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Correlation between Otoacoustic Emission and Pure Tone Audiometry in Diagnosing a Case of Presbycusis.

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ABSTRACT

Background: Outer hair cells (OHC) are most sensitive to extrinsic and intrinsic contaminants and can be irreversibly impaired. OAEs are a non invasive tool for assessing OHC dysfunction. Studies have shown that OAE can find SNHL in an early stage before it is obvious in PTA. It has also seen that there is a higher sensitivity of OAE than PTA for the diagnosis of individuals with high sensitivity to noise. Objective: This study was done with an aim to find the correlation between otoacoustic emission and pure tone audiometry for evaluating a case of presbycusis. **Methods:** A prospective study was done in a total of 150 patients who were selected from ENT OPD and ENT Ward of Jawaharlal Nehru Medical College and Hospital, Aligarh Muslim University, Aligarh after proper history and examination. **Results:** Data obtained from otoacoustic emission and audiometry were analysed and compared.It was found that otoacoustic emission can find SNHL in an early stage before it is obvious in PTA. It has also seen that there is a higher sensitivity of OAE than PTA for the diagnosis of individuals with high sensitivity to noise. **Conclusion:** With increase in the audiometric thresholds with age, there is statistically significant reduction or absence of OAEs.

Keywords: Pure tone audiometry, otoacoustic emission, outer hair cell.

INTRODUCTION

Presbycusis (presby = elder, cusis = hearing) or age related hearing loss is defined as, "mid to late adult onset, bilateral, progressive sensorineural hearing loss, where underlying causes have been excluded. The term age-related hearing loss is now in wide spread use, replacing the term presbyacusis (presbycusis in US spelling). This earlier term was derived from presbyacusia,[1,2] used to describe a loss of high frequency hearing acuity in the elderly, observed when tested with tuned whistles designed by Sir Francis Galton for testing hearing. Age related hearing loss is associated, in the majority of cases, with an audiogram that reveals greatest hearing loss at higher frequencies.

It involves a progressive sensorineural hearing loss. Presbycusis most often occurs in both ears, affecting them equally.[3]

Everyone who lives long enough will develop some degree of presbycusis, sooner or later. Those who are exposed to loud noise will develop it sooner. It is estimated that 40-50% of people aged 75 and older have some degree of hearing loss.[4]

Presbycusis may have a devastating effect on older individuals by reducing their ability to communicate, thereby jeopardizing autonomy and limiting opportunities to be active members of society. This decrease in social engagement can have profound consequences, and loneliness is a known determinant of morbidity and mortality in the elderly.[5]

According to the 2005 estimates of WHO, 278 million people have disabling hearing impairment. The prevalence of deafness in Southeast Asia ranges from 4.6% to 8.8%.

Microscopic changes seen in this condition are hair cell degeneration of the cochlea and giant stereociliary degeneration.[6] The hair-cell counts showed a reduction of approximately 80% of the outer hair cells (OHCs), mainly in the apical parts of the cochlea, and only little differences in the number of inner hair cells (IHCs) as compared with a group of normal-hearing middle-aged persons.

Pure-tone thresholds (PTTs) indicate the softest sound audible to an individual at least 50% of the time. Hearing sensitivity is plotted on an audiogram, which is a graph displaying intensity as a function of frequency.[7]

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Otoacoustic emissions (OAEs) are sounds given off by the inner ear when the cochlea is stimulated by a sound. The primary purpose of otoacoustic emission (OAE) tests is to determine cochlear status, specifically hair cell function. The normal cochlea does not just receive sound; it also produces low-intensity sounds called OAEs.[8]

Due to higher sensitivity of outer hair cell dysfunction of OAE, they are sometimes clearly abnormal in patients with hearing sensitivity within normal limits(<25dB hearing loss). The high sensitivity of OAE to outer hair cell dysfunction is a big advantage for early and conclusive documentation of auditory abnormalities due to aging.

Studies have shown that OAE can find sensorineural hearing loss (SNHL) in an early stage before it is obvious in pure tone audiometry (PTA). It has also seen that there is a higher sensitivity of OAE than PTA for the diagnosis of individuals with high sensitivity to noise. Owing to the fact that OHC are the predominant structures involved in presbycusis, thus OHC dysfunction can be detected by OAE. The American-Speech-Language-Hearing Association has advised that individuals over 50 years of age should have complete audiometric testing every 3 years. However concerns have been raised about the resource implication without proven benefits. If there is any correlation between presbycusis and OAE, perhaps this can be used as screening tool to detect early presbycusis.

MATERIALS AND METHODS

This study was performed on 150 patients in the age group of 40 years and above, having clinically normal ears with an intact and mobile tympanic membrane but complaining of hearing impairment. After a detailed history as per the proforma and thorough otorhinolaryngological examination including tuning fork test was done. Patients with history of diabetes mellitus, hypertension, ischemic heart disease, tuberculosis, allergic rhinitis, asthma or any thyroid disorders and ototoxic medication were not included in the study. Followed by this, pure tone audiogram and otoacoustic emission of both the ears were done. 50 normal individuals, between the age group of 40 years and above with clinically normal mobile tympanic membrane without any of the exclusion criteria mentioned above were selected as controls.

Patients having any otological complaints at present or in the past except hearing impairment and any rhinological or laryngological complaints at that time were excluded from the study.

The otoacoustic emission was performed using Maico Ero Scantest System. Test was performed in a silent, sound proof room and all the recordings were done by one person. Among the available tests, distortion product otoacoustic emissions (DPOAE) is the one which was selected. In otoacoustic emission, 6 frequencies were tested in the range from 1.5 to 6 KHz with the two pure tones f1 and f2 at 65 and 55dB SPL respectively. The returning signals were analyzed by the system

The air conduction threshold in 500,1000,2000,4000 and 8000 Hz were taken for analysis. The average of pure tone average of both the ears, i.e. average of 500,1000, 2000, 4000 and 8000 was taken. Pure tone average upto 25 dBHL taken as normal.

RESULTS

Table 1: Age group and sex distributions.

	Group A		Group B		Group C		Controls	
Age of patient	40-50		51-60		>60		≥40	
No. of patients	57		39		54		50	
Sex	Male	Female	Male	Female	Male	Female	Male	Female
	32	25	20	19	28	26	20	30
Percentage	38%		26%		36%		100%	

Table 2: Average air conduction thresholds in decibels (db) of both ears, of the 39 subjects in each frequency (hz).

	500 Hz	1000 Hz	2000 Hz	4000 Hz	8000 Hz
Group A	17.41	17.76	20.61	25.88	35.88
Group B	20.06	21.92	24.49	33.08	47.05
Group C	25.19	27.04	34.07	42.50	60.93
Control	12.70	14.20	15.95	20.00	26.35

Table 3: Comparison of results of OAE in various age groups using chi square test.

	Control	Group A	Group B	Group C
Pass	40	22	3	0
Refer	10	35	36	54
Chi Square			89.331	
P Value			<0.00001	

Table 4: Correlation between normal PTA average and normal OAE in various age groups using chi square test.

	No. of patients with Normal Pure tone Audiometry	No. of pts who passed OAE
Control	50	40
Group A	55	22
Group B	30	3
Group C	13	0
Chi square	21.225	
P value	0.000095	

DISCUSSION

In our study we took 150 subjects of age 40 years and above who complaints of hearing impairment in an otherwise normal ear with intact and mobile

tympanic membrane. The subjects were divided into 3 age groups, group A (40-50 years), group B (51-60 years) and group C (>60 years).

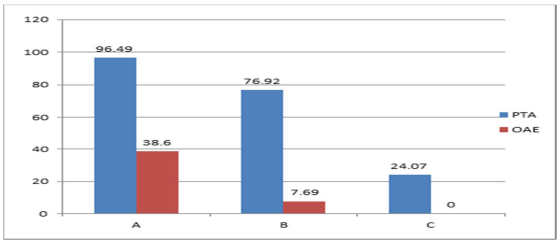

Chart 1: Graph comparing normal pure tone average with normal OAE in each group

Pure tone audiogram of controls and cases were done. The audiograms of 3 groups viz, 40-50 years, 51-60 years and >60 years, were compared with control group. Since the thresholds did not show much variation between the right and left ears, the average of both the sides in each frequency was taken to plot the diagrams. The PTA average was calculated by averaging the values at 500 Hz, 1000 Hz and 2000 Hz frequencies in each groups. The high frequency loss was determined by averaging the thresholds in 8000 Hz, the statistical significance of which was assessed with ANOVA test.

All the three groups (group A, B and C) showed characteristic hearing loss at 8 KHz which is the earliest change in the audiogram pattern in presbycusis.

Control group showed PTA average of 14.28 dBHL, and an average of 26.35 dBHL at 8 KHz.

Group A showed PTA average of 18.59 dBHL, and an average of 35.88 dBHL at 8 KHz, group B showed PTA average of 22.16 dBHL, and an average of 47.05 dBHL at 8 KHz while group C showed PTA average of 28.61 dBHL, and an average of 60.37 dBHL at 8 KHz.

Brant et al (1990)[9] conducted a longitudinal study to know age related changes in pure tone thresholds. They concluded that, for combined left and right ears there was an average longitudinal loss of 35.2–53.0 dB for 50□year□olds, and 69.0–84.5 dB for 80□year□olds at 8 KHz which is consistent with our finding in the respective age groups.

Otoacoustic emission tests were also done for controls and cases. 80% in the control group were able to pass the test. In group A, 38.6% subjects were able to pass the test while in group B only 7.69% were able to pass the test. In group C no case (0%) was able to pass the test.

Our study has shown that in control group, where the subjects do not experience any hearing or speech discrimination problem, and where PTA is normal and shows no significant hearing loss at 8 KHz in PTA i.e. <30 dB which is within the socially normal hearing limit, there is a statistically significant reduction or absence of otoacoustic emission.

All the three groups (group A, B and C) who admit to have hearing complaints, the PTA average showed hearing thresholds within the socially acceptable hearing limit (i.e. < 30 dB) but all have a significant dip at 8 KHz and showed an absent or reduced OAE in 61.4% in group A, 92.31% in group B and 100% in group C.

In a study done by Probst et al (1987),[10] they concluded that, OAE were always present when audiometric threshold was less than 35 dB HL, and in majority of the case (94%), audiometric threshold was less than 25 dB HL.

In an another study done by Bonfils et al (1988),[11] they concluded that, EOAEs have never been observed when mean audiometric thresholds were equal to or greater than 35 dB HL. EOAEs were always found when mean audiometric thresholds were equal to or lower than 22dB HL. In our study also no case was able to pass the OAE test when audiometric threshold was equal to or greater than 35 dB HL and OAEs were always found when audiometric threshold was equal to or lower than 25 dB HL which is very similar to the above study. Again the difference was that they have used click evoked OAE test for above study and we have used distortion product OAE for our study.

Collet et al (1989),[12] conducted a study to specify otoacoustic emission characteristics in relation to sensorineural hearing loss. The results show that the presence of otoacoustic emissions drops as a function of hearing loss and that there is a highly statistically significant correlation between otoacoustic emission threshold and hearing loss at the 1000-Hz frequency. Otoacoustic emissions are never found when hearing loss at 1000 Hz exceeds 40 dB hearing level and when the mean audiometric hearing loss exceeds 45 dB hearing level. In our study no subject was able to pass the test when hearing loss at 1000 Hz is 25 dB HL or more and mean audiometric threshold was equal to or greater than 35 dB HL.

Bertoli and Probst conducted a study on 'the role of transient-evoked otoacoustic emission testing in the evaluation of hearing in the elderly people' in 1997.[13] Click-evoked otoacoustic emissions (CEOAEs) were measured in 201 subjects without middle ear problems aged 60 year and older (range 60 to 97 year) who volunteered for the study because of complaints concerning their hearing. CEOAEs were not detectable in ears with a PTA > 30 dB HL. The prevalence of CEOAEs in ears with a PTA < or = 30 dB HL was 60%. In contrast to this study we used DPOAE in subjects more than 60 years (group C), who were complaining of hearing loss. In our study, irrespective of the PTA in this age group, no one was able to pass the DPOAE test.

CONCLUSION

Outer hair cells (OHC) are most sensitive to extrinsic and intrinsic contaminants and can be irreversibly impaired. OAEs are a non invasive tool for assessing

OHC dysfunction. The main OAE applications in clinical diagnostics are new born hearing screening, topological diagnostics, quantitative evaluation of hearing loss and recruitment, detecting the beginning stages of cochlear impairment during noise exposure or ototoxic drug administration and monitoring cochlear function during recovery from cochlear dysfunction. Whereas TEOAEs more qualitatively assess cochlear function, DPOAEs provide quantitative information about the operational characteristics.

The result of our study suggests that there is a strong correlation between PTA and OAE. With increase in the audiometric thresholds with age, there is statistically significant reduction or absence of OAEs.

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