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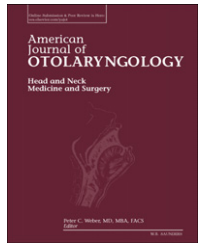

Magnetic resonance imaging-detected inner ear hemorrhage as a potential cause of sudden sensorineural hearing loss

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ARTICLE INFO

Article history:
Received 25 November 2013

ABSTRACT

Purpose: The aim of this study is to assess the value of magnetic resonance imaging in identifying the etiology of sudden sensorineural hearing loss, and to correlate the high signals in the labyrinth with clinical features to identify if inner ear hemorrhage could be implicated.

Materials and methods: In this retrospective study, inner ear magnetic resonance imaging was given to 112 patients with sudden sensorineural hearing loss in the First Affiliated Hospital of Sun Yat-sen University from 2011 to 2012. The clinical features of patients with high signals in the labyrinth on magnetic resonance imaging were analyzed.

Results: Abnormal magnetic resonance images were identified in 13 (11.6%) patients. Retrocochlear pathology was found in six patients, including two cases of lacunar infarction, one case of multiple ischemias in the brainstem and bilateral centrum semiovale, two cases of acoustic neuroma, and one case of inner ear hemangioma. There were seven cases showing high signals in the labyrinth on unenhanced T1-weighted and fluid-attenuated inversion recovery images. Clinical features of these seven patients were characterized by irreversible profound hearing impairment and vestibular dysfunction. These findings were consistent with the hypothesis that their symptoms were caused by an inner ear hemorrhage.

Conclusion: The results indicate the importance of magnetic resonance imaging in sudden sensorineural hearing loss in patients. Moreover, patients with vestibular dysfunction and sudden profound hearing loss may have an inner ear hemorrhage evident by interpreting clinical and magnetic resonance imaging results.

1. Introduction

Sudden sensorineural hearing loss (SSNHL) is typically defined as >30 dB sensorineural hearing loss in at least three frequencies occurring over a span of less than 72 hours [1]. Despite efforts to clarify the pathophysiologic characteristics of this condition, the exact cause of SSNHL remains unclear. It is estimated that approximately 90% of

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http://dx.doi.org/10.1016/j.amjoto.2014.02.004

SSNHL cases are idiopathic [1]. Possible causes include viral infection, microcirculatory disturbance of the inner ear, and immune factors. The unpredictability of idiopathic SSNHL presents a challenge to preventive care and thus etiological research investigating SSNHL is required.

Imaging studies are frequently utilized for the evaluation of SSNHL in patients. Magnetic resonance imaging (MRI) has the added advantage of identifying other causes of SSNHL (eg, cochlear inflammation or multiple sclerosis) or findings that imply an underlying etiology for the SSNHL (eg, small vessel cerebral ischemia), compared to other imaging techniques. According to the guidelines by the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) Foundation, it is recommended that patients with SSNHL undergo audiometry and MRI scans of the middle and inner ear [1].

In 1992, Weissman et al. described two patients with high signals in the labyrinth on unenhanced T1-weighted MRI who presented with SSNHL and vertigo [2]. They suggested the possibility that the high signal was caused by hemorrhage. Subsequently, a few reports of high signals on the labyrinth on unenhanced T1-weighted image (T1WI) have been presented to support this hypothesis [3–5]; however, pathological verification has not yet been obtained.

In this retrospective study, we evaluate the MRI findings of 112 patients with SSNHL in the First Affiliated Hospital of Sun Yat-sen University from January 2011 to December 2012. The goal of our study is to add our experience to the current body of data regarding the importance of routine MRI for SSNHL and the possibility of inner ear hemorrhage, not to provide a new standard of examination for SSNHL. Nevertheless, the relatively high positive rate of MRI findings and strong evidence of inner ear hemorrhage by MRI and clinical features reiterate the necessity for this examination. Therefore, the role of inner ear hemorrhage in the etiology of SSNHL should be investigated further.

2. Methods and patients

The study was approved by the institutional review board of the First Affiliated Hospital, Sun Yat-sen University. We retrospectively analyzed the MRI findings and relevant audiometric results of 112 patients with SSNHL in the First Affiliated Hospital of Sun Yat-sen University from January 2011 to December 2012. Patients underwent pure-tone audiometry (PTA) or auditory brainstem response (ABR) and auditory steady state response (ASSR). Patient inclusion was contingent upon their fulfillment of the criteria, based on the AAO-HNS guideline definition of sudden hearing loss [1].

MRI was conducted using a 3.0-Tesla superconducting magnet system (Siemens Magnetom TrioTim, Munich, Germany) with a phased-array head coil. The scanning encompassed the region from the mastoidale to the upper edge of the petrous bone. The protocol consisted of axial 2–3 mm thick T1 (repetition time [TR] 600 ms, echo time [TE] 14 ms) and T2 (TR 2500 ms, TE 80–120 ms) weighted sequences. After a 0.5-mm thick three-dimensional turbo spin echo (3D-TSE; TR 1000 ms, TE 132 ms) survey, 1-mm thick reconstructions of axial, coronal, and acoustic sagittal images were performed. Patients were additionally examined with a 2-mm thick T2-weighted imaging (T2WI) three-dimensional fluid-attenuated inversion recovery (FLAIR) sequence before contrast injection. In addition, T1-weighted three-dimensional volumetric interpolated breath-hold examination (3D-VIBE) was repeated after gadolinium-diethylenetriaminepentaacetate (Gd-DTPA) contrast enhancement in some patients.

PTA average thresholds in the conversational frequencies (0.5, 1, 2, and 4 kHz) were calculated and used to define the severity of deafness as mild (26–50 dB), moderate (50–70 dB), severe (70–90 dB), profound (90–119 dB), or anacusis (>120 dB). Response to therapy was categorized according to the Siegel criteria as follows [6]:

(1) Healing: final threshold more than 25 dB.
(2) Partial improvement: gain of more than 15 dB, final hearing threshold 25–45 dB.
(3) Slight improvement: gain of more than 15 dB, final hearing threshold more than 45 dB.
(4) No response: gain of less than 15 dB and final hearing threshold more than 75 dB.

Both “Healing” and “Partial improvement” were considered “effective”.

3. Results

In total, 112 patients (65 males and 47 females, mean age 47.6 years, ranging from 6 to 78 years) were eligible for inclusion in the study. The history of hearing loss ranged from 1 to 16 days, with a mean of 9.3 ± 3.8 days. All patients were subdivided into four categories on the basis of hearing levels: five patients with mild hearing loss, 43 with moderate loss, 30 with severe loss, and 34 with profound loss or anacusis.

MRI identified auditory pathway pathology in 13 SSNHL patients (11.6%, Table 1). The pathology was located in the brain, internal auditory canal (IAC), and inner ear. More precisely, three patients suffered from central nervous system diseases, such as temporal occipital junctional lacunar infarction. Acoustic neuroma, rarely occurring in SSNHL patients, was identified in two patients (1.79%, Fig. 1) and confirmed to be the cause of SSNHL. Conservative treatment

Table 1 – Summary of MRI findings in 112 patients with SSNHL.

Location	Abnormality	No.	Percentage	Responsible for SSNHL
Brain	Lacunar infarction	2	1.79%	Possible
	Multiple ischemias in the brainstem and centrum semiovale	1	0.89%	Possible
IAC	Acoustic neuroma	2	1.79%	Yes
	IAC hemangioma	1	0.89%	Yes
Inner ear	Possibility of inner ear hemorrhage	7	6.25%	Probably

Abbreviations: IAC, internal auditory canal; MRI, magnetic resonance imaging; SSNHL, sudden sensorineural hearing loss.