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ORIGINAL ARTICLE

Results of Audiological Evaluation in Patients with Idiopathic Intracranial Hypertension

Serdar Ozer, Pinar Altiaylik Ozer, Sule Cekic Kaya, Ahmet Atas, Emrah Altıparmak, Gamze Atay, Levent Sennaroglu

Department of Otorhinolaryngology Head and Neck Surgery, Hacettepe University Faculty of Medicine, Ankara/Turkey (SO, GA, LS)
Department of Ophtalmology, Sami Ulus Cocuk Government Hospital, Ankara/Turkey (PA)
Department of Audiology, Hacettepe University Faculty of Medicine, Ankara/Turkey (SCK)
Department of Audiology, Istanbul University Faculty of Medicine, Istanbul/Turkey (AA)
Department of Opthalmology, Acıbadem Hospital, Ankara/Turkey (EA)

Background: Idiopathic intracranial hypertension (IIH) is a syndrome characterized by increased intracranial pressure (ICP) without focal signs for neurological dysfunction except for occasional fifth, sixth, and seventh cranial nerve palsies. Presenting symptoms most commonly are headache and visual loss. These patients may also present with complaints about neuro-otological symptoms like hearing loss, and tinnitus. In this study, we investigated the presence and laterality of neuro-otological symptoms, and correlations of these symptoms with the audiological and ophthalmological findings in patients with IIH.

Materials and Methods: The study included 28 patients with the diagnosis of IIH and 18 patients as control group. Ears of the patients in the study were grouped as symptomatic ears of IIH patients, non-symptomatic ears of IIH patients and ears of control group patients. We questioned the patients for neuro-otologic symptoms. Audiological and electrophysiological evaluations and ophthalmological examinations were done.

Results: The most common presenting symptom was headache. The most commonly seen neuro-otologic symptom was tinnitus, which was present in 21 patients (75%). Tinnitus was in pulsatile pattern in 15 of these patients (71.4%). We observed sensorineural hearing loss (SNHL) in 20 patients (35.7%) when standard pure tone averages (SPTA) and SNHL in 39 patients (69.6%) when low frequency pure tone averages (LFPTA) were evaluated. Complaints were unilateral in 39.3 % of these patients. SPTA and LFPTA's of the symptomatic ears were significantly higher than the non-symptomatic ears of IIH patients (p=0.008, p=0.005 respectively).

Conclusion: Neuro-otologic symptoms are commonly seen in patients with IIH. Audiological evaluations of the patients with unilateral symptoms showed different degree of hearing losses could be seen. Since neuro-otological symptoms and findings are commonly seen, audiological evaluations may play a role in the diagnosis and follow up of the patients with IIH. Patient follow up by the ear-nose-and throat specialists and the audiologists in association with neuroophthalmologists is thought to be beneficial.

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Introduction

Idiopathic intracranial hypertension (IIH) is a syndrome characterized by increased intracranial pressure (ICP) without any focal signs of neurological dysfunction except for occasional fifth, sixth, and seventh cranial nerve palsies [1-4]**.** This syndrome affects obese women of childbearing age in more than 90 percent of cases, and rarely it may affect males, and normal weight individuals of any age [5-7]. The aetiology of the disorder is not well understood but disturbed cerebrospinal fluid (CSF) dynamics are assumed to be an important factor. Diagnosis of IIH is only made after excluding all other diseases that can cause intracranial hypertension such as tumour, obstructive hydrocephalus, or venous sinus obstruction [8]. The Modified Dandy Criterias defined for IIH are required for the diagnosis, which are listed as: 1) signs and symptoms of increased intracranial pressure, 2) no localizing signs except abducens nerve palsy, 3) CSF opening pressure >25 cm water with normal CSF composition, and 4) normal neuroimaging (ruling out venous sinus thrombosis) [9].

Corresponding address:
Serdar Ozer
42.cad 1465.sok 2/33 Balgat/Ankara
e-mail: drserdarozer@gmail.com

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Affected patients mostly suffer from posture-dependent headaches, and visual changes (blurred vision, transient visual obscurations, retrobulbar pain, diplopia) due to papilledema [10]. Although papilledema is common in these patients, its absence does not exclude this entity [11-13]. Impairment of visual function is often progressive and permanent in up to 25% of cases [14-16]. Diplopia is due to sixth cranial nerve paresis and papilledema with its associated loss of sensory visual function. Ophthalmological complications of this syndrome are well documented, and visual loss is the major morbidity with IIH reported in the literature [6]. Although the classic presentation of pseudotumor cerebri syndrome consists of headaches or visual disturbances, hearing loss, tinnitus, dizziness and aural fullness has been recognized as the main manifestation of this syndrome [17-24]. The hearing loss is generally at low frequencies, it should not be confused with the hearing loss seen in patients with Meniere's disease. This is a pseudosensorineural hearing loss secondary to the masking effect of the pulsatile tinnitus (PT), and light digital compression over the ipsilateral IJV results in immediate cessation of PT and improvement or normalization of hearing [19]. Stretching or compression of the cochlear nerve and brainstem caused by the intracranial hypertension of possible edema was also considered as possible mechanism for the hearing loss in these patients which is supported by the abnormal auditory evoked responses present in one third of these patients [23].

In this study, we investigated the presence and laterality of neuro-otological symptoms, and correlations of these symptoms with the audiological and ophthalmological findings in patients with IIH.

Materials and Methods

Patients who have been followed up with a diagnosis of IIH were included into the study. Patients' records including neurological examination, CSF opening pressure level, CSF biochemical analysis, cranial MR and MR venography findings were investigated. All patients diagnosed with IIH were checked to fulfill the Modified Dandy Criteria for the exact diagnosis [9].

Patients with an age over 18 years, normal otoscopic examination and without any audiological and neuro-otological symptoms were determined as control group. Patients with any secondary cause of intracranial hypertension, patients with a history of otologic surgery or a documented otologic disease were not eligible for inclusion. Approval for this study was obtained from the local ethics committee of our institution. Written informed consent was obtained from all participants before enrollment in the study. All clinical investigations have been conducted according to the principles of Declaration of Helsinki.

All the patients in the study group had undergone ophthalmological examination. Ophthalmological examinations included visual acuity testing with Snellen chart, visual field testing with Humprey automatic perimetry, colour vision testing with Ishihara test, grading of relative afferent pupillary defect (RAPD) with neutral density filter if present.

The study included 56 ears of 28 patients with the diagnosis of IIH and 36 ears of 18 patients in the control group. Patients were questioned for the presence of neuro-otologic symptoms (tinnitus, intolerance to loudness, vertigo, sense of pressure over the ear and hearing loss) and the laterality of tinnitus, intolerance to loudness, sense of pressure over the ear and hearing loss if present.

Ears of the patients in the study were grouped as symptomatic and non-symptomatic according to the presence of neuro-otologic symptoms. Audiometric evaluation (pure tone audiometry and speech audiometry including uncomfortable hearing level), otoacoustic emissions, tympanometric evaluation (acoustic compliance and presence of acoustic reflex) and electrocochleography were done as audiological and electrophysiological evaluations. Audiometric evaluation was done with a regular (125-6000 Hz) and low frequency (125-500 Hz) audiograms. Averages of the standard pure tone hearing levels were calculated by detecting mean values of 500 Hz., 1000 Hz., 2000 Hz. and 3000 Hz hearing thresholds. Low frequency pure tone averages were calculated by detecting mean values of 125 Hz., 250 Hz. and 500 Hz. hearing thresholds. Calculated mean values were assumed to be normal or pathologic, according to the standard values shown in Table 1. Tympanometric evaluation tests were performed with 226 Hz probe tone. Air pressure within the external auditory canal assumed to be between 200-400 daPa. Acoustic

reflex tests were performed for 500-1000-2000 and 4000 Hz. for each ear. Word recognition score (WRS) is measured with phonetically balanced 50-word list, by live voice, at maximum comfortable loudness level.

Presence of cochlear sensitivity was determined by testing the uncomfortable hearing level during speech audiometry tests. Intensity of speech was increased gradually with 5 dB increments from the lowest level that the patient could discriminate the speech, up to the level that the patient couldn't tolerate. Test was performed for each ear and the uncomfortable level below the 100 dB was accepted as the sign of the cochlear sensitivity.

ECOG test was performed with interacoustic EP25 Auditory Evoked Potential unit. Signal transmission and recording were done with ER-3 receiver, which was covered with gold sheet and placed to the external auditory canal. Signal was given 85 dB above the hearing level. Rarefaction polarization was preferred and signal speed was arranged with 11.3/second. Minimum 1500 repetition was performed in each test, which was performed twice for each ear.

Analysis of the data was done with SPSS (SPSS for Windows, version 11.5, SPSS, Chicago, IL). Continuous variables were expressed as mean ± SD and categorical variables were expressed as percentages. Significance of the difference was evaluated with Student's t test or Mann Whitney U tests when the numbers of independent groups were 2. This evaluation was performed with one-way ANOVA or Kruskal Wallis tests when the numbers of independent groups were more than 2. Wilcoxon signed rank test was used to check any significant difference between the hearing levels of right and left ears in the study and control groups. Categorical comparisons were done with Pearson chi-square, probability ratio test (G) or fisher's exact test. P-values <0.05 were considered statistically significant.

Results

Most of the patients included in the study were female (n=27/28) (96%). Mean ages of the patients were 39 and 33 years in study and control groups respectively (p=0.029). While the BMI of the control group was 24.6 kg/m^2, it was 31.3 kg/m^2 in the study group (p<0.001). Mean CSF opening pressure of the patients with IIH at the time of diagnosis was 326 (range 240 to 410) mmH_20. Most commonly seen presenting symptom was headache and seen in 22 patients (78%). Other presenting symptoms were nausea in 1 patient, tinnitus in 1 patient, cerebrospinal fluid (CSF) rhinorrhea in 1 patient, visual distortions in 1 patient and diplopia in 2 patients.

All the patients with IIH in our study reported at least one symptom in the neuro-otologic questionnaire. Most commonly seen symptom was tinnitus and it was seen in 21 patients (75%). Other associated symptoms were intolerance to loudness in 10 patients (35%), hearing loss

Table 1. Audiolojical Evaluation Criterias and Cut-off values

Audiolojical Tests	Normal	Pathologic
Pure tone avarage	≤ 15 dB	> 16 dB
ECOG (SP/AP)	≤ 0.5	> 0.5
UCL	≥ 100 dB	< 100 dB
Acoustic compliance	0.3 – 1.5 cm2	< 0.3 cm2 , >1.5 cm2
OAE presence	Pozitif	Negatif

Table 2. Mean values of hearing levels in the study and the control groups

Audiological Evaluation	Study Group (n=56 ears)	Control Group (n=36 ears)	
	Mean (min-max) ±SD	Mean (min-max) ±SD	P
Mean of Standard Pure Tone (dB)	13.86 (2.00-33.75) ± 6.50	5.30 (0-13.25) ± 3.01	<0.001†
Mean of Low frequency Pure Tone (dB)	20.38 (3.33-66.67) +/- 10.24	5.69 (0-16.67) +/- 3.45	<0.001†

† Mann Whitney U test

in 8 patients (9%), vertigo in 9 patients (32%), nausea in 3 patients (11%) and sense of pressure over the ear (aural fullness) in 10 patients (35%).

In the neuro-otologic questionnaire, laterality of the symptoms was also asked. If the patient could define the side of the tinnitus, hearing loss, intolerance to loudness and sense of pressure over ear, it was accepted as unilateral disease, which was seen in 11 patients (39.3%). If the patient could not define the side of the symptom, it was accepted as bilateral disease, which was seen in 17 (60.7%) patients. We analyzed non-symptomatic ears of the 11 patients with unilateral disease as non-symptomatic ear group (n=11). Symptomatic ears of the 11 patients with unilateral disease and both ears of the 17 patients with bilateral disease made up symptomatic ear group (n= 45). We analyzed both ears of the control group patients as control ear group (n= 36).

Tinnitus was seen in 21 patients. Tinnitus presence ratio was 13/17 (76.4%) in the bilateral disease group, 8/11 (72.7%) in the unilateral disease group, which was not statistically significant (p=0.581). Amoung them 13 (61.9%) had bilateral disease, 8 (38.1%) had unilateral disease. When characteristic of tinnitus was questioned, 15 (71.4%) patients described as pulsatile and 6 (28.6%) described as continuous type. Amoung 15 patients with pulsatile tinnitus, 9 (60%) had bilateral disease and 6 (40%) had unilateral disease.

Mean values of pure tone and low frequency hearing levels in IIH and control group patients were given in Table 2. Statistically significant differences were detected for the comparisons of the standard and low frequency pure tone averages.

Calculated mean values for the standard and low frequency hearing levels, which were between -10 to 15 dB, accepted as normal [25]. Mean values of standard and low frequency hearing levels in all ears of the control group were within normal limits. Mean values of standard pure tone hearing levels of 36 ears (64.3%) and low frequency hearing levels of 17 ears (30.4%) amoung the 56 ears in the study group were within normal limits. Remaining ears' audiograms have showed different degrees of hearing losses. Numbers of the ears in each degree of hearing losses for the pure tone and low frequency hearing levels were given in Table 3. Scattergram showing avarage pure tone hearing levels and word recognition scores were given in Table 4.

Audiologic evaluation results of the symptomatic ear, non-symptomatic ear and control ear groups were compared in the Table 5. Standard and low frequency pure tone averages in the symptomatic and non-symptomatic ear groups were significantly higher than control ear group ($p<0.001$). Standard and low frequency pure tone averages of symptomatic ear group were significantly higher than measures of non-symptomatic ear group ($p=0.037$, $p=0.005$ respectively) (Table 6). There was no significant difference between ears of IIH patients with bilateral symptoms in terms of standard pure tone averages ($p=0.148$) and low frequency pure tone averages ($p=0.066$)(Table 6).

Comparison of the symptomatic ears of the patients with unilateral symptoms with the ears of the patients with bilateral symptoms was given in Table 7. There was no significant difference when pure tone averages (standard and low frequency), cochlear sensitivity, SP/AP ratios were compared ($p= 0.233$, $p= 0.066$, $p= 0.228$, $p= 0.979$ respectively). Acoustic compliance values were significantly higher in IIH patients with unilateral symptoms than those with bilateral symptoms ($p=0.024$) (Table 7).

Comparison of audiologic evaluation results of non-symptomatic ear group and control ear group were given in Table 8. Pure tone averages (both standard and low frequency) in non-symptomatic ear group were significantly higher ($p<0.001$), but the differences were not significant when acoustic compliance and SP/AP values were compared ($p=0.060$, $p=0.080$ respectively).

Tympanometry evaluations of the ears in the groups were within normal limits. Acoustic compliance values in the groups were also in normal limits and there was no significant difference between groups ($p=0.847$) (Table 5). Acoustic reflexes were present in all the ears of the groups. Distortion product otoacoustic emissions (DPOAE) detected from all ears in the groups. Mean values for the word recognition scores of the study and control group ears were 98.4 (88-100) ± 3.4 and 99.4 (92-100) ± 1.7 respectively, which was not statistically significant ($p=0.169$).

Table 3. Number of ears in each degree of hearing losses in the study group ears at the standard and low frequency pure tone hearing levels

Hearing Loss Level	Pure Tone Hearing Level (n/56)	Low Frequency Hearing Level (n/56)
Normal -10 to 15 dB	36/56 % 64.30	17/56 % 30.35
Slight 16 to 25 dB	17/56 % 30.35	28/56 % 50.0
Mild 26 to 40 dB	3/56 % 5.35	9/56 % 16.07
Moderate 41 to 55 dB	-	1/56 % 1.78
Moderately severe 56 to 70 dB	-	1/56 % 1.78

Table 4. Scattergram of hearing results of patients with Idiopathic Intracranial Hypertension

		Word Recognition Score (WRS) %				
Pure Tone Avarage (PTA) dB		100-90	89-80	79-70	69-60	59>
	0-10	30	-		-	-
	11-20	16	-	-	-	-
	21-30	7	2			-
	31-40	-	1	-	-	-
	40 <					

Table 5. Audiological evaluation results of the symptomatic ear, non-symptomatic ear and control ear groups

Audiological Evaluation	Symptomatic ear group (n=45) Mean (min-max) ±SD	Control ear group (n=36) Mean (min-max) ±SD	Non- symptomatic ear group (n=11) Mean (min-max) ±SD	P
Mean of Standard Pure Tone (dB)	13,9 (2,0-33,7) ± 6,45	5,30 (0-13,25) ± 3,01	13,7 (4,5-27,0) ± 7,02	<0.001†
Mean of Low frequency Pure Tone (dB)	21.1 (3.3-66.7) ± 10.7	5,7 (0-16,7) ± 3	17,4 (6,7-33,3) ± 7	<0.001†
Mean of Acoustic compliance (cm2)	0.83 (0.3-1.6) ± 0.34	0.75	0.97	0.847†
SP/AP	0.63 (n=27)	0,28 (n=29)	0,41 (n=8)	0.06†
Cochlear Sensitivity Ratio	10/45 (% 22.2)	1/36 (%2.7)	2/11 (%18)	0.193‡

† Kruskal Wallis test
‡ Probability ratio test

Table 6. Audiological results of IIH patients that is grouped according to presence of the symptoms laterality

IIH patients	Bilateral Symptoms (n=17 patients)			Unilateral Symptoms (n=11 patients)		
	Right ear Mean (min-max) ±SD	Left ear Mean (min-max) ±SD	P	Symptomatic ear Mean (min-max) ±SD	Non-symptomatic ear Mean (min-max) ±SD	P
Mean of Standard Pure Tone (dB)	13.57 (3-21) ± 5.3	11,9 (2-21) ± 5.3	0.148†	17.4 (7-33) ± 8.6	13.7 (4-27) ± 7.0	0.037†
Mean of Low frequency Pure Tone (dB)	21.4 (10-31) ± 6.7	16.2 (3-26) ± 6.8	0.066†	28.3 (11-66) ± 16.1	17.4 (6-33) ± 7.8	0.005†

† Wilcoxon signed rank test

We could not perform ECOG test in all patients due to the cooperation problems in some of the patients and inability of typical waveform detection in some tests. ECOG data of 27 ears in the symptomatic ear group, 8 ears in the non-symptomatic ear group and 29 ears in the control ear group were analyzed. No statistically significant difference was found among the groups in terms of SP/AP values (p=0.06). Ratio of pathological SP/AP values (>0.5) was 74.1% in the symptomatic ear group, 10.8% in the control ear group. This difference was statistically significant (p<0.001).

Presence of cochlear sensitivity ratios in the groups was shown in Table 5. While the ratio of cochlear sensitivity was 22.2% in the symptomatic ear groups, it was 2.7% in the control ear group. This difference was statistically significant (p<0.019).

When ophthalmological examination was considered, only 2 patients had visual field defect, 1 had a decrease in the visual acuity which was better than 20/200. There were 8 patients with dischromatopsia, 1 patient with RAPD. While unilateral disc edema was seen in 15 patients, papilledema was seen in 11 patients. The patient

Table 7. Audilogical analysis of the symptomatic ear group

Audiological Evaluations of the Symptomatic Ear Group	**Bilateral** (n= 17 patients/34 ears) Mean (min-max) ±SD	**Unilateral** (n=11 patients/ears) Mean (min-max) ±SD	P
Mean of Standard			
Pure Tone (dB)	12.7 (2.0-21.2) ± 5.3	17.4 (7-33) ± 8.6	0.165†
Mean of Low frequency			
Pure Tone (dB)	18.8 (3.3-31.7) ± 7.2	28.3 (11-66) ± 16.1	0.066†
Presence of cochlear sensitivity	6/34 (% 17.6)	4/11 (% 36.4)	0.228‡
SP/AP	0.63 (0.37-0.88) ± 0.17	0.63 (0.29-0.91) ± 0.19	0.979†
Acoustic compliance (cm^2)	0,75	1,06	0.024†

† Mann Whitney U test
‡ Fisher's exact test

Table 8. Audiological results of non-symptomatic ear and control ear groups

Audilogical Evaluations	**Control ear group (n=36)** Mean (min-max) ±SD	**Non-symptomatic ear group (n=11)** Mean (min-max) ±SD	p
Mean of Standard			
Pure Tone (dB)	5,30 (0-13,25) ± 3,01	13.7 (4-27) ± 7.0	<0.001†
Mean of Low frequency			
Pure Tone (dB)	5.7 (0.0-16.7) ± 3.5	17.4 (6.7-33.3) ± 7.8	<0.001†
SP/AP	0.28*	0.41**	0.080†
Acoustic compliance mean(cm^2)	0.75	0.97	0.060†

** Analysis of 18 ears in the control group*
*** Analysis of 8 non-symptomatic ears in the study group*
† Mann Whitney U test

who had a decrease in visual acuity also had a coexisting visual field defect and unilateral disc edema. Slight degree of hearing loss was detected in this patient's audiometric evaluation.

Discussion

IIH is a syndrome characterized by increased intracranial pressure without focal signs of neurological dysfunction affecting mainly female at childbearing age. The annual incidence of IIH is 3.5/100,000 in females between 15 to 44 years of age [26]. The overall incidence rises to 19 per 100,000 in overweight women [27,28]. Usual demographic profile of the patients with IIH are obese and women of childbearing age [27-29]. All patients in our study were female except one, with a mean BMI of 31.3 kg/m^2.

Patients with IIH are generally encountered in the neurology and ophthalmology clinics as headaches and visual disturbances. Although the most commonly seen presenting symptom is headache, tinnitus, hearing loss, aural fullness can be the main manifestation of this syndrome [3,12,30]. Headache was also the most common presenting symptom in our study (78%). Tinnitus was found in 21 patients with IIH, that was the presenting symptom in only 1 patient. Even 8 patients complained from the hearing loss when the neuro-otologic symptoms were questioned, none of these patients' presenting symptom was hearing loss. Although the neuro-otologic symptoms constituted a small portion of the presenting symptom of these patients, we have encountered at least one symptom in all patients with IIH. Since the neuro-otologic symptoms are commonly seen in these patients, diagnosis of IIH may be done during their visit in otorhinolaryngology clinics.

Tinnitus was the most commonly encountered neuro-otological symptom, which was generally in pulsatile pattern in our study. We have observed SNHL especially at low frequencies in the 70% of patients with IIH, similar to the previously reported studies; Sismanis reported a study that investigated the audiograms of IIH patients and reported SNHL in 90% of patients at low frequencies and Saxene et al. reported SNHL in 52% of IIH patients [19,31]. Hearing loss seen in IIH, accepted as pseudosensorineural hearing loss. It is thought secondary to the masking effect of the pulsatile tinnitus (PT), since the light compression over the ipsilateral internal jugular vein (IJV) results in immediate cessation of PT and improvement or normalization of hearing [19,32]. IIH is one of the most common etiology of venous pulsatile tinnitus in young and obese female patients [18]. It is believed that pulsatile tinnitus result from the systolic pulsations of the CSF, which originate mainly form the arteries of the Circle of Willis [32]. These pulsations which are increased in the presence of intracranial hypertension leads to narrowing of the dural venous sinuses and converts the laminar flow to turbulent and produces the pulsatile tinnitus [19]. Farb et al. demonstrated that over 90% of patients with IIH have transverse sinuses that appear stenotic compared with those of normal patients [33]. It was not clear whether stenosis was a cause or effect of the intracranial hypertension [32-34]. Abnormal auditory-evoked response (ABR) seen in one-third of these patients leads us thinking about the stretching or compression of the cochlear nerve and brain stem because of the increased intracranial hypertension, as a possible mechanism for the hearing loss [23].

Detection of hearing loss even it is pseudo, may help us to consider and diagnose IIH. Especially low frequency hearing loss can be detected even the patient has no symptoms.

Although limited awareness and considerations, SNHL is seen in the majority of the patients with IIH. The evaluated patients in this study were generally stabile in terms of IIH related symptoms and ophthalmological findings. So, audiological evaluations of the patients unresponsive to treatments or with serious ophthalmological complications should be evaluated for the possible coexisting audiological findings. Clinical follow-up through the exacerbations of IIH will probably show any change in the audiological findings in the patients with IIH.

Fischer and Wolfson firstly discussed otologic signs and symptoms in patients with increased intracranial pressure in 1943 [19]. 'Congestive inner ear' was the term; they used to describe the ears of these patients with the symptoms of tinnitus, hearing loss and vertigo. Kaaber and Zilstorff were the first who carried on otologic examinations on 34 IIH patients in 1978 and reported tinnitus in 4, vertigo in 2 and bilateral SNHL in 1 patient [35]. Although the neuro-otological symptoms as a presenting symptom are seen

rarely, these were common when asked to the patients with IIH. We detected at least 1 neuro-otological symptom in all the patients with IIH in our study. Tinnitus was seen in the majority of the patients (75%). We noticed the unilaterality of the symptoms when investigating the presence of hearing loss, tinnitus and aural fullness. We decided to analyze the ears of the patients with unilateral symptoms. Audiological evaluations of the ears of the patients with unilateral symptoms showed the probability of different degree of hearing loss development in each ear and hearing loss in symptomatic ears were more serious than non-symptomatic ears.

When non-symptomatic ear group were compared to control ear group, pure tone averages (standard and low frequency) of non-symptomatic ear group were found to be significantly higher than control ear group. This demonstrates pathology even in the ears regarded as normal by the patients with IIH.

Electrocochleography (ECoG) is a method of recording the stimulus-induced, synchronous electrical activity produced by the cochlea and auditory nerve. This test is generally used as an objective parameter in the diagnosis of Meniere's disease (MD) [36-38]. ECOG analysis of the patients with IIH in our study showed abnormal SP/AP ratio in 74.1%, which made us thinking about the increased intracranial pressure effect to the endolymphatic compartment of the inner ear.

Tympanometric evaluation results of IIH patients were found to be in normal limits in our study. Normal acoustic compliance values, presence of acoustic reflex, and normal otoscopic findings showed normal middle ear function and absence of conductive hearing pathology, as expected and parallel to the literature in the patients of the study and control groups [19]. Presence of stapes reflex and detection of DPOAE's eliminate the possibility of neuropathy.

Presence of cochlear sensitivity in symptomatic ear group was found to be higher than that of control ear group and cochlear sensitivity of both symptomatic and non-symptomatic ear group were found to be similar. This may show the bilateral effect of increased intracranial pressure over cochlea.

Comparison of audiologic evaluations of symptomatic and non-symptomatic ears of the patients with IIH was not previously studied in the literature. Patients in the study group with unilateral or bilateral otologic symptoms demonstrated no difference in pure tone audiograms and SP/AP ratios.

Standard and low frequency pure tone hearing levels of the non-symptomatic ears, which are assumed to be normal by the patients, were significantly higher than the levels of the control group ears ($p<0.001$). Audiological results of the patients with unilateral complaint showed that IIH may appear unilaterally but the non-symptomatic ears may be affected audiologically also.

Since the number of patients who had pathology in ophthalmological examination was small, audiological findings could not be correlated with the ophthalmological ones. Audiologic evaluation may reveal a pathology even the patient had a normal ophthalmologic examination. So these two entities must be evaluated separately and otologic symptoms must also be taken into consideration as the presenting symptoms in patients, which IIH is suspected even without an established papilledema.

Neuro-otologic symptoms like tinnitus, vertigo, aural fullness and hearing disturbances should always alert the clinician for the possibility of IIH and coexistence of IIH risk factors like age, female gender and obesity may help to bend the correct diagnostic tests [39]. Since IIH may also lead to neuro-otological symptoms and findings, audiological evaluations may play a role in the diagnosis and follow up of the patients with IIH.

Conflict of interest

The authors have no proprietary interest in any material or method described in this study. This study did not have any financial support.

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