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STUDY OF OTOACOUSTIC EMISSIONS IN SUBJECTS OF NORMAL HEARING WITH AND WITHOUT TINNITUS

ENT

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ABSTRACT

Aim- To determine relation between change in otoacoustic emissions in subjects of normal hearing with and without tinnitus. **Material And Methods-** The study was conducted as observational study to compare Transient Evoked Otoacoustic Emission and Distortion Product Otoacoustic Emission in subjects of normal hearing with tinnitus and without tinnitus in the Department of Otorhinolaryngology, Gandhi Medical College, (madhya Pradesh) for a duration of 18 months. The study included 114 adult patients visiting the department with and without tinnitus but with normal hearing. Subjects with a perception of tinnitus for less than a month and a history of use of ototoxic drugs, head trauma, and middle ear surgery were excluded from the study. The sampling technique employed was the Convenience sampling technique. **Result -** The majority of the subjects had normal TEOAE (83.3%). The percentage of subjects with normal TEOAE was significantly higher in Group B compared to Group A (p-value <.05). Overall, majority of the subjects had normal DPOAE (84%). The percentage of subjects with normal DPOAE was significantly higher in Group B compared to Group A (p-value <.05). **Conclusion-** Transitory Evoked Otoacoustic Emissions and Distortion product otoacoustic emissions are significantly affected among normal hearing subjects with tinnitus. This indicated that patients with tinnitus might have neural dysfunction at either the level of the cochlea, of the auditory nerve, or of the brainstem. In the present work, we indirectly assessed the integrity of the afferent auditory pathway by using DPOAEs in tinnitus cases with normal hearing. The results showed that those affected by tinnitus show reduced OHC activity, as detected by reduced DPOAE levels which may manifest as tinnitus even before there is a shift in the hearing threshold.

KEYWORDS

Otoacoustic emission, tinnitus, outer hair cells, cochlea.

INTRODUCTION

"Tinnitus refers to the conscious awareness of a sound in the ears without an external source triggering it." It can be subjective (experienced by an individual alone) or objective (an observer can also hear the tinnitus). It is often described as hissing, sizzling, and ringing, but some individuals may describe it as voices or music.[1]. It can be unilateral (one ear) or bilateral (both ears). Sometimes patients experience tinnitus centrally in the head. [1] Onset of tinnitus is insidious in most of the cases but few may report it to be abrupt in onset. [1]

Tinnitus has a negative impact on the lives of the individuals. It can cause sleep impairment, interference with concentration, difficulty in communication, and hampered social enjoyment. [2] Tinnitus can also lead to the development of anxiety disorders and depressive symptoms. [3,4,5]

However, tinnitus can also be observed in individuals without hearing loss.[6] It has been speculated that the presence of tinnitus without hearing loss may be the presentation of the diseases that are only diagnosed after the onset of hearing loss.[7]

OAEs have the capacity to identify minor alterations in cochlear function prior to noticeable declines in a patient's hearing capabilities. Consequently, analyzing OAEs proves beneficial in distinguishing between various conditions that could lead to tinnitus.[8]

Otoacoustic emissions (OAE) are low-intensity sounds produced by outer hair cells of the cochlea transmitted ossicular chain and tympanum to the external ear canal, where they can be recorded.[9]

However, the evidence from studies about changes in OAEs in individuals with normal hearing remains inconclusive.[8] Therefore, in the present study, changes in OAEs have been studied in subjects having tinnitus with normal hearing and the findings were compared with those without tinnitus to identify the factors responsible for the development of tinnitus.

MATERIAL & METHODS

The study was conducted as observational study to compare Transient Evoked Otoacoustic Emission and Distortion Product Otoacoustic Emission in subjects of normal hearing with tinnitus and without tinnitus in the Department of Otorhinolaryngology, Gandhi Medical College, (madhya Pradesh) for a duration of 18 months.

Selection Criteria

Inclusion Criteria

1) Age 18-60 years
2) All genders
3) Subjects with either unilateral or bilateral tinnitus
4) Subjects willing to participate

Exclusion Criteria

1) Patient with a perception of tinnitus for less than a month
2) Subjects with a history of use of ototoxic drugs, head trauma, middle ear surgery

Sample size- The sample size estimation was done using Epitool sample size calculation software.

Inputs:

Proportion 1- 0.88 (percentage of subjects having normal DPOAE in subjects having normal hearing without tinnitus)

Proportion 2- 0.64 (percentage of subjects having normal DPOAE in subjects having normal hearing with tinnitus)

Confidence level- 0.95

Power- 0.80

Ratio of sample sizes (n2/n2)= 1

Output:

Sample size in group 1 = 57

Sample size in group 2 = 57

Total sample size = 114

Thus, the minimum required sample size was 114.

Sampling Technique- Convenience sampling technique.

Methodology- The study was commenced after approval from the institutional ethics committee. Only the patients meeting the inclusion criteria and providing written informed consent were included in the study.

Method Of Data Collection

The patients visiting the Department of Otorhinolaryngology and meeting the inclusion criteria were enrolled in the study. The assessment of hearing capacity was done using audiometer [Diagnostic Audiometer mode AAZZZ by interacoustic]. Subjects having PTA values within 25 decibels were considered to have normal hearing. Subjects with normal hearing with tinnitus (unilateral or bilateral) were categorized as Group A and those without tinnitus were categorized as Group B.

Age, gender, associated factors, systemic illness, history of drug intake was recorded. OAE (including TPOAE and DPOAE) was performed using Neurosyt audioscreen at 1.50, 2.00, 2.50, 3.00, 3.50 and 4.00 KHz. Results were labelled as "pass" or "referred" as shown by OAE machine.

Statistical Analysis Plan-

Data was analyzed using SPSS (Statistical Package for Social Sciences) 25.0 version. Descriptive statistics were performed. Data were described as numbers and percentages. For continuous variables, comparison was done using the Independent t-test. For categorical variables, a comparison was done using the chi-square test. P-value<.05 was considered statistically significant.

Ethical Considerations-

The study was started after approval from the institutional ethics committee of Gandhi Medical College, Bhopal. The participants were informed about the purpose of the study and were briefed about the procedures involved in it. The participants were told that their participation is voluntary and they have the right to quit at any point of time. Written informed consent was taken from participants. Confidentiality of the information was maintained.

RESULTS

The study included 114 subjects with normal hearing such that 57 were having tinnitus and 57 were not having tinnitus. Among the subjects with tinnitus, 37 (64.9%) subjects had unilateral tinnitus, and 20 (35.1%) subjects had bilateral tinnitus.

Transitory Evoked Otoacoustic Emissions

Overall, the majority of the subjects had normal TEOAE (83.3%). The percentage of subjects with normal TEOAE was significantly higher in Group B compared to Group A (p-value <.05).

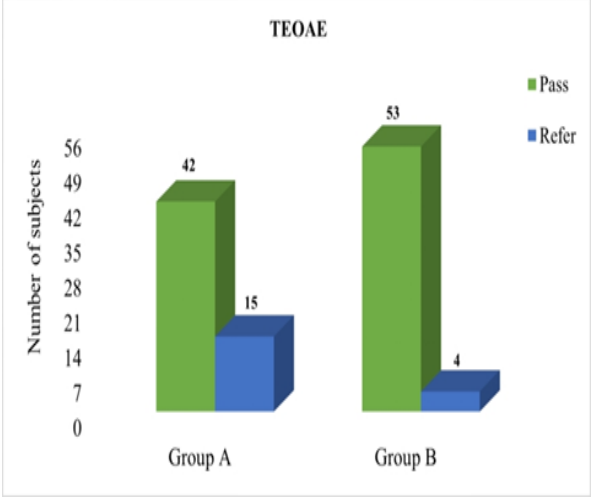

Figure 9. Distribution Of Study Subjects Based On TEOAE.

Table 6. Inter-group Comparison Of Transitory Evoked Otoacoustic Emissions Of The Subjects.

TEOAE		Group A	Group B	Total	Chi-square value	df	p-value
Pass	Number	42	53	95	7.642	1	.006*
	Percentage	73.7%	93.0%	83.3%			
Refer	Number	15	4	19			
	Percentage	26.3%	7.0%	16.7%			
Total	Number	57	57	114			
	Percentage	100.0%	100.0%	100.0%			

Chi-square test. *p-value <.05- statistically significant.

Distortion Product Otoacoustic Emissions

Overall, majority of the subjects had normal DPOAE (84%). The percentage of subjects with normal DPOAE was significantly higher in Group B compared to Group A (p-value <.05).

Table 7. Inter-group Comparison Of Distortion Product Otoacoustic Emissions Of The Subjects.

DPOAE		Group A	Group B	Total	Chi-square value	df	p-value
Pass	Number	35	49	84	8.867	1	.003*
	Percentage	61.4%	86.0%	73.7%			
Refer	Number	22	8	30			
	Percentage	38.6%	14.0%	26.3%			
Total	Number	57	57	114			
	Percentage	100.0%	100.0%	100.0%			

Chi-square test. *p-value <.05- statistically significant.

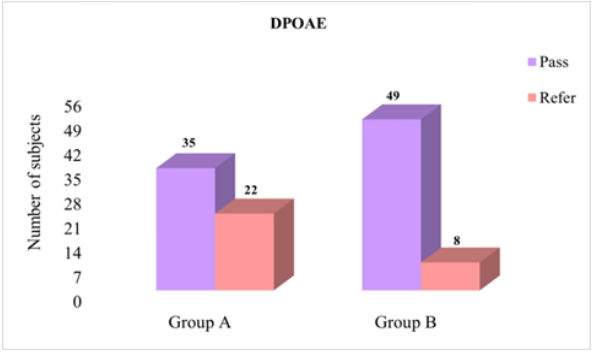

Figure 10. Distribution Of Study Subjects Based On TEOAE.

DISCUSSION

Tinnitus can have adverse effects on people's lives, leading to sleep disturbances, reduced concentration, communication challenges, and hindered social interactions.[2] Tinnitus can also lead to the development of anxiety disorders and depressive symptoms.[3,4,5] Although, 97% of those who reported tinnitus on audiometry are detected to have concomitant hearing loss.[2] However, tinnitus can also be observed in individuals without hearing loss.[6] It has been suggested that tinnitus occurring independently of hearing loss could potentially indicate underlying diseases that are typically identified only following the development of hearing impairment.[6] It is important to know which etiologies are more common in cases of normal hearing and tinnitus. This will be helpful in achieving more successful treatment outcomes by preparing for more common causes in advance and first addressing these causes. Otoacoustic emissions (OAE) has provided an objective test for the evaluation of hearing.[13] Therefore, in the present study, changes in OAEs have been studied in subjects having tinnitus with normal hearing and the findings were compared with those without tinnitus to identify the factors responsible for the development of tinnitus.

In the present study, 114 subjects with normal hearing were included such that 57 were having tinnitus and 57 were not having tinnitus.

TEOAE & DPOAE

In the present study, normal TEOAE was significantly higher in Group B compared to Group A [93% vs. 73.7%] (p-value <.05), and the percentage of subjects with normal DPOAE was also significantly higher in Group B compared to Group A [86% vs. 61.4%] (p-value

<.05). In the study done by **Thabet et al.,** TEOAE was applied to 20 patients with normal hearing and unilateral tinnitus complaints the contralateral ear was used as the control ear. They found that abnormal TEOAE responses were present in 85% of the ears with tinnitus compared to 20% of control ears.[37] Similarly, **Campos Granjeiro R et al. (2013)** in their study reported that a significantly greater number of subjects in the study group (67.0%) had altered TEOAE compared to the control group (19.6%) (P< .0001).[30] A significantly greater number of subjects in the study group (65.2%) had altered DPOAE compared to the control group (50.0%) (P= .029). Hussein Q et al. (2010) also reported decreased DPOAE in tinnitus patients with normal hearing.[29] **Emadi M et al. (2018)** also found that the prevalence of abnormal DPOAE and TEOAE was significantly higher in the study group compared to the control group.[32] Contrary to our findings, **Kara E et al. (2020)** found no significant differences in the DPOAE and TEOAE responses between normal hearing subjects with and without tinnitus.[34]

Study	**TEOAE findings**	
	Tinnitus	Without tinnitus
Campos Granjeiro R et al. (2013)[30]	Altered in 67.0% of subjects	Altered in 19.6% of subjects
Mokrian H et al. (2014)[31]	TEOAE amplitude in right ear =12.77 (5.41) TEOAE amplitude in left ear = 13.77 (5.07)	TEOAE amplitude in right ear= 12.74 (4.21) TEOAE amplitude in left ear= 12.55 (3.71)
Emadi M et al. (2018)[32]	Normal TEOAE- 76%	Normal TEOAE- 94%
Dadoo S et al. (2019)[33]	Significant differences in TEOAE between the tinnitus and no-tinnitus groups	
Present study	Normal- 73.7% in	Normal- 93.0%

Study	**DPOAE findings**	
	With tinnitus	Without tinnitus
Sztuka A et al. (2010)[28]	Higher DPOAE amplitudes in subjects with tinnitus compared to subjects without tinnitus	
Hussein Q et al. (2010)[29]	Decreased DPOAE in subjects with tinnitus compared to subjects without tinnitus	
Campos Granjeiro R et al. (2013)[30]	Altered DPOAE in 65.2% of subjects	Altered DPOAE in 50.0% of subjects
Mokrian H et al. (2014)[31]	DPOAE amplitude in right ear = 6.66 (2.45) DPOAE amplitude in left ear = 7.46 (3.27)	DPOAE amplitude in right ear= 9.23 (3.08) DPOAE amplitude in left ear= 9.23 (3.08)
Emadi M et al. (2018)[32]	Normal DPOAE- 64%	Normal DPOAE- 88%
Dadoo S et al. (2019)[33]	Significant differences in DPOAE between the tinnitus and no-tinnitus groups	
Acle-Cervera L et al. (2022)[15]	A non-significantly decreased mean of S/N levels in DPOAEs in tinnitus group compared to control group	
Present study	Normal- 73.7%	Normal- 93.0%

LIMITATIONS

- single centre based study hence lacks generalizability.
- Amount of change in amplitude of TEOAE not analyzed.

CONCLUSION

Results of the study showed that:

Transitory Evoked Otoacoustic Emissions and Distortion product otoacoustic emissions are significantly impacted in individuals with normal hearing who experience tinnitus. This suggests the potential presence of neural irregularities within the cochlea, auditory nerve, or brainstem in tinnitus patients. The study conducted here indirectly assessed tinnitus cases with normal hearing to examine the integrity of the afferent auditory pathway utilizing DPOAEs. Findings revealed that individuals with tinnitus exhibit reduced outer hair cell (OHC) function, as evidenced by lower DPOAE levels, which could trigger tinnitus symptoms even prior to any changes in hearing sensitivity.

Conflict Of Interest None

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