



ORIGINAL RESEARCH PAPER

Audiology

INTERMITTENT TINNITUS IN ADULTS: AN INSIGHT INTO COVERT HEARING LOSS

KEY WORDS: Intermittent & continuous tinnitus, EHF thresholds, DPOAE.

Badariya M. *	Associate Professor, Department of Audiology and Speech Language Pathology, AWH Special College, Kallai, Calicut-673003. *Corresponding Author
Madhavan B.	Associate Professor, Department of Audiology and Speech Language Pathology, AWH Special College, Kallai, Calicut-673003.
Afreen Najeeb C.H.	Student, II MASLP, Department of Audiology and Speech Language Pathology, AWH Special College, Kallai, Calicut-673003.
Pooja Surendran	Student, I MASLP, Department of Audiology and Speech Language Pathology, AWH Special College, Kallai, Calicut-673003.

ABSTRACT

Objectives: Association of high frequency hearing loss/minor damage in peripheral auditory system in continuous chronic tinnitus with normal PTA is well established. The purpose of the study was to verify whether this finding is true for intermittent unilateral or bilateral tinnitus patients with normal PTA using EHF audiometry and conventional DPOAEs.

Materials and method: This study was conducted on 45 normal hearing adults between the age ranges of 18-30 years. Among them 30 adults comprised of study group with intermittent tinnitus which varies in laterality. Tinnitus evaluation was done on these population followed by THI administration. DPOAE and EHF audiometry was completed on all subjects after conventional hearing assessment program.

Result and Discussion: Kruskal Wallis H test & Wilcoxon signed rank test was used to compare OAE amplitude & EHF thresholds. Spearman's correlation was used to evaluate the correlation between DPOAE amplitude with EHF threshold. Reduced hearing sensitivity in the extended high frequency region may be early predictor of outer hair cell dysfunction in the most basal area. Findings of this study suggest that intermittent tinnitus may also lead to subtle lesion at the basal region of cochlea which would result in a significant hearing loss with continuous tinnitus in future.

Conclusion: Intermittent tinnitus may increase the fragility of peripheral auditory system which may lead to permanent lesions and would be evident as elevated thresholds in conventional PTA.

INTRODUCTION

Clinical evidence suggests that tinnitus is not homogenous; rather umbrella term tinnitus includes many subgroups. Tinnitus can be categorised as continuous, intermittent or temporary (Elouse A Koop, Fathima.T. Hussain 2019). In intermittent tinnitus, periods of presence and absence of the tinnitus alternate, and occur in a more or less periodic fashion (Humphriss, Hall, and Baguley 2016; Oiticica and Bittar 2015). Prevalence of intermittent tinnitus has not been well divulged into by previous researchers (Elouse A Koop, Fathima.T. Hussain 2019).

Association of subtle cochlear damage in continuous chronic tinnitus with normal Pure Tone Audiometry (PTA) is well established. From the audiological perspective, two tests are considered to be pertinent in detecting slight hearing alterations: otoacoustic emissions (OAE) and Extended High Frequency (EHF) audiometry of frequencies above 8,000 Hz (Sanchez TG et al., 2014). Various studies among adults using conventional pure tone audiometry has shown that the presence of tinnitus is often linked to changes in OAEs (Nieschalk et al., 1998; Sanchez et al., 2005; Sanches et al., 2010; Thabet et al., 2009). This reinforces that tinnitus may appear before hearing loss and that OAEs can detect minimal cochlear alterations in individuals with normal audiometry. Hence it is important to incorporate these two tests with conventional hearing assessment program in individuals with chronic tinnitus. Nevertheless the question remains whether this is true for chronic intermittent tinnitus population. One possible answer to approach this question is investigation, whether intermittent tinnitus also reflects in the same manner in EHF audiometry and DPOAE testing. The purpose of the study was to confirm whether intermittent tinnitus also points to hidden hearing loss/ basal cochlear lesions with normal PTA. Hence this study was undertaken. Aim of the study was to assess the presence of sub clinical OHC damage/subtle cochlear lesions in normal hearing individuals with intermittent tinnitus using EHF audiometry and DPOAEs.

OBJECTIVES:

1. Comparison of DPOAE amplitude and EHF threshold between normal hearing individuals with unilateral and bilateral intermittent tinnitus and control group.
2. To find correlation between DPOAE amplitude with EHF threshold across the groups.

MATERIALS AND METHODS

Participants:

Present study was conducted on 45 normal hearing adults between the age ranges of 18-30 years without gender preference. Subjects were divided into three groups of 15 subjects each. Participants of group one & two were considered as study group with intermittent tinnitus which varies in laterality. Control group comprised age matched normal hearing adults. All participants fulfilling the following selection criteria were included in the study; like, dearth of noise exposure or ototoxicity, trauma; medical and other psychological complications in both the ears without hyperacusis. Bilateral normal otoscopic findings with PTA ≤20dB HL at octave frequencies between 250 Hz to 8 KHz and >90% SIS scores at 40dBSL. Normal middle ear functioning in both the ears, as tested by immittance evaluation. Individuals with pulsatile tinnitus were excluded from the study.

Clinical characteristics of tinnitus of the study group

Tinnitus duration: six months to one year, location of perception: unilateral as well as bilateral, frequency of perception: intermittent/temporary (once/twice in a week) and duration of each episode: less than an hour.

Procedure & Instrumentation:

Tinnitus Handicap inventory was administered on subjects with tinnitus who fulfilled aforementioned criteria. Tinnitus evaluation was carried out on these subjects using MAICO MA 42 clinical audiometer with supra aural headphones. Two alternative forced choice pitch matching procedure was done and pitch of the tinnitus was determined according to the frequency of the signal that was matched with the tinnitus and

this frequency was considered as reference for the loudness match. For loudness matching, a frequency that was matched to the patient's tinnitus was presented at a level just below the threshold and intensity increased until the subject signalled a match. A calibrated MAICO MA 42 clinical audiometer with supra aural headphones was used to obtain thresholds for conventional pure tone audiometry (250Hz to 8 KHz) and speech audiometry. Extended high frequency (10 to 16 KHz) thresholds were determined via Sennheiser HAD 300 circum aural headphones. Radio ear B-71 bone vibrator was used to determine bone conduction thresholds. A calibrated GSI Tymstar pro and MAICO ERO-SCAN OAE instrument was used for Immittance evaluations and to record DPOAEs bilaterally.

The DPOAE were recorded from both ears of each group using the MAICO ERO-SCAN in a sound proof room. DPOAEs were measured in the form of DP grams, with intensity of the two eliciting tones fixed between 1.6kHz to 8 kHz at 65(L1) and 55dB SPL (L2) and with a frequency ratio F1/F2 of 1.22:1. DPs were considered to be present, only when the amplitude of DPOAE is greater than -5dB SPL with a signal to noise ratio (SNR) exceeding 6dB SPL. Tympanometry was carried out using 226Hz pure tone and reflexometry obtained for frequencies 500 Hz, 1 kHz, 2 kHz and 4 kHz. Modified Hughson and Westlake procedure was carried out to perform PTA and phonetically balanced PB words was used to estimate SIS.

The results were analysed using the Statistical Package for the Social Sciences (SPSS version 26.0).

RESULTS

Results of THI revealed, 73.3% of group 1 individual rated tinnitus as having slight handicap with high pitched tinnitus and reduced loudness in the right ear and 46.7% of group 2 with similar pitch & loudness in both ears. Median & quartile of DPOAE amplitude depicted better amplitude at mid frequencies but differences were not statistically significant across frequencies between groups.

Median and quartiles of EHF showed poorer thresholds towards high frequencies for both ears in individuals with tinnitus irrespective of tinnitus laterality.

Table 4: Median & quartiles of extended high frequency thresholds.

(n = 45)			Frequency (kHz)					
			9K	10K	11.2K	12.5K	14K	16K
Group 1	RT	Median	5	5	10	10	5	20
		Q ₁	5	0	5	5	5	15
		Q ₃	10	5	15	15	15	35
	LT	Median	5	5	10	10	5	25
		Q ₁	5	0	5	0	0	10
		Q ₃	10	15	20	15	30	35
Group 2	RT	Median	5	5	10	10	10	20
		Q ₁	0	0	10	10	5	10
		Q ₃	10	10	20	15	20	50
	LT	Median	10	5	10	5	10	25
		Q ₁	5	0	5	5	5	15
		Q ₃	15	15	10	10	15	30
Group 3	RT	Median	0	5	5	0	5	15
		Q ₁	0	0	0	0	-5	0
		Q ₃	5	5	15	10	15	20
	LT	Median	0	5	5	-5	0	10
		Q ₁	-5	0	0	-5	-5	0
		Q ₃	5	5	10	5	10	15

Results of Mann Whitney U test on extended high frequency threshold between group 1 & control group revealed a statistically significant difference (p= < 0.05) in left ear. The same was true between bilateral tinnitus & control group. But significant difference was absent between group one and two.

Table 5: Comparison of extended high frequency thresholds between individuals with unilateral tinnitus & control group

	Group 1 & 3			
	RT		LT	
	Z	p value	Z	p value
9KHz	-1.787	0.074	-2.53	0.011*
10KHz	-0.313	0.754	-2.176	0.030*
11.2KHz	-1.517	0.129	-2.321	0.020*
12.5KHz	-2.62	0.009*	-3.147	0.002*
14KHz	-1.115	0.265	-2.467	0.014*
16KHz	-1.845	0.065	-2.883	0.004*

(*Significant)

The Mann Whitney U test was used to check whether the differences in extended high frequency threshold between individuals with unilateral tinnitus and control group were statistically significant or not, difference was present only at 12.5 KHz in the right ear and all the frequencies at left ear. The same was repeated between bilateral tinnitus and control group and significant differences was present only in the left ear except at 10 KHz.

Table 6: Comparison of extended high frequency threshold between individuals with bilateral tinnitus & control group

	Group 2 & 3			
	RT		LT	
	Z	p value	Z	p value
9KHz	-1.383	0.167	-3.133	0.002*
10KHz	-1.225	0.221	-1.931	0.053
11.2KHz	-2.182	0.029*	-2.12	0.034*
12.5KHz	-3.34	0.001*	-3.287	0.001*
14KHz	-1.727	0.084	-2.507	0.012*
16KHz	-1.713	0.087	-3.298	0.001*

To evaluate the correlation between DPOAE amplitude with EHF threshold across groups for both ears, Spearman's rho was used. For this, median values of DPOAE amplitude across frequencies from 1.6 KHz to 8 KHz among and between groups were correlated with the median values of EHF threshold from 9 KHz to 16 KHz for both ears. Significant negative correlation was found across the groups for all EHF's except at 10 KHz on both ears.

DISCUSSION

Most of the participants rated their tinnitus as having slight handicap on THI with high pitched tinnitus having a median value of 8 KHz which was in accordance with literature Vernon and Meikle (2003), Gouveris et al., (2005) and Zhao et al., (2014).

In the present study, tinnitus laterality and elevated thresholds were evident (Vielsmeier V et al., 2015). This finding suggests that even intermittent tinnitus may be an indicator of subtle cochlear lesion at the basal region which would result in a significant hearing loss with continuous tinnitus in future. Absence of hyperacusis in the study group excluded the possibility of neural/maladaptive central gain origin of tinnitus (Hébert S, Fournier P, Noreña, A 2013).

To investigate the first objective of the study, absence of statistically significant difference in DPOAE amplitude could be due to reduced number of damaged outer hair cells in the study group which was not detectable through conventional DPOAE procedures. (Harding GW et al., 2004). Conventional DPOAE levels are useful for detecting broad OHC losses of greater than 10% and large focal OHC lesions greater than 0.6 mm. Absence of significant differences in DPOAE amplitude across groups does not rule out the absence of subtle cochlear lesion in the study group. Similarly in the present study, OHC functioning beyond 8 KHz region in the cochlea could not be assessed as the DPOAEs were measured at frequencies from 1.6 kHz - 8 kHz. The study group might

display differences in DPOAE amplitude if high frequency DPOAEs were employed.

Statistically significant EHF thresholds across groups verified the hypothesis that intermittent tinnitus might be an indicator towards subtle cochlear damage in the basal region. The study was able to identify major differences between the groups in extended high-frequency audiograms, suggesting subtle cochlear impairment in the tinnitus group. Elevated thresholds in the extended high frequency region may be early predictor of outer hair cell dysfunction in the most basal area. Tinnitus perception in the study group might be triggered by damage to the basal region of the cochlea. Lack of significant difference in EHF thresholds between individuals with unilateral and bilateral tinnitus could be due to the symmetry of tinnitus severity/tinnitus generation mechanism among the subjects in the study groups.

Significant negative correlation between DPAOE amplitude and EHF thresholds might be linked with decreased number of functioning OHCs beyond 8 KHz region. As extended high frequency threshold worsens, the corresponding cochlear impairment also progresses systematically in a basal to apical direction (Osterhammel D, 1979). Thus present study suggests that EHF audiometry is a good tool to assess subclinical cochlear damage which affects the basal part of the cochlea initially. Result of this study indicate low efficiency of conventional DPOAE in detecting minor alterations in OHC functioning in the study population. DPOAEs at conventional frequencies lag in detecting damage confirmed with high-frequency audiometry (>8 kHz) (Reavis KM et al., 2008).

SUMMARY AND CONCLUSION

To summarize, the results of the present study suggest that even temporary tinnitus is an early predictor of subtle progressive cochlear abnormalities. As well as increasing the vulnerability of the cochlea to further traumatic stimulation which was evident in extended high frequency audiometry. Thus the present study recommends, use of high frequency DPOAEs and EHF audiometry in individuals who complaint of chronic intermittent tinnitus along with conventional hearing assessment program.

In conclusion, extended high frequency audiometry can be considered as an early detector of cochlear abnormalities at the basal region of cochlea before the manifestation of hearing loss in conventional audiometry. Extended high frequency audiometry could be combined with high frequency DPOAE that specifically evaluate pre-neural peripheral function along with conventional DPOAE measures (Poling G et al., 2012) would disclose more valuable evidence to our hypothesis.

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