Original Article

Hearing impairment in patients with alopecia areata

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Abstract

Background: Alopecia areata is an autoimmune disease that damages hair follicles and follicular melanocytes can be involved in the autoimmune process. Therefore, similar to vitiligo, there may be a relationship between sensorineural hearing loss and alopecia areata.

Aims/objectives: This study aimed to investigate potential hearing impairments in patients with alopecia areata.

Methods: A total of 42 subjects with alopecia areata and 42 healthy individuals enrolled in this cross-sectional study. The hearing was evaluated by vestibular evoked myogenic potential, otoacoustic emission and pure tone audiometry tests in the patients and control subjects.

Results: A normal otoacoustic emission was reported in 59.5% and 100% of subjects with alopecia areata and the controls, respectively ($P = 0.02$). Higher speech recognition thresholds ($P = 0.02$) and speech discrimination scores were reported more in subjects with alopecia areata than in controls ($P < 0.001$); however, the most comfortable level of speech was not significantly different between the groups ($P = 0.06$). The greatest increase in the hearing threshold was recorded at a frequency of 8000 Hz, while at frequencies of 500 and 1000 Hz, the patients and controls did not significantly differ ($P > 0.05$). About 6 (14.3%) and 2 (4.8%) of patients with unilateral and bilateral involvement, respectively, demonstrated no vestibular evoked myogenic potential response in the alopecia areata group. The patients and controls did not significantly differ in terms of amplitudes of the vestibular evoked myogenic potential test ($P = 0.097$).

Limitations: Small sample size and qualitative measurement of otoacoustic emission were limitations of our study.

Conclusions: Hearing loss was more common in alopecia areata patients than in healthy individuals. Follicular melanocytes may be involved in the alopecia areata inflammatory process, and destroying melanocytes may impact hearing function in the inner ear. However, there was no significant relationship between the duration and severity of alopecia areata and hearing loss.

Key words: Alopecia areata, hearing loss, vestibular evoked myogenic potential, pure-tone audiometry

Plain Language Summary

Alopecia areata, an autoimmune disease, damages hair follicles. Follicular melanocytes can be involved in the autoimmune process. This study aimed to investigate potential hearing impairments in patients with alopecia areata. The hearing was evaluated by vestibular evoked myogenic potential, otoacoustic emission and pure tone audiometry tests in the patients and control subjects. Higher speech recognition thresholds and speech discrimination scores were reported more in subjects with alopecia areata than in controls; however, the most comfortable level of speech was not significantly different between the groups. The greatest increase in the hearing threshold was recorded at a frequency of 8000 Hz. Hearing loss was more common in alopecia

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Introduction

Alopecia areata is an autoimmune disease that can damage hair follicles. Published evidence demonstrates an association between alopecia areata and other autoimmune diseases, with an estimated prevalence of 12%.[1] The existence of inflammatory lymphocytes around and inside the involved hair follicles and increased hair growth following the administration of immunosuppressive agents indicates that alopecia areata is an autoimmune disease.[2] Some studies have demonstrated that follicular melanocytes can play a significant role in the alopecia areata autoimmune process. Moreover, melanocytes in other organs, such as the ear, may be affected during the course of the disease, and this can lead to melanocyte destruction in the skin.[3]

Vitiligo is an acquired disorder with the pathology being in the epidermal melanocytes, and the inhibitory function of the inner ear melanocytes may be jeopardised in the process. Moreover, the inner ear is vulnerable to harmful environmental factors,[4] and the resident melanocytes are essential to protect hair cells[3]; therefore, follicular melanocytes may be considered critical targets in the alopecia areata autoimmune process. Thus, hearing loss may develop through a similar mechanism in patients with alopecia areata. Therefore, the current study was performed to detect hearing changes in a group of patients with alopecia areata who presented to a dermatology clinic and these results were compared with a control group.

Materials and Methods

Patients

This cross-sectional study was performed in the outpatient dermatology department between 2019 and 2020. A total of 45 patients with alopecia areata, all referred to the Department of Dermatology, Razi hospital, Iran, Tehran, were enrolled in this study. A diagnosis of alopecia areata was made based on clinical and dermoscopic examination. If there was any doubt as to the clinical diagnosis, a biopsy specimen was obtained. Patients with both types of alopecia areata, namely patchy and extensive (Totalis and Universalis), were enrolled in the study. The severity of the disease was determined based on the Severity of Alopecia Tool score. Patients between 18–55 were included in the study. Three patients didn't undergo hearing tests, and forty-two subjects were assigned to the case and control groups. Age and sex-matched healthy individuals from the cosmetic department of the hospital were recruited and included in the control group.

Exclusion criteria

The exclusion criteria were: the presence of concomitant inflammatory diseases such as infections and autoimmune diseases (e.g., autoimmune thyroid disease, psoriasis, vitiligo, pernicious anemia and lupus), history of head trauma, middle ear disease, ear surgery, pre-existing hearing problems, family hearing loss, chronic noise exposure, and the use of systemic ototoxic drugs. Patients with a history of otological disease and familial hearing loss were excluded from the study.

Audiometric examinations, including vestibular evoked myogenic potential, otoacoustic emission, and pure tone audiometry, was carried out on both ears of the patients and controls. The subjects' information was collected confidentially, and appropriate information was provided to the participants before obtaining informed consent. The Ethics Committee of Tehran University of Medical Sciences approved the current study.

Sample size

According to a study by Shaheen *et al*.[5] the intensity of hearing at 12,000 Hz in a group of patients with alopecia areata was 16.3 ± 32.8 and in the control group was 6.8 ± 22.9 (Hz). Therefore, considering an alpha equal to 0.05, beta equal to 0.05, $Z_{1-a/2}$ equal to 1.96, and Z_{1-B} equal to 1.6, plus 10% of the additional sample volume to prevent loss-withdrawal, the final sample volume was calculated as 45 patients in each group.

Severity of Alopecia tool score

The severity of the disease was measured based on the Severity of Alopecia tool score. The scalp was divided into four parts for the calculation of the Severity of Alopecia Tool score. The Severity of Alopecia Tool scores for the left profile (18%), right profile (18%), vortex (40%), and posterior part (24%) were calculated using a formula in the literature. The duration of the disease was classified into two groups of ≤3 months and >3 months.

Pure tone audiometry test

The pure tone audiometry test is a primary hearing test that detects neural hearing loss, transitional hearing loss, speech detection, and understanding threshold.

This test identifies an individual's hearing threshold to determine the degree, type and configuration of hearing loss and provides a basis for the diagnosis and management. In this test, pure sounds with different intensities and frequencies are listened to once through air conduction and once through bone conduction. Subsequently, the air and bone conduction thresholds are measured. The measurements are commonly performed at 8,000, 4,000, 2,000, 1,000, 500 and 250 Hz frequencies.

The speech recognition threshold is the level of the ability of a listener to repeat 12% of words from a list of two-syllable words. The average hearing threshold is usually 250, 500

and 1,000 Hz. Generally, the most comfortable level is usually about 32 dB higher than the speech recognition threshold. Finally, to measure the speech discrimination score, the examiner uses a list of single-syllable words presented at a suprathreshold level (40 dB above the speech recognition threshold), and the individual is asked to repeat 95–100% of these words correctly.

Otoacoustic emission test

The otoacoustic emission test examines the condition of the cochlea and the function of the hair cells just before the signal enters the nerve. It primarily detects sensory hearing loss or sensory hearing damage and evaluates the presence or absence of a response by two parameters, the transient evoked otoacoustic emissions and otoacoustic product distortions, by placing the prop inside the ear and recording the resulting waves. It should be noted that these two parameters complement each other. Overall, the transient evoked otoacoustic emissions is sensitive to cochlear pathologies at a specific frequency. In contrast, in adults, otoacoustic product distortions have a more comprehensive frequency range of observation (>10 kHz) and are less sensitive to minor and subclinical conditions.

Vestibular evoked myogenic potential test

The vestibular evoked myogenic potential test is used to evaluate the function of the utricle and the saccule (components of the ear balance system) and the lower neural part of the ear balance system. This test uses positive and negative P13N23 waves recorded from the lateral muscle (sternocleidomastoid), which is evoked by a shock or a click to one ear. It measures the presence or absence of a vestibular evoked myogenic potential response by placing electrodes on the upper half of the sternocleidomastoid muscle and above the sternum, followed by sound stimulation by recording the muscle potential as positive and negative waves. Latency is the time taken for each wave to reach its peak in milliseconds and is measured by calculating the time interval on the curve. Also, amplitude, expressed in microvolts, is the distance from the peak P31 wave to the N23 trough.

Statistical analysis

The analysis of data was performed using Statistical Package for the Social Sciences software (version 21). Quantitative data were expressed as mean ± standard deviation. Qualitative data were expressed as numbers and percentages (%). To evaluate the mean differences between the two groups, if the normal distribution of variables was confirmed in both groups, a *t*-test was used, while if the data did not have a normal distribution, its nonparametric equivalent (i.e., Mann–Whitney *U* test) was utilised. Analysis of variance was also used if the data distribution was confirmed to be normal in the groups and the equality of variance was observed. On the other hand, its nonparametric equivalent (Kruskal–Wallis test) was used when there was no equality of variance. Pearson's correlation test was applied to investigate the relationships between quantitative variables with a normal distribution, whereas Spearman's correlation test was utilised in the case of the non normal distribution of data. Finally, a binary logistic regression was performed to investigate relationships between the variables. The significance level was set to be <0.05.

Results

The current study was performed on 42 subjects with alopecia areata and 42 healthy controls who were age- and gender-matched with the patients. The mean age values of the patients and controls were 32.71 ± 10.22 (range: 18–54) and 33.38 ± 10.13 (range: 18–56) years, respectively ($P = 0.93$). Overall, 19 (45.2%) women and 23 (54.8%) men were included in each group. The participants' mean age at the onset of the disease was 28.69 ± 10.92 years (range: 12–46), and the mean disease duration was 4.11 ± 3.24 years. Alopecia totalis and patchy hair loss were observed in 20 (47.6%) and 22 (52.4%) subjects, respectively. The mean Severity of Alopecia Tool score was measured as 41.13 ± 18.76. Also, nail involvement was present in 4.8% of patients [Table 1].

Based on the findings of the vestibular evoked myogenic potential test, 34 (81%) patients had a normal response, six (14.3%) patients had unilateral involvement and two (4.8%) patients had bilateral involvement. The amplitude values of vestibular evoked myogenic potential in the patients and controls were 78.99 ± 45.35 and 73.67 ± 37.17, respectively; however, the patients and controls did not significantly differ ($P = 0.24$). The latency in the vestibular evoked myogenic potential test was 7.18 ± 2.6 and 8.49 ± 5.25 in the case and control groups, respectively. The patients and controls did not significantly differ in this regard ($P = 0.97$) [Table 2].

Moreover, according to the findings of the otoacoustic emission test, 17 (40.5%) patients did not have a normal response in the case group. Bilateral involvement was found in 11 patients in transient evoked otoacoustic emissions, and only the left ear was involved in six patients. Regarding otoacoustic product distortion, nine patients showed bilateral involvement, and six patients only showed left ear involvement [Table 2].

Table 1: Demographic information of the participants

		Case	Control	*P*-value
Age		32.71 ± 10.22	33.38 ± 10.13	0.93
Gender	Male	23 (54.76%)	23 (54.76%)	1
	Female	19 (45.23%)	19 (45.23%)	
Age of onset (y)		28.69 ± 10.92	–	–
Mean disease duration (y)		4.1 ± 3.24	–	–
Type of AA	Alopecia totalis	20 (47.6%)	–	–
	Patchy hair loss	22 (52.4%)		
Nail involvement		2 (4.76%)	–	–
SALT score	Alopecia totalis	100	–	–
	Patchy hair loss	41.13 ± 18.76		

AA: alopecia areata, SALT: severity of alopecia tool, mean ± SD

Table 2: Auditory test results of patients and controls

				Patients	Controls	*P*-value
VEMP	Amplitude			78.99 ± 45.35	73.67 ± 37.17	0.24
	Latency			7.18 ± 2.6	8.49 ± 5.25	0.97
OAE				17 (40.5%)	–	>0.05
	TeOAE	Bilateral		11 (26.2%)	–	
		Unilateral	Left	17 (40.5%)		
			Right	11 (26.2%)		
	DPOAE	Bilateral		9 (21.4%)	–	
		Unilateral	Left	15 (35.7%)		
			Right	15 (35.7%)		
PTA	MCL			42.26 ± 4.5	41.79 ± 3.08	0.06
	SRT			12.26 ± 4.71	12.02 ± 2.48	0.02
	SDS			99.40 ± 1.97	97.7 ± 2.27	0.001

DpOAE: distortion product otoacoustic emission, MCL: most comfortable level, OAE: otoacoustic emission, PTA: pure tone audiometry, SDS: speech discrimination score, SRT: speech recognition threshold, TeOAE: transient evoked otoacoustic emissions, VEMP: vestibular-evoked myogenic potential

The pure tone audiometry test was normal in 76.2% of the subjects of the case group; however, all individuals were normal in the control group. The greatest hearing loss was recorded at 4000–8000 Hz. Among patients with an abnormal pure tone audiometry, 21% had mild hearing loss (21–24 dB), 41% had moderate hearing loss (31–23 dB), and 31% had severe hearing loss (43–31 dB). The most comfortable level of speech values was 42.26 ± 4.5 and 41.79 ± 3.08 in the patients and controls, respectively, and the patients and controls did not significantly differ ($P = 0.06$). The mean speech recognition threshold in the case and control groups was 12.26 ± 4.71 and 12.02 ± 2.48, respectively, and the mean speech discrimination score values in the patients and controls was 99.40 ± 1.97 and 97.7 ± 2.75, respectively. Remarkably higher mean speech recognition threshold ($P = 0.02$) and speech discrimination score ($P = 0.01$) scores were reported in the patients compared to the controls [Table 2].

The patients and controls did not significantly differ at a frequency of 250 Hz for the right ear ($P = 0.655$) and 500 Hz (P value right ear (PR) = 0.403 and P value left ear (PL) = 0.069), and 1000 Hz (PR = 0.068 and PL = 0.341) for both ears. However, a significant difference was noticed between the patients and controls at a frequency of 250 Hz for the left ear ($P = 0.011$) and 2000 Hz (PR = 0.025 and PL = 0.006), 4000 Hz (PR = 0.015 and PL = 0.001), and 8000 Hz (PR = 0.029 and PL = 0.001) for both ears [Figure 1]. Therefore, the most significant difference in the hearing threshold between the patients and controls was recorded at 8000 Hz; nevertheless, the patients and controls did not significantly differ at 500 and 1000 Hz [Figure 1]. Based on the logistic regression analysis results, age, gender, duration, and severity of disease variables had no significant effects on the vestibular evoked myogenic potential, otoacoustic emission and pure tone audiometry ($P > 0.05$).

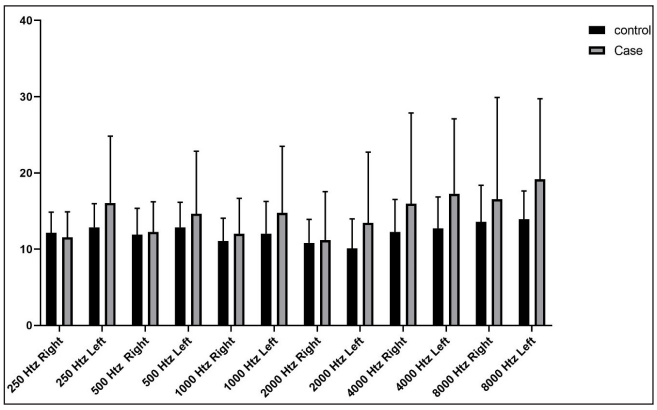

Figure 1: Comparison of the hearing threshold in the case and control groups

Discussion

Alopecia areata is a T-cell-mediated autoimmune disease affecting hair follicles which can lead to hearing loss.[6] In a study by Sheng-Hsiang Ma *et al*. the incidence of hearing disorders in alopecia areata patients compared with the controls was 77.46–17.53/100,000 people, indicating the effect of this autoimmune disease on hearing.[7] In this study, alopecia areata patients were reported to have a higher level of sensorineural hearing loss than healthy controls, and bilateral hearing loss was reported at high frequencies (>2000 Hz). The patients and controls significantly differed in the otoacoustic emission. Remarkably higher speech recognition threshold and speech discrimination score were reported in alopecia areata patients than in controls. Also, the vestibular evoked myogenic potential test was employed to examine the saccule, vestibulospinal tract and inferior vestibular nerve. No significant differences were noticed in the mean amplitude or latency of waves between the patients and healthy controls.

Previous studies have identified follicular melanocytes as the main targets in the autoimmune process.[8] Melanocytes in the foetus originate from the neuroectoderm. They are found in the epidermis, hair follicles, retinal pigmented epithelium and leptomeninges.[9] The inner ear's membranous labyrinth includes melanocytes, and high pigmentation is observed in this area, particularly in the scala vestibuli. Melanocytes exist in the stria vascularis, auditory receptors or hair cells and endolymphatic sac in the inner ear.[10]

Due to its semiconductor properties, melanin in the auditory system responds to phonic, acoustic, and electrical stimulations and can convert energy to molecular and vibrational rotations. Melanocytes in the inner ear are critical for the survival of hair cells, normal vascular and cochlear functions of the striae, development of intracochlear potential and maintenance of ionic and fluid gradients between the endolymph and perilymph.[11,12] Follicular melanocytes are also key targets in the alopecia areata autoimmune process. In patients with alopecia areata, follicular melanocytes demonstrate histological and ultrastructural abnormalities.[13]

In this regard, Trautman *et al*. observed a decrease in the number of follicular melanocytes in alopecia areata[14] and hair bulb melanocytes involved in alopecia areata. In this regard, morphologic changes, increased numbers of bizarre melanosomes, and unusual outer root sheaths have been reported.[15]

In a study by Ucak *et al*. sensorineural disorders were reported in a larger number of patients (54.9%) than in our study (23.8%). In the present study, unilateral hearing loss was found at 250 Hz, while in their research, unilateral mild hearing loss was reported only at high frequencies (4000–16,000 Hz); in both studies, bilateral mild hearing loss was reported at high frequencies (>4000 Hz).[16] In another study, Ucak *et al*. found that cochlear dysfunction significantly correlated with the severity of alopecia areata, according to the transient evoked otoacoustic emissions test.[17]

On the other hand, Shaheen *et al*. reported a hearing impairment rate similar to our finding and observed significant hearing loss in the subjects with alopecia areata in comparison with controls. However, unlike our study, they observed that the severity and duration of the disease affected the audiometric results.[6] The findings of this study are in line with those of previous studies, indicating a higher hearing threshold in patients with alopecia areata at different frequencies, especially at high frequencies (2000–4000 Hz and 8000 Hz), compared to the control groups.[18]

Limitations

One limitation of this study was recruiting the patients based on multiple inclusion and exclusion criteria. Also, numerous time-consuming hearing tests posed serious challenges to the audiometry personnel. It should be mentioned that three patients didn't perform hearing tests, and only 42 subjects were assigned to the case and control groups. Finally, considering the normal and abnormal otoacoustic emission measurement techniques without calculating the numerical values in this study, the use of a larger sample size and numerical measurement of all parameters is recommended in future projects.

Conclusion

Based on the pure tone audiometry, otoacoustic emission and vestibular evoked myogenic potential tests, hearing impairments were more frequent in patients with alopecia areata than in healthy individuals, but this was not statistically significant. Nevertheless, age, sex and duration or severity of the disease had no significant effects on these patients. As in this study, the vestibular evoked myogenic potential was evaluated for the first time in patients with alopecia areata, and significant results were recorded; further research in this field is recommended.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Nil.

Conflicts of interest

There are no conflicts of interest.

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