Frequency of Cochlear Enhancement on Magnetic Resonance Imaging in Patients With Autoimmune Sensorineural Hearing Loss

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Objective: To evaluate magnetic resonance imaging (MRI) scans for enhancement of inner ear structures of patients with sensorineural hearing loss and documented antibodies to the 68-kd inner ear antigen.

Study Design: Retrospective case review with reexamination of MRI scans.

Setting: Outpatient office.

Patients: Thirty-five patients with autoimmune sensorineural hearing loss defined by audiograms documenting a sensorineural hearing deficit in one or both ears and the presence of an anti-inner ear antibody (68-kd band) in serum samples who underwent precontrast and postcontrast T1-weighted axial and coronal MRI scans of the inner ear, which were performed concurrently with the hearing loss.

Interventions: Diagnostic.

Main Outcome Measures: Frequency and intensity of cochlear enhancement on MRI scans.

Results: One patient demonstrated +2 cochlear enhancement. However, that finding was thought to represent postoperative inflammatory change.

Conclusion: No correlation was found between the presence of antibodies to inner ear antigen in patients with hearing loss and cochlear enhancement on MRI scans.

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AUTOIMMUNE sensorineural hearing loss has been recognized as a cause of sensorineural hearing loss. Many clinical tests and examinations have been proposed to aid in the diagnosis of this disorder. Among these, the presence of 68000-d (68-kd) serum antibodies to an inner ear antigen that is detectable on Western blot assay has been shown to correlate with autoimmune disease activity and to predict response to treatment in patients with sensorineural hearing loss. However, the conclusions of completed studies are controversial, and many authors do not accept the autoimmune model of hearing loss or the tests ordered to diagnose it.

Magnetic resonance imaging (MRI) has also been used to evaluate the inner ear for signs of autoimmune cochleopathy. Investigators have shown this modality to be excellent for evaluating the inner ear for signs of inflammation and neoplasm, especially when comparing precontrast and postcontrast T1-weighted studies using gadolinium–diethyleneetriamine pentaacetic acid. Some authors have described incidental cases of enhancement of inner ear structures on postcontrast MRI studies in patients diagnosed with autoimmune sensorineural hearing loss. The total number of patients within each of these reports ranged from 6 to 12 patients, not all of whom had a positive result on Western blot assay for antibodies to the 68-kd inner ear antigen. To our knowledge, the frequency of such enhancement has not been studied in a larger population of patients diagnosed as having autoimmune hearing loss confirmed by Western blot assay, nor has it been determined whether enhancement correlates with improvement of auditory function after a course of therapy.

RESULTS

Two hundred three patients with sensorineural hearing loss from the practice of the senior author (R.T.S.) had results reported from a Western blot assay for anti-
PATIENTS AND METHODS

We performed a retrospective study of the medical records of 35 patients with autoimmune sensorineural hearing loss (parameters: audiogram documenting a sensorineural hearing deficit in one or both ears and a positive result on Western blot assay with 68-kd band for antibodies to inner ear antigens) and examined pre-contrast and postcontrast T1-weighted axial and coronal MRI scans of the inner ear. Western blots were obtained at the time of the patient’s presentation to the senior author (R.T.S.), and the assays were performed at Massachusetts General Hospital, Boston (n=17), University of California at San Diego (n=7), IMMCO Diagnostics Laboratory, Buffalo, NY (n=3), and Kresge Hearing Research Institute, University of Michigan, Ann Arbor (n=8). False-positive and false-negative rates have not been established with certainty, but for most assays, the false-positive rate is believed to be approximately 2% to 5%, and the false-negative rate is roughly 30%.14,15 The MRI scans were also performed shortly after each patient’s initial visit, and before the initiation of treatment with steroids, starting with prednisone (60 mg/d), or cytotoxic drugs. The images were interpreted by a neuroradiologist (V.M.R.) who was blinded to all information regarding each patient except the clinical history of sensorineural hearing loss (side of lesion not specified) and the known presence of the inner ear antibody. The neuroradiologist was aware of the purpose of the study as outlined above. A scale of 0 through 3 was used to quantify the intensity of enhancement as follows: 0, no enhancement; 1, trace enhancement; 2, moderate enhancement; and 3, profound enhancement.

The neuroradiologist also recorded the specific location of all areas of cochlear enhancement. The MRI findings were then compared with the severity of hearing loss, the ear affected, response to treatment with high-dose corticosteroids, presence and absence of other autoimmune markers (presence of HLA-Cw7, HLA-Cw4, and HLA-B35 and absence of HLA-DR4), and temporal proximity of the MRI study with onset of hearing loss.

bodies reactive with the 68-kd bovine inner ear antigen. Of these 203 patients, 51 (25%) tested positive on Western blot analysis, thus fulfilling the requirements for consideration in this study. Within the study population, 13 MRI studies were unavailable and 3 were inadequate, leaving 35 patients with adequate MRI scans and a positive result on Western blot assay.

The MRI study of 1 patient (3%) showed +2 enhancement of the middle turn of the right cochlea (Table 1). The MRI scan also revealed postoperative changes in the right temporal bone and an enhancing mass in the right internal auditory canal. The patient had previously undergone resection of a right acoustic neuroma at another institution, with known residual tumor in the right internal auditory canal. However, the MRI scan had been ordered to evaluate an asymptomatic, sloping, high-frequency, left-sided hearing loss noted on routine audiological follow-up for a history of a right acoustic neuroma. No other MRI scans reviewed in this study demonstrated enhancement of inner ear structures. Of the 44 available original MRI reports from the 51 patients included in our study, none described enhancement of the inner ear.

The mean number of days between the onset of hearing loss and the date of the MRI scan for 25 patients (the date of the onset of symptoms was not available for 10 patients) was 2210 (6 years); the median was 1095 (3 years); and the range was 4 to 7665 (21 years). The 1 patient who exhibited right cochlear enhancement had a 6-year (2190-day) history of hearing loss on the right side before surgery and was unaware of any hearing loss on the left side.

The results of autoimmune serologic tests for the absence of HLA-DR4 were available for 25 patients (Table 2). The results of HLA serologic tests were not reported for the 1 patient who exhibited cochlear enhancement.

Five to 20 persons per 100 000 present with the complaint of sudden loss of hearing each year. Many eventually have to accept “idiopathic” as the explanation for their loss of function.36 Others suffer a more insidious onset of hearing loss. Currently, there is a battery of historical questions, physical examinations, audiological tests, laboratory tests, radiographic studies, and other investigations that each patient may be requested to undergo at the discretion of the physician. New information regarding the efficacy of such tests may help clinicians to evaluate patients with unexplained hearing loss.

Known causes of sensorineural hearing loss include neoplasms, multiple sclerosis, hypercoagulable states, viral and bacterial infection, medications, ischemia, labyrinthe membrane rupture, autoimmune conditions, metabolic imbalances, heredity, and many other conditions.17-21

Table 1. Results of Magnetic Resonance Imaging (MRI) of Patients With Autoimmune Sensorineural Hearing Loss

<table>
<thead>
<tr>
<th>Intensity</th>
<th>Frequency From Our Reading</th>
<th>Frequency From Original Report</th>
</tr>
</thead>
<tbody>
<tr>
<td>No cochlear enhancement</td>
<td>34</td>
<td>44</td>
</tr>
<tr>
<td>MRI scan unavailable</td>
<td>13</td>
<td>7</td>
</tr>
<tr>
<td>MRI scan inadequate</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>51</td>
<td>51</td>
</tr>
</tbody>
</table>

*Rated on a scale of 0 (no enhancement) to 3 (profound enhancement). NA indicates not applicable.

Table 2. Results of Serologic Evaluation for HLA Associations

<table>
<thead>
<tr>
<th>Presence of HLA-DR4</th>
<th>Presence of HLA-Cw7</th>
<th>Presence of HLA-Cw4</th>
<th>Presence of HLA-B35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive, No. (%)</td>
<td>17 (68)</td>
<td>13 (41)</td>
<td>10 (31)</td>
</tr>
<tr>
<td>Negative</td>
<td>8</td>
<td>19</td>
<td>22</td>
</tr>
<tr>
<td>Not tested</td>
<td>10</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>35</td>
<td>35</td>
</tr>
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</table>
Genetic markers and antibodies to inner ear antigens have been isolated. In addition to the presence of antibodies to the 68-kd inner ear antigen, 4 proteins from the HLA antigen complex have been shown to be associated with autoimmune sensorineural hearing loss. Increased expression of HLA-Cw7, HLA-Cw4, and HLA-B35 can be found in patients with autoimmune sensorineural hearing loss, with the HLA-Cw7 locus showing the strongest association in 51% of patients (compared with 21% of controls). Also, absence of HLA-DR4 corresponds with the disease. These tests appear to be helpful in diagnosing immune-mediated hearing loss. In our study, the presence of HLA-Cw7, HLA-Cw4, and HLA-B35 and the absence of HLA-DR4 did not seem to increase the probability of finding cochlear enhancement on MRI scans. None of the patients serologically tested for autoimmune markers showed enhancement of the inner ear on MRI scans. The only patient with cochlear enhancement was not tested for HLA loci associated with autoimmune hearing loss. The enhancement was thought to be the result of postoperative inflammatory changes in his right ear, and he was being evaluated for a new left-sided sensorineural hearing loss.

Magnetic resonance imaging is another diagnostic study commonly used in the evaluation of patients presenting with sudden hearing loss. Though expensive, MRI is rapid and associated with minimal risk. It provides a higher quality image of soft tissue contrast than computed tomography. Pathologic tissues, including tumor and inflammation, can be enhanced with the use of a low-risk contrast agent, such as gadolinium–diethylenetriamine pentaaetic acid. Magnetic resonance imaging scans will also show foci of demyelination (as seen in multiple sclerosis) and may demonstrate slow or absent blood flow (associated with ischemic sensorineural hearing loss). Although authors report varying findings regarding cochlear enhancement in patients evaluated for sensorineural hearing loss with MRI, we found no correlation between the presence of antibodies to the 68-kd bovine inner ear antigen and cochlear enhancement on MRI scans. Notwithstanding our findings that none of our patients had MRI enhancement of the involved inner ear membranes or internal auditory canal, MRI remains an important modality in the evaluation of patients with sensorineural hearing loss and should be included in a patient’s workup when appropriate. However, it does not appear to be helpful in the diagnosis or management of autoimmune sensorineural hearing loss.

Autoimmune sensorineural hearing loss can pose difficult diagnostic and therapeutic challenges for the physician and patient. Although MRI has been reported incidentally to show cochlear enhancement in patients with autoimmune hearing loss, we found no correlation between the presence of antibodies to the 68-kd bovine inner ear antigen and cochlear enhancement on MRI scans. Although authors report varying findings regarding cochlear enhancement on MRI scans. The only patient with cochlear enhancement was not tested for HLA loci associated with autoimmune hearing loss. The enhancement was thought to be the result of postoperative inflammatory changes in his right ear, and he was being evaluated for a new left-sided sensorineural hearing loss.

It has been documented that an inner ear affected by sensorineural hearing loss of probable autoimmune origin undergoes changes similar to those seen in animal models of autoimmune hearing loss, including lymphocytic infiltration of the spiral ganglia, endolymphatic sac, perisaccular area, inferior cochlear vein, and Rosenthal canal. The study of Hoistad et al21 also revealed destruction of the organ of Corti, endolymphatic hydrops, fibrosis, and osteoneogenesis of the cochlea and vestibule. Their findings are consistent with the inflammatory histologic changes in the inner ear that are expected in patients with autoimmune sensorineural hearing loss. Such tissue should enhance on T1-weighted MRI studies. Mark and Fitzgerald11 showed that in some patients the level of enhancement within the cochlea actually correlated with the frequency range of hearing loss, although this was by no means universal.

The lack of cochlear enhancement in 34 (and in all 35 with regard to the ear of interest) of our 35 patients argues strongly that cochlear enhancement should not be used as a diagnostic criterion for autoimmune sensorineural hearing loss, even though such a finding may indicate inflammation of the cochlea.