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Original Article

Comparing OAE and ABR Tests in Tinnitus Patients with and without Hearing Loss

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Abstract

Background: Tinnitus is the perception of sound in the absence of any external stimulus. It may be generated by abnormalities in both peripheral or central auditory system. The auditory tests are useful tools for the evaluation of tinnitus origin.

Purpose: In this study, we compared the results of OAE(Otoacoustic Emissions) and ABR (Auditory Brainstem Response) hearing tests among patients with tinnitus without hearing loss and patients with tinnitus and hearing loss.

Methods: In this cross-sectional study, 60 patients with tinnitus were enrolled and were divided into two groups; a group without hearing loss and other group with hearing loss. DPOAE (Distortion Product Otoacoustic Emissions) TEOAE (Transient Evoked Otoacoustic Emissions), and ABR were performed for all patients with tinnitus referring to ENT clinic of Taleghani Hospital during 2014.

Results: In the present study, 60 patients with a mean age of 52.76±15.69, including 37 (61.7%) male and 23 (38.3%) female, were studied. Patients without hearing loss were younger than those with hearing loss (P=0.001). The mean Speech Reception Threshold (SRT) in the group without hearing loss in both ears was significantly lower than patients with hearing loss (P=0.001). The difference between two groups regarding ABR in right ear in waves I, V, and I-V was statistically significant (P<0.05). In patients without hearing loss there was a significant difference between two age groups (>55 and ≤55 years) in wave III of ABR in left ear (P=0.03).

Conclusion: We revealed that SRT and ABR in waves I, V, and I-V in the group with hearing loss were higher than patients without hearing loss.

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Introduction

Tinnitus reflects the perception of sound in the absence of any external physical stimulus. In most patients, the tinnitus is not audible for the physician and termed subjective tinnitus (1), and is considered as chronic tinnitus if lasts more than 3 months (2). The tinnitus may be generated by abnormalities in both peripheral or central auditory system (3, 4). Some studies indicated that about 90 percent of the patients with tinnitus have some degree of hearing impairment, such as presbycusis, ototoxic medications, middle ear infections, inner ear diseases, noise exposure and etc (2,3,4). However, the results of previous reports are not conclusive and it may be seen in patients with the normal hearing system and normal auditory threshold without any hearing loss (5,6). These authors have revealed that the incidence of patients with tinnitus without hearing loss was near to 8% for people with pure-tone thresholds lower or equal to 20 decibels hearing level (dB HL) for all standard audiometric frequencies up to 8 kHz. Moreover it occurs in 30% of patients with average threshold at 1, 2, 4, and 6 kHz lower or equal to 25 dB HL (7). The auditory tests are useful tools for the evaluation of the tinnitus origin. TEOAEs(Transient Evoked Otoacoustic Emissions) originate by cochlear and are highly sensitive to the pathology of cochlear (8). Furthermore, Auditory Evoked Potentials (AEPs) including ABRs(Auditory Brainstem Response) are useful techniques to the evaluation of the neural activity synchronization and documentation of abnormal neural activity in the auditory brainstem pathways and centers. The studies

that used these techniques to determine the origin of tinnitus indicated increased interpeak, abnormalities in OAE(Otoacoustic Emissions) response, absolute waves latency, and wave amplitude changes among the patients (9-11). The studies about the tinnitus in people with normal hearing are rare, moreover the results of studies about the causes of the tinnitus are not conclusive. Hence, to address these concerns, we compared the results of OAE and ABR tests in patients with tinnitus and hearing loss versus tinnitus patients without hearing loss to a better understanding of the possible causes of tinnitus.

Patients and Methods

Patients and Study Criteria

In this cross-sectional study 60 patients with tinnitus referring to the ENT clinic of Taleghani Hospital during 2014 were enrolled. The patients were interviewed and demographic information such as sex and age were recorded. Then the study procedure was explained to all patients and consents were taken. Moreover, the study protocol was approved by the ethic committee of Shahid Beheshti University of Medical Sciences. The audiometry tests such as ABR, TEOAE, and DPOAE were performed for them. The inclusion criteria were: constant tinnitus more than 6 months and age more than 18 years old. On the other hand, the patients were excluded if they had hyperacusis. Then the patients were matched regarding sex and age and were randomized into two groups with hearing loss (25-40 dB) and without hearing loss (the hearing threshold lower than 25 dB).

TEOAE Testing

In a sound treated room where the environment noise was maintained about 20 to 40 dB, the TEOAEs test was done using unfiltered clicks of 80 μs duration in non-linear modes. In the outer ear canal, the stimulus level was 80±2 dB peSPL and the click rate was 50/second. When the reproducibility was more than 50%, stimulus stability was better than 70% and the difference between TEOAE's amplitude and corresponding noise floor was at least 3 dB in at least four out of five 1/2 octave frequency bands centered at 1.0, 1.5, 2.0, 3.0, and 4.0 kHz26, the TEOAEs responses were considered(11).

DPOAE Testing

The stimulus included a pair of primary pure tones (f1 and f2) at a frequency ratio = 1.22. The primary tones' levels were offered at 65 dB SPL (f1) and 55 dB SPL (f2). The results were considered as a Distortion-Product (DP) audiogram; the 2f1 - f2 DPOAE amplitude was plotted against the f2 from 1000 to 6169 Hz.

The existence of DP amplitude was recognized as valid when the signal to +2 SD noise floor ratio exceeded 3 dB and the absolute DPOAE amplitude was at least -10 dB SPL at each individual f2(11).

ABR Testing

In the supine position with closed eyes, the ABRs were recorded using the ICS CHARTR with a horizontal electrode montage. The stimuli were 2000 sweeps of alternating polarity clicks, provided through the earphones at 90 dB SPL and a repetition rate of 11.1 clicks/second(9).

Speech Reception Threshold (SRT)

Compound words (two smaller words) were presented to the patients and asked the patient to repeat it. The aim was to find the softest sound level at which one can hear and repeat nearly one-half of the compound words correctly. An SRT is considered to be normal if it falls in the range of -10 to 25 dB HL.

Statistical Analyses

The data were analyzed using statistical package for social studies version 16.0 (SPSS Inc, Chicago, III). Categorical data are presented as numbers (%), and continuous data as mean ±SD. We used the Chi-Square test to compare categorical variables and the Student's t-test, to compare continuous variables. $P<0.05$ was considered significant.

Results

In this study, 60 patients (30 patients with hearing loss, 30 patients without hearing loss) with tinnitus including 37 males (61.7%) and 23 females (38.3%), mean age 52.76±15.96 were evaluated. The age of 23 patients was lower than 55 and 37 patients was more than 55 years old. The mean age of patients with hearing loss was more than patients without hearing loss and the difference between two groups was significant(P=0.001). The mean of SRT in the group without hearing loss in both ears was lower than patients with hearing loss and the difference was significant. In ABR in right side the difference between two groups in I, V, and I-V waves was significant, but in other conditions was not significant (Table 1).

The difference between male and female in patients with and without hearing loss was not

significant regarding to age, SRT, and ABR (Tables 2 and 3).

The difference between patients more than 55 and lower than 55 years old was not significant regarding to ABR and SRT in patients without hearing loss (Table 4).

Only one patient in the group with hearing loss was lower than 55 years, so in this group the patients more than 55 and lower than 55 years old were not compared.

Table 1. The difference in age, SRT, and ABR between two groups of tinnitus patients with and without hearing loss.

Variable		Tinnitus patients with hearing loss	Tinnitus patients without hearing loss	*P* value
Age		62.25±9.60	42.62±14.61	0.001
SRT	Right	32.00±5.81	10.00±5.50	0.001
	Left	32.66±4.68	9.33±5.37	0.001
ABR(Right)	I	1.51±0.07	1.45±0.14	0.03
	III	3.66±0.10	3.63±0.17	0.42
	V	5.72±0.10	5.50±0.28	0.001
	I-III	2.15±0.11	2.18±0.18	0.39
	I-V	4.21±0.10	4.05±0.23	0.001
ABR(Left)	I	1.44±0.12	1.44±0.18	0.86
	III	3.63±0.14	3.65±0.17	0.64
	V	5.68±0.11	5.56±0.31	0.05
	I-III	2.18±0.13	2.21±0.22	0.52
	I-V	4.23±0.13	4.12±0.34	0.08

Table 2. The difference in age, SRT, and ABR between male and female in the tinnitus patients without hearing loss.

Variable		Female	Male	*P* value
Age		44.84±13.69	40.05±15.35	0.38
SRT	Right	11.53±5.54	9.11±5.37	0.23
	Left	10.38±4.31	8.52±6.06	0.35
ABR(Right)	I	1.40±0.11	1.48±0.14	0.08
	III	3.58±0.08	3.67±0.20	0.17
	V	5.40±0.23	5.57±0.30	0.10
	I-III	2.18±0.12	2.18±0.21	0.97
	I-V	4.00±0.22	4.08±0.23	0.35
ABR(left)	I	1.42±0.18	1.45±0.19	0.66
	III	3.63±0.14	3.70±0.19	0.05
	V	5.44±0.29	5.65±0.30	0.06
	I-III	2.15±0.20	2.25±0.22	0.19
	I-V	4.02±0.34	4.20±0.32	0.16

Table 3: The difference in age, SRT, and ABR between male and female in the tinnitus patients with hearing loss.

Variable		Female	Male	*P* value
Age		63.90±5.40	63.15±8.24	0.79
SRT	Right	31.50±5.29	32.25±6.17	0.74
	Left	31.50±4.11	33.25±4.94	0.34
ABR(Right)	I	1.50±0.08	1.52±0.07	0.51
	III	3.63±0.10	3.68±0.11	0.24
	V	5.75±0.08	5.72±0.08	0.54
	I-III	2.13±0.09	2.16±0.12	0.50
	I-V	4.25±0.10	4.20±0.09	0.25
ABR(Left)	I	1.41±0.11	1.46±0.12	0.24
	III	3.58±0.10	3.65±0.16	0.19
	V	5.68±0.10	5.69±0.11	0.82
	I-III	2.17±0.12	219±0.14	0.70
	I-V	4.27±0.11	4.22±0.14	0.40

Table 4. The difference in SRT and ABR between patients more than 55 and less than 55 years in the tinnitus patients without hearing loss.

Variable		age >55 years	age ≤ 55 years	*P* value
SRT	Right	10.00±5.34	10.22±5.66	0.92
	Left	9.37±5.62	9.31±5.41	0.98
ABR (Right)	I	10.22±5.66	1.44±0.12	0.77
	III	9.31±5.41	3.61±0.16	0.30
	V	1.44±0.12	5.51±0.25	0.64
	I-III	3.61±0.16	2.16±0.15	0.45
	I-V	5.51±0.25	4.07±0.20	0.45
ABR(Left)	I	2.16±0.15	1.43±0.17	0.86
	III	4.07±0.20	3.60±0.16	0.03
	V	10.00±5.34	10.22±5.66	0.92
	I-III	9.37±5.62	9.31±5.41	0.98
	I-V	10.22±5.66	1.44±0.12	0.77

Discussion

Several hypotheses have explained the tinnitus mechanism (12). Although the sensorineural hearing loss is the most important factor in the generation of tinnitus, because the sensorineural hearing loss triggers neurophysiological processes, which are perceived as tinnitus, however, tinnitus may occur in patients without any hearing loss in audiogram (13). A review in 2011 by Knipper et al. indicated that the most important factors initiating the tinnitus in people are age, hearing loss and social stress (14). In current practice, 60 patients, mean age 52.76±15.96, with tinnitus and with or without hearing loss were compared, the results showed the mean age of patients with hearing loss was significantly more than patients without hearing loss. The mean of SRT in the group without hearing loss in both ears was significantly lower than patients with hearing loss. In ABR in right side the difference between two groups in I, V, and I-V waves were significant. A study by Antonelli et al. in Italy in 1990 showed that the abnormal ABR of patients with neuropathy was more than patients without neuropathy (39% versus 24%), moreover the study showed that the V, I-V, III-V, and I-III waves in normal female patients was significantly shorter. On the other hand, V and I-V waves were shorter in female patients with neuropathy and I-III waves was significantly longer in aged patients (15). Singh and collegues showed the audiological test results between patients with tinnitus and normal patients had a statistically significant difference between two groups regarding wave I latency prolongation, wave V shortening and absolute I-III and I-V interpeak latency, and DP and DPOAE signal-to-noise ratios (16). A study by Rosenhall et al. in 1995 in Sweden evaluated the ABR latency of 56 patients with normal or mild hearing loss and compared them to patients with moderate to severe hearing loss and showed increasing wave I and III-V latency in two groups with tinnitus (17). Other studies indicated that the tinnitus mainly changed the auditory tests, in this case, Sztuka et al. signified that the DPOAE in patients with tinnitus is more than control (18) and Thabet et al. indicated more abnormal OAE in patients with tinnitus (19). Moreover, similar results were indicated by several authors, such as Granjierro et al. (20), Mao et al. (21) and Onishi et al. (22).

In summary the study showed that most patients with hearing loss were male and more than 55 years, moreover the results emphasized that in patients without hearing loss the mean of wave III in ABR in patients >55 was significantly higher. In ABR in right side, the difference between two groups regarding waves I, V, and I-V was significant and the SRT was lower in patients with normal hearing.

Our experience was the first study in Iran comparing the tinnitus patients with and without hearing loss, however some limitations should be mentioned such as relatively small sample size that limits the ability to generalize the results of this study. Further studies with larger series are required.

Conclusion

We detected SRT and ABR in waves I, V, and I-V in the tinnitus patients with hearing loss were higher than patients without hearing loss. Moreover, the patients with hearing loss were older than those without hearing loss.

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Conflict of interest
The authors declare no conflict of interest.

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