A Study on Hearing Impairment in Type 2 Diabetes Patients in Comparison to Normal Using Pure Tone Audiometry

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KEYWORDS

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ABSTRACT

Introduction: Pure-tone audiometry is a psychoacoustic test based on hearing thresholds, frequency-modulated sound. Both air and bone conduction thresholds are tested with PTA. this is a case-control study to determine hearing loss with T2DM and those without T2DM about age, BMI, and duration of diabetes using PTA

Aim and Objectives: To study the effect of type 2 diabetes on auditory structures through PTA in comparison with controls

Materials and Methods: Patients with type 2 diabetes with hearing impairment, both gender was included with an age limit between 30-60 years; minimum duration of diabetes after the diagnosis was 7 years and also 30 normal subjects as controls.

Results: There is no statistically significant relation regarding age distribution in between the groups(P-value>0.05). There is no statistically significant relation regarding sex distribution in between the groups(P-value>0.05). There is a statistically significant relation regarding blood glucose levels between the groups(P-value<0.05). There is a highly significant relation between PTA of control group and T2DM group indicating that the altered blood sugar levels have an impact on auditory threshold.

Introduction:

Diabetes is a metabolic disorder caused by either insulin deficiency or insulin resistance. It is a lifelong disease with many pathological changes in patients. Chronic hyperglycemia causes nephropathy, retinopathy, neuropathy and cardiovascular disease. All disorders of the hearing mechanism lead to hearing loss. Therefore, hearing measurement is necessary to determine the extent and type of hearing loss, which helps to make decisions about rehabilitation and preventive measures. Tests used for this purpose include pure-tone audiometry. Pure-tone audiometry is a psychoacoustic test based on the determination of hearing thresholds, which is tested at a single frequency. It requires the active participation of the participant; if the participant misunderstands the instructions, this can lead to mistakes. This can be determined with a pulse or frequency-modulated audiometer. Both air and bone conduction thresholds are tested with pure tone audiometry; air conduction tests the entire auditory system, while bone conduction tests the function of the inner ear and auditory nerve.[1] T2DM affects all body systems, including the auditory system, and causes sensorineural hearing loss with difficulties in hearing and understanding speech.[2] Knowing your hearing status and preventing further damage therefore requires a hearing evaluation. Thus, this study is a case-control study to determine hearing loss in patients with T2DM and non-T2DM about age and blood glucose levels using pure-tone audiometry.

Aim and Objectives: To investigate the effects of type 2 diabetes on the auditory structures and pathway using pure-tone audiometry compared to normal subjects.

Materials and Methods:

This case-control study was conducted in a tertiary care hospital in Vikarabad. Participants were included in the study after obtaining informed consent, and the study population was divided into two groups: normal subjects (n = 30), and hearing-impaired subjects with T2DM (n = 30) were included. Patients with type 2 diabetes (WHI) with hearing impairment, both sexes, age range was 30-60 years; the minimum duration of diabetes since diagnosis was 7 years, and 30 normal subjects were also included as controls. The control group consisted of normal subjects with no hearing problems and without diabetes. The degree of hearing loss is classified as: mild hearing loss (26 dB HL - 40 dB HL), moderate hearing loss - (41 dB HL - 55 dB HL), moderate hearing loss - (56 dB HL) - 70 dB HL), Severe hearing loss (71 dB HL to 90 dB HL) and Profound hearing loss > 91 dB HL. All patients underwent a thorough otorhinolaryngological examination, with particular attention to a detailed examination of the ear, spine, preauricular region, external auditory canal and tympanic membrane. The subjects' cranial nerves were examined. Hearing acuity was checked at the bedside (Rinne test, Weber test, modified Schwabach test, fistula test) and an anterior examination, posterior examination, and oropharyngeal examination were also performed. In addition, pure-tone audiometric tests were performed.

Results:

Table 1: Age distribution of the study population

Age in years	T2DM Group (N=30)	Control Group (N=30)
31-40 YEARS	8	8
41-50 YEARS	12	12
51-60 YEARS	10	10

There is no statistically significant relation regarding age distribution between the groups(P-value>0.05) (Table 1).

Table 2: Sex distribution of the study population

Sex	T2DM Group (N=30)	Control Group (N=30)
MALE	17	16
FEMALE	13	14

There is no statistically significant relation regarding sex distribution between the groups(P-value>0.05) (Table 2).

Table 3: Blood sugar levels in the study population

	Control group	T2DM group	P-value
FBS	82.00±10.06	168.58±58.62	<0.05
PPBS	110.08±6.52	262.64±94.04	<0.05

There is a statistically significant relation regarding blood glucose levels between the groups(P-value<0.05) (Table 3).

Table 4: One-way analysis of variance of PTA in normal and T2dm group

Parameter	Ear	Control Group	T2DM group	P-value
PTA in decibels	RIGHT	5.340±0.694	34.649±0.878	<0.001
	LEFT	7.680±0.819	36.161±0.681	<0.001

There is a highly significant relation between pure tone audiometry of the control group and T2DM group indicating that the altered blood sugar levels have an impact on the auditory threshold (Table 4).

Discussion:

Jordao first identified diabetic hearing loss in case series studies in 1857 Shafeeq et al,. In T2DM, many audiometric studies have described progressive, bilateral and mild to moderate sensorineural hearing loss at higher frequencies.[3-5] T2DM has adverse effects on the auditory system and other systems, so awareness of changes in the auditory system in diabetes is important Wolfe et al,. In this study, pure tone averages were increased in both ears of the WHI

group compared to normal subjects, similar findings to previous studies consistent with this study.[6,7] Although other researchers have observed hearing loss in diabetes, other factors such as noise, ototoxic drugs, duration of disease, metabolic control, and the presence and degree of complications and presbycusis affect both glucose metabolism and the internal. ear function Therefore, it is difficult to find a link between hearing loss and diabetes.[8] Some researchers have shown that there are important differences between the two sexes in terms of hearing loss and audiological tests, which have not been observed; However, the proportion of men with SNHL was slightly higher than that of women with SNHL. Previous studies comparing men and women found no gender differences in audiological tests.[6,9,10] Although audiometry is used to know the sensitivity of hearing and hearing loss, it is not enough to detect hearing problems in the early stages of diabetes, so we need electrophysiological tests such as brain stem hearing sensitivity and otoacoustic emissions.[11] This study can help doctors screen all elderly and newly diagnosed diabetics with pure tone audiometry, even if the patient has no complaints. Rajendran et al., reported equal prevalence in both sexes (typically, the asymmetry between left and right ear auditory functions occurred peripherally and centrally. The right ear is more sensitive to processing simple sounds and even complex sounds than the left ear, due to the peripheral and central advantage of the right ear, this is a reduced advantage with increasing age[12] and also due to T2DM, because it damages the vascular endothelium, which reduces blood flow to the right ear, causing the right ear advantage to interfere.[13] In the WHI group, the average differences in pure tone between the right and left ears were not, this may be due to systemic diabetic changes resulting in symmetrical hearing loss in both ears.[14] In this study, pure tone averages were not statistically correlated with age for either ear. WHI cohorts and this finding is consistent with a previous study.[15] However, findings on the effect of age on the association between diabetes and hearing loss have been conflicting. Diabetes Age-independent changes in glucose metabolism affect the auditory system and hearing.[16] Duration of diabetes is not associated with increased hearing threshold in the WHI group. The results of this study are consistent with previous studies[9,17], but conflicting results were also found in some studies where it was stated that the hearing threshold increases as the duration of diabetes increases.[18,19] Recent large epidemiological studies have shown that diabetes is associated with early onset of hearing loss, showing a higher pure threshold at a younger age compared to controls.[2,8,20] Orita et al, showed that the thickness of the wall of cochlear vessels was greater in patients with type 2 diabetes receiving insulin therapy than those receiving oral hypoglycemic drugs. In such situations, administration of vasodilators, corticosteroids, vitamin B12 and hyperbaric oxygen therapy results in better recoveries from idiopathic sudden onset in patients with diabetes mellitus Orita et al, 2007. In this study, pure-tone averages were not statistically correlated with BMI in both ears of the WHI group, indicating that without an increase in BMI, the chance of hearing loss increases in T2DM patients. This result is consistent with the study of who found that BMI was not a favourable predictor of age-related hearing loss, and BMI may be substituted as a covariate for obesity in future epidemiological studies. active metabolic parameters with a better ability to predict age-related hearing loss than BMI.[21] In this study, BMI was correlated with PTA values in all subjects.

Some previous studies mentioned that increased BMI impairs auditory function in patients with T2DM.[2,22,23] Some studies have found an association between diabetes, obesity and BMI.[24] If the BMI is elevated, it indicates obesity. This causes insulin resistance and releases large amounts of non-esterified fatty acids, glycerol, hormones, and pro-inflammatory cytokines, which contribute to the development of T2DM. Increases in BMI and development of T2DM suggest some genetic contribution to environmental factors. Previous studies mentioned that diabetes and hyperlipidemia were independent risk factors for sensory neural disease. hearing loss and that the combination of the two had the greatest effect on hearing. The incidence of hearing loss was higher in diabetic patients with hyperlipidemia, which may be due to vascular complications caused by diabetic dyslipidemia Swaminathan et al,. Lipoproteins are glycated, which predisposes them to atherosclerosis. Advanced glycation end products (AGE) bind to

macrophage receptors and stimulate them to secrete interleukin-1 (IL-I) and tumour necrosis factor (TNF), causing vessel wall damage, leading to microvascular disease, atherogenesis and macrovascular disease. Saturated fatty acids may play a role in determining dysmetabolic status in some patients with sensorineural hearing loss. Hearing loss depends on diabetes treatment. Various parameters such as FBS, PPBS and HbA1c are used to detect diabetes control; they vary more with the higher frequencies of the sound than with the lower frequencies of the sound. In this study, HbA1c is considered to describe diabetes control. In this study, pure tone means were not statistically correlated with HbA1c for ears in either WHI group and this finding is consistent with a study by Rajendran et al, who found that glycaemic control did not change hearing sensitivity Rajendran et al. In this study, HbA1c values were correlated with PTA values in all subjects. This result is consistent with previous studies [9,10] and inconsistent with other studies. Although audiometry is used to know the sensitivity of hearing and hearing loss, it is not enough to detect hearing problems in the early stages of diabetes, so we need electrophysiological tests such as brain stem hearing sensitivity and otoacoustic emissions.[11,25] This study can help doctors screen all elderly and newly diagnosed diabetics with pure tone audiometry, even if the patient has no complaints.

Conclusion:

The hearing threshold increased in the diabetic group compared to the control group. Prediabetes, diabetics and doctors should consider the importance of regular hearing screening for patients. Because early detection of hearing loss can delay the onset of diabetes and complications of hearing loss.

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Declarations

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Conflict of Interest: All authors clearly stated that they do not have any conflicts of interests.

Data availability:

Usually , the sets of data are created during and / or analysed throughout the entire study and are available from the corresponding author on reasonable request.

Ethics approval:

The ethical approval was aquired from institutional ethical committee of mahavir institute of medical sciences MIMS/TEC/36/January /2020.

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ABBREVIATIONS

PTA : Pure Tone AUDIOMETRY
T2DM : Type 2 Diabetes Mellitus
HbA1C : Hemoglobin A1C
Non T2DM : Non Type 2 Diabetes Mellitus
WHI : With Hearing Impairment
dB : Decibel
HL : Hearing Loss
SNHL : Sensori neural Hearing Loss
BMI : Body Mass Index
AGE : Advanced Glycation End Products
FBS : Fasting Blood Sugar
PPBS : Post Prondial Blood Sugar
TNF : Tumor Necrosis Factor