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Original Research Article

Auditory acuity in type II diabetes mellitus patients vs healthy individuals: a comparative study

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ABSTRACT

Background: There is an unprecedented rise in the number of patients being diagnosed with type II diabetes mellitus. The end organ damage associated with uncontrolled diabetes is well-known and has been the focus of attention of the treating physician. Less dramatic consequences such as subtle hearing loss and cochlear damage is usually the neglected part of the management of these patients. We conducted this study to compare the degree of auditory loss in patients with type 2 diabetes mellitus and healthy individuals of same age with the help of pure tone audiometry.
Methods: This was a case control study in which 130 type II diabetis patients (Group A) and 130 normoglycemic individuals (Group B) were included. Pure tone audiometry was done in all the patients. Cochlear response to audiometry, air conduction and bone conduction of both the ears were determined.
Results: Patients with diabetes were found to be affected by sensori-nerural hearing loss more commonly than healthy individuals and the difference was found to be statistically highly significant (p=0.0001). Also there was statistically significant difference in threshold of air and bone conduction in both the groups (p=0.0001).
Conclusions: Type II diabetes mellitus is found to be associated with increased incidence of auditory loss. ENT specialists need to be aware of possibility of subtle hearing loss in these patients so as to be able to detect it at an early stage and prevent progression of hearing loss to a significant level.

Keywords: Type II diabetes, Pure tone audiometry, Auditory loss, Early diagnosis

INTRODUCTION

With rapid urbanization and changing life styles there appears to be a pandemic of type 2 diabetes gripping the world. Diabetes mellitus is a multisystem clinical syndrome characterized by hyperglycemia, due to deficiency or diminished effectiveness of insulin.[1] While deficiency of Insulin is the basic mechanism in type I diabetes resistance to insulin action is responsible for type II diabetes mellitus. Despite control of blood sugar level by various drugs it appears that metabolic and microvascular complications are inevitable. The well-known complications of diabetes include nephropathy, retinopathy and peripheral neuopathy.[2] It is one of the major risk factors for cardiovascular morbidity and mortality. The relationship between sensori-neural hearing loss and type 2 diabetes mellitus has been studied since 1857, when Jordao reported one case of hearing impairment associated with incipient diabetic coma[3].The long standing metabolic derangement of diabetes mellitus is frequently associated with permanent and irreversible functional and structural changes in the cells of the body, those of the vascular system being particularly susceptible. The changes lead in turn to the development of well-defined clinical entities, the so called complications of diabetes, which most characteristically

affect the eye, the kidney, nervous system, cardio-vascular system and hearing[4]. The individuals with type 2 diabetes are at a higher risk of development of auditory complications such as secondary neuropathy, cell damage, acclereated atherosclerosis and vasculitis. Diabetes mellitus may be associated with damage to cochlear cells and also may cause injury to spiral ganglion neurons, organ of Corti and stria vascularis. This may explain symptoms such as giddiness and tinnitus in addition to hearing loss.[5]

There is no uniformity in which the hearing is impaired in patients with diabetes mellitus and while some patients may have progressively severe sensoneural hearing loss others appears to be not affected at all. Though there are many studies which have reported a causal link between hyperglycemia and age-related hearing loss it is very difficult to establish the correlation between diabetes control and incidence of deafness.[6] The difficulty in establishing or even understanding the relationship between diabetes and hearing loss is because of the presence of confounding factors such as physiological decline in hearing with age and the difficulty in attributing with confidence the hearing impairment to diabetes and its complications.[7]

The diagnosis and management of hearing impairment in these patients largely remains neglected and all the time, energy and efforts are usually utilised for the management of diabetes itself. It is prudent therefore to diagnose deafness and manage it so as to prevent severe hearing impairment leading to immense socio-economic consequences.[8] Therefor it is important for ENT surgeons to be aware of this complication and auditory functions must be tested in patients with diabetes so as to be able to diagnose hearing impairment at an early stage so as to be able to prevent further deterioration by appropriate interventions.[9]

We conducted this study to compare the degree of auditory loss in patients with type 2 diabetes mellitus and healthy individuals of same age with the help of pure tone audiometry.

METHODS

This was a case control study in which 130 type II diabetes patients and 130 normoglycemic individuals were included on the basis of a predefined inclusion and exclusion criteria. The study was conducted in the department of ENT of Bharati Vidyapeeth (deemed to be university) Medical College and Hospital, Sangli, Maharashtra after obtaining ethical committee approval. A detailed history was taken in all the patients. The duration of diabetes and presence of other systemic illnesses such as hypertension was noted. If the patients were on oral hypoglycemic drugs or on insulin then it was also noted. General and systemic examination was done in all the cases. Systematic examination of the ears, nose and throat was done in all the cases. Routine investigations including blood sugar level, complete blood count and glycosylated hemoglobin was done in all the cases. Audiometry was carried out in all patients. Cochlear response to audiometry, air conduction and bone conduction of both the ears were determined. Statistical analysis was done using SSPE 16 software. P value of less than 0.05 was taken as statistically significant.

Audiometry

Audiological examination was performed using an ARPHI pure tone audiometer (mark IV model 700), in a sound proofed room of audiology. Each ear was tested for the frequency range 250 Hz to 8000 Hz. for air conduction and 250 Hz. to 4000 Hz. for bone conduction. Patients were instructed to raise the index finger or press the indicator switch, on the slightest sound of the audiometer.

Audiometric analysis

- The mean air conduction thresholds and mean bone conduction thresholds for each frequency were calculated.
- The mean air conduction threshold of both ears were calculated
- The mean hearing threshold for speech frequency (500 Hz. to 2000 Hz.) of both ears was calculated.

Inclusion criteria

Inclusion criteria were person having fasting blood sugar level more than 140 mg/dl and postprandial blood sugar level of 200 mg/dl on at least two separate occasions was labelled as diabetic and 130 such patients were included in Group A whereas 130 patients with normal blood sugar levels were included in group B; age group of 35-55 years; normal mental status; well controlled blood sugar level; patients having normal blood pressure and normal renal function tests; patients giving informed consent to be part of the study.

Exclusion criteria

Exclusion criteria were Cochlear symptoms prior to onset of diabetes; family history of hearing loss, h/o excessive noise exposure; patients with middle ear pathology from this study; patients on long term ototoxic drugs.

RESULTS

Out of total 260 individuals enrolled in this study there were 143 (55%) males and 117 (45%) females with a M:F ratio of 1:0.76 (Figure 1).

Age distribution of the studied cases showed that the most common age group in Group A (diabetes mellitus type II) was 46-50 years (16.54%) followed by 41-45 years (16.15%) and 51-55 years (14.23%). In group B

(normal individuals) the most common age group was found to be 51-55 years (17.31%) followed by 46-50 years (15.38%) and 41-45 years (13.85%). The mean age of group A and group B was found to be 47.13±4.97 and 47.52±5.03 respectively. The age groups were found to be comparable and there was no statistically significant difference in mean age of both the groups (p=0.53) (Table 1).

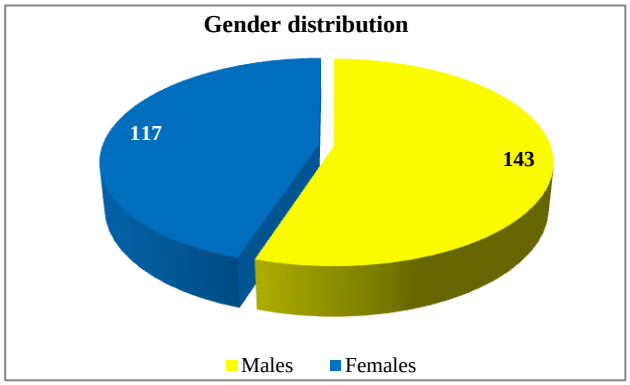

Figure 1: Gender distribution amongst the studied cases.

Table 1: Age group of the studied cases.

Age group (in years)	Group A		Group B	
	No. of patients	%	No. of patients	%
35-40	8	3.08	9	3.46
41-45	42	16.15	36	13.85
46-50	43	16.54	40	15.38
51-55	37	14.23	45	17.31
Total	130	50	130	50
Mean age	47.13±4.97		47.52±5.03	

Table 2: Mean fasting and postprandial blood sugar levels in both the groups.

	Group A	Group B	Significance
Fasting	174.26± 48.12	82.12±8.74	P≤0.0001 significant
Post prandial	248.32± 72.22	110.24± 12.02	P≤0.0001 significant

The analysis of mean blood sugar levels of both the groups showed that the mean fasting blood sugar level in group A and group B was 174.26±48.12 82.12±8.74 respectively. Whereas mean post prandial blood sugar level in group A and group B was 248.32±72.22 and 110.24±12.02 respectively. The difference in fasting and postprandial mean blood sugar levels was found to be statistically significant (p<0.0001) (Table 2).

The analysis of cochlear response to audiometry showed that in group B (non-diabetic individuals) there was presence of mild sensorineural hearing loss at speech frequency in 13 (10%) patients and there was no patient with moderate or severe sensorineural hearing loss. Whereas all patients had some degree of hearing loss in group A (diabetics). Out of 130 patients in group A 43 patients were found to have mild sensorineural hearing loss whereas moderate and severe hearing loss was seen in 57 and 8 patient respectively. Patients with diabetes were found to be affected by sensori-nerural hearing loss more commonly than healthy individuals and the difference was found to be statistically highly significant (p=0.0001) (Figure 2).

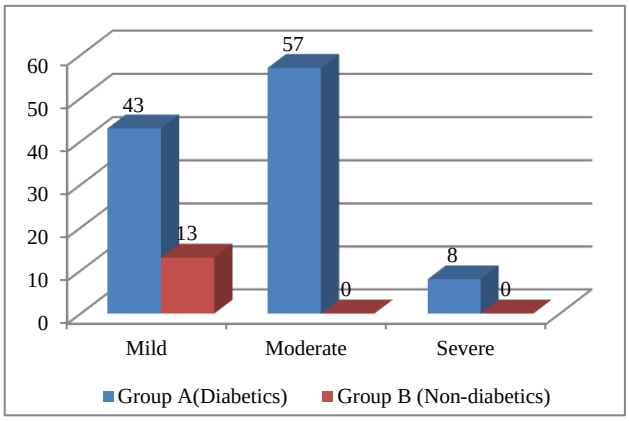

Figure 2: Sensori-neural hearing loss at speech frequency in both the groups.

Table 3: Air conduction in right ear in both the groups at different frequencies (n=130).

Freq Hz	Diabetic group		Control group		P value (Significant)
	Mean	S.D.	Mean	S.D.	
250	9.0	4.0	4.3	3.1	<0.0001
500	13.0	8.2	4.1	2.6	<0.0001
1000	15.6	8.7	6.3	4.5	<0.0001
2000	16.0	10.6	6.6	5.4	<0.0001
4000	16.8	12.4	7.0	4.9	<0.0001
6000	18.33	12.5	7.6	5.8	<0.0001
8000	22.5	13.9	9.3	7.4	<0.0001

The analysis of air conduction threshold in right ear showed that there was an increased incidence of hearing loss in almost all frequency levels and the difference in group A and group B was found to be statistically significant at all frequencies (Table 3).

Table 4: Bone conduction in right ear in both the groups at different frequencies (n=130).

Freq Hz	Diabetic group		Control group		P value (Significant)
	Mean	S.D.	Mean	S.D.	
250	7.1	4.5	4.1	3.0	<0.0001
500	13.0	8.2	4.0	2.6	<0.0001
1000	15.6	8.3	6.8	4.7	<0.0001
2000	17.0	9.7	7.3	5.2	<0.0001
4000	17.8	12.7	7.1	5.2	<0.0001

Similarly bone conduction in right ear also showed that there was an increased incidence of hearing loss in almost all frequency levels and the difference in group A and group B was found to be statistically significant at all frequencies (Table 4).

Table 5: Air conduction in left ear in both the groups at different frequencies (n=130).

Freq Hz	Diabetic group		Control group		P value (Significant)
	Mean	S.D.	Mean	S.D.	
250	7.0	4.7	4.1	3.0	<0.0001
500	13.6	6.1	4.0	2.5	<0.0001
1000	15.1	8.8	6.1	4.3	<0.0001
2000	18.3	10.4	6.6	5.2	<0.0001
4000	20.0	12.2	6.8	4.8	<0.0001
6000	22.1	13.7	7.5	5.6	<0.0001
8000	25.3	15.3	9.1	7.2	<0.0001

The analysis of air conduction threshold in left ear showed that there was an increased incidence of hearing loss in almost all frequency levels and the difference in group A and group B was found to be statistically significant at all frequencies (Table 5).

Table 6: Bone conduction in left ear in both the groups at different frequencies (n=130).

Freq Hz	Diabetic group		Control group		P value (Significant)
	Mean	S.D.	Mean	S.D.	
250	7.1	4.5	4.0	2.9	<0.0001
500	12.1	6.9	3.8	2.6	<0.0001
1000	16.0	9.1	7.1	4.5	<0.0001
2000	18.5	11.8	6.8	5.4	<0.0001
4000	19.5	13.4	7.0	5.2	<0.0001

Similarly bone conduction in left ear also showed that there was an increased incidence of hearing loss in almost all frequency levels and the difference in group A and group B was found to be statistically significant at all frequencies (Table 6).

DISCUSSION

This study comprised of 130 patients having type II diabetes mellitus that were included in group A (Cases group). 130 ages matched healthy individuals were included in group B (control group). Mean blood sugar levels and air and bone conduction (in right and left ears) were analysed and compared.

The mean age in cases and control group was found to be 47.13±4.97 and 47.52±5.03 respectively. The age groups were comparable and there was no statistically significant difference in the mean age of the patients in cases and control group. Similarly the analysis of fasting and postprandial blood sugar levels in both the groups showed that the difference in fasting and postprandial mean blood sugar levels were statistically significant ($p<0.0001$).

Out of 130 patients in group A 43 patients were found to have mild sensorineural hearing loss whereas moderate and severe hearing loss was seen in 57 and 8 patient respectively. The difference was found to be statistically significant. Kakarlapudi et al in a retrospective database review comprising of 53461 nondiabetic age-matched patients and 12575 diabetic patients found that Sensorineural hearing loss was more common in patients with diabetes than in the nondiabetic patients.[10] Moreover the authors found that the severity of hearing loss correlated with progression of disease as reflected by rising serum creatinine level. The authors attributed this to microangiopathic disease in the inner ear. Similar increased incidence of sensoneural hearing loss in diabetic patients was reported by the authors such as Weng et al and Srinivas et al.[11,12] In one of the significant study Misra et al reported that even early diabetic patients without symptoms of hearing loss had mild bilaterally symmetrical purely sensorineural hearing loss (32.65%) signifying the diabetic hypoacusis is present significantly even in early aural symptomless diabetics.[13]

In our study the analysis of air conduction threshold in right as well as left ear showed that there was an increased incidence of hearing loss in almost all frequency levels in diabetic patients. Nemati et al conducted a cross sectional study of 104 patients with type II diabetes. One group consisted of 52 patients with poor control and the other consisted of patients with moderate-to-good control (according to glycated hemoglobin [HbA1c] level). All subjects underwent pure tone audiometry (PTA) and distortion product otoacoustic emission (DPOAEs) assessments. A hearing threshold higher than 20 dB and a signal-to-noise ratio ≤3 in each frequency were considered abnormal. The authors founs that poorly controlled patients showed more frequent hearing loss compared with the well-controlled group, especially at higher frequencies. On the basis of these findings the authors concluded that poor control status of diabetes can affect hearing sensation and cause hearing loss, especially at high frequencies.[14] Konrad-Martin et al in their study of 130 patients of type II diabetes found that uncontrolled diabetes had significant differences in hearing at speech frequencies, including poorer hearing by 3 to 3.5 dB for thresholds at 250 Hz. The authors concluded that tight control of blood sugar levels may prevent or delay the onset of hearing loss in patients with type II diabetes.[15]

CONCLUSION

Type II diabetes mellitus is found to be associated with increased incidence of auditory loss. It is important for ENT specialist to be aware of possibility of subtle hearing loss in patients with type II diabetes so as to be able to detect it at an early stage and prevent progression of it to a significant level.

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REFERENCES

1. Wilcox G. Insulin and insulin resistance. Clin Biochem Rev. 2005;26(2):19-39.
2. Papatheodorou K, Papanas N, Banach M, Papazoglou D, Edmonds M. Complications of Diabetes 2016. J Diabetes Res. 2016;2016:6989453.
3. Jordao AMD. Consideration sur un cas du diabete. Union medicale du Paris. 1857;11:446.
4. Lichtenauer UD, Seissler J, Scherbaum WA. Diabetic complications. Micro and macro-angiopathic end-organ damage. Internist (Berl). 2003;44(7):840-6.
5. Wong AC, Ryan AF. Mechanisms of sensorineural cell damage, death and survival in the cochlea. Front Aging Neurosci. 2015;7:58.
6. Michikawa T, Mizutari K, Saito H, Takebayashi T, Nishiwaki Y. Glycosylated hemoglobin level is associated with hearing impairment in older Japanese: the Kurabuchi Study. J Am Geriatr Soc. 2014;62(7):1231-7.
7. Bielefeld EC, Tanaka C, Chen GD, Henderson D. Age-related hearing loss: is it a preventable condition? Hear Res. 2009;264(1-2):98-107.
8. Helzner EP, Contrera KJ. Type 2 Diabetes and Hearing Impairment. Curr Diab Rep. 2016;16(1):3.
9. Hao J, Fu X, Zhang C, Zhang X, Zhao S, Li Y. Early detection of hearing impairment in patients with diabetes mellitus with otoacoustic emission. A systematic review and meta-analysis. Acta Otolaryngol. 2017;137(2):179-185.
10. Kakarlapudi V, Sawyer R, Staecker H. The effect of diabetes on sensorineural hearing loss. Otol Neurotol. 2003;24(3):382-6.
11. Weng SF, Chen YS, Hsu CJ, Tseng FY. Clinical features of sudden sensorineural hearing loss in diabetic patients. Laryngoscope. 2005;115(9):1676-80.
12. Srinivas CV, Shyamala V, Shiva Kumar BR. Clinical Study to Evaluate the Association Between Sensorineural Hearing Loss and Diabetes Mellitus in Poorly Controlled Patients Whose HbA1c >8. Indian J Otolaryngol Head Neck Surg. 2016;68(2):191-5.
13. Misra V, Agarwal CG, Bhatia N, Shukla GK. Sensorineural deafness in patients of type 2 diabetes mellitus in uttar pradesh: a pilot study. Indian J Otolaryngol Head Neck Surg. 2012;65(3):532-6.
14. Nemati S, Hassanzadeh R, Mehrdad M, Sajedi Kia S. Hearing Status in Patients with Type 2 Diabetes Mellitus According to Blood-Sugar Control: A Comparative Study. Iran J Otorhinolaryngol. 2018;30(99):209-218.
15. Konrad-Martin D, Reavis KM, Austin D, Reed N, Gordon J, McDermott D, et al. Hearing Impairment in Relation to Severity of Diabetes in a Veteran Cohort. Ear Hear. 2015;36(4):381-94.

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