type 2 diabetes mellitus. Most diabetic patients had mostly bilateral mild to moderate sensorineural hearing loss affecting hearing thresholds in higher frequencies than the healthy controls as assessed by pure tone audiometry.

Keywords: Auditory threshold; Hearing loss; Pure tone audiometry; Type 2 diabetes mellitus

Correspondence:

Dr. Gita Khakurel, MD
Department of Physiology,
Kathmandu Medical College, Duwakot, Bhaktapur,
Nepal.
ORCID ID: 0000-0002-9504-9266
Email: khakurelgita@gmail.com

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INTRODUCTION

Diabetes mellitus (DM) is a chronic metabolic disorder associated with auditory organ dysfunction.¹ The usual pattern of hearing loss in diabetes is progressive, bilateral sensorineural hearing loss (SNHL) affecting higher frequencies.²

The proposed mechanisms leading to hearing loss in diabetes mellitus are microangiopathy of the inner ear, neuropathy of the cochlear nerve, dysfunction of outer hair cell, and disruption of endolymphatic potential.^{3,4} Pure tone audiometry (PTA) is an

important hearing test which determines the hearing threshold levels in an individual. This subjective test helps in characterizing the degree, type and configuration of hearing loss.⁵

The studies conducted so far to analyze the relation between diabetes and hearing loss, have suggested varying and incongruous results. A study done by Meena R et al¹ reported that the mean hearing threshold in the pure tone audiometry was significantly higher at all frequencies, whereas, other study observed the

strongest association of hearing loss at the lowest frequency at 500 Hz.⁶ Even though there is a clear association of diabetes mellitus with other complications, there are still uncertainty in establishing its relationship with hearing dysfunction.⁷ Therefore, the aim of this study was to use pure tone audiometry to compare hearing threshold between patients with type 2 diabetes mellitus and age- and sex-matched controls.

MATERIALS AND METHODS

This was a case-control comparative study, conducted at the Department of ENT, Kathmandu Medical College from October 2019 to February 2020. The ethical approval for the study was taken from the Institutional Review Committee of Kathmandu Medical College Teaching Hospital, Sinamangal. The informed written consent was obtained from each participant. Those patients in the age between 35 to 55 years and who met the diagnostic criteria for type 2 diabetes (symptoms of diabetes and fasting plasma glucose ≥ 126 mg/dl) and symptoms of diabetes and 2-hour postprandial plasma glucose ≥ 200 mg/dl were included in the study. The patients with type 1 diabetes mellitus, gestational diabetes, or other specific types of diabetes, those with history of ear surgeries performed in the past and history of recent infection in the nose, throat or ear, family history of deafness, history of prolonged exposure to noise, use of ototoxic medications, other co-morbid conditions like hypertension, thyroid disorders, history of head injury, cerebrovascular accidents or radiotherapy were excluded from the study. Patients were grouped into cases like diabetes and controls as a non diabetic based on the history and the investigations provided by them.

The current study included 40 patients of type 2 diabetes mellitus from 35 to 55 years of age who met the above inclusion criteria. The control group included patients attending ENT OPD who were non- diabetic and presented with problems other than hearing loss. They were matched with the age and sex of the patients with diabetic group. The diabetic patients were further categorized into two groups according to the duration of diabetes as less than 5 years and more than 5 years duration.⁸ The duration of type 2 DM was taken with reference to the time the patient was first diagnosed to be diabetic.

Data was collected using questionnaires which include age, gender, family history of hearing loss, history of ear surgeries or trauma, duration of diabetes mellitus, and type of treatment. The patient’s hearing levels in decibel was assessed with Grason-Stadler Pello audiometer (Model 2064; Year 2018; serial number: GS0071070) in an acoustically treated soundproof room by an experienced audiologist who was blinded while performing PTA. Air conduction thresholds were measured for tones of 250, 500, 1000, 2000, 4000, and 8000 Hz. Bone conduction thresholds were measured for 250, 500, 1000, 2000, and 4000 Hz. At each frequency, an initial stimulus of 10 dB was given and then the level of the tone was increased in steps of 5 dB, presenting one pulse at each level until a response was obtained. The level at which the subject gave response after the raise of 5 dB was the threshold. The mean hearing loss was calculated through the pure tone average taken at 500 Hz, 1000 Hz, and 2000 Hz.¹

According to the WHO guidelines (1980), patients were categorized based on the degree of hearing loss into five groups

as mild (26-40 dB), moderate (41-55 dB), moderately severe (56-70 dB), severe (71-90 dB), and profound (>90 dB). The data was entered and analyzed using the Statistical Package for Social Science (SPSS version 22.0). The data were presented as mean \pm standard deviation. Student’s unpaired t-test was used to compare the hearing threshold between the diabetic group and healthy controls. A p-value ≤ 0.05 was considered as statistically significant.

RESULTS

Forty diabetes patients (18 males and 22 females) in the age range of 35-55 years and 40 age- and sex-matched healthy controls were included in the present study. The mean age for diabetes patients was 47.68 ± 5.66 years and healthy controls were 45.80 ± 6.43 years. The audiograms of the diabetic patients showed no air-bone gap indicating that the hearing loss was of the sensorineural type. Among diabetic patients group, 29 (72.5 %) had bilateral SNHL. Eleven diabetic patients had normal hearing. According to the WHO classification of mean pure tone average, diabetic patients in our study have mild hearing loss. (Table 1 and 2)

At all frequencies except at 250 Hz, the hearing thresholds of the diabetes group were higher than the control group for both right and left ear and the differences were statistically significant. The mean pure tone average was statistically significant in both ears of the diabetic group than the control group. (Table 1 and 2)

Table 1: Mean hearing thresholds and pure tone average in diabetics and control group in the right ear

Frequency (Hz)	Diabetics (n=40)	Control group (n=40)	p value
250 Hz	31.08 \pm 4.83	29.63 \pm 6.24	0.24
500 Hz	34.88 \pm 4.31	16.38 \pm 3.75	0.000
1000 Hz	34.00 \pm 4.69	19.25 \pm 3.49	0.000
2000 Hz	34.25 \pm 4.60	20.75 \pm 3.49	0.000
4000 Hz	41.25 \pm 6.95	36.63 \pm 3.98	0.001
8000 Hz	44.63 \pm 8.27	39.75 \pm 4.07	0.001
PTA	34.28 \pm 3.95	18.78 \pm 2.13	0.000

Table 2: Mean hearing thresholds and pure tone average in diabetics and control group in the left ear.

Frequency (Hz)	Diabetics (n=40)	Control group (n=40)	p value
250	31.00 \pm 4.69	28.75 \pm 5.96	0.06
500	34.75 \pm 3.74	17.25 \pm 3.19	0.000
1000	34.25 \pm 4.01	19.75 \pm 3.57	0.000
2000	35.00 \pm 4.08	20.63 \pm 3.78	0.000
4000	41.38 \pm 6.79	37.13 \pm 6.39	0.005
8000	45.13 \pm 8.28	39.00 \pm 6.90	0.001
PTA	34.58 \pm 3.21	19.30 \pm 2.58	0.000

Table 3 shows that there was a significant difference in the hearing thresholds at 4000 and 8000 Hz between patients with a short duration of type 2 diabetes (≤ 5 years) versus a long duration (>5 years).

Table 3: Mean hearing threshold in diabetes according to the duration of disease

Frequency (Hz)	Duration of diabetes		p value
	≤5 years (n=16)	>5 years (n=24)	
250	30.31 ± 5.90	31.58±4.03	0.42
500	34.13 ± 5.12	36.04 ± 3.29	0.06
1000	33.44 ± 5.39	34.38 ± 4.25	0.54
2000	32.81 ± 5.46	35.21 ± 3.75	0.10
4000	38.44±7.46	43.13±6.04	0.03
8000	40.31±7.84	47.50±7.37	0.005

DISCUSSION

The present study showed sensorineural hearing loss in 72.5 % of type 2 diabetic subjects. A higher prevalence of 76.8% sensorineural hearing loss was seen in a study done by Tiwari A et al in India.⁹ Similar comparable prevalence result was reported by Rajendran et al as 73.3%.¹⁰ However, our results are quite high as compared to those of Meena R et al¹ (58%) and Mozaffari M et al¹¹ (45%). These variations in the prevalence rates can be explained by the fact that different studies have different sample sizes with variations in the duration of the study period. There are also differences in the age group included in various studies. Diabetes patients in our study had mild hearing loss and the mean PTA was around 34 dB in both ears. A similar finding of mild hearing loss was seen in the study done by Cayonu M et al.¹²

In our study, the auditory threshold in the pure tone audiometry was significantly higher in all the frequencies except at 250 Hz in diabetic patients in comparison to the healthy controls for both right and left ear. Similar results were observed in other studies.^{1,7,13} In one study done in Iran, 1500 diabetes patients had significant hearing loss in high frequencies (4000-8000 Hz) as compared to those of control groups and the hearing loss was more in complicated diabetic patients.⁴ The probability of hearing loss in patients with diabetes is twice as high as in healthy people suggesting hearing loss as a complication of diabetes.¹⁴

In this study, the mean hearing threshold was significantly higher at 4000 Hz and 8000 Hz in diabetic patients with the duration

of diabetes for more than 5 years. According to Ozkurt FE et al, it takes at least 5 years after the diagnosis of diabetes to show the effect on hearing threshold.¹⁴ On contrary to these findings, the studies done in India reported that the duration of diabetes had no impact on the hearing threshold in diabetic patients.^{1,13} It is postulated that the duration of poor glycemic control is more important than the duration of diabetes mellitus itself.¹³ Our findings agree with the study conducted by Isa et al¹⁵ and Lasisi et al¹⁶ who found a correlation between the duration of DM and the development of hearing impairment. The probable reasons for the higher frequency being affected might be due to accelerated atherosclerosis and thickening of the basement membrane, which results in decreased blood flow to cochlea leading to cell degeneration and loss of high frequency sounds.¹⁷

There are some limitations to our study. Firstly the sample size taken was small and the cases included in the study may not be representative of the Nepalese population. A more extensive study involving a larger sample size and wide geographical area is necessary. Secondly, pure tone audiometry which was used to determine the hearing loss depends on the patient response which is a subjective test. Few patients with diabetes mellitus in our study did not show any hearing impairment. We were unable to explain this as subclinical hearing impairment cannot be excluded. Thirdly, whether diabetes mellitus was under controlled or uncontrolled with the treatment was not considered in the study which affects the development of hearing loss in diabetic patients.

CONCLUSIONS

Diabetes mellitus was associated with mild sensorineural hearing loss. The hearing thresholds were significantly affected in higher frequencies in diabetes patients when compared with age- and sex-matched healthy controls.

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