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Correlation of body mass index with pure tone average values in type 2 diabetes mellitus

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Abstract

Background: Assessment of hearing is important to know the type, extent of hearing impairment in diabetics which helps to take decisions on rehabilitative and preventive measures. **Objectives:** Present study is focused on relationship between body mass index (BMI) with pure tone average (PTA) values in type 2 diabetics. **Materials and methods:** Type 2 diabetic patients with (WHI) and without (WoHI) hearing impairment, both the gender was included with age limit between 35-55 years and also ten normal subjects were included as controls. Pure tone average (PTA) is the average of hearing threshold levels at the frequencies 500Hz, 1000Hz, 2000Hz and 4000Hz. This value gives information about an individual's hearing level in each ear. **Statistical analysis:** All the data were expressed as mean ± SE. The mean were analyzed by one way ANOVA. Pearson correlation test was done to see the relationship between right and left ear PTA values in normal subjects, WoHI and WHI groups with BMI values. **Results:** The right ear of WoHI (P= 0.716) and WHI (P=0.474) group and left ear of WHI (P=0.399) group shows negative correlation with BMI. **Conclusion:** The PTA is useful to know the status of hearing sensitivity and type, severity of the hearing impairment in the T2DM patients. The BMI values are correlated with PTA values in all subjects.

Key words: BMI, pure tone average, type 2 diabetes, WHI, WoHI.

Introduction

Type 2 diabetes mellitus (T2DM) affects all systems in the body including auditory system and results as sensorineural hearing impairment with difficulty in hearing and understanding of speech [1]. So it requires hearing assessment to know the status of hearing and to prevent the further damage. The present study is carried out as cross sectional study with and without hearing impairment to determine the hearing loss in T2DM with pure tone audiometry in relation to the BMI.Pure tone audiometry is commonly used to assess hearing impairment and is a psychoacoustic test and based on determining the thresholds of hearing and it is tested at a single frequency. Both air conduction and bone conduction thresholds are tested in pure tone audiometry; air conduction tests the performance of the whole auditory system, whereas bone conduction tests the performance of the inner ear and auditory nerve [2].

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Materials

Study design: It is a cross-sectional study.

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Inclusion criteria: The present study was carried out after getting the ethics committee approval (FWA 00002084; dated 16/03/2015). Type 2 diabetic patients with hearing impairment (WHI) (n=50) and without hearing impairment (WoHI) (n=50), both the gender was included with age limit between 35-55 years; minimum duration of diabetes after the diagnosis was 5 years and also ten normal subjects were included as controls. The participants were enrolled in the study after acquired the informed consent.

Exclusion criteria: Participants who had a history of immune/metabolic diseases like hyperbilirubinaemia/ kernicterus, type 1 diabetes, anoxia/hypoxia, sarcoidosis, rheumatoid arthritis, uraemia, Guillain-Barré Syndrome; chronic infections like Leprosy, AIDS, Borreliosis, Ramsey Hunt syndrome; using heavy metals like lead, cobalt, mercury; drugs like carboplatin, methyldopa and reserpine; neoplasma / intracranial cystic lesions, chronic middle ear diseases, cranial trauma, ear surgeries, recent surgeries, congenital problems, noise exposure, smoking, alcoholism, hypertension, stroke and hepatic encephalopathy were excluded from the study.

Methods

Calculation of BMI: Height and weight were measured on the subjects in standing position. The weighing scales and the measuring tapes were calibrated periodically. BMI was calculated from the formula, BMI = weight (kg) / height^2 (mts). BMI normal values are below 18.5 (underweight), 18.5-24.9 (normal), 25.0-29.9 (pre obesity), 30.0-34.9 (obesity class I), 35.0-39.9 (Obesity class II) and Above 40 (Obesity class III).

Measurement of pure tone average (PTA): Pure tone audiometry is the basic subjective audiological evaluation that assists to rule out the presence or absence of hearing loss with testing the air conduction (AC) and bone conduction (BC) mechanisms in both the ears and is carried out in a sound attenuated room. The obtained results are plotted as decibels in graph called audiogram; it serves to establish severity of hearing loss. In the present study pure tone audiometry is done by using instrument "Elkon 3N3 multi diagnostic audiometer with TDH-49 P headphones and B71 RADIO EAR bone vibrator". The stimulus used is pure tone, continuous in nature and method is Hughson-Westlake descending method. Pure tone average (PTA) is the average of hearing threshold levels at the frequencies 500Hz, 1000Hz, 2000Hz and 4000Hz. This value gives information about an individual's hearing level in each ear and these frequencies are considered to be most important for understanding speech. It is calculated by pure tone audiometry.

Statistical analysis: All the data were expressed as mean ± SE. The mean were analyzed by one way ANOVA (Student-Newman-Keuls method). Pearson correlation test was done to see the relationship between right and left ear PTA values with BMI and HbA1c values in normal subjects, WoHI and WHI groups. For all the statistics and graph plotting, SigmaPlot 13.0 (Systat software, USA) was used. P <0.05 was considered as significant.

Results

The comparison of PTA values was done by one way analysis of variance in normal subjects, WoHI and WHI groups with their mean and standard error of mean represented in table - 1 and in figure - 1. PTA values of WHI group showed statistically significant difference from the normal subjects, WoHI group in the right and left ears (P <0.001).

Table 1: One way analysis of variance of PTA in normal subjects, T2DM WoHI and WHI groups

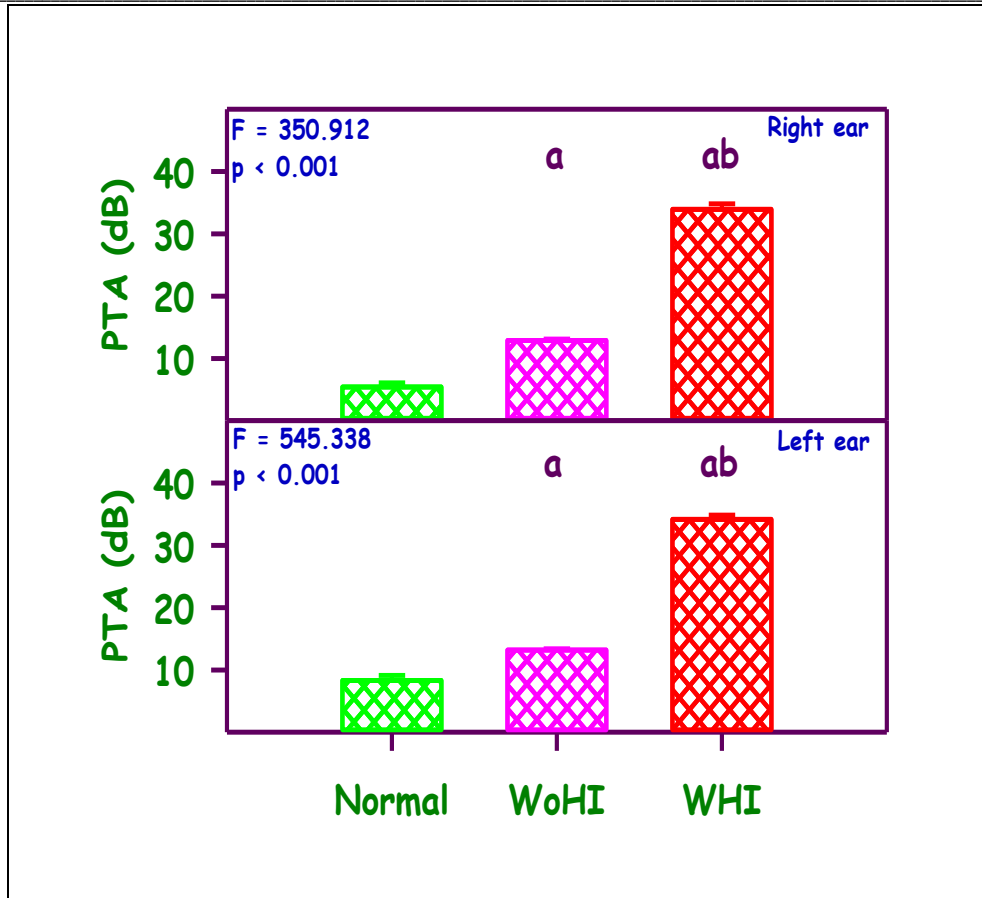| Parameter	Ear	Normal subjects (Mean±SEM)	T2DM WoHI (Mean±SEM)	T2DM WHI (Mean±SEM)	P-Value
PTA (dB)	Right	5.420±0.653	12.882±0.235	33.926±0.895	Given in figure 1
	Left	8.310±0.818	13.200±0.204	34.162±0.678	

Fig 1: The pure tone average (PTA) in normal subjects, type 2 diabetes without (WoHI) and with (WHI) hearing impairment.
Mean + SE (n ± 50 each in WoHI and WHI groups, n+10 in normal subjects).
The 'F' and P values are comparing normal subjects, WoHI and WHI of right and left ear.
a – significantly different from normal subjects
b – significantly different from WoHI group

The correlation of PTA values and BMI values for both the ears in normal subjects were given in table - 2. The age, BMI, HbA1c values are not correlated with PTA values in normal subjects. The correlation of PTA values and BMI values for both the ears in all subjects were given in table - 3. The BMI (P<0.0001) values were statistically positively correlated with PTA values of both ears in all subjects. This showed that with increase in BMI levels, the PTA values are increased in diabetic subjects with increased hearing threshold.

Table 2: Correlation of independent variables and PTA in normal subjects

S.No	Independent variable	Dependent variable PTA (dB)	r-value	p-value
1	BMI (sq.m)	Right ear	0.276	0.441
		Left ear	0.132	0.717

Table 3: Correlation of independent variables and PTA in all subjects

S.No	Independent variable	Dependent variable PTA (dB)	r-value	p-value
1	BMI (sq.m)	Right ear	0.382	<0.001
		Left ear	0.404	<0.001

The correlation of pure tone average values and BMI for both the ears in WoHI and WHI groups were given in figure - 2. In both the groups pure tone average values are not statistically correlated with BMI. The right ear of WoHI (P= 0.716) and WHI (P=0.474) group and left ear of WHI (P=0.399) group shows negative correlation with BMI.
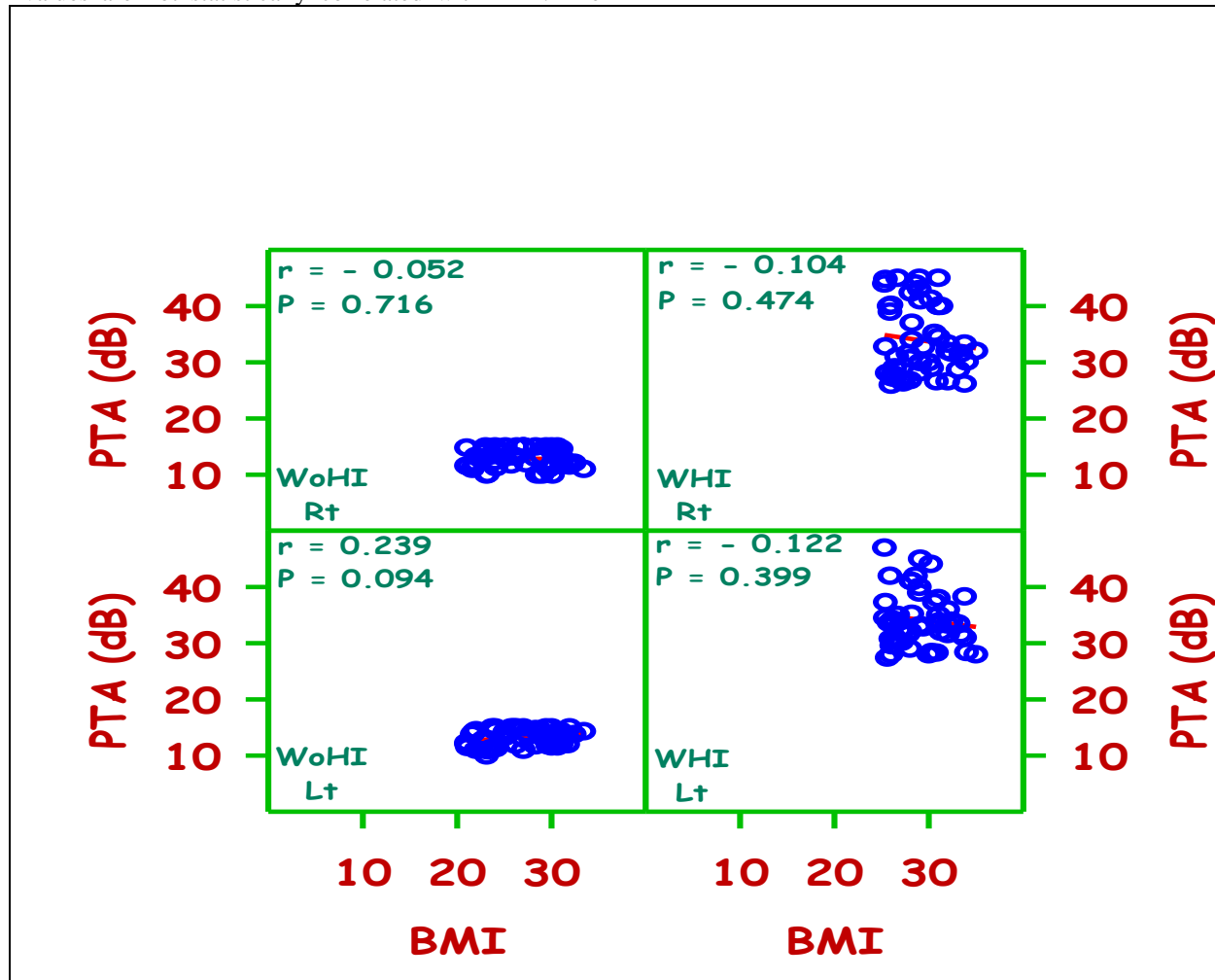

Fig 2: Correlation of pure tone average (dB) and BMI (Sq.m) in type 2 diabetes, without (WoHI) and with (WHI) hearing impairment.The 'r' and P values are correlating WoHI and WHI right and left ear

Discussion

In T2DM many audiometric studies described progressive, bilateral and mild to moderate sensori-neural hearing loss for higher frequencies [3-8].
T2DM shows harmful effects on auditory system along with other systems, so awareness about the changes happened in the auditory system in diabetes are required [9]. In the present study, pure tone average values were increased in both ears of WHI group when compared with normal subjects, WoHI group; similar findings found in previous research in line with the present study [10, 11]. To study the effect of diabetes on hearing is difficult because of many confounding factors like presbycusis, hypertension and obesity. Vaughan et al (2006) have shown that though the other researchers found hearing loss in diabetes, other factors like noise exposure, ototoxic drugs, duration of disease, metabolic control and the presence and degree of complications and presbycusis also affect both glucose metabolism and cochlear function. Due to this, the establishment of association between hearing loss and

diabetes is difficult [12].In the present study there was no difference between the right and the left ear pure tone average values in the WHI group, it may be due to diabetic systemic changes affect the body as a whole, thus leading to symmetrical hearing loss in both ears of WHI group [13].In the present study, pure tone average values are not statistically correlated with BMI in both the ears of WoHI and WHI groups indicates that without raising in BMI the chances for hearing loss increases in the T2DM patients. This result is in line with a study conducted by Jung et al (2016), which stated that the BMI was not advantageous for the prediction of age related hearing loss and in future epidemiological studies, BMI as a covariate of obesity may be replaced by other active metabolic parameters that have better predictive ability of age related hearing loss than BMI [14].

In the present study, the BMI is correlated with PTA values in all subjects. Previous research performed by some have mentioned that there is increase in BMI, worsens the hearing function in T2DM patients [15-20]. Some studies found relationship between the diabetes, obesity and BMI [21-23]. When the BMI is increased, it indicates obesity. This causes insulin resistance and releases high amount of non-esterified fatty acids, glycerol, hormones, pro-inflammatory cytokines involved in the development of T2DM. Increase in BMI and development of T2DM shows some genetic involvement with environmental factors [24- 26]. Previous studies mentioned that diabetes and hyperlipidaemia were the independent risk factors for sensorineural hearing loss and that the combination of these two had the greatest effect on hearing.

The incidence of hearing loss was more with hyper-lipidaemia in the diabetics possibly due to the vascular complications which were produced by diabetic dyslipidemia[5]. The lipoproteins get glycated, which predisposes them to atherosclerosis. The advanced glycation end-products (AGEs) bind to the macrophage receptors and stimulate them to secrete Interleukin-1 (IL-I) and Tumour Necrosis Factor (TNF) which causes vessel wall damage, resulting in micro-vascular disease, atherogenesis and macro-vascular disease [27]. The saturated fatty acids may play a role in determining the dysmetabolic state in a subset of sensorineural hearing loss patients [28].

Conclusion

The PTA is useful to know the status of hearing sensitivity and type, severity of the hearing impairment in the T2DM patients. Correlated the BMI values in relation to PTA in WoHI and WHI groups for both the ears and found that hearing impairment is not correlated with BMI values in the WHI group for both the ears. The right ear of WoHI (P= 0.716) and WHI (P=0.474) group and left ear of WHI (P=0.399) group showed negative correlation with BMI. The BMI values are correlated with PTA values in all subjects. The present study can be helpful to the physicians to screen all old and newly diagnosed diabetic patients with pure tone audiometry, even if the patient does not have any complaint.

Acknowledgement

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