ISSN: 2230-9926

Available online at http://www.journalijdr.com

IJDR

International Journal of Development Research
Vol. 09, Issue, 08, pp. 29439-29444, August, 2019

RESEARCH ARTICLE OPEN ACCESS

A CLINICAL STUDY OF OTOACOUSTIC EMISSIONS ON THE PATIENTS WITH TINNITUS

[1]Achin Pant and [2]Anshul Chatrath

[1]Senior Resident, Department of ENT, Susheelatiwari Hospital, Haldwani, India
[2]Junior Resident, Department of ENT, Susheelatiwari Hospital

ARTICLE INFO

Article History:
Received 03rd May, 2019
Received in revised form
26th June, 2019
Accepted 11th July, 2019
Published online 30th August, 2019

Key Words:

Tinnitus, Otoacoustic emissions,
Pure tone audiometry,
DPOAE.

ABSTRACT

Background and Objectives: Otoacoustic emissions (OAEs) are acoustic signals emitted from the cochlea to the middle ear and into the external ear canal where they are recorded. They are most probably generated by active mechanical contraction of the outer hair cells, spontaneously or in response to sound. Our objective of this study is to evaluate the effect of tinnitus occurring due to any middle or inner ear pathology excluding external ear pathology on otoacoustic emissions which are being done by taking proper history, clinical examination and specific investigations in patients attending department of Otorhinolaryngology, tertiary care teaching hospital/centre. **Study Design:** Cross sectional study. **Methods:** A total of hundred patients attending Ear, Nose, Throat Out Patient Department and diagnosed as tinnitus were selected after detailed history of symptoms through questionnaires,pure tone audiometry and DPOAE's. Results were analysed on the basis of DPOAE interpretation. Data collected was analysed using appropriate tools. **Results:** A total of fourty nine males and fifty one females were included in the study. At the end of study, interpretation of DPOAE's as PASS or REFER was correlated with patients having tinnitus with r= -.376 and p= .76 which wasinsignificant. **Conclusion:** Application of distortion product otoacoustic emissions (f2 frequency levels 6KHz, 4KHz, 3KHz & 2KHz, 65-55dB SPL and DP definition 2f1-f2) on the patients of tinnitus also showed reduction of emissions.

Citation: Achin Pant and Anshul Chatrath. 2019. "A clinical study of otoacoustic emissions on the patients with tinnitus", *International Journal of Development Research*, 09, (08), 29439-29444.

INTRODUCTION

Otoacoustic emissions (OAEs) are acoustic signals emitted from the cochlea to the middle ear and into the external ear canal where they are recorded. They are most probably generated by active mechanical contraction of the outer hair cells, spontaneously or in response to sound (Pratt, 2008). Otoacoustic emission measures can be affected not only by the status of the generator site in the cochlea, namely outer hair cells, but also by the condition of the ear canal and middle ear (Koike, 1999).

Types of OAE

All four types of OAEs are recorded with a sensitive, low noise microphone that is placed in the sealed external ear canal.

Corresponding author: **Achin Pant,**
Senior Resistant, Department of ENT, Susheelatiwari Hospital, Haldwani, India

Spontaneous OAE: Spontaneous otoacoustic emissions are narrowband signals that occur in the ear canal without introduction of an eliciting signal. It is present in over 50% of all normal hearing ears.

Transient Evoked OAE: sounds emitted in response to an acoustic stimulus of short duration usually clicks but it can be a tone burst. Most commonly 80-85dB SPL stimuli are used clinically.

Distortion Product OAE: sounds emitted in response to simultaneous tones of different frequencies. The frequencies of the two sinusoidal signals are designated as f1 and f2 (f2≥f1) and corresponding intensity levels are L1 and L2. DPOAEs allow greater frequency and specificity (Stach, 2010).

Tinnitus

Tinnitus, from the latin word tinnire, meaning "to ring," is a phantom perception of sound when no such sound is present

externally (Hussain, 2011). Tinnitus may be defined variously, as 'a sound perceived for more than five minutes at a time, in the absence of any external acoustical or electrical stimulation of the ear and not occurring immediately after exposure to loud noise', 'phantom auditory perception', or 'head noise' (Ceranic, 2008). Tinnitus affects the quality of life of millions of people around the world and is associated in most cases with hearing impairment (Roberts, 2010). Chronic, ongoing, or fre5quent, tinnitus prevalence increases with age and hearing loss (Tsai, 2012). Tinnitus can arise either from the external or middle ear but it usually starts in the cochlea and generates abnormal activity in the central pathways, which prolongs the systems; the central auditory pathways do not need to be structurally altered (Granjeiro, 2008). Damage to cochlear structures represents the main cause of hearing loss in tinnitus subjects. Defects of the cochlea can develop as a consequence of ageing, exposure to loud noise, cochlear ischemia, viral infections or ototoxic drugs (Schecklmann, 2012). Otoacoustic emissions are an important tool for the objective evaluation of the inner ear function, especially the outer hair cells of the cochlea (Mokrian, 2014). As otoacoustic emissions are invariably associated with functioning outer hair cells, their presence is a reliable indicator of cochlear structural integrity, and their absence may indicate a cochlear lesion., by recording otoacoustic emissions, a subclinical cochlear lesion may be detected, as up to 30% of the outer hair cells population may experience damage before any audiometric evidence is apparent in the quarter octaves pure tone audiometry from 0.125 kHz to 16 kHz. Therefore otoacoustic emissions are selected to evaluate the cochlear emissions in tinnitus patients (Ceranic, 1998). The purpose of this study is to evaluate the effect of tinnitus occurring due to any middle or inner ear pathology excluding external ear pathology on otoacoustic emissions which are being done by taking proper history, clinical examination and specific investigations. This trial further assess the diagnostic importance of otoacoustic emissions in tinnitus patients.

MATERIALS AND METHODS

1. **Study design**: Cross Sectional study
2. **Set Up**: Department of Otorhinolaryngology, GMC, Haldwani
3. **Duration of study**: One calendar year (august 2018 - 2019)
4. **Study population**: All patients having tinnitus due to middle and inner ear pathology attending the Otorhinolaryngology Department of Susheela Tiwari hospital, Haldwani, Uttarakhand

Inclusion Criteria

1. Patients having tinnitus cause due to any middle or inner pathology in the ear.
2. All patients having tinnitus due to any cause other than ear pathology.

Exclusion Criteria

1. Patients having tinnitus with previous history of any psychiatric disorder.
2. Patients having tinnitus due to any pathology in the external ear.
3. All the patients who refuse to participate in the study.

Sample size

All patients presenting with tinnitus fulfilling the above inclusion and exclusion criteria were inducted in the study.
The sample size was calculated following the scientific method as:

$$n=4pq/L2$$

Where n= sample size
l = allowable error
p = prevalence rate
q = 100-p

Where p=50%, l= 10%, (according to a study conducted by Abdullah B *et al.,* 2012).

Calculation: n=4x50x50/100 (q=100-p, 100-50=50)
=100 (sample size is 100, which is equivalent to 200 ears)

Study variables

1. Age distribution
2. Sex (male/female)
3. Occupation
4. Address
5. Socioeconomic status
6. Religion

Each of the participants were interviewed with a pre-tested structured questionnaire (Annexure) and examined clinically and with investigations like Pure tone audiometry, Tympanometry and Distortion product otoacoustic emissions.

Working definitions

Distortion product otoacoustc emissions (DPOAEs): Distortion product otoacoustic emissions (OAE) are sounds emitted in response to simultaneous tones of different frequencies. The frequencies of the two sinusoidal signals are designated as f1 and f2 (f2≥f1) and corresponding intensity levels are L1 and L2. DPOAEs allow greater frequency and specificity.

Study tools

1. Otoscope by Heinz Optotechnik GmbH & Co. KG, Model D 01. 70. 220, Germany.
2. Distortion Product Otoacoustic Emission Analyzer (ADS DP2000 Module), Starkey, Mimosa acoustics, version 5.1, Minnesota-USA.

Method of data collection: Data of the patient was collected in pre-designed proforma which is enclosed in the annexure. The particulars, investigations, treatment, examinations, history and follow-up details etc. were recorded at the relevant time. The assessment of the patient included a complete history and head and neck examination. In the history, importance was given to, infection, noise induced hearing loss, sudden deafness, previous otologic procedures, tinnitus, any previous operative reports were reviewed although they did not reflect the current status of the middle ear. Any previous history of psychiatric disease, trauma & intake of any drugs like salicylates, non-steroidal anti-inflammatory drugs, aminoglycosides, antibiotics, loop diuretics, chemotherapy

agents (e.g. platins and vincristine) &cinchona was documented. Other medical problems such as diabetes, heart, lungs and kidney disorders were documented.

Procedure

Requirements:

1. A quiet room
2. DPOAE analyser (DP2000)
3. An Otoscope for ear examination

The ear examination starts with evaluation of the pinna for any lesions or signs of infection such as cellulitis, perichondritis, or discharge at the meatus. Theexternal auditory canal was evaluated for cerumenimpaction, discharge, or canal skin infection or lesions. The tympanic membrane was evaluated. Middle ear containing fluid was visualized by otoscopic examination.

Procedure of the test (distortion product otoacoustic emissions): Otoacoustic emissions were carried out for all the patients having tinnitus arising due to middle or inner ear pathology.

Pre requisites:

1. Unobstructed outer ear canal
2. Seal of the ear canal with a probe
3. Optimal positioning of the probe
4. A quiescent patient
5. Relatively quiet recording environment

A probe was inserted with a soft flexible tip in the ear canal to obtain a seal. Different probes were used for neonates and adults; the probes were calibrated differently because of the significant difference in ear canal volume. The smaller ear canal results in a higher effective sound pressure level (SPL), thus a different probe was used to correct for the difference. Multiple responses were averaged. The distortion product otoacoustic emissions (DPOAEs) were carried out with f2 frequency levels 6 KHz, 4 KHz, 3 KHz & 2 KHz, primary tones L1, L2 65-55dB SPL and DP definition (2f1-f2). The results were interpreted in following fashion and data collected was categorized into two groups with interpreted results.

1. Pass
2. Refer

Statistical analysis

At the end of the study the data collected from the study was tabulated and analyzed using IBM SPSS version 21. Summarization and presentations of qualitative data were done using percentages and quantitative data with mean and standard deviation. Pearson correlation and chi square tests were used for analysis. Probability value of less than 0.05 was taken as significant.

RESULTS AND OBSERVATION

Age distribution: Majority of the patients were from the age group 5-15 years (32%). Mean age of the patients is 30.47±20.7.

Table 1. Distribution of study subjects according to age

Age group	No. of patients	Percentage (%)
5-15	32	32.0
16-30	26	26.0
31-50	22	22.0
>50	20	20.0
Total	100	100
Mean± SD	30.47±20.7	

Sex distribution: Study consisted majority of male patients which accounted for 51% of cases as compared to females 49%.

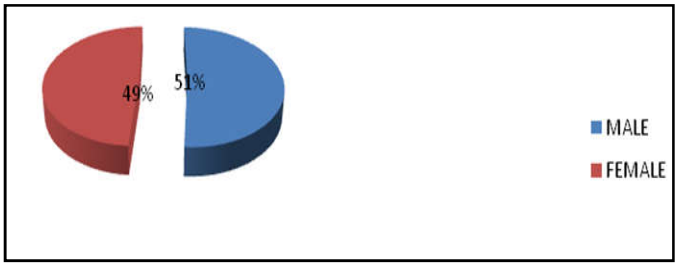

Figure 1. Pie chart showing sex distribution of respondents

Distribution of respondents according to occupation: Most of the patients were students (36% of all cases) followed by housewives (22%).

Table 2. Distribution of respondents according to occupation

Occupation	Number of patients	Percentage (%)
Student	36	36
Govt. Employee	15	15
Pvt. Employee	3	3
Housewife	22	22
Unemployed	4	4
Others	20	20
Total	100	100

Distribution of respondents according to address: Majority of the patients in our study belongs to rural areas (54% of all cases). Rest patients were from urban areas (46%).

Table 3. Distribution of respondents according to address

Address	Number of patients	Percentage (%)
Urban	46	46
Rural	54	54
Total	100	100

Table 4. Distribution respondents according to symptoms

Symptoms		Number of patients	Percentage (%)
Only Ringing sensation	Right ear	7	13.2
	Left ear	18	33.9
	Both ears	28	52.8
	Total	53	100
Decreased hearing with ringing sensation	Right ear	8	17.0
	Left ear	14	29.7
	Both ears	25	53.1
	Total	47	100

Distribution of respondents according to tympanic membrane findings: Out of total 100 right ears, tympanic membrane was found to be retracted in 30 ears (30%) followed by dullness in 26 ears (26%), normal in 41ears (41%) & mobility of the tympanic membrane was restricted in 17 ears

(17%). Similarly out of 100 left ears, tympanic membrane was found to be retracted in 34 ears (34%) followed by dullness in 26 ears (26%), normal in 39ears (39%)& mobility of tympanic membrane was restricted in 14ears (14%).

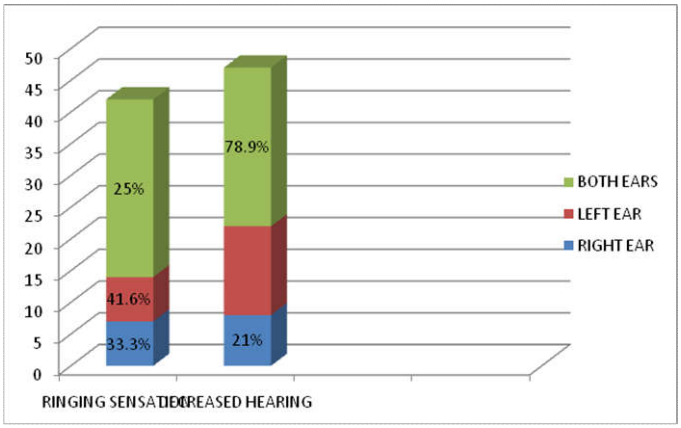

Figure 2. Bar diagram showing distribution of symptoms among the respondents

Table 5. Distribution of the respondents according to tympanic membrane findings

Findings of tympanic membrane		Number of ears	Percentage (%)
	Right ear	41	41
Normal	Left ear	39	39
	Right ear	30	30
Retracted	Left ear	34	34
	Right ear	26	26
Dull	Left ear	26	26
	Right ear	17	17
Restricted mobility	Left ear	14	14

Distribution of study subjects according to pure tone average: In our study, it was found that out of total right ears pure tone average upto 25dB was in 17% of right ears, 26-40dB in 62%, 41-55dB in 15% and 56-70dB in 6%, with mean pure tone average of 33.8±11.5. Similarly out of total left ears pure tone average upto 25dB was in 20% of left ears, 26-40dB in 58%, 41-55dB in 16% and 56-70dB in 6%, with mean pure tone average of 33.3±12.8.

Distribution of study subject according to diagnosis: tinnitus was diagnosed in 15 % right ears and 32% left earsand bilateral tinnitus was present in 53%.

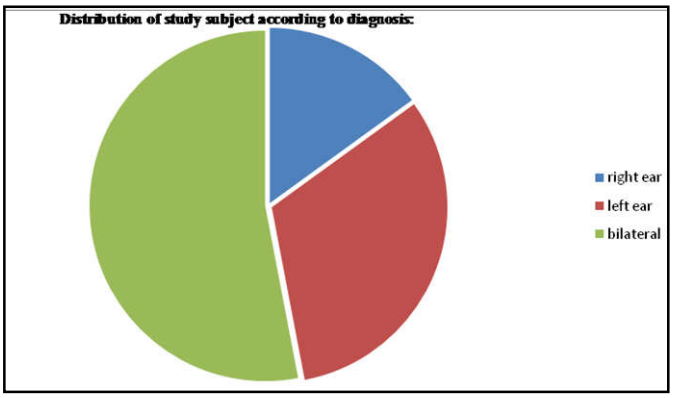

Figure 3. Pie chart showing distribution of study subject according to diagnosis

Table 6. Results of distortion product otoacoustic emissions in tinnitus cases

DPOAE Results	Right Tinnitus (%)	Left Tinnitus (%)	Bilateral Tinnitus (%)	P-value
Bilateral Pass	0	25	40.7	
Bilateral refer	0	0	33.3	
Right pass, left refer	0	75	7.4	
Right refer, left pass	100	0	13.7	0.000

Correlation between Tinnitus and distortion product otoacousticemissions: In our study, tinnitus was also found to be negatively correlated with distortion product otoacoustic emissions with r value -0.033 and P=0.76, which is not significant.

DISCUSSION

Tinnitus, from the latin word tinnire, meaning "to ring," is a phantom perception of sound when no such sound is present externally (Stach, 2010).

Age group: It was observed that out of total tinnitus patients majority were in the age group of more than 51years. Similar findings were seen in other studies with study group ranging from 20-50years (Mokrian, 2014; Ceranic, 1998; Granjeiro, 2006 Riga, 2017). The fact tinnitus being common in this age group is attributed to personal smoking habits commonly seen in this age group which thereby results in damage to outer hair cells and middle ear.

Gender: In our study 49% were males and 51% were females with tinnitus which is in accordance with the studies conducted by Granjerio RC et al (Granjeiro, 2008) who reported similar findings in their studies.

Occupation: it was observed that tinnitus was found to be more in housewives 48.3% followed by students 45.1%, which is almost comparable. The fact that tinnitus is more common in students and housewives, collaborates with the exposure to noise and increased habituation of smoking among the students.

Symptoms & Past history: Ringing sensation was present in total of 53% patients out of which ringing sensation in right ears in 13.2% patients, left ears 33.9% and in both ears, it was present in 52.8% of patients. Similar findings were present in a study done by Tuli BS et al (2001) who reported tinnitus in 36% of study subjects. Decreased hearing with ringing sensation was present in total of 47% patients out of which decreased hearing in right ears is present in 17% of all patients with decreased hearing, left ears having decreased hearing in 29.7% patients, whereas decreased hearing in both ears was present in 53.1% of patients. Which is in accordance with the study done by Park MS et al (Park, 2012) who reported decreased hearing in 40.5% in his study subjects and a study done by Abdullah B et al. (Abdullah, 2007) reported it to be in 52% of his study subjects.

Tympanic membrane findings: In our study, out of total 200 ears, tympanic membrane was found to be retracted in 64% ears followed by dullness in 52%, normal in 80% & mobility of the tympanic membrane was restricted in 31% ears. Similar findings were reported by Abdullah B et al (Schecklmann,

2012) who found dullness in 42% and retraction of tympanic membrane in 24% and Sharma K et al[28] who found dull retracted tympanic membrane in 41.2% of his study subjects.

Pure tone audiometry: In present study, out of 200 ears pure tone average upto 25dB was in 18.5%, 26-40dB in 60%, 41-55dB in 15.5% and 56-70dB in 11%. The mean pure tone average for right ears was 33.8±11.5dB and in left ears it was 33.3±12.8dB falling in the category of mild hearing loss, which is contrary to the study done by Sharma K et al (2016) who reported 68.5% ears having degree of hearing loss upto 25dB and Yamamah G et al (2012) who reported only 8.5% cases with mild to moderate hearing loss. In a similar study done by Yeo SW et al (Yeo, 2003) reported pure tone average 22.57±7.71dB in medical responders and 24.88±8.52dB in medical non responders group.

Tinnitus and Distortion product otoacoustic emission results: On the application of distortion product otoacoustic emissions (f2 frequency levels 6 KHz, 4KHz, 3KHz & 2KHz, 65-55dB SPL and DP definition 2f1-f2) in the patients with tinnitus, DPOAE showed refer in 100% of right sided tinnitus, 75% of left sided tinnitus. In 27 cases of bilateral tinnitus, 40.7% showed pass, 33.3% showed refer in both ears, whereas 7.4% showed pass on right side and 3.4% showed refer on right side and vice versa. Similar findings were present in a studies conducted by Granjeiro RC et al, Gentil F et al and Shiomi Y et al who found reduction in distortion production otoacoustic emissions ranging from 50-93.3% in their study subjects. The present study is contrary to the study done by Sztuka A et al reported increased DPOAE amplitudes in frequency ranges 3003, 4004, 5005 Hz. We also found that there is a negative correlation between tinnitus and distortion product otoacoustic emissions with r value -0.376 and p=0.76, which is not significant. The reduction of emissions is attributed to the outer hair cell dysfunction in such patients due to increase exposure to noise in urban areas and increased incidence of smoking whereas passage of emissions indicates tinnitus arising due to other middle ear pathologies.

Conclusion

Tinnitus is a reasonably common condition in out-patient set up in our Otolaryngological practice. Tinnitus can present at any age and it increases with age. There is no sex discrepancy in tinnitus. Otoacoustic emissions are acoustic signals emitted from the cochlea to the middle ear and into the external ear canal where they are recorded. Distortion product ofotoacoustic emissions are the sounds emitted in response to simultaneous tones of different frequencies. The frequencies of the two sinusoidal signals are designated as f1 and f2. Application of distortion product otoacoustic emissions (f2 frequency levels 6KHz, 4KHz, 3KHz & 2KHz, 65-55dB SPL and DP definition 2f1-f2) on the patients of tinnitus also showed reduction of emissions. Overall after using statistical analysis it is concluded that increased damage to the outer hair cells of cochlea reduces the emissions as evident in tinnitus patients. However additional research is needed to determine the value of otoacoustic emission testing in tinnitus patients.

REFERENCES

Abdullah B, Hassan S, Sidek D. Clinical and audiological profiles in children with chronic otitis media with effusion requiring surgical intervention. *Malays J Med Sci* 2007;14(2):22-7.

Ceranic B, Luxon LM. Tinnitus and other dysacuses. In: Gleeson M, Browning GG, Burton MJ, Clarke R, Hibbert J, Jones NS, Lund VJ, Luxon LM, Watkinson JC, editors. Scott-Brown's Otolaryngology, Head and Neck Surgery. 7thed. Great Britain: Edward Arnold Publishers Ltd; 2008. p. 3594-619.

Ceranic BJ, Prasher DK, Raglan E, Luxon LM. Tinnitus after head injury: evidence from otoacoustic emissions.J Neurol Neurosurg Psychiatry1998; 65(4):523–9.

Granjeiro RC, Kehrle HM, Bezzera RL, Almeida VF, Sampaio ALL, Oliviera CA. Transient and distortion product evoked otoacoustic emissions in normal hearing patients with and without tinnitus. *Otolaryngol Head and Neck Surg* 2008;138(4):502-6.

Granjeiro RC, Kehrle HM, Bezzera RL, Almeida VF, Sampaio ALL, Oliviera CA. Transient and distortion product evoked otoacoustic emissions in normal hearing patients with and without tinnitus. *Otolaryngol Head and Neck Surg* 2008; 138(4):502-6.

Granjeiro RC, Sampaio ALL, Kehrle HM, Oliviera C, Bezzera RL, Almeida VF. Otoacoustic Emissions in Patients with Tinnitus. *Otolaryngol Head and Neck Surg* 2006; 135(2):245-6.

Hussain FT, Medina RE, Davis CW, Bennett YS, Simonyan K, Pajor NM, et al. Neuroanatomical changes due to hearing loss and chronic tinnitus: a combined VBM and DTI study. Brain res 2011;1369(1):74-88.

Koike KJ, Wetmore SJ. Interactive effects of the middle ear pathology and the associated hearing loss on transient-evoked otoacoustic emission measures. *Otolaryngol Head Neck Surg* 1999;121(3):238-44.

Mokrian H, Shaibanizadeh A, Farahani S, Jalaie S, Mahdi P, Amali A, et al. Evaluation of distortion and transient evoked otoacoustic emission in tinnitus patients with normal hearing. *Iran J Otorhinolaryngol* 2014;26(1):19-24.

Park MS, Lee HY, Kang HM, Ryu EW, Lee SK, Yeo SG. Clinical manifestations of aural fullness. *Yonsei Med J* 2012;53(5):985-91.

Pratt H. Evoked physiological measurement of auditory sensitivity. In: Gleeson M, Browning GG, Burton MJ, Clarke R, Hibbert J, Jones NS, Lund VJ, Luxon LM, Watkinson JC, editors. Scott-Brown's Otolaryngology, Head and Neck Surgery. 7thed. Great Britain: Edward Arnold Publishers Ltd; 2008. p. 3276-97.

Riga M, Komis A, Marangoudakis P, Naxakis S, Ferekidis E, Kandiloros D, et al. Differences in the suppression of distortion product otoacoustic emissions by contralateral white noise between patients with acute or chronic tinnitus. *Int J Audiol* 2017;56(8):589-95.

Roberts LE, Egermont JJ, Caspary DM, Shore SE, Melcher JR, Kaltenbach JA. Ringing Ears: the neuroscience of tinnitus. *J Neurosci* 2010;30(45):14972-9.

Schecklmann M, Vielsmeier V, Steffens T, Landgrebe M, Langguth B, Kleinjung T. Relationship between audiometric slope and tinnitus pitch in tinnitus patients: insights into the mechanisms of tinnitus generation. *Plos One* 2012;7(4):1-7.

Sharma K, Pannu MS, Arora A, Sharma V. Preventive audiology: screening for hearing impairment in children having recurrent URTI. *Indian J Otolaryngol Head Neck Surg* 2016;68(2):163–6.

Stach BA. Audiologic evaluation of otologic/neurotologic diseases. In: Shambaugh G, Gulya AJ, Minor LB, Poe DS,

editors. Surgery of the Ear. 6th ed. USA: People's medical publishing house; 2010. p. 189-219.

Tsai BS, Sweetow RW, Cheung SW. Audiometric asymmetry and tinnitus laterality. Laryngoscope 2012;122(5):1148–53.

Tuli BS, Parmar TL, Singh B. Evaluation of tympanostomy tubes in middle ear infections. *Indian J Otolaryngol Head Neck Surg* 2001;53(3)217-20.

Yamamah G, Mabrouk A, Ghorab E. Middle ear and hearing disorders of school children aged 7–12 years in South Sinai Egypt. *East Mediterr Health J* 2012;18(3):255–60.

Yeo SW, Park SN, Park YS, Suh BD. Prognostic value of otoacoustic emissions in children with middle ear effusion. *Otolaryngol Head Neck Surg* 2003;129(1):136-40.

****