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Journal name: Iranian Journal of Allergy, Asthma and Immunology

Manuscript title: Investigation of Hearing in Patients with Allergic Rhinitis

Abstract:

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Investigation of Hearing in Patients with Allergic Rhinitis

Running title: Allergic Rhinitis and Hearing

Category of Manuscript: Original Manuscript

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Investigation of Hearing in Patients with Allergic Rhinitis

Abstract

Objective: The aim of the current study is to investigate hearing function in patients with allergic rhinitis.

Study design: Prospective, case control study.

Materials & Methods: Fifty-eight patients with positive skin prick test (Group 1) (116 ears) and 31 subjects with negative skin prick test (62 ears) as group 2 were included. Pure tone audiometry at 250, 500, 1000, 2000, 4000 and 8000 Hz and immittance measures, including tympanometry and acoustic reflex tests, were performed in both groups.

Results: There was statistically significant difference between pure-tone threshold of the group 1 and group 2 at 8000 Hz (p< 0.05).

Conclusion: Based on our study, the patients with allergic rhinitis had better hearing than the control group at 8000 Hz

Key words: Allergic rhinitis, audiometry, histamine, inner ear, hearing

Introduction

Allergic rhinitis (AR) is a type-I hypersensitivity reaction of the nasal mucosa, primarily mediated by immunoglobulin E (IgE) that is regarded as a complex etiology, determined by genetic and environmental interactions. AR of prevelance involves between 9% and 42% in the general population \[1\]. The clinical symptoms of allergic rhinitis are nasal obstruction, watery rhinorrhea, sneezing and itching at the nose, palate and nasopharyngeal region. The diagnosis is made based on the detailed history taking and symptoms of the patient \[2\]. It is believed that allergy may affect the outer, the middle, or the inner ear \[3\]. Therefore, some
authors have investigated the correlation between inner ear symptoms and allergy \[^{[4,5]}\]. However, there are very few studies regarding auditory evaluation in patients with known allergic rhinitis. The aim of the current prospective study is to evaluate of hearing in patients with allergic rhinitis.

**Materials and method**

**Patients**

We conducted a case-control study with totally 89 subjects. The study group consisted of 58 patients (116 ears) with positive skin prick test (Group 1). The control group had sixty two ears of 31 patients (62 ears) with negative skin prick test (Group 2). A detailed medical history was obtained about possible etiological factors leading to hearing loss (ototoxic drugs, noise exposure, ear surgery, perforated tympanic membrane, Meniere’s disease, cranial trauma, metabolic diseases and systemic disease) from each participant. The diagnosis of allergic rhinitis was made according to the Joint Task Force on Practice Parameters in Allergy, Asthma and Immunology that included the presence of discolored rhinorrea, sneezing, itching and/or nasal blockage, excessive tearing or conjunctival redness when exposed to allergens, in combination with positive skin test reactions to suspected allergens \[^{[6]}\].

**Skin prick testing**

Patients withheld antihistamine medication for four days prior to skin prick testing. We performed following a standard protocol (Stallergens testing solution, France) using extracts including two storage mites, three moulds, one insect, three epithelia, three animal epithelia, fifteen pollen, six food extracts in addition to a positive (0.1% histamine solution) and negative controls (saline solution). Skin prick tests were read after 15 min, as positive if the mean wheal diameter was 3 mm greater than negative control \[^{[7]}\].
Audiometry

Pure-tone and speech audiometry were performed by using a diagnostic audiometer (Madsen Orbiter 922-2, Denmark) in a sound-treated cabin. TDH-39 standard headset was used for air conduction thresholds and speech tests. Radio ear B-71 vibrator was used in high frequency audiometry. Air conduction pure tone thresholds were measured at the frequency of 250, 500, 1000, 2000, 4000 and 8000 Hz. Bone conduction thresholds were measured at the frequency of 500, 1000, 2000 and 4000 Hz. Measurements were done using an ascending-descending technique, in 5 dB steps at all frequencies. If a patient made two or more responses to a set of 3 stimuli, she/he was deemed to have heard the sound.

Normal middle-ear function was defined as proper if the hearing threshold for both air and bone conduction was equal. Tympanometric measurements were done using a TDH-39 headset and Middle Ear Analyzer (TympStar GSI, Grason-Stadler Inc., Milford, USA). On immitance, all participants had a normal peak compliance, peak pressure, gradient and ear canal volume, and acoustic reflex, as defined by American Speech Language and Hearing Association.\textsuperscript{[8,9]}

Excluding criteria

We applied excluding criteria as follows: (1) use of ototoxic agents; (2) systemic disorders, (3) otoscopic evidence of a perforated tympanic membrane or other middle-ear pathology, (4) a flat tympanogram or absence of acoustic reflexes at 1 kHz with contralateral stimulation, (5) an air-bone gap $>5$ dB at any frequency, (6) 40 years older for presbyacusia.

The statistical analyses were performed using SPSS 15.0 for Windows. Criterion for statistically significant difference was accepted for two-tailed p values of less than 0.05. For overall comparisons of the groups (i.e. allergic rhinitis patients and controls), Mann-Whitney
U test were performed. The Independent Sample T Test was used to compare the ages of patients and controls. Chi-square testing was used to compare the number of hearing loss and the gender of patients and controls.

Results

The mean age of patients with group1 was $27.7 \pm 6$ years (range 18-40 years), 43 were female and 15 were male patients. The mean age of group 2 was $27.4 \pm 5.7$ years (range 19-37 years), there were 19 female and 12 were male subjects. Otoscopic examination was normal in all participants. There was no statistically significant difference between the ages and genders of the groups ($p > 0.05$).

The pure tone audiometry descriptive results of both ear for each group are shown in Table I. Compared to groups the pure tone thresholds significantly differed at 8000 Hz ($p=0.026$) There were no statistically significant differences between the right and the left ear thresholds at all frequencies in both groups. Pure tone thresholds results are shown in Figure 1.

Pure tone averages (PTA) of air conduction thresholds at 250, and 500 Hz (PTA1), 500, 1000 and 2000 Hz (PTA2), 4000, and 8000 (PTA3), for each ear separately were measured. Compared to groups the pure tone averages were significantly different for PTA 3 ($p=0.035$). Pure tone average (PTA) results are shown in Figure 2. The PTA results over 15 dB was described as hearing loss. According to PTA, the number of patients with hearing loss is shown in Table II.

Speech discrimination scores were within Normal limits in all patients and controls. Normal peak compliance, peak pressure, gradient, ear canal volume and acoustic reflexes were obtained by immittance measures in all patients and controls.
Discussion

Histamine is the main mediator in Type 1 hypersensitivity reaction and allergic rhinitis. It demonstrates its effects via activation of receptor system. Histamine acts by binding to receptors on target cells, and different cell types express different receptors. There are 4 main types of histamine receptors: histamine1 H1, H2, H3, and H4 \cite{10,11} The histamine H1 receptor causes contraction of smooth muscle, increases vascular permeability, and excites sensory nerve endings\cite{12}. Several experimental studies have suggested that histamine may play physiological role in the inner ear \cite{13-18}. Azuma et al have found mRNAs encoding the H1, H2, and H3 histamine receptors is expressed in the rat modiolus, axial part of cochlea, spiral ganglion, nerve fibers, cochlear artery and cochlear vein. They measured expression of H1 and H2 receptor mRNA may indicate localization of these receptors in the cochlear artery \cite{13}. Dagli et al. showed the immunohistochemical localization of H1, H2, and H3 histamine receptors in the ES of rabbits. These receptors may be important in the homeostasis of the inner ear. In addition, they may be target receptors in the medical treatment of inner ear disorders such as endolymphatic hydrops\cite{14}.

The question arises why histamine had a protective effect on inner hair cells in their study, since it is assumed that histamine may act as an extracellular signal to stimulate neurotransmitter release from inner hair cells \cite{15}. Azuma et al speculated that histamine at a low concentration may act as a neurotransmitter or neuromodulator in the cochlea by way of both H1 and H2 receptors, which are present in the modiolus of the cochlea. Minoda et al reported that the inhibitory effects of histamine are in supraphysiological concentrations,
while the excitatory effects of histamine are in low concentrations in cochlea of the guinea pigs [16].

Histamine appears to be a mediator involved in both the physiologic and immunopathologic states of the inner ear, and the ES is 1 of the most important structures that play a role in the homeostasis of the inner ear. The presence of mast cells in the subepithelial connective tissue of the human ES has been described, and histamine seems to play an important role in the physiologic functions of the ES as well as in some pathologic states of the inner ear [17]. In the inner ear of guinea pigs, histamine released from the mast cells is distributed in the ES to induce calcium response in vestibular hair cells by acting through H1, H2, and H3 receptors located on the vestibular hair cell membranes, and may regulate cell function and signal transduction in the vestibular nerve hair cell afferent system [18].

In our prospective study we found that the patients with allergic rhinitis had considerably better hearing at 8000 Hz then the control group, in contrast Lasisi [14] demonstrated in a retrospective study that there were hearing loss in patients with allergic rhinitis. We speculated that histamine may have protective effect on hearing by vasodilatation in cochlear artery and vein.

**Conclusion**

To date, this study is the first prospective study that has been conducted to evaluate hearing in patients with allergic rhinitis. Based on our study, the patients with allergic rhinitis had better hearing at 8000 Hz the control group. In addition, our findings support that histamine might play a physiological role in the cochlea. A detailed evaluation of cochlear with OEA test should be done in the future studies that would provide more accurate information.
References


Table I: Pure tone audiometry results of patient and control group

<table>
<thead>
<tr>
<th>Frequency (Hz)</th>
<th>Group 1 (Right ear)</th>
<th>Group 1 (Left ear)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Range (dB)</td>
<td>Mean (dB)</td>
</tr>
<tr>
<td>250</td>
<td>0-20</td>
<td>11.0</td>
</tr>
<tr>
<td>Frequency (Hz)</td>
<td>Group 2 (Right ear)</td>
<td>Group 2 (Left ear)</td>
</tr>
<tr>
<td>----------------</td>
<td>---------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td></td>
<td>Range (dB)</td>
<td>Mean (dB)</td>
</tr>
<tr>
<td>250</td>
<td>5-25</td>
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</tr>
<tr>
<td>500</td>
<td>0-20</td>
<td>9.4</td>
</tr>
<tr>
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<td>0-20</td>
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</tr>
<tr>
<td>2000</td>
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<td>5.8</td>
</tr>
<tr>
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<td>9.7</td>
</tr>
<tr>
<td>8000</td>
<td>0-45</td>
<td>23.5</td>
</tr>
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Table II: Number of hearing loss in patient and control group

<table>
<thead>
<tr>
<th></th>
<th>Group 1</th>
<th>Group 2</th>
<th>P value (Chi Square)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PTA 1</td>
<td>10 (8.6%)</td>
<td>11 (17.7%)</td>
<td>0.089</td>
</tr>
<tr>
<td>PTA 2</td>
<td>0</td>
<td>3 (4.8%)</td>
<td>0.041</td>
</tr>
<tr>
<td>PTA 3</td>
<td>36 (31%)</td>
<td>32 (51.6%)</td>
<td>0.009</td>
</tr>
</tbody>
</table>
Figure I: Hearing thresholds at pure tone audiometry results in patients’ and controls’ ears.
Figure 2: Pure tone average thresholds for patient and control groups at 250, and 500 Hz (PTA1), 500, 1000 and 2000 Hz (PTA2), and 4000 and 8000 Hz (PTA3).