

The Prevalence of Hearing Loss in Patients with Autoimmune Thyroid Disease: A Prospective Study

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Abstract

Aims: To investigate the effect of Hashimoto's thyroiditis and Graves' disease on hearing thresholds of adult patients.

Materials and methods: 75 Patients participated in this study, they were divided into two groups: Hashimoto's thyroiditis group (n=41), and Graves' disease group (n=34). Otoscope examination, immittance testing, and pure tone audiometry were performed for both groups.

Results: All participants had normal findings with otoscopic examination and the 0.226 KHz tympanometry test. Pure tone audiometric (PTA) testing showed mild to moderate sensorineural hearing (SNHL) loss in 16 (39%) patients diagnosed with Hashimoto's thyroiditis and 8 (23.5%) patients with Graves' thyroiditis.

Conclusion: Based on our study, mild to moderate SNHL was present in 32% of the patients with autoimmune thyroid diseases. Therefore, it was suggested that thyroid autoimmunity has a negative impact on the hearing acuity, particularly at the high frequencies. Our findings are in agreement with regional and international literature regarding this manner. Hence, an annual hearing screening is recommended for patients with thyroid autoimmune disease in order to provide early management.

Keywords: Autoimmune thyroid disease, Hashimoto's, Graves', Sensorineural hearing loss.

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Introduction

Chronic autoimmune thyroid disease is common in the general population occurring in 10-20% of women and 1-2 % of men. However, most of these patients have thyroid function test values that lie within the normal range⁽¹⁾.

According to World Health Organization (WHO), 360 million of the world populations suffer from hearing loss⁽²⁾. Hearing loss is associated with much pathology, including autoimmune diseases which degenerate the normal function and structure of the auditory system^(1, 3). An early diagnosis of hearing loss

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promotes an early effective intervention.

The association between hypothyroidism and hearing loss has been suggested in multiple studies^(1, 4, 5, & 6). Some of these studies have also shown some improvement in hearing loss after correcting hypothyroidism^(1,4). The association between hyperthyroidism and high frequency hearing loss has also been found by Berker⁽⁷⁾. The lack of full improvement of hearing sensitivity after levothyroxine replacement may suggest a possible underlying autoimmune etiology, rather than just low T4 levels⁽¹⁾.

Although there are various studies that evaluated hypothyroid patients' hearing, research examining the hearing function of hyperthyroid patients is limited^(8,9). There is substantial controversy when it comes to relating hearing loss to thyroid disorders.

In a study by Arduc and colleagues, 30 patients with Hashimoto's thyroiditis had decreased hearing thresholds at frequencies 250, 500 and 6000 Hz. This hearing loss was sensorineural and the degree was up to mild⁽³⁾.

Due to the high prevalence of autoimmune thyroid disease and the big controversy on whether it affects the underlying audiological mechanisms or not, the aim of the present study was to investigate the auditory function in this specific population. In this study, full comprehensive audiological tests were performed on patients with autoimmune thyroid disease, including Graves' disease and Hashimoto's thyroiditis to explore the presence of hearing loss.

Methods: Subjects, Assessment and Statistical Analysis

Subjects

The study was approved by the Institutional Review Board (IRB) at Jordan University Hospital. Seventy five adults diagnosed with Hashimoto's thyroiditis and Graves' thyroiditis

participated in this study. Inclusion criteria was: a confirmed autoimmune thyroid disease per positive serum autoimmune thyroid antibodies (thyroid peroxidase antibodies, anti-thyroglobulin antibodies, or thyroid stimulating immunoglobulin), and/or positive thyroid ultrasonic findings for Hashimoto's thyroiditis in the settings of primary or subclinical hypothyroidism (baseline TSH >5.0 uU/ml) or diffusely increased thyroid uptake and scan that is consistent with Graves' disease in the setting of primary hyperthyroidism (baseline TSH <0.1 uU/ml). Exclusion criteria for both groups were as follows: older than 55 years to eliminate the risk of hearing loss due to aging (presbycusis), prior ear surgery, having an altered otoscopic exam, previous audiological or otological diseases, a type B, C, As or Ad tympanometry, ototoxic medicine, a history of noise exposure, history of hereditary hearing loss, a genetic syndrome, or a central nervous system pathology.

The participants were 65 females and 10 males; 37 females in Hashimoto's group and 28 females in Graves' group, whereas only 4 males with Hashimoto's thyroiditis and 6 males with Graves' thyroiditis participated in this study. The subjects' ages in both groups ranged between 16-50 years with a mean age of 34.2±9.5 SD. The recruited participants were divided into two groups with regard to the diagnosed disease. We aimed for the two groups to be equally balanced with regard to the number of participants to avoid an allocation bias. However, this was not possible due to the higher prevalence of Hashimoto's disease in accordance to Graves' disease.

Patients with primary or subclinical hypothyroidism were receiving thyroxine replacement therapy, while patients with Graves' hyperthyroidism were on carbimazole medication. All patients signed a consent form prior to participation.

Assessment

The experiment took place at the University of Jordan, the Faculty of Rehabilitation Sciences, Audiology Department. It started with a physical examination of the outer ear, using a hand held otoscope. Following that, the acoustic immittance of the middle ear was measured through an Interacoustic AA222 diagnostic tympanometer in order to ensure the absence of middle ear abnormalities.

The hearing tests were carried out in a sound-treated booth in order to ensure minimal levels of background noise and distraction for the participants during the experiment. The hearing of the participants was tested using an AC40 clinical audiometer through TDH supra aural earphones and bilateral pure tone. Air conduction thresholds at 250, 500, 1000, 2000, 4000 and 8000Hz as well as bone conduction throughout 500-4000Hz were tested. The BSA standard clinical procedures were implemented⁽⁸⁾.

The audiometric results were classified as sensorineural hearing loss (SNHL), conductive hearing loss (CHL), or mixed hearing loss. Any participant with a CHL or mixed hearing loss due to an otological pathology was excluded from the study and referred back to the ENT unit at the University of Jordan hospital.

Statistical Analysis

Data was analyzed using SPSS software version 23. Descriptive statistics were performed for the two groups separately and the normal distribution of the data was examined, using a Shapiro-Wilk test⁽⁹⁾. The Shapiro-Wilk test ($p < 0.05$) and a visual inspection of their histograms, normal Q-Q plots, and box plots showed that the data was not normally distributed for both groups (Hashimoto's and Graves' disease).

The mean of pure tone audiometric (PTA) and average hearing threshold, which is "the average of hearing thresholds across the frequencies 500, 1000 and 2000 Hz",⁽¹⁰⁾ was calculated for each group in order to represent the mid and low frequencies. The thresholds at 250Hz, 4000Hz and 8000Hz were represented separately. All of the 75 patients had normal immittance testing results, Tympanogram type A.

Results**Hearing Threshold Results of Participants**

The percentages of the hearing loss were calculated for each group and ear separately for a detailed result. The hearing loss was not necessarily bilateral. Therefore, the results described in this section were ear and frequency specific. Hearing thresholds were considered elevated for ≥ 20 dB HI following the BSA clinical procedures⁽⁸⁾.

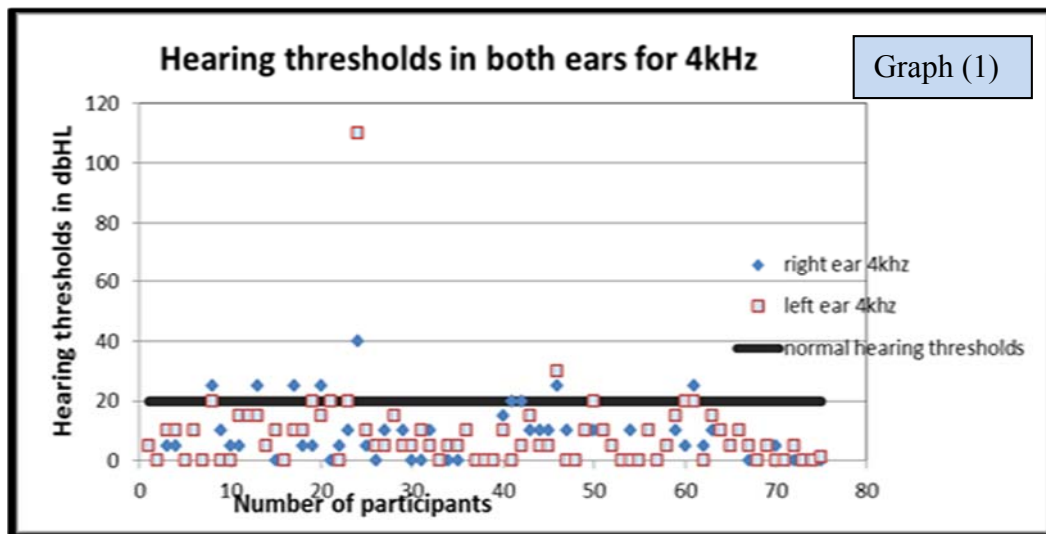
Statistical analysis showed that at 250 Hz in patients with Hashimoto's disease, 8 right sided ears and 9 left sided ear showed a mild SNHL with a percentage of 19.5% and 22% respectively, whereas in patients with Graves' disease, the number was lower showing 5 right sided ears and 4 left sided ears with a mild SNHL (14.2%, 11.4% respectively).

Concerning the frequencies 500, 1000 and 2000Hz, the hearing thresholds of ≥ 20 dB HI for Hashimoto's disease were three patients with mild SNHLs with a percentage of 7.3% for the right ear and two patients with a percentage of 4.8% for the left ear; the degrees were mild and profound. With respect to Graves' disease, only one patient had a mild SNHL in the right ear.

Graph (1), (2) shows the thresholds at 4 kHz

and 8 kHz bilaterally in both groups. The constant line represents the border line for normal hearing <20 dB HI⁽⁸⁾, whereas any value

below this line indicates normal hearing thresholds, because the lower the value, the better.

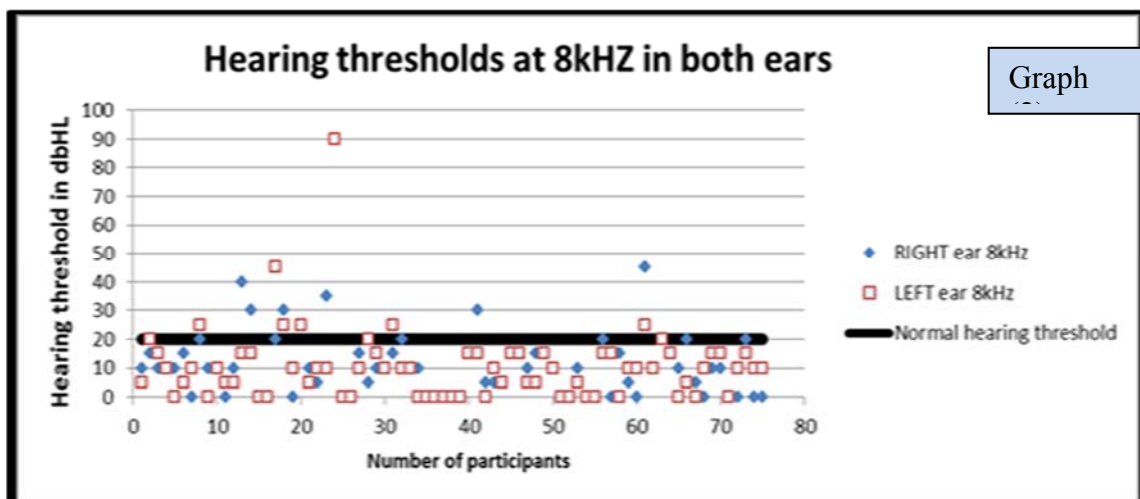


For patients diagnosed with Hashimoto's disease at 4 kHz, five were presented with mild SNHL with a percentage of 12% in the right ear. Regarding the left ear, the number of patients with elevated thresholds was also 5, whereas 4 had mild SNHL and one had a profound hearing loss. With regard to patients with Graves', 4 had mild SNHL in both ears with a percentage of 11%.

data was beneath the reference line. However, at this frequency there were more participants with higher thresholds than for the mid, and low frequencies and 4000Hz, but not 250Hz.

With respect to 8kHz, the majority of the

Six Graves' disease patients had elevated thresholds in the right ear and two had elevated thresholds in the left ear with percentages of 17% and 5.7%, respectively. Hearing losses were sensory neural and ranged between mild to moderate.



The number of patients, with mild and moderate SNHL for Hashimoto's disease, was higher, whereas nine patients had elevated thresholds in the right ear and eight in the left ear with a percentage of 22% and 19.5%, respectively.

Difference between the PTA Averages of the Right and Left Ear for the Two Groups

In order to explore if the observed small differences between the thresholds at the mid and low frequencies of the two groups were statistically significant; a Mann-Whitney U test for the non-parametric data was performed.

The results of the Mann-Whitney U test indicated that the pure tone average of the right and left ear respectively ($U=696$, $p=0.5$), ($U=635$, $p=0.25$) for patients with Hashimoto's disease was not statistically significantly compared with the patient's with Graves' disease.

Difference between Hearing Thresholds at 4kHz and kHz in the Two Groups

In order to explore if the difference between the hearing thresholds of the higher frequencies among the two groups was statistically significant, a Mann-Whitney U test was performed. The test indicated that the thresholds at 4kHz of the right ear ($U=689.5$, $p=0.47$) for patients with Hashimoto's disease was not statistically significantly compared with the patient's with Graves' disease. The results also showed that the thresholds for the left ear at 4kHz for the patients with Graves' were not statistically significant ($U=617$, $p=0.2$) compared to those with Hashimoto's disease.

With regard to the two ears at 8kHz, the Mann-Whitney U test indicated that the thresholds for the patients with Hashimoto's

disease were not statistically significantly compared to the thresholds for the patients with Graves' ($U=612$, $P=0.17$), ($U=656$, $P=0.37$).

Discussion

In this study, 39% of patients with Hashimoto's and 23.5% of patients with Graves' thyroiditis were presented with mild to moderate SNHL and these results are close to the international figures (1, 4, 5&6).

The type of hearing loss found in this study was SNHL, with the degree ranging from mild to moderate. At 250Hz, the percentage of patients who had a mild SNHL was 22% and 19.5% for the right and left ear, respectively for patients with Hashimoto's disease, and 11.4% and 14.2% in the left and right ear, respectively for patients with Graves' disease. These findings are similar to the findings of Arduc and colleagues⁽³⁾. However, they reported a higher prevalence of hearing loss in comparison to this study. The differences may be due to the fact that their patients were not using any hormone thyroid therapy as opposed to this study, whereas all patients were on therapy.

At the frequencies 500, 1000, and 2000Hz, hearing thresholds were better, whereas the percentage of hearing loss went down for both groups. For Hashimoto's the prevalence was 7.3% and 4.8% for the right and left ear respectively, which is low in comparison with the other frequencies. While only one patient with Graves' disease had a SNHL at those frequencies in the left ear.

The higher frequencies 4Hz and 8kHz were assessed separately, since the high frequencies are more prone to and are the first to be affected by diseases. This phenomenon is explained by the place theory, suggesting that the high-frequency sounds are perceived in the basal end of the cochlea. Therefore, when hearing

impairment begins, the high frequencies are often lost first^(11, 12 & 13). The results showed that 4 patients with Hashimoto's disease had mostly mild SNHL in the right and left ear at 4kHz, the same number of patients with SNHL was found in the Graves' disease group, with an approximate percentage of 12%.

Regarding 8KHz, the prevalence of a hearing loss increased to 9 right ears with SNHL and 8 left ears (22%, 19.5%), respectively with SNHL for the Hashimoto's group. The prevalence was lower for the Graves' disease group, where 6 right sided ears had mild to moderate SNHL and only 2 had a hearing loss in the left ear (17%, 5.7%). These findings are in agreement with previous studies^(7, 14) that found abnormal hearing thresholds at frequencies above 3000Hz in patients with hypothyroidism, despite the difference in prevalence and degree of the hearing loss.

The exact cause of this high frequency loss is still unknown. Uziel⁽¹⁵⁾ suggested that thyroid hormone deficiency leads to defects in morphological and neuronal developments in the organ of Corti. Santos and colleagues⁽¹⁶⁾ explained that hearing loss may occur in patients with acquired hypothyroidism. The latter is thought to be due to deterioration of oxygenation and metabolism in the organ of Corti and the stria vascularis, changes in protein synthesis, enzyme functions, and myelin production, hypertension, hyperlipidemia, and electrolyte imbalance. Additionally, SNHL is known to occur in many autoimmune diseases^(17&18). There were no statistical significant differences between the two groups with regard to the hearing thresholds, meaning that no disease had more effect on the hearing acuity than the other.

The most widely documented effects of autoimmune diseases contribution to SNHL are

mediated by a vascular mechanism⁽¹⁹⁾. Neuronal degeneration, fibrous tissue proliferation endolymphatic edema, and atrophy of the organ of Corti occur due to the vascular and inflammatory processes of the autoimmune damage and the compression of the perilymphatic space⁽²⁰⁾.

The findings in this study indicate a likelihood of a SNHL in this population at 250Hz and high frequencies (4 and 8kHz) although these percentages were lower than what was reported in previous literature^(16 & 21). This can be explained by the differences in their studies from ours in terms of the sample size and testing method. They also only examined patients with hypothyroidism or hyperthyroidism but not both, whereas in this study we examined patients with Hashimoto's and Graves' thyroiditis at the same time, using a conventional behavioral pure tone audiometric testing. Some previous studies have also suggested that patients with hypothyroidism had a mixed hearing loss⁽¹⁾, suggesting that some had abnormalities in the middle ear. However, in this study, all of the 75 patients had normal middle ear functions according to the results of the tympanometry test that was performed on each patient prior to hearing testing, and the shape of the audiogram for each which indicated the absence of a conductive hearing loss in any of the 75 participants.

In this study, one participant had a unilateral profound SNHL. However, due to the shape of this hearing loss, it was suggested that is more likely to be due to another peripheral pathology. Therefore, this patient was referred to an ENT for further assessment.

Conclusion

Based on our study, mild to moderate SNHL was present in 32% of patients with

autoimmune thyroid diseases. Therefore, thyroid autoimmunity has a negative impact on the hearing acuity, particularly at high frequencies. Our findings are in agreement with regional and international literature regarding this manner. Hence, an annual hearing screening is recommended for patients with thyroid autoimmune disease in order to provide early management.

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دراسة مدى انتشار فقدان السمع لدى المرضى الذين يعانون من أمراض الغدة الدرقية بسبب المناعة الذاتية: دراسة استطلاعية

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الملخص

الأهداف: دراسة تأثير أمراض الغدة الدرقية بسبب المناعة الذاتية على عتبات السمع لدى المرضى البالغين.
المواد والطرق: شارك 75 مريضاً في هذه الدراسة، تم تقسيمهم إلى مجموعتين: مجموعة مصابة بمرض الغدة الدرقية Hashimoto's thyroiditis (n = 41)، ومجموعة مصابة بمرض الغدة الدرقية Graves' disease (n = 34). تم فحص الاذن الخارجية بالمنظار، وفحص الاذن الوسطى بجهاز وفحص السمع لكلتا المجموعتين.
النتائج: كانت نتائج فحص المنظار وفحص الأذن الوسطى ضمن المعدل الطبيعي لدى جميع المشاركين في الدراسة (0.226 كيلوهرتز). وأظهرت الدراسة وجود ضعف سمع حسي عصبي بدرجة خفيف الى متوسط لدى 24 (32%) من المرضى المشاركين في الدراسة (16 مريضاً من مرضى Hashimoto's thyroiditis و8 من مرضى Graves' disease).
استنتاج: أمراض الغدة الدرقية بسبب المناعة الذاتية قد يكون لها تأثير سلبي على حدة السمع، وخاصة في الترددات العالية. تتفق نتائج الدراسة الحالية مع نتائج الدراسات الإقليمية والدولية وبناء على ذلك نوصي بإجراء فحص سمع سنوي روتيني للمرضى الذين يعانون من أمراض الغدة الدرقية بسبب المناعة الذاتية.

الكلمات الدالة: أمراض الغدة الدرقية بسبب المناعة الذاتية Hashimoto's thyroiditis; Graves' disease; فقدان السمع الحسي العصبي.