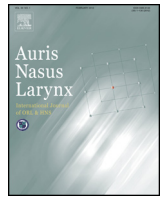




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Sudden sensorineural hearing loss in children and adolescents: Clinical characteristics and age-related prognosis

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ABSTRACT

Objective: Although many studies have investigated sudden sensorineural hearing loss (SSNHL) in adults, there were few studies on SSNHL in the pediatric population; especially research on treatment and prognosis of pediatric SSNHL was limited. The aim of this study was to evaluate clinical characteristics, treatment outcomes and prognostic factors in children and adolescents with SSNHL. **Methods:** A retrospective review of medical records of 67 pediatric patients (67 ears) who had diagnosed with SSNHL at our hospitals was performed to analyze patients' clinical manifestations and audiograms. All patients were treated with high-dose systemic prednisolone (1 mg/kg), and 17 of them underwent intratympanic steroid injection therapy. Audiological evaluation was carried out before and after treatment, and hearing recovery was defined as complete recovery and partial recovery according to Siegel's criteria. Patients were divided into two groups: childhood group (ages between 4 and 12 years old) and adolescence group (age > 12 years), and clinical characteristics and treatment outcomes were investigated. In addition, patients were divided into two groups according to degree of hearing recovery, and evaluation was made regarding possible prognostic factors.

Results: The recovery rate in total 67 patients was 55.2%. The recovery rate of the childhood group was significantly lower than that of the adolescence group ($p = 0.038$). While the presence of vertigo did not significantly correlate with prognosis ($p = 0.219$), the presence of tinnitus was significantly associated with hearing recovery ($p = 0.005$). Audiological assessment revealed that a low initial hearing threshold, high speech discrimination score, and descending type of audiogram were positively associated with hearing recovery ($p = 0.002$, $p = 0.003$, and $p = 0.029$, respectively).

Conclusion: The childhood group had worse treatment outcomes than the adolescence group. High initial hearing threshold and absence of tinnitus were poor prognostic factors of hearing recovery. Active treatment is required for patients with these poor prognostic factors and childhood patients with SSNHL.

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1. Introduction

Sudden sensorineural hearing loss (SSNHL) is defined as rapidly developing hearing loss within less than three days, and the level of the hearing loss is more than 30 dB in at least three consecutive frequencies [1]. In the United States, the incidence of SSNHL has been reported to be 27 per 100,000 per year [2]. However, some authors have suggested that the incidence of SSNHL might be much higher than the figures previously reported [3]. SSNHL commonly occurs in patients aged between 25 and 60 years old, with a peak in prevalence for patients between 46 and 49 years old [4,5]. SSNHL in children is very rare and its cause is still unclear. It has been reported that 6.6% of patients with SSNHL were under 18 years of age, 3.5% under 14 years, and only 1.2% under 9 years [6]. Due to the rarity of SSNHL in the pediatric population, research regarding etiology, treatment outcomes, and prognosis of SSNHL in children is limited.

Several studies have shown hearing recovery rates of 32%–65% (average 46.7%) without treatment, typically within 2 weeks of onset; medical treatment including steroids is known to improve hearing recovery [7–9]. Some studies have shown that the prognosis in children with SSNHL is worse than that in adults [9,10]. Because children grow rapidly with time, in addition, a pediatric population will have large developmental variability according to age, and different prognosis can be present among the children due to this variability. However, there are few studies of the prognosis of SSNHL according to age in a homogenous pediatric population, and the results are controversial [11,12]. Prognostic factors such as patient age, pattern of audiogram, presence of vertigo at onset and late initiation of treatment have been reported in large adult populations with SSNHL [9,13–15]. Due to its low incidence, there have been few studies regarding prognostic factors in homogenous pediatric populations [10,16]. The aims of this study were to analyze clinical and audiological characteristics associated with prognosis in children and adolescents with SSNHL and investigate age-related treatment outcomes in a pediatric population.

2. Materials and methods

2.1. Study design and patients

We performed a retrospective medical record review of SSNHL patients in three large medical centers from January 2005 to August 2016 and identified 67 patients aged between 4 and 19 years. These 67 patients were divided into two groups: childhood group (ages between 4 and 12 years old), and adolescence group (age > 12 years). Age, gender, time of onset and laterality were investigated. Endoscopic ear examinations were performed to rule out external and/or middle ear diseases that could cause hearing impairment. Pure tone audiometry and speech audiometry were carried out in all patients to evaluate their hearing loss. Furthermore, following tests were reviewed to exclude patients with possible secondary causes of hearing loss: complete blood count (CBC), blood urea nitrogen (BUN), creatinine, urine analysis, antinuclear antibody (ANA), rheuma-

toid factor (RF), erythrocyte sedimentation rate (ESR), thyroid-stimulating hormone (TSH), free thyroxine (FT4), and rapid plasma reagin (RPR). Inner ear magnetic resonance imaging (MRI) was performed in 45 patients (67.2%) to exclude middle ear diseases and inner ear malformations. The inclusion criteria of patients enrolled in this study were as follows: (1) had sensorineural hearing loss of 30 dB or greater in at least three consecutive frequencies within less than three days; (2) aged ≤ 19 years old; (3) underwent early therapeutic management, begun before 2 weeks, and (4) had follow-up duration longer than 1 month. Exclusion criteria were patients: (1) aged under 4 years; (2) who had middle ear or retro-cochlear pathology; (3) who had a history of Meniere disease, autoimmune hearing loss or radiation-induced hearing loss; (4) who had a history of genetic hearing loss; (5) who had evidence of acute or chronic otitis media upon examination; or (6) who had a history of otologic surgery. This study was approved by the institutional review board (permit no. 16-2016-144).

2.2. Audiometric assessment

The patients were evaluated using standard methods for examining pure tone thresholds. The standard audiometric protocol involved examining pure tone air and bone conduction thresholds at 0.125, 0.25, 0.5, 1, 2, 3, 4, and 8 kHz. Mean pure tone audiograms were calculated at 0.5, 1, 2, and 3 kHz for air conduction thresholds to evaluate hearing levels. Four types of audiograms were defined based on the pattern of hearing loss in the initial pure tone audiometry (PTA): ascending (the average threshold of 0.25–0.5 kHz was 20 dB higher than the average threshold of 4–8 kHz), descending (the average threshold of 4–8 kHz was 20 dB higher than the average threshold of 0.25–0.5 kHz), flat (similar threshold observed across the all frequency ranges) and profound (the average threshold in 0.5, 1, 2, and 3 kHz over 90 dB HL). Hearing levels were assessed before treatment, and final treatment outcomes after treatment were measured with audiogram – PTA and speech discrimination scores (SDS) – performed from one to three months after treatment. The hearing gain was calculated as the difference between initial and final hearing levels (PTA). Siegel's criteria [17] were employed to assess treatment results of the subjects (Table 1). According to Siegel's criteria, hearing recovery was defined as complete recovery (CR) and partial recovery (PR), whereas slight recovery (SR) and no improvement (NI) were categorized as no recovery.

Table 1
Siegel's criteria of hearing recovery.

Grade	Hearing recovery
I. Complete recovery (CR)	Final hearing level was less than 25 dB
II. Partial recovery (PR)	Final hearing from 25 to 45 dB with hearing gain of ≥ 15 dB
III. Slight recovery (SR)	Final hearing over 45 dB with hearing gain of ≤ 15 dB
IV. No improvement (NI)	Final hearing level over 75 dB with hearing gain of ≤ 15 dB

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