REVIEW

11122 Diet and microbiome in the beginning of the sequence of gut inflammation
Ceballos D, Hernández-Camba A, Ramos L

MINIREVIEWS

11148 Stem cell therapy: A promising treatment for COVID-19
Zheng ZX

ORIGINAL ARTICLE

Case Control Study

11156 Association between serum Sestrin2 level and diabetic peripheral neuropathy in type 2 diabetic patients
Mao EW, Cheng XB, Li WC, Kan CX, Huang N, Wang HS, Hou NN, Sun XD

11165 Plasma brain natriuretic peptide, platelet parameters, and cardiopulmonary function in chronic obstructive pulmonary disease
Guo HJ, Jiang F, Chen C, Shi JY, Zhao YW

Retrospective Cohort Study

11173 Analysis of the incidence and influencing factors of hyponatremia before ¹³¹I treatment of differentiated thyroid carcinoma
Cao JJ, Yun CH, Xiao J, Liu Y, Wei W, Zhang W

Retrospective Study

11183 Cognitive magnetic resonance imaging-ultrasound fusion transperineal targeted biopsy combined with randomized biopsy in detection of prostate cancer

11193 Nomogram based on inflammation-related markers for predicting survival of patients undergoing hepatectomy for hepatocellular carcinoma
Pu T, Li ZH, Jiang D, Chen JM, Guo Q, Cai M, Chen ZX, Xie K, Zhao YJ, Liu FB

11208 Association of frailty with in-hospital outcomes in elderly patients with heart failure
Kang YP, Chen LY, Zhu JJ, Liu WX, Ma CS

11220 COVID-19 pandemic and exacerbation of ulcerative colitis
Suda T, Takahashi M, Katayama Y, Tamano M

11228 Surgical perspectives of symptomatic omphalomesenteric duct remnants: Differences between infancy and beyond
<table>
<thead>
<tr>
<th>Title</th>
<th>Authors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clustering cases of <em>Chlamydia psittaci</em> pneumonia mimicking COVID-19 pneumonia</td>
<td>Zhao W, He L, Xie XZ, Liao X, Tong DJ, Wu SJ, Liu J</td>
</tr>
<tr>
<td>Sodium nitroprusside injection immediately before balloon inflation during percutaneous coronary intervention</td>
<td>Yu Y, Yang BP</td>
</tr>
<tr>
<td>Machine learning approach to predict acute kidney injury after liver surgery</td>
<td>Dong JF, Xue Q, Chen T, Zhao YY, Fu H, Guo WY, Ji JS</td>
</tr>
<tr>
<td>Influence of pontic design of anterior fixed dental prosthesis on speech: A clinical case study</td>
<td>Wan J, Cai H, Wang T, Chen JY</td>
</tr>
<tr>
<td>Real-world data on the infliximab biosimilar CT-P13 (Remsima®) in inflammatory bowel disease</td>
<td>Huguet JM, Cortès X, Bosca-Watts MM, Aguas M, Maroto N, Martí L, Amorós C, Paredes JM</td>
</tr>
<tr>
<td>Correlation of periodontal inflamed surface area with glycemic status in controlled and uncontrolled type 2 diabetes mellitus</td>
<td>Anil K, Vadukkekatil RJ, Radhakrishnan C, Parambath FC</td>
</tr>
<tr>
<td>Audiological characteristics and exploratory treatment of a rare condition of acute-otitis-media-associated sudden sensorineural hearing loss</td>
<td>Cao X, Yi HJ</td>
</tr>
<tr>
<td>Yield of testing for micronutrient deficiencies associated with pancreatic exocrine insufficiency in a clinical setting: An observational study</td>
<td>Jalal M, Campbell JA, Tesfaye S, Al-Mukhtar A, Hopper AD</td>
</tr>
<tr>
<td>Birthing ball on promoting cervical ripening and its influence on the labor process and the neonatal blood gas index</td>
<td>Shen HC, Wang H, Sun B, Jiang LZ, Meng Q</td>
</tr>
<tr>
<td>Ductal breast carcinoma metastasized to the rectum: A case report and review of the literature</td>
<td>Ban B, Zhang K, Li JN, Liu TJ, Shi J</td>
</tr>
</tbody>
</table>
De Garengeot hernia with avascular necrosis of the appendix: A case report
Yao MQ, Yi BH, Yang Y, Weng XQ, Fan JX, Jiang YP

Mature mediastinal bronchogenic cyst with left pericardial defect: A case report
Zhu X, Zhang L, Tang Z, Xing FB, Gao X, Chen WB

Difficulties in diagnosing anorectal melanoma: A case report and review of the literature
Apostu RC, Stefanescu E, Scurtu RR, Kacso G, Drasovean R

Solid pseudopapillary neoplasm of the pancreas in a young male with main pancreatic duct dilatation: A case report

Acute myocardial infarction in a young man with ankylosing spondylitis: A case report
Wan ZH, Wang J, Zhao Q

Acute appendicitis complicated by mesenteric vein thrombosis: A case report
Yang F, Guo XC, Rao XL, Sun L, Xu L

Inguinal endometriosis: Ten case reports and review of literature
Li SH, Sun HZ, Li WH, Wang SZ

Dramatic response to immunotherapy in an epidermal growth factor receptor-mutant non-small cell lung cancer: A case report
Li D, Cheng C, Song WP, Ni PZ, Zhang WZ, Wu X

Three-dimensional inlay-guided endodontics applied in variant root canals: A case report and review of literature

Ectopic pregnancy implanted under the diaphragm: A rare case report
Wu QL, Wang XM, Tang D

Ear ischemia induced by endovascular therapy for arteriovenous fistula of the sigmoid sinus: A case report
Li W, Zhang SS, Gao XR, Li YY, Ge HJ

Giant schwannoma of thoracic vertebra: A case report

Severe digital ischemia coexists with thrombocytopenia in malignancy-associated antiphospholipid syndrome: A case report and review of literature
Chen JL, Yu X, Luo R, Liu M

Rare spontaneous extensive annular intramural esophageal dissection with endoscopic treatment: A case report
Hu JW, Zhao Q, Hu CY, Wu J, Lv XY, Jin XH
Contents

Weekly Volume 9 Number 36 December 26, 2021

11475  Mucinous cystic neoplasm of the liver: A case report
Yu TY, Zhang JS, Chen K, Yu AJ

11482  Retroperitoneal parasitic fetus: A case report
Xia B, Li DD, Wei HX, Zhang XX, Li RM, Chen J

11487  De novo mutation loci and clinical analysis in a child with sodium taurocholate cotransport polypeptide deficiency: A case report
Liu HY, Li M, Li Q

11495  Surgery for hepatocellular carcinoma with tumor thrombosis in inferior vena cava: A case report
Zhang ZY, Zhang EL, Zhang BX, Zhang W

LETTER TO THE EDITOR

11504  Advantages and issues of concern regarding approaches to peripheral nerve block for total hip arthroplasty
Crisci M, Cuomo A, Forte CA, Bimonte S, Esposito G, Tracey MC, Cascella M
ABOUT COVER
Editorial Board Member of World Journal of Clinical Cases, Moises Rodriguez-Gonzalez, MD, Adjunct Professor, Senior Researcher, Department of Pediatric Cardiology, Hospital Universitario Puerta del Mar, Cadiz 11009, Spain. doctormoisesrodriguez@gmail.com

AIMS AND SCOPE
The primary aim of World Journal of Clinical Cases (WJCC, World J Clin Cases) is to provide scholars and readers from various fields of clinical medicine with a platform to publish high-quality clinical research articles and communicate their research findings online.

WJCC mainly publishes articles reporting research results and findings obtained in the field of clinical medicine and covering a wide range of topics, including case control studies, retrospective cohort studies, retrospective studies, clinical trials studies, observational studies, prospective studies, randomized controlled trials, randomized clinical trials, systematic reviews, meta-analysis, and case reports.

INDEXING/ABSTRACTING
The WJCC is now indexed in Science Citation Index Expanded (also known as SciSearch®), Journal Citation Reports/Science Edition, Scopus, PubMed, and PubMed Central. The 2021 Edition of Journal Citation Reports® cites the 2020 impact factor (IF) for WJCC as 1.337; IF without journal self cites: 1.301; 5-year IF: 1.742; Journal Citation Indicator: 0.33; Ranking: 119 among 169 journals in medicine, general and internal; and Quartile category: Q3. The WJCC’s CiteScore for 2020 is 0.8 and Scopus CiteScore rank 2020: General Medicine is 493/793.

RESPONSIBLE EDITORS FOR THIS ISSUE
Production Editor: Ji-Hong Liu; Production Department Director: Xu Gao; Editorial Office Director: Jin-Lai Wang.

NAME OF JOURNAL
World Journal of Clinical Cases

ISSN
ISSN 2307-8960 (online)

LAUNCH DATE
April 16, 2013

FREQUENCY
Weekly

EDITORS-IN-CHIEF
Bao-Gan Peng, Jerzy Tadeusz Chudek

EDITORIAL BOARD MEMBERS
https://www.wjgnet.com/2307-8960/editorialboard.htm

PUBLICATION DATE
December 26, 2021

COPYRIGHT
© 2022 Baishideng Publishing Group Inc

INSTRUCTIONS TO AUTHORS
https://www.wjgnet.com/bpg/gerinfo/204

GUIDELINES FOR ETHICS DOCUMENTS
https://www.wjgnet.com/bpg/GerInfo/287

GUIDELINES FOR NON-NATIVE SPEAKERS OF ENGLISH
https://www.wjgnet.com/bpg/gerinfo/240

PUBLICATION ETHICS
https://www.wjgnet.com/bpg/gerinfo/288

PUBLICATION MISCONDUCT
https://www.wjgnet.com/bpg/gerinfo/208

ARTICLE PROCESSING CHARGE
https://www.wjgnet.com/bpg/gerinfo/242

STEPS FOR SUBMITTING MANUSCRIPTS
https://www.wjgnet.com/bpg/gerinfo/239

ONLINE SUBMISSION
https://www.f6publishing.com
Observational Study

Audiological characteristics and exploratory treatment of a rare condition of acute-otitis-media-associated sudden sensorineural hearing loss

Xin Cao, Hai-Jin Yi

ORCID number: Xin Cao 0000-0001-8244-3697; Hai-Jin Yi 0000-0003-4661-7607.

Author contributions: Yi HJ designed and coordinated the study, interpreted the data; Cao X performed the experiments, acquired and analyzed data; all authors wrote the manuscript and approved the final version of the article.

Institutional review board statement: This study was approved by the Human Research Ethics Committee of Beijing Tsinghua Changgung Hospital, No. 21192-6-01.

Informed consent statement: Informed consent was obtained from all the subjects.

Conflict-of-interest statement: All authors have nothing to disclose.

Data sharing statement: No additional data are available.

STROBE statement: The authors have read the STROBE Statement—checklist of items, and the manuscript was prepared and revised according to the STROBE Statement—checklist of items.

Abstract

BACKGROUND
Acute otitis media (AOM) is a common disease that is more prevalent in children. Most studies concerning AOM-associated sudden sensorineural hearing loss are case reports and retrospective in nature, hence the etiology of AOM-associated sudden hearing loss has not been fully established.

AIM
To analyze audiological characteristics of AOM-associated sudden hearing loss and evaluate efficacy of combined tympanostomy tube placement (TTP) and intratympanic methylprednisolone.

METHODS
Eight adult patients who were diagnosed with AOM-associated sudden hearing loss and ineffectively treated by conventional medical therapy were enrolled in this study. Basic data were collected, and pure tone audiometry was performed to assess the audiological characteristics. Combination therapy with TTP and intratympanic methylprednisolone injection was given to the patients.

RESULTS
Mixed or sensorineural hearing loss was observed at high frequencies (2–4 kHz). All the cases in this study were cured after TTP and intratympanic methylprednisolone. After treatment, the average hearing threshold at affected frequencies was significantly lower than those in the pretreatment group ($P < 0.05$) and was similar to that in the healthy ears ($P > 0.05$).

CONCLUSION
AOM rarely induces sudden sensorineural hearing loss. Combination therapy
Acute otitis media (AOM) is a common disease that is more prevalent in children, affecting > 80% of children before the age of 3 years[1]. Globally, there are > 709 million new cases reported every year[2,3]. AOM is mainly caused by acute viral infection of the upper respiratory tract, which alters eustachian tube function and exposes the middle ear to bacterial infiltration[4]. There may be a conductive hearing loss if the patient also has tympanic effusion, and the degree of hearing loss can vary from negligible to 60 dB[5-8]. In the clinic, antibiotics and early myringotomy are the only two treatment options currently available for AOM patients[9]. Sudden sensorineural hearing loss is a frightening symptom that affects about 5-27 per 100000 people annually, with around 66000 new cases per year in the United States[10]. Most of these cases received corticosteroids as initial therapy[11]. Furthermore, intratympanic steroid administration is suggested as salvage therapy when initial therapy fails[11,12]. However, AOM-associated sudden sensorineural hearing loss is a rare otological condition and the mechanism and treatment methods have not been defined.

Most studies concerning AOM-associated sudden sensorineural hearing loss are case reports and retrospective in nature[12-14], hence, the etiology of AOM-associated sudden hearing loss has not been fully established. One of the hypotheses is that effusion in the middle ear causes vibration limitation and hypoxia of two windows, which leads to bone conduction hearing loss[15]. Another hypothesis for the sudden deafness is that the toxins released by infection enter the inner ear through the round window membrane (RWM)[16]. Since absorbing the effusion in the middle ear does not completely restore sensorineural hearing loss, the latter hypothesis currently seems more acceptable. Even though AOM-associated sudden hearing loss is a rare otological disorder, if not treated on time, it might cause permanent hearing loss. Therefore, it is important that the disorder is diagnosed early and treated immediately. This study described the audiological features of patients with AOM-associated sudden hearing loss and evaluated the clinical efficacy of tympanostomy tube placement and intratympanic methylprednisolone injection after failure of conventional medical treatment.

**INTRODUCTION**

Acute otitis media (AOM) is a common disease that is more prevalent in children, affecting > 80% of children before the age of 3 years[1]. Globally, there are > 709 million new cases reported every year[2,3]. AOM is mainly caused by acute viral infection of the upper respiratory tract, which alters eustachian tube function and exposes the middle ear to bacterial infiltration[4]. There may be a conductive hearing loss if the patient also has tympanic effusion, and the degree of hearing loss can vary from negligible to 60 dB[5-8]. In the clinic, antibiotics and early myringotomy are the only two treatment options currently available for AOM patients[9]. Sudden sensorineural hearing loss is a frightening symptom that affects about 5-27 per 100000 people annually, with around 66000 new cases per year in the United States[10]. Most of these cases received corticosteroids as initial therapy[11]. Furthermore, intratympanic steroid administration is suggested as salvage therapy when initial therapy fails[11,12]. However, AOM-associated sudden sensorineural hearing loss is a rare otological condition and the mechanism and treatment methods have not been defined.

Most studies concerning AOM-associated sudden sensorineural hearing loss are case reports and retrospective in nature[12-14], hence, the etiology of AOM-associated sudden hearing loss has not been fully established. One of the hypotheses is that effusion in the middle ear causes vibration limitation and hypoxia of two windows, which leads to bone conduction hearing loss[15]. Another hypothesis for the sudden deafness is that the toxins released by infection enter the inner ear through the round window membrane (RWM)[16]. Since absorbing the effusion in the middle ear does not completely restore sensorineural hearing loss, the latter hypothesis currently seems more acceptable. Even though AOM-associated sudden hearing loss is a rare otological disorder, if not treated on time, it might cause permanent hearing loss. Therefore, it is important that the disorder is diagnosed early and treated immediately. This study described the audiological features of patients with AOM-associated sudden hearing loss and evaluated the clinical efficacy of tympanostomy tube placement (TTP) and intratympanic methylprednisolone injection after failure of conventional medical treatment.
MATERIALS AND METHODS

Subjects
Patients with AOM-associated sudden hearing loss who visited the Department of Otolaryngology of Beijing Tsinghua Changgung Hospital between October 1, 2018 and June 1, 2020 were enrolled for this retrospective study. Written consent was signed by all the subjects, and this study was approved by the Human Research Ethics Committee of Beijing Tsinghua Changgung Hospital.

The patients were chosen based on following criteria: (1) Age 18–70 years; (2) AOM was diagnosed based on clinical symptoms, pneumatic otoscopy, pure-tone audiometry (PTA) and tympanometry; (3) Sudden hearing loss was diagnosed according to the Guidelines for Diagnosis and Management of Sudden Hearing Loss (2015), if PTA showed a decrease in hearing threshold ≥ 20 dB, for at least two consecutive frequencies from 0.25 to 4 kHz\(^{[17]}\); and (4) Conventional medical therapy was ineffective.

Exclusion criteria were as follows: (1) Current administration of oral or topical antibiotics for the affected ear; (2) Steroid treatment within 10 d before enrollment; (3) Previous perforation in the affected ear; (4) Allergic to cefuroxime axetil, cefdinir or moxifloxacin; and (5) Grommet (ventilation tube) i in the affected ear.

Intervention
All patients underwent myringotomy under local anesthesia, a ventilation tube was placed, and intratympanic injection of methylprednisolone (approximate 0.4 mL, 40 mg/mL) was given once every 3–4 d. The surgical procedures were performed by an experienced physician. The injection was given at most four times and PTA was performed 2 d after the last treatment or when hearing improvement was reported by the subjects.

Audiometric evaluation

**Pure-tone test:** It was conducted by using audiometry (TDH-39P Telephonics headset; Clinical Audiometer AC40, Interacoustics Company, Assens, Denmark, and the B-71 bone vibrator) in a sound-insulated cabin. The frequency-specific threshold was determined as the lowest sound intensity that the patient could hear at the specific frequency. The air conduction thresholds at 0.25, 0.5, 1, 2 and 4 kHz were determined.

**Measurement of bone conduction thresholds:** A B-71 bone vibrator was placed on the mastoid protrusion of the temporal bone of the subjects. The BC threshold values were determined at 0.25, 0.5, 1, 2 and 4 kHz.

**Air–bone gap:** The air–bone gap (ABG) was calculated as the difference between the pure-tone bone conduction and air conduction thresholds.

**Average hearing at affected frequencies:** When the bone conduction threshold was ≥ 20 dB over two or more consecutive frequencies, these frequencies were determined as affected frequencies. An average hearing at the affected frequencies was determined as the average hearing threshold at the corresponding frequencies.

Evaluation of efficacy
An improvement of ≥ 15 dB of the average hearing threshold at the affected frequencies after treatment was identified as effective, whereas an improvement of < 15 dB was identified as ineffective. A cure was defined as restoring the average hearing threshold at the affected frequencies to the normal hearing levels or the contralateral hearing levels after treatment.

Statistical analysis
The data were evaluated by using SPSS version 26.0 (Chicago, IL, United States). The data were expressed as mean ± SD. The changes in the hearing threshold values before and after treatment were analyzed by nonparametric test, and the difference was considered statistically significant if \( p < 0.05 \).
Cao X et al. AOM-associated sudden sensorineural hearing loss

RESULTS

Demographics
Eight patients who met the inclusion criteria were included in the study (Table 1), with an average age of 51.1 ± 13.60 years. All of them were affected in one ear with different degrees of bone conduction hearing loss.

Audiological characteristics pretreatment
The bone conduction and air conduction threshold values of the affected ears and healthy ears at different frequencies are listed in Table 2. Table 2 shows that the hearing threshold values of the affected ears were significantly higher than those of the contralateral healthy ears over 0.5, 1, 2 and 4 kHz for bone conduction (P < 0.05) and at all frequencies for air conduction. The audiogram data clearly showed that conductive hearing loss was observed at low frequencies, and mixed or sensorineural hearing loss was seen at high frequencies (Figure 1). Bone conduction hearing was impaired at 2 kHz in all patients, i.e., an incidence rate of 100%. The average hearing threshold of the affected frequencies was 37.19 ± 9.49 dB.

The frequency ranges of 0.25–1 kHz and 2–4 kHz were defined as low and high frequencies, respectively. The bone conduction threshold values at low frequencies were close to normal, and hearing loss was observed at high frequencies, with significant difference (P < 0.05) (Table 3). The average ABG was greater in the low frequency group, but the difference between the two groups was not statistically significant (Table 3).

Audiological characteristics and efficacy after treatment
The average interval from disease onset to the start of treatment was 8.63 ± 10.60 d (range, 3–30 d). All eight patients received TTP and intratympanic methylprednisolone injection (the average number of injections was 2), and were cured after treatment. The average hearing threshold value at the affected frequencies post-treatment was significantly lower than the pre-treatment value (P < 0.05), whereas it was not significantly different from that of the healthy ears (P > 0.05) (Table 4). The audiological changes observed after the treatment were shown in a post-treatment audiogram (Figure 2). The average ABG was significantly improved (P < 0.05) (Table 5). These results indicated that the combination of TTP and intratympanic methylprednisolone injection was a good salvage treatment regimen for patients suffering from AOM associated sudden hearing loss after failure of the conventional treatment.

DISCUSSION
The pathogenesis of sensorineural hearing loss in patients with AOM has been investigated, and the leading proposed theory is that an inflammation induces increased permeability of RWM, which allows the entry of endotoxins and ionic disequilibrium in the cochlea[17]. The bacterial (e.g., Streptococcus pneumoniae) byproducts and inflammatory mediators associated with AOM have been proven to enhance the permeability of RWM and cause subsequent cochlear damage[16,18,19]. It was found that the resulting hearing loss predominantly affected the hearing threshold values at high frequencies, which supports the above-mentioned theory[20]. In this study, it was found that the audiological characteristics of the patients with AOM-associated sudden hearing loss were as follows: ABG at low frequencies and bone conduction hearing loss at high frequencies. These results were in accordance with a previous case report, in which a female patient who was diagnosed with AOM-associated bilateral sudden hearing loss presented with higher hearing threshold values for both bone and air conduction at 2 and 4 kHz frequencies[13]. Despite the similar results reported in several studies, the pathological explanation for the elevation in hearing thresholds at high frequencies following AOM with effusion has not been fully elucidated. It is noteworthy that the prognosis of low frequency hearing loss was demonstrated to be better than that of high frequency. Patients with low frequency hearing loss showed a significantly higher recovery rate (74.1%, 40/54) than those with high frequency hearing loss (45.6%, 26/57) (P < 0.001)[21]. High-frequency hearing loss has also been associated with various symptoms such as deterioration in music perception[22]. In addition, a longitudinal cohort study showed that patients who had chronic suppurative otitis media and hearing loss after recurrent AOM are more likely to suffer from dizziness in adulthood[23], indicating that AOM-associated high frequency
hearing loss in childhood may influence the hearing and quality of life in the long term. Therefore, high-frequency audiometry should be considered for AOM patients to detect early changes in the auditory thresholds, and early intervention should be planned when plausible. To the best of our knowledge, this study is the largest case study that has investigated the audiological characteristics of patients with AOM-associated sudden deafness.

Currently, the front-line treatment choices for AOM, according to the guidelines and clinicians, are antibiotics and myringotomy, alone or in combination with ventilation tube placement. Song et al.\(^9\) suggested that early myringotomy (with or without placing ventilation tubes) and antibiotics significantly improved clinical outcomes of eight patients with AOM. As for the sudden sensorineural hearing loss, it was recommended by the American Academy of Otolaryngology guidelines that systemic

### Table 1 Demographics of the enrolled patients (n = 8, mean ± SD)

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Side of the affected ear</th>
<th>Gender</th>
<th>Age (yr)</th>
<th>Hearing loss</th>
<th>Tinnitus</th>
<th>Curve type</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Left</td>
<td>Right</td>
<td>Male</td>
<td>Female</td>
<td>Yes</td>
<td>No</td>
</tr>
<tr>
<td>1</td>
<td>√</td>
<td>√</td>
<td>37</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>2</td>
<td>√</td>
<td>√</td>
<td>38</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>3</td>
<td>√</td>
<td>√</td>
<td>47</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>4</td>
<td>√</td>
<td>√</td>
<td>63</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>5</td>
<td>√</td>
<td>√</td>
<td>59</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>6</td>
<td>√</td>
<td>√</td>
<td>67</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>7</td>
<td>√</td>
<td>√</td>
<td>34</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>8</td>
<td>√</td>
<td>√</td>
<td>64</td>
<td>√</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Total</td>
<td>6</td>
<td>2</td>
<td>2</td>
<td>6</td>
<td>8</td>
<td>0</td>
</tr>
</tbody>
</table>

### Table 2 Comparison of bone conduction and air conduction thresholds between the affected and contralateral healthy ears (dB HL, mean ± SD)

<table>
<thead>
<tr>
<th>Group</th>
<th>No.</th>
<th>0.25 kHz, BC</th>
<th>0.5 kHz, BC</th>
<th>1 kHz, BC</th>
<th>2 kHz, BC</th>
<th>4 kHz, BC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Affected ears</td>
<td>8</td>
<td>9.38 ± 5.60</td>
<td>17.50 ± 9.63</td>
<td>18.75 ± 9.16</td>
<td>33.12 ± 12.51</td>
<td>39.38 ± 17.41</td>
</tr>
<tr>
<td>Healthy ears</td>
<td>8</td>
<td>8.13 ± 5.30</td>
<td>13.13 ± 5.30</td>
<td>11.25 ± 6.40</td>
<td>17.50 ± 8.86</td>
<td>22.50 ± 11.34</td>
</tr>
<tr>
<td>Z</td>
<td>-0.220</td>
<td>-1.282</td>
<td>-1.973</td>
<td>-2.570</td>
<td>-2.161</td>
<td></td>
</tr>
<tr>
<td>P</td>
<td>0.826</td>
<td>0.200</td>
<td>0.048</td>
<td>0.010</td>
<td>0.031</td>
<td></td>
</tr>
<tr>
<td>Group</td>
<td>No.</td>
<td>0.25 kHz, AC</td>
<td>0.5 kHz, AC</td>
<td>1 kHz, AC</td>
<td>2 kHz, AC</td>
<td>4 kHz, AC</td>
</tr>
<tr>
<td>Affected ears</td>
<td>8</td>
<td>28.13 ± 11.63</td>
<td>31.88 ± 15.34</td>
<td>38.75 ± 18.27</td>
<td>38.75 ± 16.42</td>
<td>56.25 ± 22.16</td>
</tr>
<tr>
<td>Healthy ears</td>
<td>8</td>
<td>28.13 ± 11.63</td>
<td>31.88 ± 15.34</td>
<td>38.75 ± 18.27</td>
<td>38.75 ± 16.42</td>
<td>56.25 ± 22.16</td>
</tr>
<tr>
<td>Z</td>
<td>-2.965</td>
<td>-2.971</td>
<td>-3.242</td>
<td>-2.797</td>
<td>-2.905</td>
<td></td>
</tr>
<tr>
<td>P value</td>
<td>0.003</td>
<td>0.003</td>
<td>0.001</td>
<td>0.005</td>
<td>0.004</td>
<td></td>
</tr>
</tbody>
</table>

AC: Air conduction; BC: Bone conduction.

### Table 3 Comparison of average bone conduction thresholds and air-bone gap at low and high frequency

<table>
<thead>
<tr>
<th>Group</th>
<th>0.25-1 kHz</th>
<th>2-4 kHz</th>
<th>Z</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average BC threshold</td>
<td>15.25 ± 6.52</td>
<td>36.25 ± 6.52</td>
<td>-2.897</td>
<td>0.004</td>
</tr>
<tr>
<td>Air-bone gap</td>
<td>16.25 ± 11.64</td>
<td>11.56 ± 6.80</td>
<td>-0.527</td>
<td>0.598</td>
</tr>
</tbody>
</table>

BC: Bone conduction.
Table 4 Comparison of the average hearing threshold at affected frequencies pre- and post-treatment with healthy ears

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean hearing threshold at affected frequencies (dB HL)</th>
<th>Z</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-treatment</td>
<td>37.19 ± 9.49</td>
<td>-2.804</td>
<td>0.005</td>
</tr>
<tr>
<td>Healthy ears</td>
<td>19.69 ± 7.95</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Post-treatment</td>
<td>21.66 ± 9.14</td>
<td>-0.370</td>
<td>0.712</td>
</tr>
</tbody>
</table>

Table 5 Comparison of the pre-treatment air-bone gap with post-treatment values

<table>
<thead>
<tr>
<th>Group</th>
<th>Air-bone gap (dB HL)</th>
<th>Z</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-treatment</td>
<td>14.38 ± 9.40</td>
<td>-3.165</td>
<td>0.002</td>
</tr>
<tr>
<td>Post-treatment</td>
<td>3.25 ± 2.71</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Figure 1 Audiogram. Audiogram pretreatment: conductive hearing loss was observed at low frequencies of 0.25–1 kHz, and sensorineural hearing loss was seen at high frequencies of 2–4 kHz; the hearing threshold of the left ear was normal. #: Bone conduction of right ear with sheltering; <: Bone conduction of left ear; O: Air conduction of right ear; Δ: Air conduction of right ear with sheltering; ×: Air conduction of left ear; blue markers = left ear; red markers = right ear.

corticosteroids and/or hyperbaric oxygen therapy should be adopted as soon as the diagnosis was made, if needed an intratympanic steroid injection was recommended as a possible salvage therapy[11].

However, there is no standard treatment modality for patients with AOM-associated sudden deafness due to limited evidence and rarity of the disease. In the current study, antibiotics and intravenous methylprednisolone were administered in all eight patients; however, the treatment was ineffective. A combination treatment of TTP and intratympanic methylprednisolone injection was applied as a salvage and exploratory therapy. All the patients in this study showed improvement in BC threshold values at the affected frequencies and showed improvement in ABG. The results were in accordance with a previous study. Seven patients with sensorineural hearing loss associated with AOM were offered intratympanic steroids after oral antibiotics and oral prednisolone failed to improve hearing. Hearing improvement was achieved in 57% of patients (4/7) after intratympanic injections of methylprednisolone. A possible reason is that intratympanic methylprednisolone injection can provide a concentrated local steroid effect in nonresponders to antibiotics. The results clearly indicated that the combination therapy of TTP and intratympanic glucocorticoid injection was a good choice for treating patients with AOM-associated sudden deafness after failure of conventional medical treatment.

However, further well-designed studies are needed to verify the findings of the current study as there were some limitations to this study. Firstly, AOM-associated sudden hearing loss is a rare disease in adults, thus, the sample size of this study was too small. Secondly, a control group in which no further treatment was provided after failure of the first treatment was not accommodated in this study. Hence in the future,
CONCLUSION

In summary, the current case study indicated that AOM may rarely induce sudden sensorineural hearing loss, and high frequencies (2–4 kHz) are often involved. Combination therapy with TTP and intratympanic methylprednisolone injection may be a good salvage treatment modality for patients with AOM-associated sudden hearing loss after failure of conventional treatment.

ARTICLE HIGHLIGHTS

Research background
Acute otitis media (AOM) is a common disease in children, affecting > 80% of children before the age of 3 years. AOM-associated sudden sensorineural hearing loss is a rare otological disorder, and the mechanism and treatment methods remain to be investigated.

Research motivation
If AOM-associated sudden hearing loss is not treated on time, it might cause permanent hearing loss. Therefore, early diagnosis and treatment of AOM-associated sudden hearing loss are important.

Research objectives
This study aimed to describe the audiological features of the patients with AOM-associated sudden hearing loss and evaluate the clinical efficacy of tympanostomy tube placement (TTP) and intratympanic methylprednisolone injection after failure of conventional medical therapy.

Research methods
Patients with AOM-associated sudden hearing loss who visited the Department of Otolaryngology of Beijing Tsinghua Changgung Hospital between October 1, 2018 and June 1, 2020 and were ineffectively treated by conventional medical therapy were enrolled in this study. Basic data were collected, and pure-tone audiometry was performed to assess the audiological characteristics. Combination therapy with TTP and intratympanic methylprednisolone injection was given to the patients.

Figure 2 Audiogram. Audiogram after treatment: Conducive hearing loss at low frequencies of the same patient disappeared and sensorineural hearing loss observed at high frequencies of 2–4kHz was restored to the hearing level of the healthy ear; the hearing threshold of the left ear was normal. O: Air conduction of right ear = bone conduction of right ear; ×: Air conduction of left ear = bone conduction of left ear; blue markers = left ear; red markers = right ear.

Well-designed studies with a larger sample size are required to further corroborate findings of this study.
Cao X et al. AOM-associated sudden sensorineural hearing loss

Research results
Mixed or sensorineural hearing loss was observed at high frequencies (2–4 kHz). All the patients in this study were cured after TTP and intratympanic methylprednisolone. After treatment, the average hearing threshold at affected frequencies was significantly lower than those in the pretreatment group and was similar to those in the healthy ears.

Research conclusions
Our study indicated that AOM may rarely induce sudden sensorineural hearing loss, and high frequencies (2–4 kHz) are often involved. Combination therapy with TTP and intratympanic methylprednisolone injection may be a good salvage treatment modality for patients with AOM-associated sudden hearing loss after failure of conventional treatment.

Research perspectives
Our study may bring more chances for recovery of patients with AOM-associated sudden hearing loss after failure of conventional treatment. However, our findings remain to be verified by well-designed studies with a large sample size.

REFERENCES


20 Cordeiro FP, da Costa Monsanto R, Kasemmodel ALP, de Almeida Gondra L, de Oliveira Penido N. Extended high-frequency hearing loss following the first episode of otitis media. Laryngoscope 2018; 128: 2879-2884 [PMID: 30194735 DOI: 10.1002/lary.27309]


