

# Inner ear contrast MRI for patients with definite Meniere's disease and low- and low-to-mid-tone hearing loss

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## Abstract

**Abstract BACKGROUND:** Meniere's disease (MD) involves cochlear and vestibular symptoms, but the underlying cause remains unclear. Findings predominantly show a low-to-mid-tone hearing impairment, and it is not possible to predict hearing improvement after an attack. **OBJECTIVE:** To examine whether improvement in hearing in definite MD (DMD) patients could be predicted using inner ear contrast magnetic resonance imaging (IEC-MRI) and pure tone audiometry (PTA) at the time of an attack. **METHODS:** Between April 2020 and March 2022, seven DMD outpatients were enrolled based on the Bárány Society DMD criteria. Patients were divided into two groups: a low-tone hearing loss (LTL) group and a low-to-mid-tone hearing loss (LMTL) group. Hearing improvement rates were examined. We also examined whether endolymphatic hydrops and hearing improvement were related. **RESULTS:** Endolymphatic hydrops was found in two of four LTL cases. One of three LMTL cases had prominent lymphedema. All LTL patients showed hearing improvements. Only one LMTL patient showed hearing improvement. Endolymphatic hydrops did not correlate with hearing improvement. **CONCLUSIONS:** It is not possible to estimate hearing improvement using IEC-MRI. PTA showed that LTL had a better hearing prognosis than LMTL. Therefore, it is possible to estimate hearing improvement using PTA.

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**Results:** Endolymphatic hydrops was found in two of four LTL cases. One of three LMTL cases had prominent lymphedema. All LTL patients showed hearing improvements. Only one LMTL patient showed hearing improvement. Endolymphatic hydrops did not correlate with hearing improvement.

**Conclusions:** It is not possible to estimate hearing improvement using IEC-MRI. PTA showed that LTL had a better hearing prognosis than LMTL. Therefore, it is possible to estimate hearing improvement using PTA.

**Keywords:** Meniere’s disease, magnetic resonance imaging, endolymphatic hydrops, pure tone audiometry

**Key points:**

1. Meniere’s disease (MD) involves a low-to-mid-tone hearing impairment, and it is not possible to predict hearing improvement after an attack.
2. It is not possible to estimate hearing improvement in MD patients using inner ear contrast magnetic resonance imaging.
3. Pure tone audiometry could be used to estimate hearing improvement in MD patients.
4. Endolymphatic hydrops is not correlated with hearing improvement.
5. According to pure tone audiometry results, patients with low-tone hearing loss have a better prognosis than those with low-to-mid-tone hearing loss.

**Introduction**

Meniere’s disease (MD) was first reported by Prosper Meniere in 1861, and the name MD was proposed in 1867 [1, 9]. It has been proposed that MD combines cochlear symptoms and vestibular symptoms, and this differentiates it from Meniere’s syndrome. The Bárány Society emphasizes that hearing impairment in the low-to-mid-tones is observed in patients with a confirmed diagnosis of MD [5], offering the following definition of definite MD (DMD) [4]:

1. Two or more spontaneous episodes of vertigo, each lasting 20 minutes 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

In this study, we focused on item B above, involving hearing impairment in the low-to-mid-tones. We examined whether hearing prognosis could be predicted depending on whether a hearing impairment is predominant in the low-tones and examined whether the prognosis can be estimated using inner ear contrast magnetic resonance imaging (IEC-MRI).

**Materials and methods**

The Strengthening the Reporting of Observational studies in Epidemiology (STROBE) guideline was followed in this study. This study was conducted with the approval of the(Blinded for review).

During the 2 years from April 2020 to March 2022, DMD patients who visited our general outpatient department of otolaryngology were enrolled. Patients with a normal healthy side were compared using a left-right difference, and those with an abnormal hearing on the healthy side were diagnosed with MD by comparison with the average hearing level for the relevant age group.

The diagnostic criteria of the Barany Society do not clearly describe Hz in the low-to-mid-tone range. Therefore, in this study, the low-tone range was defined as 125 Hz, 250 Hz, and 500 Hz; the mid-tone range was defined as 1000 Hz and 2000 Hz, and the high-tone range was defined as 4000 Hz and 8000 Hz. Pure tone audiometry (PTA) was performed by clinical laboratory technicians with an experience of more than 10 years and who were fully proficient in the test technique. There was a total of seven DMD patients.

To examine the hearing improvement rate of DMD patients, we compared the low-to-mid-tone range on PTA and examined whether the hearing disorder was predominantly low. Patients [?]5 dB between the low threshold average and the mid-tone threshold average were defined as low-tone loss DMD (LTL). Patients <5 dB were defined as low-to-mid-tone loss DMD (LMTL) (Figure 1).

A hearing improvement was defined as an improvement of 5 dB or more in all three consecutive sound regions. At the same time, all cases underwent IEC-MRI and were evaluated by our radiologist. Hearing test results were not reported to the radiologist in all cases. The image conditions and shooting method used were as reported by Naganawa et al. [8]. The evaluation method was based on the evaluation criteria

[8] by Naganawa et al. The evaluation was performed on the entire inner ear, regardless of the cochlea or vestibule, and the judgment was made based only on whether endolymphatic hydrops was observed in the affected inner ear.

We used Fisher’s exact test for the statistical analysis method. A p-value of  $<0.05$  was considered significant.

## Results

All DMD patients were women. The duration of the illness ranged from months to years. Endolymphatic hydrops was found in three of seven cases. Treatment involved diuretic administration [3] in the acute phase, pulse steroid therapy [6] according to the results of individual pure-tone hearing tests, and endolymphatic sac shunt surgery [10] at a later date if both are ineffective. During the asymptomatic periods, the patients did not receive medications as is the standard of care.

Of the four cases of LTL, endolymphatic hydrops was found in two cases based on imaging. One of the three cases of LMTL had prominent endolymphatic hydrops. Therefore, there was no significant difference in endolymphatic hydrops images in LTL and LMTL patients ( $p=0.62$ ). Moreover, endolymphatic hydrops detected on imaging did not correlate with hearing prognosis ( $p=0.71$ ).

Hearing improvement was observed in all cases of LTL. Only one LMTL patient showed improvement in hearing. Neither the duration of illness nor the treatment content correlated with the hearing improvement rate or HYDROPS imaging (Table 1). A comparison between the hearing-improved and non-improved groups showed that the presence or absence of endolymphatic hydrops did not correlate with hearing improvement. The method of differentiation used in this study was novel.

## Discussion

In terms of treatment, five outpatient doctors consulted with patients to decide each treatment policy, and no treatment intervention was performed. In fact, LMTL patients showed a wide range of hearing threshold increases from the low-to-mid-tone range, and there were no patients with only mid-tone range hearing losses in this study. In LTL, hearing was improved in all four cases, and in two cases, hearing was improved at all frequencies. Based on this, it was shown that LTL has a good hearing prognosis.

On the other hand, LMTL showed improvement in hearing in one case, but in other cases, hearing did not improve across the whole sound region but rather deteriorated in some frequencies. From this, it was shown that it is difficult to recognize the improvement in hearing.

It is known that the cochlear top rotation dominates the low Hz and the high Hz dominates the basal rotation [2]. In terms of PTA, the more widespread the disorder is across the frequency range (low-to-mid-tone range), the wider the range of damage (from the top rotation to the basal rotation), and this indicates that the damage is more difficult to heal.

From the above, it was concluded that MD patients with predominantly low-tone disorders had a good hearing prognosis, suggesting that PTA can predict the hearing prognosis in DMD patients.

No significant difference was found between IEC-MRI and the hearing improvement rate. Since IEC-MRI screened not only for irritant internal lymphedema but also for degenerative internal lymphedema and retentive internal lymphedema [11,12], we considered that there was no significant difference. Since IEC-MRI forms part of the complete assessment at the patient’s first visit to our facility, we do not perform MRIs during an acute attack. In terms of hearing improvement, it is unlikely that IEC-MRI selectively captures irritant endolymphatic hydrops. Therefore, it can be inferred that it does not correlate with the improvement of auditory symptoms.

In the future, it will be necessary to improve the imaging time after administration of the contrast medium [7] and to establish a medical care protocol that enables IEC-MRI imaging at the time of an attack.

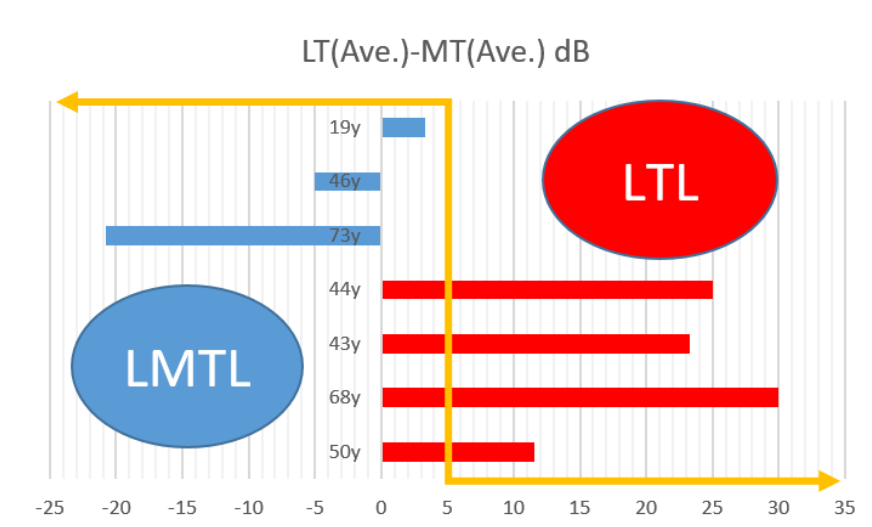
## Conclusions

Using IEC-MRI, which is the current imaging method, it cannot be concluded that hearing improvement estimation is possible. However, we suggest that it is possible to estimate hearing improvement using PTA.

At this time, there were few populations, and a clear significant difference could not be detected. We expect that multi-center prospective studies for DMD using PTA and IEC-MRI will be conducted in the future.

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