

ORIGINAL RESEARCH

Tinnitus characteristics in patients with idiopathic sudden sensorineural hearing loss and acute tinnitus

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Funding information

Chosun University Hospital. Grant/Award Number: 2023

Abstract

Objective: Tinnitus is a common symptom of idiopathic sudden sensorineural hearing loss (ISSHL). This study aimed to investigate the characteristics and outcomes of acute tinnitus in patients with ISSHL.

Methods: A total of 59 patients with ISSHL and acute tinnitus were enrolled. All patients underwent audiological assessment, tinnitus matching for loudness and frequency, and steroid treatment for sudden hearing loss. Tinnitus-related distress was assessed using the tinnitus handicap inventory (THI) questionnaire. The outcomes of hearing recovery and tinnitus remission were investigated retrospectively.

Results: The loudness and pitch of acute tinnitus were 63.2 ± 22.4 dB HL and 2010.63 ± 2368.99 Hz, respectively. Complete and partial recovery rates of acute tinnitus in ISSHL patients were 32.2% and 39% according to the THI scores. The group with complete recovery of hearing showed significantly greater improvement in tinnitus distress than the group with no improvement in hearing. The loudness and pitch of tinnitus did not correlate with tinnitus remission.

Conclusion: Hearing recovery is more important for tinnitus remission than the psychoacoustic characteristics of acute tinnitus. Timely identification and proper treatment of hearing loss are important to improve tinnitus remission in patients with ISSHL.

Level of Evidence: Level 4.

KEYWORDS

hearing loss, inner ear, outcomes, sensorineural, tinnitus

1 | INTRODUCTION

Tinnitus is a medical condition in which a person perceives a ringing or buzzing sound in the ears that is not generated from any external source. Tinnitus can be caused by various underlying medical conditions and is frequently accompanied by hearing impairment, including idiopathic sudden sensorineural hearing loss (ISSHL).¹ The incidence

of tinnitus in patients with ISSHL is 80%–95%.^{2,3} ISSHL and tinnitus may have similarities in lesions such as cochlear hair cells.⁴ Decreased signals from the cochlea reduce lateral inhibition in the central auditory system including the dorsal cochlear nucleus and inferior colliculus, and lead to cause hyperactivity of neurons around the frequency of hearing loss.^{5–7} Therefore, successful recovery of hearing after steroid treatments can be accompanied by improvement of acute tinnitus

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concomitant with ISSHL.³ Contrastingly, some patients still have tinnitus despite the successful treatment of hearing loss and suffer from mental distress, depression, and disruptions in personal relationships.⁸ Tinnitus improvement after ISSHL treatments may be different depending on several factors including tinnitus pitch, tinnitus loudness, hearing thresholds, and tinnitus handicap inventory (THI) scores.⁹ Previous studies have reported conflicting results between tinnitus improvement and hearing recovery. Some studies have shown a significant relationship between hearing recovery and tinnitus improvement.^{3,10} However, other studies have reported a poor correlation between hearing recovery and tinnitus improvement.² The characteristics and outcomes of acute tinnitus in patients with ISSHL remain unclear. The present study aimed to investigate the tinnitus characteristics and recovery in patients with ISSHL and acute tinnitus.

2 | METHODS

2.1 | Participants

This study included 59 patients who were diagnosed with unilateral ISSHL and acute tinnitus at our hospital between January 2017 and December 2022. Patients with bilateral or pulsatile tinnitus, head trauma, otologic surgery, Meniere's disease, or central nervous system disorders were excluded. ISSHL was defined as a sensorineural hearing impairment of more than 30 dB in three or more consecutive audiometric frequencies within 72 h. The eligibility criterion for acute tinnitus was that the new-onset tinnitus should not exceed 1 month. All patients underwent audiological assessments, tinnitus examinations, magnetic resonance imaging (MRI), and ISSHL treatment with systemic steroids (prednisolone, 1 mg/kg/day) for 7 days, followed by tapering doses for 7 days. As an adjuvant therapy, intratympanic dexamethasone injections (4 times/2 weeks) were offered to patients who had no hearing recovery after systemic therapy. Labyrinthine hemorrhage, intralabyrinthine schwannoma, and vestibular schwannoma were not observed in the MRI scans of any patients. The Institutional Review Board of the hospital (IRB 2023-01-004) approved this study, and the requirement for informed consent was waived. The clinical characteristics of the patients, including age, sex, THI, visual analog scale (VAS) for tinnitus, and outcomes of recovery from hearing loss and tinnitus, were investigated retrospectively.

2.2 | Tinnitus matching tests

The test for matching tinnitus frequency and loudness was conducted in a sound-proof-shielded room. Tinnitus frequency matching was performed by giving the patients test tones (125, 250, 500, 1000, 2000, 3000, 4000, 6000, and 8000 Hz) and letting the patients choose the stimulus with the closest frequency to their tinnitus. Exact approximate frequency matching was obtained by adjusting in a half-octave step. Tinnitus loudness matching was performed by a gradual increase in 1 dB step and determined as the closest sensory level (dB SL) with tinnitus of patients.

2.3 | Statistical analysis

All data were analyzed using the SPSS software (version 25.0; SPSS Inc., Chicago, IL, USA). The Mann-Whitney *U* test was used to analyze the significant difference in THI scores between the initial and last THI. One-way ANOVA was used to analyze significant differences between the hearing thresholds and hearing recovery groups. Univariate linear regression analysis was used to assess the association between improvements in THI, tinnitus pitch, and tinnitus loudness. A *p*-value <.05 was considered statistically significant.

3 | RESULTS

3.1 | General characteristics of patients with ISSHL and acute tinnitus

Of the 59 patients diagnosed with ISSHL and acute tinnitus, 32 were male and 27 were female. The mean age was 50.6 ± 16.3 years. With respect to the affected ears, 33 and 26 ears were on the left and right sides, respectively. The duration of tinnitus ranged from 1 to 30 days. Among the 59 patients, the loudness and pitch of 47 patients were recorded. The average tinnitus loudness and pitch were 63.2 ± 22.4 dB HL and 2010.63 ± 2368.99 Hz, respectively. The distribution of THI was as follows: light handicap, 26 (44.1%); mild handicap, 11 (18.6%); moderate handicap 7 (11.9%); severe handicap 6 (10.2%); and catastrophic handicap 9 (15.2%; Table 1).

3.2 | Tinnitus improvement after treatments for ISSHL and acute tinnitus

To investigate the improvement in tinnitus in patients with ISSHL and acute tinnitus, changes in the final THI scores were assessed 3 months after onset to evaluate tinnitus handicap improvement. Complete recovery was observed in 19 patients (32.2%); 23 patients (39.0%) showed a decrease in THI scores, three patients (5.0%) showed no change in THI scores, and 14 patients (23.8%) showed an increase in THI scores. The light handicap group showed a significant improvement in tinnitus, the mild to moderate handicap groups showed no change in tinnitus, and the severe to catastrophic groups showed a significant increase in tinnitus (Figure 1A). Regarding the initial hearing thresholds, there was no significant difference in the change in THI scores among the mild, moderate-to-moderately severe, and severe hearing loss groups (Figure 1B).

3.3 | Comparison of tinnitus changes with tinnitus loudness, tinnitus pitch, and hearing recovery in patients with ISSHL and acute tinnitus

To investigate the relationship between tinnitus recovery and the loudness and pitch of tinnitus in patients with ISSHL and acute

Variable	Group	Pretreatment	Posttreatment
Gender (M/F)		32/27	
Age (years)		50.63 ± 16.27	
Tinnitus duration (days)		7.07 ± 6.33	
Left ear/right ear		33/26	
Tinnitus loudness (dB HL)		63.19 ± 22.44	
Tinnitus frequency (Hz)		2010.63 ± 2368.99	
THI	Light handicap	26 (44.07)	34 (57.63)
	Mild handicap	11 (18.64)	6 (10.17)
	Moderate handicap	7 (11.86)	11 (18.64)
	Severe handicap	6 (10.17)	5 (8.47)
	Catastrophic handicap	9 (15.25)	3 (5.08)
VAS 1 (loudness)	No discomfort	0 (0.00)	12 (22.22)
	Mild discomfort	19 (32.20)	19 (35.19)
	Moderate discomfort	33 (55.93)	19 (35.19)
	Severe discomfort	7 (11.86)	4 (7.41)
VAS 2 (annoyance)	No discomfort	2 (3.39)	18 (33.33)
	Mild discomfort	15 (25.42)	15 (27.78)
	Moderate discomfort	30 (50.85)	12 (22.22)
	Severe discomfort	12 (20.34)	9 (16.67)
VAS 3 (quality of life)	No discomfort	1 (1.69)	18 (33.33)
	Mild discomfort	19 (32.20)	16 (29.63)
	Moderate discomfort	26 (44.07)	15 (27.78)
	Severe discomfort	13 (22.03)	5 (9.26)
Hearing loss (dB HL)	Normal		28 (47.46)
	Mild	15 (25.42)	10 (16.95)
	Moderate	15 (25.42)	11 (18.64)
	Moderately severe	11 (18.65)	5 (8.47)
	Severe	18(30.51)	5 (8.47)
WRS (%)		49.22 ± 39.11	81.75 ± 26.64

TABLE 1 General and tinnitus characteristics of the study population ($n = 59$). Data are presented as means ± standard deviation.

Abbreviation: THI, tinnitus handicap inventory; VAS, visual analog scale; WRS, word recognition score.

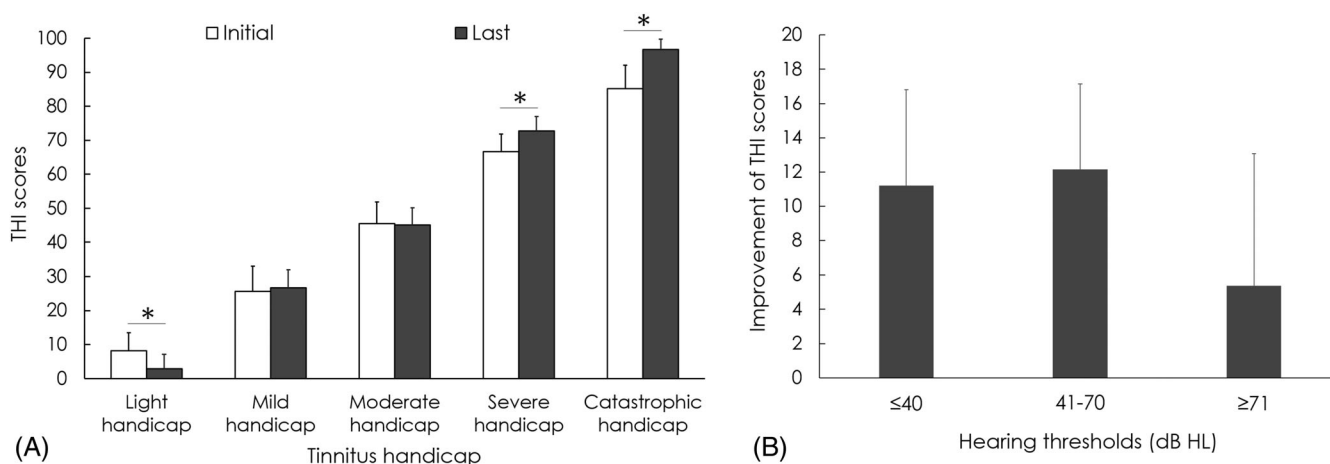


FIGURE 1 The changes in THI scores after treatment, according to THI categories and initial hearing thresholds in patients with ISSHL and acute tinnitus. The light handicap group showed a significant decrease in THI scores, while the severe and catastrophic handicap groups showed a significant increase in THI scores (A). Based on hearing thresholds, no difference was seen in the improvement of THI scores between the groups (B) (ISSHL, idiopathic sudden sensorineural hearing loss; THI, tinnitus handicap inventory; Mann-Whitney U test and one-way ANOVA, $p < .05$).

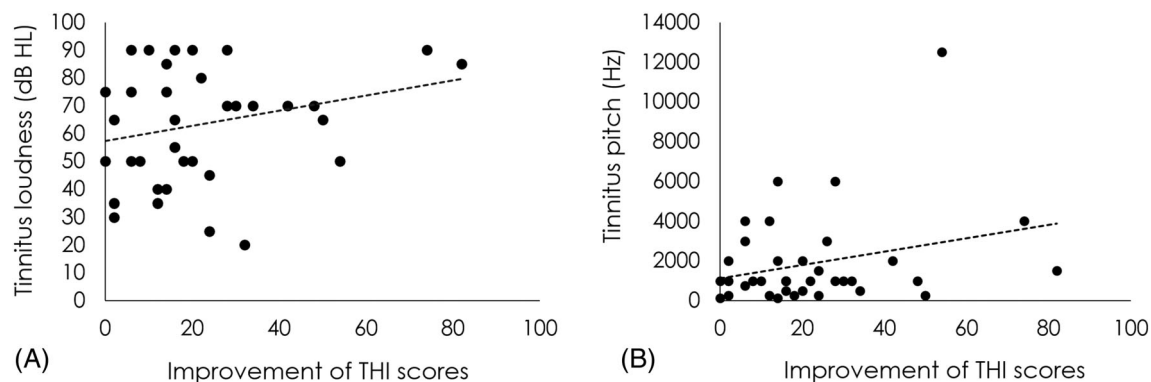


FIGURE 2 The relationship between the characteristics of acute tinnitus and the improvement of THI scores in patients with ISSHL and acute tinnitus. The loudness (A, $p = .09$) and pitch (B, $p = .21$) of tinnitus were not correlated with the improvement of THI scores (ISSHL, idiopathic sudden sensorineural hearing loss; THI, tinnitus handicap inventory; univariate linear regression analysis).

tinnitus, changes in THI scores were assessed according to the loudness and pitch of tinnitus. The changes in THI scores depending on the loudness and pitch of tinnitus indicated no correlation between these variables (Figure 2). Regarding hearing recovery, according to Siegel's criteria,¹¹ the complete recovery group showed greater improvement in THI scores than the no-improvement group (Figure 3A). There was no difference in tinnitus loudness or pitch according to hearing recovery according to Siegel's criteria (Figure 3B,C).

4 | DISCUSSION

ISSHL is frequently accompanied by tinnitus.^{12,13} However, the outcome of acute tinnitus in patients with ISSHL are not fully understood. The present study showed that complete and partial recovery rates of acute tinnitus in patients with ISSHL were 32.2% and 39%, respectively. The recovery rates were similar to recovery rates of hearing in ISSHL patients.¹⁴ Previous studies also reported that the largest improvement of tinnitus was seen in patients with a short duration of tinnitus.¹⁵ However, 22%–24% of patients with ISSHL had the long-term presence of annoying tinnitus.¹⁶

While the pitch of chronic tinnitus is concentrated in the higher-frequency region, the pitch of acute tinnitus is more diffusely distributed and concentrated at the middle frequency.⁵ In the present study, the mean frequency of acute tinnitus was 2.01 kHz of the middle frequency. The main etiologies of ISSHL are viral infections and ischemia in the inner ear, leading to cochlear hair cell damage. These lesions may alter the activity of the auditory neural pathway and induce an increase in neural synchronization in the primary auditory cortex. Increased neural synchronization may result in a sound sensation in the absence of external sound stimuli.^{17,18} Therefore, the frequency of acute tinnitus in patients with ISSHL is usually consistent with the frequency of hearing loss due to this mechanism.¹⁹ However, the frequency of chronic tinnitus might differ due to reorganization of the auditory cortex.⁵

In the present study, improvement in acute tinnitus was seen in patients with light handicap scores, while aggravation of acute tinnitus was seen in patients with severe and catastrophic handicap scores. These results suggest that the psychological aspects of tinnitus can affect the natural habituation process and improve tinnitus tolerance.²⁰ Severe and catastrophic handicap groups can have negative reactions to tinnitus perception and increase their tinnitus handicap. Clinicians should provide supportive management, including counseling and sound therapy such as Mozart's sonata,²¹ to patients with severe or catastrophic handicaps related to tinnitus.

The degree of initial hearing loss in patients with ISSHL did not correlate with improvement in acute tinnitus. These results are consistent with those of previous studies. The severity of hearing loss in patients with ISSHL did not influence the occurrence of tinnitus.²² Additionally, no significant relationship was observed between hearing loss and tinnitus severity.²³

A previous study reported that tinnitus with a medium-frequency pitch improved less than tinnitus with high- and low-frequency pitches. The authors explained that the medium pitch in ISSHL has greater fluctuation and results in less improvement of tinnitus.²⁴ However, the recovery of acute tinnitus depending on THI scores was not correlated with tinnitus pitch in the present study. There was also no significant relationship between tinnitus loudness and recovery from acute tinnitus in patients with ISSHL. These results suggest that the mental and emotional aspects of acute tinnitus, rather than the characteristics of tinnitus, may contribute to patient distress.²

The improvement in acute tinnitus was significantly greater in patients who had complete recovery of hearing in the present study. Hearing normalization is important for the remission of acute tinnitus because functional changes in the brain may be transient, and the cochlear component of neural plasticity is the major mechanism of tinnitus development.²⁵

The present study showed the characteristics of acute tinnitus and outcomes of tinnitus following treatment in patients with ISSHL. Timely identification and prompt management of hearing loss and tinnitus are important to reduce tinnitus-associated distress in patients with ISSHL.

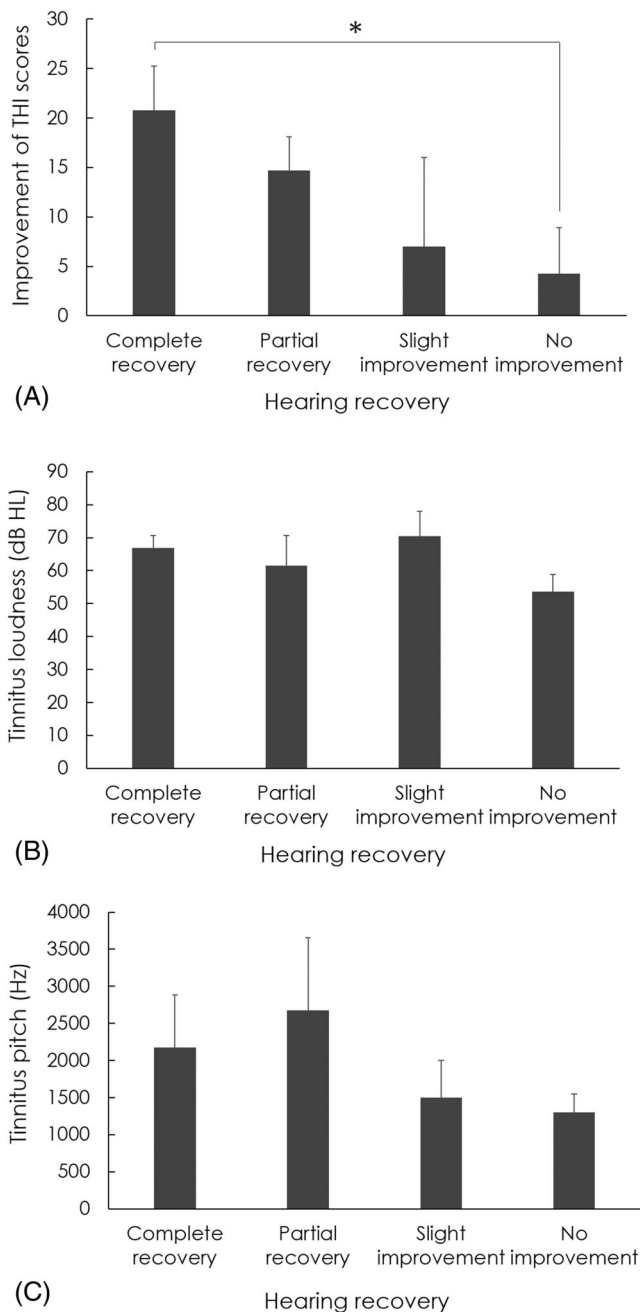


FIGURE 3 The changes in tinnitus according to the hearing recovery based on Siegel's criteria. Improvement of THI scores was significantly higher in the complete recovery group than in the no improvement group (A). The loudness and pitch of tinnitus were not different among these groups (B, C) (THI, tinnitus handicap inventory; one-way ANOVA, $p < .05$).

5 | CONCLUSION

The pitch and loudness of acute tinnitus are not correlated with tinnitus remission in patients with ISSHL. Hearing recovery, rather than psychoacoustic characteristics of acute tinnitus, is crucial for tinnitus remission. Proper treatment for hearing recovery can also improve tinnitus remission in patients with ISSHL.

FUNDING INFORMATION

This study was supported by research fund from Chosun University Hospital, 2023.

CONFLICT OF INTEREST STATEMENT

None of the authors has a conflict of interest to declare.

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How to cite this article: Mokhatrish M, Baek W, Nam G-S, Cho SI. Tinnitus characteristics in patients with idiopathic sudden sensorineural hearing loss and acute tinnitus. *Laryngoscope Investigative Otolaryngology*. 2023;8(5):1384-1389. doi:[10.1002/lio.2.1137](https://doi.org/10.1002/lio.2.1137)