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Evaluation of Meniere's disease, allergy, and their association in a group of patients with vertigo using electrocochleography and skin prick test

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Abstract

Background Meniere's disease is an idiopathic disorder of the inner ear characterized by episodic vertigo, tinnitus, fluctuating hearing loss, and aural fullness. Allergic disorders have been implicated among the heterogeneous causative factors of Meniere's disease. Here, we aimed to evaluate the different types of allergy in Meniere disease and analyze the association of several characteristics between allergic and non-allergic groups.

Methods The 53 of the 385 patients with definite Meniere's disease based on definite Meniere's disease criteria which confirmed by Electrocochleography(ECOG) test was included in this study. A questionnaire was used to obtain the required data. ECOG and skin prick test were performed in all the participants. Those fulfilling the clinical criteria alongside having a summing potential/action potential ratio of ≥ 0.5 in electrocochleogram were considered as having Meniere's disease.

Results Twenty-five of 53 Meniere patients (47.2%) showed different types of allergy. Inhalant allergy 25 (47.2%) and food allergy 8 (15.1%) were the most prevalent allergy types among Meniere patients. Among the underlying diseases, the prevalence of tinnitus was reported in 92% of the allergic patients. Moreover, the family history of Meniere disease and tinnitus were significantly associated with allergy. The pattern of threshold elevation showed that the flat pattern in allergic group and the low pattern in non-allergic group were significantly more prevalent.

Conclusion In this study, about half of Meniere patients showed different types of allergy by predominance of inhalant allergy. Tinnitus and Meniere's family history are significantly more common in Meniere's patients with allergy. So, allergy control in Meniere patients would be helpful on the treatment process.

Keywords Vertigo, Meniere disease, Hypersensitivity, Audiometry, Evoked response, Skin prick test

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Background

Meniere's disease is a disorder of the inner ear characterized by episodic vertigo, tinnitus, fluctuating hearing loss, and aural fullness [1]. It has an approximate incidence of 10–150 per 100,000 persons [2]. Meniere's disease is multifactorial and has a heterogeneous pathophysiology. Some of the suggested causative factors in Meniere's disease include the disturbed fluid dynamics and resultant endolymphatic hydrops of the labyrinthine system of the inner ear, anatomical variations in the temporal bone,

genetics, autoimmunity, migraine, cellular and molecular mechanisms, and allergy [3].

The association between allergies and Meniere's disease was first described by Duke [4]. From then on, other studies have been published regarding the role of allergic disorders and the possible mechanisms in producing symptoms of Meniere's disease. These include (1) antigen entry through the endolymphatic sac's peripheral and fenestrated blood vessels and subsequent stimulation and degranulation of mast cells in the peri-saccular connective tissue, toxic accumulation of metabolic products, and interference in hair cell function; (2) deposition of circulating immune complex through the fenestrated blood vessels of the endolymphatic sac leading to inflammation; and (3) a viral antigen-allergic interaction resulting in a chronic low grade inflammation through the migration of T-cells of the Waldeyer ring to the endolymphatic sac as well as epithelial surface damage and enhancement of histamine release [5–8].

The diagnosis of Meniere's disease is made based upon clinical findings along with complementary inner ear tests. The following criteria are required for the clinical diagnosis of Meniere's disease: (a) two or more spontaneous episodes of vertigo, each lasting 20 min to 12 h; (b) audiometrically documented low- to mid-frequency sensorineural hearing loss in the affected ear; (c) fluctuating aural symptoms (reduced or distorted hearing, tinnitus, or fullness) in the affected ear; and (d) symptoms not better accounted for by another vestibular diagnosis [9]. The complementary inner ear tests consist of audiometry, vestibular evoked myogenic potential (VEMP) testing, caloric testing, and electrocochleography [2, 3].

Electrocochleography has an important role in the diagnosis, assessment, and monitoring of Meniere's disease/endolymphatic hydrops [10]. It measures the stimulus-related cochlear potentials [11]. Cochlear microphonic (CM) is an alternating current voltage mimicking the waveform of acoustic stimulus, while summing potential (SP) is the stimulus-related potential of cochlea and action potential (AP) is the summed response of the synchronous firing of the nerve fibers [11]. A high average SP/AP ratio in electrocochleogram is attributable to endolymphatic hydrops/Meniere's disease [10].

There are scarce number of studies evaluating the association between Meniere's disease and allergy in Iran. Therefore, the definition of the number of affected patients and pathogenesis of this condition could elucidate more insights into the better comprehension of the disease and prevalence of the affected patients, appropriate management, and increasing the patients' quality of

life. Hence, in the current study, we aimed to evaluate different types of allergy in Meniere disease and analyze the association of several characteristics between allergic and non-allergic groups.

Material and methods

Study population

The present cross-sectional study was performed on patients referred to Imam Reza Hospital with a chief complaint of vertigo during April–September of 2018. Patients were included in this study if they had definite Meniere's disease criteria and electrocochleography test results as complementary test confirmed the disease.

Definite Meniere's disease criteria are as follows: “1. Two or more spontaneous episodes of vertigo, each lasting 20 min to 12 h. 2. Audiometrically documented low- to medium-frequency sensorineural hearing loss in one ear, defining the affected ear on at least one occasion before, during or after one of the episodes of vertigo. 3. Fluctuating aural symptoms (hearing, tinnitus or fullness) in the affected ear. 4. Not better accounted for by another vestibular diagnosis” [9].

Due to lack of enough data on electrocochleographic changes in patients with vertigo and allergy, we considered *P* to be 50% and the largest sample size which was 385 cases.

Data collection

A one-page questionnaire was designed and completed for each patient consisting of demographic information, accompanying clinical signs and symptoms (conductive or sensorineural hearing loss, tinnitus, and feeling of fullness in the ear), allergy history (allergic rhinitis, food or respiratory allergies, allergic contact dermatitis, and asthma), previous history of vertigo, and positive family history of same symptoms or Meniere's disease.

Electrocochleography (ECoChG)

Prior to ECoChG, all the patients underwent a full clinical evaluation including head and neck examination and pure-tone and speech audiometry. Extratympanic ECoChG was conducted using a Nicolet Spirit acoustic evoked potential test instrument (Nicolet, Madison, WI) in an electrically and acoustically shielded room by a trained audiologist. TIPtrode electrodes were used as the active and reference electrodes. The active electrode was placed into the external ear canal of the test ear, while the reference electrode was placed on the mastoid process of non-test ear. A low forehead-surface electrode was used as the ground electrode. Monaural test stimuli consisted of alternating polarity clicks (90 dB normal hearing level) presented at a rate of 11.3 per second. An average of 1000 stimulus repetitions within 10 ms was sufficient to obtain

a well-defined electrocochleogram. Each average was replicated at least two times. The recordings were amplified and bandpass filtered from 5 to 1500 Hz. The results were then assessed by an ear-nose-throat (ENT) specialist. An SP/AP ratio of ≥ 0.5 was considered abnormal, which in accompaniment with the abovementioned clinical criteria led to the diagnosis of Meniere's disease.

Skin prick test (SPT)

Skin prick testing was performed in all the patients based on the European standards with some modification [12]. The type of allergen extracts may differ based on geographical location and the country where the patient lives. The SPT panel for allergen extracts used in the present study are as follows: (a) inhalant allergen extracts; (b) food allergen extracts; (c) histamine dihydrochloride 0.1% as the positive control; and (d) NaCl 0.9% as the negative control.

In summary, a drop of each allergen extract solution was placed on the skin of the volar aspect of the forearm, at least 2–3 cm from the antecubital fossae and the wrist. A test grid was used to mark the location of each allergen. Then, the drop was immediately pricked using a single-head metal lancet held against the skin for at least 1 s. A distance of ≥ 2 cm was used between two SPTs. A new lancet was used for each allergen with equal pressure applied for each test. Each test result was read 15–20 min following application. The largest diameter of the wheal of each test was measured. The test result was considered positive if the wheal was ≥ 3 mm. The SPT results were then assessed by an allergologist to determine the clinical relevance of any detected sensitization along with a complete history taking and a physical examination.

Data analysis

Statistical analysis was accomplished using SPSS software (SPSS Inc., version 20, USA). We used Kolmogorov–Smirnov and Shapiro–Wilk tests to check data normality. Descriptive statistics were reported for quantitative data. Analytical analyses were performed using Mann–Whitney and chi-square or Fisher's exact tests. Correlations were measured using Pearson or Spearman analysis. P value < 0.05 was considered statistically significant.

Results

The demographic characteristics of the 2 allergic and non-allergic groups are provided in Table 1.

Among 53 patients with bilateral Meniere's disease, 25 (47.2%) had shown different types of allergy and 28 (52.8%) were categorized as non-allergy group. In allergic group, the proportion of males was more than females. Five types of allergy including inhalant allergy 25 (47.2%), food allergy 8 (15.1%), asthma 7 (13.2%),

contact allergy 3 (5.7%), and mite allergy 1 (1.9%) were identified in patients with Meniere. Among the underlying diseases, the prevalence of tinnitus was reported in 92% of the allergic patients, which was significantly different from the non-allergic group ($P = 0.004$). Moreover, allergic group significantly showed positive family history of Meniere disease compared with non-allergic patients ($P = 0.008$). The pattern of threshold elevation in the allergic group showed that the flat pattern was predominant while in the non-allergic group the low pattern was more prevalent than flat pattern ($P = 0.017$). All of the participants suffer of sensorineural hearing loss with different pattern of hearing loss all frequencies.

The results of electrocochleography for both right and left ears of patients with Meniere disease indicated that there was any significant difference between allergic and non-allergic groups ($P > 0.05$). In Meniere patients, allergic group mostly presented 21 to 40 dB of hearing loss (40%, mild), while normal hearing of ≤ 20 dB was recorded mostly for non-allergic group (52%). However, no significant difference was observed between two mentioned groups ($P > 0.05$).

Discussion

Vertigo, hearing loss, tinnitus, and vomiting were considered as the symptoms of Meniere disease; recurrent/fluctuating vertigo was used to diagnose vestibular hydrops; and hypersensitivity reactions with high blood IgE levels were used to diagnose allergies [13]. The association of the histocompatibility antigens with Meniere disease provided more evidence of the role of immune system [14]. Previous studies reported that Meniere disease has been linked to various types of allergy [5, 15, 16]. Sen et al. used a patient-completed web-based survey to compare 108 patients with Meniere disease with 100 non-Meniere's controls from an ear, nose, and throat clinic. They discovered that the Meniere's group had much higher rates of both allergies and migraines [17]. Derebery and Berliner represented that among 734 Meniere's disease patients, 59.2% reported a potential airborne allergy, 40.3% had or suspected a food allergy, and 37% had confirmed allergy testing by skin or in vitro [18]. Our study robust this evidence base, 42.7% of all Meniere patients represented five types of allergy with positive skin test which confirmed the previous studies' results. Another study by Derebery and Berliner showed that 41% of patients with Meniere disease had positive skin tests and 58% of patients had a history of allergies. This number is about three times the population as a whole [19].

Our finding indicated that among the five types of examined allergy, the highest prevalence was related to inhalant allergy and food allergy. Similarly, Banks et al.

Table 1 Subject characteristics

Variables	Allergy group (n = 25)		Non-allergy group (n = 28)		P-value
Gender	Female	Male	Female	Male	-
	8 (32)	17 (68)	16 (57.1)	12 (42.9)	
Age	39.2 ± 14.7		49.1 ± 12.7		0.572
polyps	0		0		-
Vertigo	25 (100)		28 (100)		-
Ear fullness	24 (96)		23 (82.1)		0.196
Tinnitus	23 (92)		11 (39.2)		0.004
Diabetes	1 (4)		0		0.472
Hypertension	1 (4)		1 (3.6)		1.000
Renal diseases	1 (4)		2 (7.1)		1.000
Family history of allergy	6 (24)		0		0.008
Right ear hearing frequency					
Normal	9 (36)		9 (32)		0.017
Flat	10 (40)		3 (10.7)		
Low	6 (24)		16 (57.1)		
Left ear hearing frequency					
Normal	12 (48)		12(42.9)		0.868
Flat	4 (16)		6 (21.4)		
Low	9 (36)		10 (35.7)		
R-ECOG	0.523 ± 0.252		0.446 ± 0.233		0.735
L-ECOG	0.502 ± 0.213		0.425 ± 0.220		0.915
R-Hearing loss severity					
Normal (≤ 20 dB)	8 (32)		13 (52)		0.575
Mild (21 to 40 dB)	10 (40)		7 (28)		
Moderate (41 to 70 dB)	4 (16)		3 (12)		
Severe (71 to 90 dB)	3 (12)		2 (8)		
Profound (≥ 91)	0		0		
L-Hearing loss severity					
Normal (≤ 20 dB)	4 (14.3)		13 (46.4)		0.721
Mild (21 to 40 dB)	15 (53.6)		10 (35.7)		
Moderate (41 to 70 dB)	6 (21.4)		3 (10.7)		
Severe (71 to 90 dB)	3 (10.7)		2 (7.1)		
Profound (≥ 91)	0		0		

R-ECOG right ear-electrocochleography, L-ECOG left ear-electrocochleography, dB decibels

reported that both inhalant and food allergies have been associated with symptoms of Meniere disease [20]. In line with our study, Derebery and Berliner disclosed that in comparison to control patients with other otologic disorders and the general population, patients with Meniere disease showed greater rates of allergy history and positive skin tests [21].

In Singh et al. study, patients with allergic rhinitis reported higher rates of hearing loss and aberrant otoacoustic emission than controls [22], and our study's result showed the same outcome.

The patients with Meniere disease have been found to have an increased risk of allergies, autoimmune diseases,

high levels of antibodies to certain food allergens, and positive prick test [23] which is inconsistent with our results.

A prevalence of 92% of tinnitus in allergic Meniere's subjects suggests that this is a serious problem. Additionally, it can allude to the likely pathogenetic function of allergies in these patients. As tinnitus is one of most common symptom of Meniere's disease and allergy is so prevalent in these subjects, therefore, in allergic Meniere's subjects is high prevalence. Our results are similar to Derebery and Berliner findings in Meniere patients that the prevalence of airborne allergy, food allergies, and had confirmatory skin or in vitro tests for allergy was

59.2%, 40.3%, and 97%, respectively [19]. Also, previous studies showed that there is a positive correlation between Meniere disease and family history of allergy [5, 24] which is consistent with our findings. The endolymphatic sac is susceptible to allergy. The endolymphatic hydrops occurrence may be as a result of cross-reaction of allergen-induced IgE antibodies to self-antigen which hypothesized a role for the autonomic nervous system and immune system dysfunction in etiology of Meniere's disease [14].

In allergic patients with Meniere's syndrome, electrocochleographic changes have been seen [25, 26]. According to Clemis's study, allergy introduced as a reason of cochlear hearing loss [27]. Also, our results indicated that Meniere disease with allergy mostly presented 21 to 40 dB of hearing loss (40%, mild) which proved previous findings. The tinnitus and cochlear hearing loss were more evident in allergic Meniere's patients than the non-allergic. The concept of allergy is one of the factors led to MD's pathogenesis was proposed by Duke [4]. It seems that allergy may deteriorate the hearing cells and may cause autoimmune inner ear disease. Evidence showed that about 1/3 of Meniere's disease cases seem to be of an autoimmune basis although the immunological mechanisms involved are not apparent [28].

Conclusion

In this study, approximately 50% of Meniere patients showed different types of allergy, most of which were male. The most common type of allergy in these patients is the inhalant allergy. Tinnitus and Meniere's family history are significantly more common in Meniere's patients with allergy group compared with non-allergy group. Consequently, it seems that due to the high prevalence of allergy in patients with Meniere disease, the control of allergy in the patients would have a positive effect on the treatment process.

Authors' contributions

Jabbari-Moghaddam Y conceptualized the study. Sadeghi-Shabestari M supervised the study. Razi-Soofiyani S wrote and revised the paper. Karimi S collected the data, analyzed data. All authors reviewed the manuscript.

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Data availability

No datasets were generated or analysed during the current study.

Declarations

Ethics approval and consent to participate

The study was ethically approved by the Ethical Committee of Tabriz University of Medical Sciences (Approval No: IR.TBZMED.REC.1398.271).

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests

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