

# Comparison of OAE profile in individuals with normal hearing with tinnitus and individuals with normal hearing without tinnitus

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## Abstract

**Background:** Tinnitus is an auditory sensation whose source comes from external stimulus to the body. The aim of this study was to investigate the possible role of cochlear outer hair cells function with TEOAE and DPOAE test in patient with normal hearing having tinnitus. **Materials And Method:** A total of 100 subjects (age range of 18-60 years) participated in the study and were categorized into two groups (study and control). The study group included 50 individuals with normal hearing having tinnitus and control group includes 50 individuals with normal hearing without tinnitus. The TEOAE were recorded with click stimulus at 1000, 2000, 3000, 4000 Hz and DPOAE were measured with two frequency (range 1 – 4 kHz and ratio between f1 and f2 was 1.2) and intensity of L1=55 dB-SPL and L2=65 dB-SPL. **Results And Conclusion:** according to our results mean amplitude of TEOAE and DPOAE in control group were greater than study group but this difference was statistically non significant. In conclusion of our results could provide that there was no evidence of an association of tinnitus and outer hair cells activities.

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## INTRODUCTION

An otoacoustic emission (OAE) is a sound which is generated from within the inner ear. Having been predicted by Thomas Gold in 1948, its existence was first demonstrated experimentally by David Kemp in 1978. OAEs are considered to be related to the amplification function of the cochlea. In the absence of external stimulation, the activity of the cochlear amplifier increases, leading to the production of sound. Several lines of evidence suggest that, in mammals, outer hair cells are the elements that enhance cochlear sensitivity

and frequency selectivity and hence act as the energy sources for amplification. Broadly speaking, there are two types of otoacoustic emissions: spontaneous otoacoustic emissions (SOAEs), which can occur without external stimulation, and evoked otoacoustic emissions (EOAEs), which require an evoking stimulus.

### Types

#### Spontaneous

Spontaneous otoacoustic emissions (SOAE)s are sounds that are emitted from the ear without external stimulation and are measurable with sensitive microphones in the external ear canal. At least one SOAE can be detected in approx. 35-50% of the population. The sounds are frequency-stable between 500 Hz and 4500 Hz to have unstable volumes between -30 dB SPL and +10 dB SPL. The majority of the people are unaware of their SOAEs; portions of 1-9% however perceive a SOAE as an annoying tinnitus.

#### Evoked

Evoked otoacoustic emissions are currently evoked using three different methodologies.

- Stimulus Frequency OAEs (SFOAEs) are measured during the application of a pure-

tone stimulus, and are detected by the vectorial difference between the stimulus waveform and the recorded waveform (which consists of the sum of the stimulus and the OAE).

- Transient-evoked OAEs (TEOAEs or TrOAEs) are evoked using a click (broad frequency range) or toneburst (brief duration pure tone) stimulus. The evoked response from a click covers the frequency range up to around 4 kHz, while a toneburst will elicit a response from the region that has the same frequency as the pure tone.
- Distortion product OAEs (DPOAEs) are evoked using a pair of primary tones and with particular intensity (usually either 65 - 55 dB SPL or 65 for both) and ratio.

### AIMS AND OBJECTIVES

1. To evaluate the comparison of OAE profile in individuals with normal hearing having tinnitus and individuals with normal hearing without tinnitus.
2. To study the OAE profile in tinnitus patients.
3. To evaluate the outer hair cell function in tinnitus patients.

### MATERIALS AND METHODS

This was a case control study performed from December 2017 to March 2019 at the department of Otorhinolaryngology, Govt Medical College and attached group of medical college Kota.

**Method Subjects:** A total of 100 (52 males and 48 females) subjects in the age range of 18 to 60 years participated in the study. They were categorized into two groups:

- a. Study group and
- b. Control group.

**Clinical group** included 50 individuals (26 males and 24 females) with tinnitus having normal hearing.

While **control group:** This group had 50 individuals (26 males and 24 females) with normal hearing, without

tinnitus. All subjects in the clinical group had tinnitus either in one ear or both the ears. Subjects in both the group had pure tone thresholds within 15 dB HL in octave frequencies from 250 Hz to 8 kHz for air conduction. They had no history of exposure to noise or ototoxicity which might cause hearing loss. No observable neurological symptoms or any other general body weakness noticed or reported. None of them reported to have any history of ear pain, ear discharge and giddiness. Subjects in the clinical group had “A” type tympanogram with presence or absence of acoustic reflexes. While in the control group subjects had “A” type tympanogram with presence of acoustic reflexes. All Audiological evaluations and recording of OAEs were carried out in a sound treated room. The ambient noise was within the permissible limits as recommended by ANSI (S3.1, 1991).

### PROCEDURE

To obtain the data from both the clinical and control group, the whole study was carried out in two phases.

**Phase 1** included physiological assessment which was done in both clinical and control group participated.

**Phase 2** included psychoacoustic assessment of tinnitus which involved psychocoustic tinnitus evaluation (pitch matching and loudness matching) and was done only in the clinical group.

**INCLUSION CRITERIA:** Patient having confirm diagnosis of tinnitus for >3 months with normal hearing levels (<25dB). Patients having normal A type of tympanogram. Patient age from 18-60 years. Patients having normal anatomy of ear and tympanic membrane

**EXCLUSION CRITERIA:** Patients having tinnitus for < 3 months. Patients age <18 years and > 60 years. Patients with conductive or sensorineural hearing loss (>25dB). Patients having otological diseases (otitis media, fluid in middle ear, otosclerosis, tumors of external ear etc). Patients having congenital abnormality of ear (anotia, microtia, congenital absence of ossicles etc). Patients having tympanogram other than A type (like As type, Ad type, B type, C type). Patients having any systemic and chronic diseases (diabetes, HTN, carcinoma etc)

### OBSERVATIONS AND RESULTS

**Table 1: GENDER WISE DISTRIBUTION**

Subject	No. of Subject who had tinnitus in one year	No. of Subject who had tinnitus in both Ear
Male	22	4
Female	18	6
<b>Total</b>	<b>40</b>	<b>10</b>

**Table 2: Tinnitus Frequencies (Pitch Matching)**

Frequencies of tinnitus by pitch matching	No. of ear (%)
8 kHz	27 (45%)
4-8 kHz	20 (34%)
< 4 kHz	13 (21%)

**Table 3: Loudness of tinnitus (loudness matching)**

Loudness matching(dB) and degree	No. of ears(%)
0-15 dB (mild)	15
16-30 dB (moderate)	40
31-45 dB (severe)	5

**Table 4: No. and Percentage of Ear that have refer and pass TEOAE in Study group and Control Group**

Group	Total Ear	TEOAE (PASS)	TEOAE (Reffer)	P Value
Study Group	60	46 (76%)	14 (24%)	0.0672
Control Group	100	94 (94%)	6 (6%)	

**Table 5: No. and Percentage of Ear that have refer and pass DPOAE in Study group and Control Group**

Group	Total Ear	DPOAE (PASS)	DPOAE (Reffer)	P Value
Study Group	60	38 (64%)	22 (36%)	0.0997
Control Group	100	88 (88%)	12 (12%)	

**Table 6: Mean and SD of TEOAE with patient tinnitus in right ear in study group and control group**

TEOAE and Ferqence	GROUP	MEAN	SD	P Value
TEOAE 1000 HZ	Study Group	4.1	5.63	0.0253
	Control Group	6.84	4.68	
TEOAE 2000 HZ	Study Group	4.77	5.54	0.7785
	Control Group	4.37	6.75	
TEOAE 3000 HZ	Study Group	4.07	6.23	0.9187
	Control Group	4.22	6.76	
TEOAE 4000 HZ	Study Group	0.88	8.2	0.0757
	Control Group	4.09	7.68	

**Table.7: Mean and SD of TEOAE in patient tinnitus in Left ear in study group and control group**

TEOAE and Ferqence	GROUP	MEAN	SD	P Value
TEOAE 1000 HZ	Study Group	3.42	8.72	0.0199
	Control Group	6.98	4.53	
TEOAE 2000 HZ	Study Group	5.03	6.39	0.6095
	Control Group	5.82	6.49	
TEOAE 3000 HZ	Study Group	3.15	7.3	0.1038
	Control Group	5.892	6.74	
TEOAE 4000 HZ	Study Group	-0.33	7.56	0.8148
	Control Group	0.156	9.36	

**Table 8: Mean and SD of DPOAE with patient tinnitus in right ear in study group and control group**

DPOAE and Ferqence	GROUP	MEAN	SD	P Value
DPOAE 1.7KHZ	Study Group	4.7	6.74	0.229
	Control Group	6.3	5.14	
DPOAE 2.1KHZ	Study Group	3.46	7.18	0.0107
	Control Group	7.26	5.93	
DPOAE 3.3KHZ	Study Group	1.35	7.95	0.0021
	Control Group	6.35	6.28	
DPOAE 4.2KHZ	Study Group	0.73	9.01	0.0774
	Control Group	3.9	6.99	

**Table 9:** Mean and SD of DPOAE in patient tinnitus in Left ear in study group and control group

DPOAE and Ferqence	GROUP	MEAN	SD	P Value
DPOAE 1.7KHZ	Study Group	5.95	7.27	0.9497
	Control Group	6.04	5.13	
DPOAE 2.1KHZ	Study Group	5.41	7.67	0.2339
	Control Group	7	4.03	
DPOAE 3.3KHZ	Study Group	2.36	8.05	0.0188
	Control Group	6.24	5.97	
DPOAE 4.2KHZ	Study Group	1.8	9.45	0.7237
	Control Group	2.48	7.27	

**Table 10:** Mean and SD of TEOAE and DPOAE in patient tinnitus in right ear in study group and control group

OAE	GROUP	MEAN	SD	P Value
TEOAE Right Ear	Study Group	3.45	1.74	0.2398
	Control Group	4.88	1.31	
DPOAE Right Ear	Study Group	2.56	1.84	0.0273
	Control Group	5.95	1.43	

**Table 11:** Mean and SD of DPOAE in patient tinnitus in Left ear in study group and control group

OAE	GROUP	MEAN	SD	P Value
TEOAE Left Ear	Study Group	2.817	2.25	0.3597
	Control Group	4.711	3.08	
DPOAE Left Ear	Study Group	3.88	2.1	0.3253
	Control Group	5.44	2.01	

## DISCUSSION

The Present study was conducted on 100 patients divided into two groups of study and control according to their complains and hearing status selected in the Department of ENT , M.B.S Medical College , Kota. Table no.1: Shows that 40 patients had tinnitus in one ear (22 male 18 female) and 10 patients had tinnitus in both ears (4 males 6 females). Thus there is no significant difference regarding gender between the two groups. The study conducted by Maryam Emadi, Mohammad Rezaei, SirvanNajafi, Ali Faramarzi, and Farhad Farahani shows that females had greater amplitude in TEOAE and DPOAE but there was no significant difference regarding gender and age between the two group. Distribution of perceived tinnitus frequencies in 60 ears (tinnitus ear) of the study group. These frequencies were obtained from pitch matching and was calculated and seen Table no.2 which shows that 27 ears(45%) had tinnitus of frequency 8 kHz and 20 ears(34%) had tinnitus of 4-8 kHz and 13 ears(8%) had tinnitus of < 4 kHz. The result shows that all selected patients had tinnitus. Table no 3 shows loudness of tinnitus after loudness matching. The obtained results were : 15 ears (25 %) had mild degree of tinnitus (0-15 dB) 40 ears(67%) had moderate degree of tinnitus (16-30 dB) And 5 ears (8%) had severe degree of tinnitus (31-45 dB) Thus all selected patients had tinnitus. Table no. 4 and 5: Table no. 4 shows that TEOAE in 94% of the control group and 76% in study group was normal and TEOAE in 6% in control group and 24% in study group showed reffer (p=0.0672). Thus there is no significant difference between the two

groups. Table no.5 shows that DPOAE in 88% of the control group and 64% of the study group was normal and DPOAE in 12% of the control group and 36% of the study group showed refer(p=0.0997),but there was no significant difference between the two groups. The study conducted by Maryam Emadi, Mohammad Rezaei, SirvanNajafi, Ali Faramarzi, and Farhad Farahani showed the same result i.e the mean amplitude of TEOAE and DPOAE in control group were greater than that of study group but this difference was statically non significant. Table no. 6 and 7: Table no.6 shows: Mean and SD of TEOAE in patients having tinnitus in right ear in study and control group. Table no.7 shows : Mean and SD of TEOAE in patients having tinnitus in left ear in study and control group.In Table no.6and7 TEOAE in both ear at 1000 Hz is statically significant (p=0.0253 right ear and p=0.0199 left ear) but at the frequency 2000 ,3000,4000 Hz TEOAE in both ears showed no significant difference between the study and control groups. The study conducted by Dhanya M.1 and Barman A.2 also showed that TEOAE statistically was not significant between the two groups at various frequencies. Table no.8 and 9: Table no.8 shows : Mean and SD of DPOAE in patients having tinnitus in right ear in study and control group. Table no. 9 shows : Mean and SD of DPOAE in patients having tinnitus in left ear in study and control group. DPOAE were measured using frequency f1 and f2 and ratio between f1 and f2 is 1.2 and DPOAE was eliciated at 1.7 kHz, 2.1kHz , 3.3kHz, 4.2 kHz and DPOAE amplitutde obtained from right and left ear for both the groups showed that DPOAE at 2.1 kHz for both



the groups ( $p=0.0107$ ) and DPOAE at 3.3 kHz for both the groups ( $p=0.0021$ ) showed statistically significant difference between the two groups for right ear (Table No. 8). DPOAE at 1.7 kHz and 4.2 kHz was statistically not significant for both the groups in right ear. DPOAE at 3.3 kHz for both the groups ( $p=0.0188$ ) in left ear showed statistically significant difference for both the groups (Table no. 9). DPOAE at 1.7 kHz, 2.1 kHz, 4.2 kHz was statistically not significant for both the groups in left ear. The study conducted by Dhanya M.1 and Barman A.2 also reported same result where there was no significant difference for DPOAE and mean value of DPOAE is higher in control group than in study group. Table no. 10 and 11: Table no. 10 shows: mean and SD of TEOAE and DPOAE in patient tinnitus in right ear in study group and control group. Table no. 11 shows: mean and SD of TEOAE and DPOAE in patient tinnitus in left ear in study group and control group. Table no. 10: DPOAE in right ear show significant difference ( $p=0.0273$ ) between the study and control group but TEOAE in both ear and DPOAE in left ear showed no significant difference between the study and control group. The study conducted by Maryam Emadi, Mohammad Rezaei, Sirvan Najafi, Ali Faramarzi, and Farhad Farahani showed almost the same result where DPOAE in one ear showed significant and TEOAE for both ear and DPOAE in one ear showed no significant difference for both the study and control groups.

## SUMMARY AND CONCLUSION

The present study was conducted in dept. of Otorhinolaryngology MBS Hospital Govt. Medical College Kota Rajasthan from Dec 2017 – March 2019. After approval of study protocol by the Local Ethical Committee and obtaining fully informed consent from the patients of 18-60 years of age and do comparison of OAE profile (TEOAE and DPOAE) in the study and control group. In study group 50 patients having tinnitus in one or both the ears with normal hearing and in control group 50 normal individuals having normal hearing without tinnitus.

### The study revealed following results

1. The TEOAE in 94% control group and 76% study group was normal with not significant difference between the two groups ( $p=0.672$ ). The DPOAE in 88% control group and 64% study group was normal and the difference statistically was not significant ( $p=0.0997$ ).
2. According to our results mean amplitude of TEOAE and DPOAE in control group were greater than study group but this difference was statistically not significant.
3. According to our results DPOAE in right ear shows significant difference ( $p=0.0273$ ) between the study and control group and TEOAE in the

both ear and DPOAE in the left ear shows no significant difference between the study and control group.

Conclusion of our results could provide that no evidence for an association between tinnitus and the outer hair cell activities because in our study the difference was statistically not significant for both DPOAE and TEOAE. But the mean amplitude of TEOAE and DPOAE in control group is greater than study group which shows that outer hair cell of the cochlea may be involved in the generation of tinnitus. Following the possible role of OHC damage or dysfunction of the cochlear efferent system in tinnitus subject may require more than 4 (6 or 8) frequencies in the future studies.

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