Master's Thesis in Medicine

Differences in Clinical Characteristics and Prognosis of Sudden Low- and High-Frequency Hearing Loss

Ajou University Graduate School

Major in Medicine

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- Abstract -

Differences in Clinical Characteristics and Prognosis of Sudden Low- and High-Frequency Hearing Loss

Objectives/Hypothesis: We compared the clinical characteristics between acute low- and high-frequency hearing loss (LF and HF, respectively) patients, and the efficacy of three different treatment protocols (systemic steroids, intratympanic steroid injection, and combination therapy).

Study Design: Prospective, randomized controlled study.

Methods: A total of 111 patients diagnosed with LF or HF were treated on an outpatient basis. Each group was randomly divided into three equal subgroups based on therapy: oral steroid, intratympanic dexamethasone injection (IT), and combination therapy. Hearing gain was estimated by comparing pre- and post-treatment pure-tone averages. Recovery rate was assessed by Clinical Practice Guideline: Sudden Hearing Loss from the American Academy of Otolaryngology - Head and Neck Surgery.

Results: In comparison of chief complaints, ear fullness and hearing loss were more common in the LF and HF group, respectively (P =.033 and P =.001, respectively). Hearing recovery rates were significantly different between the two groups (i.e., 74.1% [40/54] in the LF group and 45.6% [26/57] in the HF group; P < .001). Oral steroid therapy was most effective in the LF group (P = .017). In the HF group, all three modalities showed similar results, although IT tended to be the most effective (P =.390).

Conclusions: There were differences in chief complaints and treatment responses between LF and HF patients. Although they showed similar partial damage in the cochlea, the pathophysiology of LF and HF may be quite different.

Key Words : Sudden hearing loss, frequency, treatment, steroid, dexamethasone, hearing.

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Ⅰ. INTRODUCTION

Idiopathic sudden sensorineural hearing loss (ISSNHL) is an urgent otological disease commonly defined as >30 dB hearing loss (HL) in at least three audiometric frequencies occurring over 3 days or less. The incidence of ISSNHL is roughly five to 20 per 100,000,[1] and possible causes include viral infection, autoimmune disorders, vascular compromise, and intralabyrinthine membrane rupture.[2,3] Although the rate of spontaneous recovery from ISSNHL has been reported to be 32% to 65%,[4,5] many treatment methods, including corticosteroids (systemic and/or intratympanic), antiviral agents, vasodilators, osmotic agents, plasma expanders, anticoagulants, and hyperbaric oxygen or carbon dioxide-rich gases have been used.[6] Furthermore, many factors also affect the prognosis of this disease, including the age of the patient, glucocorticoid dosage, the interval between the onset of hearing loss and initiation of therapy, the severity of hearing loss, speech discrimination score, the presence of vertigo and the pattern of audiometric appearance.[1,7 - 9]

Acute low-frequency sensorineural hearing loss (LF), with preservation of high-frequency hearing, was initially considered a subtype of ISSNHL and has attracted interest from its introduction as a distinct disease category by Abe in 1982.[10] Diagnosis of ALHL is based on subjective symptoms and objective hearing results. The specific hearing impairment of ALHL is mainly confined to the lower frequencies of 125, 250 and 500 Hz, with relatively normal hearing being maintained at higher frequencies of 2, 4, and 8 kHz in the absence of vertigo and any structural damage 25,29 Although the pathophysiology of LF remains unknown, it has been associated with cochlear hydrops or early stage Menie're's disease.[11 - 13] LF is known to have a better prognosis than ISSNHL and generally improves within a short time after treatments.[14] However, fluctuation of HL or progression to overt Menie're's disease has been also reported.[15] In contrast to LF, acute

high-frequency hearing loss (HF), with preservation of low-frequency hearing, may also be considered as a subtype of ISSNHL, but there have been few reports regarding its clinical characteristics and prognosis.

Although diverse modalities, such as systemic steroid therapy, intratympanic steroid injection (IT), and combination therapy have been introduced for treatment of ISSNHL, including LF and HF, systemic steroid therapy is still the most widely used form of treatment. In the ISSNHL patients, a neutrophil count above the reference range was associated with severe hearing loss and poor prognosis, and was accompanied by low NKCA and high IL-6. These inflammatory biomakers induce NF-κB activation in the cochlea and cause severe ISSNHL.[16] These being so, the main cause of broad usage of steroid is to reduce the inflammatory effect in the inner ear, such as viral infection or autoimmune disease.[17] However, systemic steroid therapy is associated with adverse effects, such as avascular necrosis of the femur, endocrinological problems, osteoporosis, and weight gain.[18,19] Due to these problems, ear, nose, and throat specialists frequently recommend IT as a primary or salvage therapy for ISSNHL because it shows better hearing gain in patients refractory to systemic steroid therapy and may cause reduced systemic steroid absorption and toxicity.[20 - 22] IT is also considered to have similar efficacy to systemic steroid therapy as a primary treatment for ISSNHL.[23] Some studies hypothesized that IT can deliver a higher intracochlear concentration of medication via round window membrane absortion, compared with oral administration of steroids.[17] Another drugs used with IT is various. It includes vasodilators such as histamine, nicotinic acid, and carbogen. Histamine has potential vasodilatory and increased permeability effect on RWM, hyaluronic acid has known osmotic effects, and dimethylsulfoxide, an organic solvent, may increase the solubility of medication in perilymph.[22-23]

More recently, the combination of systemic steroid therapy and IT as an initial treatment for ISSNHL has been used frequently by otolaryngologists. The concept

of combination therapy is that maximal delivery of a steroid to the inner ear using both systemic and intratympanic routes optimizes the potential for hearing recovery by achieving rescue of intracochlear spiral ganglion neuritis and/or hair cells.[22] Unfortunately, there have been few clinical reports comparing the effectiveness of three different modalities as initial treatment for subtypes of ISSNHL, such as LF and HF.

Therefore, in this prospective randomized clinical study, we treated LF or HF patients with several protocols. This study was performed to compare the clinical characteristics between LF and HF, and the efficacy of three different treatment protocols (i.e., systemic steroid, IT, and combination therapy) for patients with LF or HF.

Ⅱ. MATERIALS AND METHODS

The present study was performed with a prospective randomized clinical trial design. A total of 151 patients diagnosed with LF or HF through the outpatient department from July 2010 to November 2014 were enrolled in the study. We received approval from the institutional review board of Ajou University School of Medicine, Suwon, Republic of Korea.

The diagnostic criteria for LF were: 1) acute onset sensorineural HL at low frequency (250, 500, and 1,000 Hz), 2) hearing threshold at high frequency (2,000, 4,000, and 8,000 Hz) on the affected side 25 dB, 3) low-frequency average 20 dB or worse than the highfrequency average on the affected side, and 4) pure-tone average (PTA) on the unaffected side (500, 1,000, 2,000, and 4,000) 25 dB. The diagnostic criteria for HF were: 1) acute onset sensorineural HL at high frequency (2,000, 4,000, and 8,000 Hz), 2) hearing threshold at low frequency (250, 500, and 1,000 Hz) on the affected side 25 dB, 3) high-frequency average 20 dB or worse than the low-frequency average on the affected side, and 4) PTA on the unaffected side (500, 1,000, 2,000, and 4,000) 25dB. The following criteria were exclusionary: 1)conductive HL; 2) bilateral involvement; 3) history of recurrent vertigo, fluctuation of hearing impairment, and acoustic trauma; 4) retrocochlear lesions; and 5) cases where the patients failed to appear for follow-up. Finally, 111 patients (54 patients in the LF group and 57 patients in the HF group) were included in the present study. All patients were examined by routine tests, including history taking of symptoms, physical and neurological examination, serological tests, autoimmune tests, pure-tone audiometry, and inner ear magnetic resonance imaging.

Subjects in the LF and HF groups were randomly and prospectively assigned to three subgroups based on the method of steroid administration: oral steroid, IT, and combination therapy (oral steroid 1 IT). Randomization was performed by

consecutive allocation according to visit sequence. All treatments were performed on an outpatient basis without hospitalization. The schedule of oral steroid administration was 10-day prednisolone (Solondo; Yuhan, Seoul, Korea) medication for 10 days consisting of 60 mg/d for 5 days, 40 mg/d for 2 days, 20 mg/d for 2days, and 10 mg/d for 1 day. The schedule of IT was twice a week for 2 weeks, for a total of four times. The schedule of the combination therapy consisted of a simultaneous IT procedure twice a week for 2 weeks and oral steroid for 10 days. The assessors were blinded to patient treatment conditions to reduce bias.

A. IT Procedure

After confirming an intact tympanic membrane in the supine position, local anesthesia was performed with a lidocaine 10% pump spray (xylocaine, 10 mg/dose; AstraZeneca Korea, Seoul, Korea). Using a 25-gauge spinal needle, one anterosuperior puncture was made for ventilation and another puncture was made at the anteromedial portion for perfusion. The patients received intratympanic injections of 0.3 to 0.4 mL of dexamethasone solution (dexamethasone disodium phosphate, 5mg/mL; Il Sung Pharma, Seoul, Korea). During this procedure, patients were instructed to avoid swallowing or moving with the head tilted 458 toward the healthy side for 30 minutes. The procedure was performed twice weekly for 2 consecutive weeks.

B. Outcome Measures

Pure-tone audiometry was initially performed immediately prior to treatments in the LF and HF groups, and was repeated 2 weeks later. We measured pure-tone audiograms at 250, 500, 1,000, 2,000, 4,000, and 8,000 Hz. The PTA was calculated based on three frequencies (i.e., 250, 500, and 1,000 Hz in the LF group, and 2,000, 4,000, and 8,000 Hz in the HF group). We used the outcomes assessment in the

Clinical Practice Guideline: Sudden Hearing Loss from the American Academy of Otolaryngology–Head and Neck Surgery (AAO-HNS) from 2012 to determine treatment success.23 In this guideline, complete recovery is defined as hearing return to within 10 dB HL and word recognition score to within 5% to 10% of the unaffected ear. Partial recovery is defined in two ways (clinically meaningful recovery/nonmeaningful recovery) based on whether or not the degree of initial hearing loss after the event of ISSNHL rendered the ear nonserviceable. Serviceable hearing is defined as PTA 50 dB and word recognition score 50%. No recovery is defined as anything less than 10 dB HL improvement.

C. Statistical Analysis

Statistical analyses were performed using SPSS for Windows software (version 18.0; IBM, Armonk, NY). Independent t test, analysis of variance, and v2 test were used for intergroup comparisons of normally distributed parameters, and the treatment effects were compared among the three groups using the Kruskal–Wallis test, v2 test, and Fisher exact test. A confidence level of $P < .05$ was considered statistically ignificant.

Table 1.

Clinical Characteristics of the LF and HF Groups

	LH Group n = 54	LH Group n = 67	*P* Value
Age, yr	44.3 ± 10.9	49.2 ± 15.3	.061
Sex (M:F)	23:31	33:24	.077
Right : Left	20:34	32:25	.057
Duration from onset (d)	8.8 ± 9.8	6.8 ± 6.7	.197
F/U period (wk)	70.6 ± 106.9	50.2 ± 59.1	.213
Hearing loss	20	41	.001
Ear fullness	17	6	.033
Tinnitus	9	4	.251
Vertigo	8	6	.751

F = female; F/U = follow-up; HF = acute high frequency hearing loss; LF = acute low frequency hearing loss; M = male

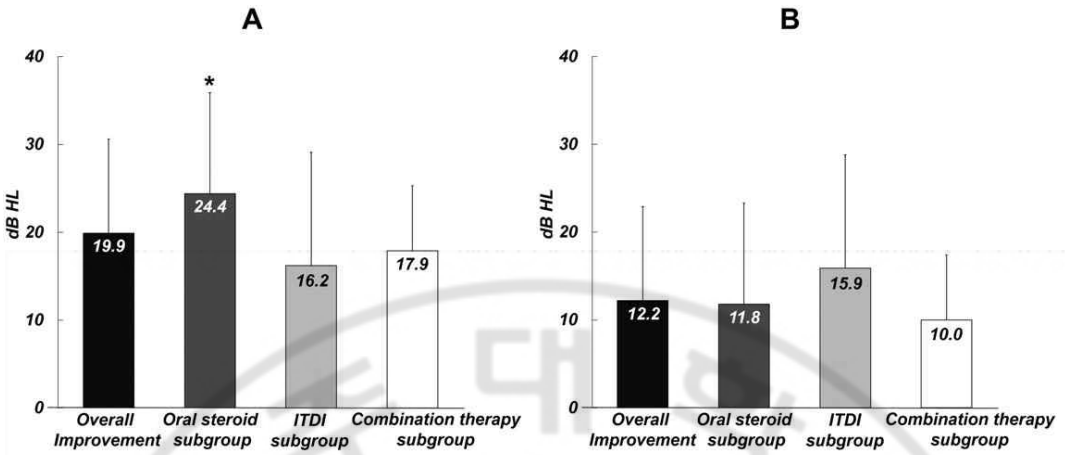

Fig. 1. Comparison of hearing gains between the LF (A) and HF (B) groups. The differences were analyzed using the Kruskal-Wallis test. *P < .05. HF = acute high-frequency hearing loss; HL = hearing level; ITDI = intratympanic dexamethasone injection; LF = acute low-frequency hearing loss.

Ⅲ. RESULTS

Patient characteristics in the LF and HF groups are summarized in Table I. The mean age was 39.7 ± 10.9 years in the LF group and 45.5 ± 16.1 years in the HF group. The male:female gender ratio was 23:31 in the LF group and 33:24 in the HF group. The age and gender distribution was not significantly different between the LF and HF groups. The duration from onset to treatment to the follow-up period showed no significant differences between the two groups.

Comparison of Presenting Symptoms: LF Versus HF Hearing Loss

In the LF group, the mean time from onset of symptoms to initiation of treatment was 8.8 ± 9.8 days, with the chief complaints being HL (37.1%), ear fullness (31.5%), tinnitus (16.7%), and vertigo (14.7%). In the HF group, the mean time from onset of symptoms to initiation of treatment was 6.8± 6.7 days, with the main chief complaints being HL (71.9%), ear fullness (10.5%), tinnitus (7.1%), and vertigo (10.5%). Patients with LF tended to show diverse symptoms, whereas the main complaint in patients with HF was HL. The LF group complained more frequently of ear fullness than the HF group, whereas the HF group complained more frequently of HL than the LF group; these differences were statistically significant (P = .033 and P = .001, respectively). However, there were no significant differences in the frequency of the chief complaints of tinnitus and vertigo between the LF and HF groups (P = .251 and P = .751, respectively). In addition, patients presenting with two or more of the four significant symptoms (hearing impairment, tinnitus, ear fullness, and vertigo) were more common in the LF group (42.6%) than the HF group (21.3%), and this difference was statistically significant (P=.033).

Comparison of Hearing Recovery: LF Versus HF Hearing Loss

Figure 1 shows the differences in hearing gain after treatments between the LF and HF groups. In the LF group, the mean PTAs before and after treatments were 44.3 ± 7.5 dB and 24.5 ± 14.5 dB, respectively, and the average hearing gain was 19.9 ± 12.8 dB. In the HF group, the mean PTAs before and after treatment were 56.5 ± 14.6 dB and 44.3 ± 17.6 dB, respectively, and the average hearing gain was 12.2 ± 10.7 dB. The hearing gain in the LF group was markedly higher than that in the HF group, and the difference was statistically significant (P = .001). The hearing recovery rates in the LF and HF groups, according to the AAO-HNS Clinical Practice Guidelines, are shown in Table II. Subjects showing complete and partial recovery according to the AAO-HNS Clinical Practice Guidelines were classified into the treatment response group, and those with no improvement comprised the no response group. The overall rates of hearing recovery in the LF and HF groups were 74.1% (40/54) and 45.6% (26/57), respectively. Thus, patients with LF showed a higher recovery rate than those with HF, and the difference was statistically significant (P = .001). Figure 2 shows post-treatment scattergrams for LF and HF and indicated that hearing improvement in LF group was more frequent than that in HF group.

Tables III and IV show the patient profiles of the three subgroups (oral steroid, IT, and combination therapy) in the LF and HF groups, respectively. In the LF group, the average hearing gain of the oral steroid subgroup was 24.4 ± 8.7 dB, whereas that in the IT subgroup was 16.2 ± 17.4 dB, and that in the combination therapy subgroup was 17.9 ± 11.9 dB (Fig. 1A). The recovery rates of these three subgroups in the LF group were 90% (18 of 20), 57.1% (8 of 14), and 70% (14 of 20), respectively (Table V). The effectiveness of oral steroid treatment was significantly different from IT and combination therapy in the LF group (P = .017). On the other hand, in the HF group, the average hearing gain was 11.8 ± 11.5 dB in the oral steroid subgroup, 15.9 ± 12.9 dB in the IT subgroup, 10.0 6 7.4 dB in

the combination therapy subgroup, and there was no statistically significant difference between the groups (P = .466) (Fig. 1B). The recovery rates of these three subgroups were 42.9% (9 of 21), 60% (9 of 15), and 38.1% (8 of 21), respectively (Table VI). There were no significant differences in effectiveness among treatment modalities in the HF group (P =.390).

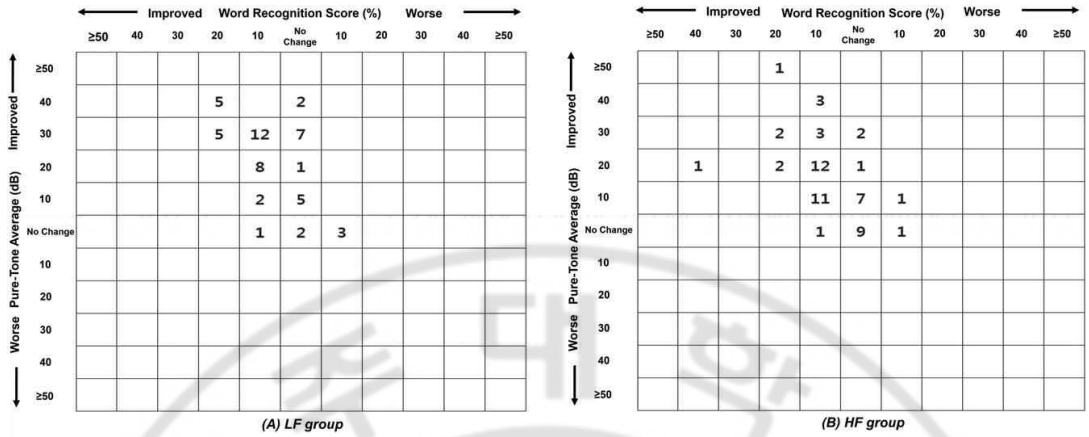

Fig 2. Comparison of post-treatment scattergram for patients with LF and HF. Hearing improvement in the LF group is more frequent than that in the HF group. (A) LF group. (B) HF group. HF = acute high-frequency hearing loss; LF = acute low-frequency hearing loss.

Table 2.

Comparison of Recovery Rates Between the LF and HF Groups According to the AAO-HNS Clinical Practice Guidelines

Treatment Outcome	LF Group n = 54, No. (%)	HF Group n = 57, No. (%)	*P* Value
Complete recovery	30 (55.6)	13 (22.8)	
Partial recovery			
Meaningful	10 (18.5)	5 (8.8)	
Nonmeaningful	0	8 (14.0)	
No recovery	14 (25.9)	31 (54.4)	<.001

There was a statistically significant difference in hearing recovery rate between the LF group and the HF group using Fisher exact test and χ^2 test (P <.001).

HF = acute high frequency hearing loss; LF = acute low frequency hearing loss

Table 3.

Comparison of Patient Profiles Among Subgroups in the LF Groups

	Oral Steroid Subgroup, n = 20	IT Subgroup, n = 14	Combination Therapy Subgroup, n = 20	*P* Value
Age(yr)	43.4 ± 9.3	43.1 ± 12.2	46.2 ± 11.9	.658
Sex(M:F)	7:13	6:8	10:10	.613
Initial PTA(dB HL)	41.7 ± 6.4	45.1 ± 8.1	46.5 ± 7.7	.106
Duration from onset(d)	9.2 ± 9.2	7.1 ± 7.8	9.8 ± 11.7	.671

F = female; HL = hearing level; IT = intratympanic dexamethasone injection; LF = acute low frequency hearing loss; M = male; PTA = pure-tone average.

Table 4.

Comparison of Patient Profiles Among Subgroups in the HF Groups

	Oral Steroid Subgroup, n = 21	IT Subgroup, n = 15	Combination Therapy Subgroup, n = 21	*P* Value
Age(yr)	48.2 ± 11.3	55.0 ± 15.2	46.0 ± 18.1	.333
Sex(M:F)	8:13	9:6	13:8	.297
Initial PTA(dB HL)	55.5 ± 12.6	56.8 ± 16.9	57.2 ± 15.2	.924
Duration from onset(d)	6.5 ± 7.4	8.4 ± 7.9	6.0 ± 4.9	.623

F = female; HL = hearing level; IT = intratympanic dexamethasone injection; HF = acute high frequency hearing loss; M = male; PTA = pure-tone average.

Table 5.

Comparison of Recovery Rates Among the Subgroups of the LF Group According to the AAO-HNS Clinical Practice Guidelines

Treatment outcome	Oral Steroid Subgroup, n = 20, No.(%)	IT Subgroup, n = 14, No.(%)	Combination Subgroup, n = 20, No.(%)	*P* Value
Complete recovery	16 (80.0)	7 (50.0)	7 (35.0)	
Partial recovery				
Meaningful	2(10.0)	1(7.1)	7(35.0)	
Nonmeaningful	0	0	0	
No recovery	2 (10.0)	6 (42.9)	6 (30.0)	.017

There was a statistically significant difference in hearing recovery rate among the group using Fisher exact test and χ^2 test (P =.044).

AAO-HNS= American Academy of Otolaryngology-Head and Neck Surgery; IT = intratympanic dexamethasone injection; LF = acute low frequency hearing loss

Table 6.

Comparison of Recovery Rates Among the Subgroups of the HF Group According to the AAO-HNS Clinical Practice Guidelines

Treatment outcome	Oral Steroid Subgroup, n = 21, No.(%)	IT Subgroup, n = 15, No.(%)	Combination Subgroup, n = 21, No.(%)	*P* Value
Complete recovery	4 (19.1)	6 (40.0)	3 (22.8)	
Partial recovery				
Meaningful	3 (14.3)	0	2 (9.5)	
Nonmeaningful	2 (9.5)	3 (20.0)	3 (14.3)	
No recovery	12 (57.1)	6 (40.0)	13 (61.9)	.390

There was no statistically significant difference in hearing recovery rate among the group using Fisher exact test and χ^2 test ($P > .05$).

AAO-HNS= American Academy of Otolaryngology-Head and Neck Surgery; IT = intratympanic dexamethasone injection; HF = acute low frequency hearing loss

Ⅳ. DISCUSSION

The present study was performed to investigate the differences in clinical characteristics, and to compare the efficacies of three different treatment protocols, between LF and HF. Patients with LF had diverse symptoms, including HL, ear fullness, tinnitus, and vertigo, whereas patients with HF complained mainly of HL. We also found that outpatient-based steroid treatment outcomes of LF, based on the AAO-HNS Clinical Practice Guidelines, were better than those of HF (74.1% vs. 45.6%, respectively). Furthermore, oral steroid therapy was more effective than combination therapy or IT in patients with LF, but IT tended to be more effective than oral steroid or combination therapy in patients with HF.

Various diagnostic criteria for LF have been used in previous studies, involving pure-tone hearing thresholds at three lower and higher frequencies. Yamasoba et al. reported that the sum of hearing thresholds at three low frequencies (125, 250, and 500 Hz) in LF should be 100 dB or more, whereas the sum of hearing thresholds at three high frequencies (2, 4, and 8 kHz) should be 60 dB or less.[12] Nozawa et al. suggested that LF should be defined in terms of an average HL at three low frequencies (125, 250, and 500 Hz) of 30 dB or more, and an average HL at three frequencies (2, 4, and 8 kHz).[24] Suzuki et al. recommended that pure-tone hearing thresholds at higher frequencies should not differ by more than 10 dB between the right and left ears, that the sum of pure-tone hearing thresholds at lower frequencies should be 80 dB or more, and that the sum of pure-tone hearing thresholds at lower frequencies should be at least 40 dB higher on the affected side than contralaterally.[25] Fushiki et al. divided low tone type HL into two subgroup, ALHL and non-ALHL. The low-tone loss type (ALHL) meets the following criteria: the average hearing level at 125, 250, and 500 Hz is at least 10 dB worse than that at 2, 4, and 8 kHz, and there is less than 10 dB difference in the hearing level at 1 kHz in comparison with that at both the adjacent frequencies (500 Hz

and 2 kHz). And another patients with the low-tone loss type were excluded by the audiometric definition of ALHL (non-ALHL); the sum of hearing levels at high frequencies of 2, 4, and 8 kHz was 65 dB or more.[26] In the present study, we used rather broad diagnostic criteria of LF: low-frequency average (250, 500, and 1,000 Hz) of 20 dB or worse than the high-frequency average (2,000, 4,000, and 8,000 Hz). Furthermore, we suggested diagnostic criteria for HF: a high-frequency average (2,000, 4,000, and 8,000 Hz) of 20 dB or worse than the low-frequency average (250, 500, and 1,000 Hz).

Several authors have recently reported different results of corticosteroid therapy in LF. Hui et al. found that high-dose glucocorticoid was more effective than a low dose in 44 LF patients, Mao and Wang reported that corticosteroid therapy probably had some effect on LF,[27] and Fuse et al. showed that a steroid was an effective therapy for LF.[14] On the other hand, Kitajiri et al. reported that corticosteroids were ineffective for improving hearing in 42 patients with LF,[28] Morita et al. showed that steroid - diuretic combination therapy was more effective than steroid or diuretic treatment alone,[29] and Suzuki et al. found that corticosteroid therapy, but not diuretic therapy, was effective in patients with LF.[24] Alatas also recommended IT as an effective treatment for recovery in cases of LF and reported a complete recovery rate of 71.4%.[30] The differences in treatment results in LF may be related to use of different steroid protocols and administration routes, and differing definitions of LF and hearing recovery. Therefore, we investigated three different routes of steroid administration (i.e., oral steroid, IT, and combination therapy) in LF, and the results indicated that oral steroid therapy was the most effective in these patients.

Although LF is generally known to have a relatively good prognosis and to improve within a short time after treatment, there have been few reports regarding the prognosis or recovery rates of HF. In an analysis of audiogram shape as a

prognostic factor in ISSNHL, the recovery rates of low-, mid-, and high-frequency (down sloping) HL were 63% to 88%, 36% to 71%, and 19% to 38%, respectively.[31 - 37] Similar results were obtained in the present study despite differences in inclusion criteria of LF and HF. High-frequency HL was less likely to improve than other subtypes of ISSNHL. The reasons were differences in vulnerability between the basal and apical hair cells, and different steroid concentrations in different anatomical locations.[38] Despite the poor prognosis of HF, few reports have examined the methods of treatment for this condition. Jun et al. investigated the results of treatment of ISSNHL according to audiogram patterns. They reported that there were no differences between systemic steroid and systemic steroid with IT in the descending or ascending type.[38] In the present study, we investigated three different routes of steroid administration (i.e., oral steroid, IT, and combination therapy) in HF. Our results indicated that IT was the most effective treatment in HF, but the difference was not significant. The effectiveness of IT in HF was supported by Chandrasekhar's observation that the perilymph steroid level was higher after IT than after systemic steroid injection alone in an animal study.[17] In addition, Jun et al. also reported that the concentrations of steroids passing through the round window membrane may decrease from the base to the apex of the cochlea.[38] Therefore, we postulated that high steroid concentrations, regardless of whether they were applied systemically or locally, may be necessary to treat HF, and IT could achieve a high steroid concentration in the inner ear environment. Although combination therapy would be considered the most effective method for the inner ear environment, our data showed that IT was the most effective method. Further studies are needed to compare the treatment effects of IT and combination therapy in larger numbers of patients with HF.

Several authors have suggested that LF, one subtype of ISSNHL, may be related to Menie're's disease. Noguchi et al. reported that electrophysiological findings in

LF were similar to those seen in Menie're's disease, suggesting a similarity in pathogenesis between LF and early-stage Menie're's disease.[40] With regard to the etiology, Yamasoba et al. reported that the glycerol test was positive and summating potential/action potential ratio were abnormally increased in electrocochleography in most patients with LF, and they suggested that LF may be caused by endolymphatic hydrops.[12] In addition, Junicho et al. reported that 47% of 184 low-frequency sudden deafness patients had fluctuating HL after onset, and only 9% (17/184) developed Menie're's disease.[41] Also, Fuse et al found that Th1 lymphocyte predominance in the peripheral blood of both ALHL patients and MD patients. This imbalance between Th1 and Th2 lymphocytes indicates the relation of an immune response in the etiology of ALHL.[14] According to previous studies, patients with ALHL have been administered diuretic, a treatment for EH, and/or steroids to suppress the immune response.[46] The effect of diuretics in ALHL patient is controversy, but our study did not compare it with another treatment modalities. And, there have been few investigations of the clinical features or pathogenesis of HF. Therefore, we compared the clinical features between LF and HF, and showed that ear fullness in LF, and hearing impairment in HF, were the most prominent symptoms. Of the four significant symptoms (hearing impairment, tinnitus, ear fullness, and vertigo), two or more symptoms were experienced significantly more often in patients with LF than in those with HF. Similarly, Fuse et al. also reported that tinnitus, sensation of ear fullness, and autophony frequently accompany the HL in LF.[14] Therefore, these features of LF may suggest a relationship with Menie're's disease, and also that LF seems to be in a different disease spectrum from HF.

There are some limitations in this study. First, the sample size was small. Further studies are necessary to analyze the treatment method in larger number of patients with LF and HF. Second, wide diagnostic criteria of LF and HF were used. Finally, we enrolled patients with one episode of vertigo, which may cause confusion between LF and Menie're's disease. However, we did not enroll patients

with recurrent vertigo or fluctuation of hearing impairment, and all patients experienced LF for the first time. Unfortunately, we did not investigate the extent of recurrent vertigo or fluctuation of hearing impairment, or the rate of progression of Menie're's disease caused by long-term follow-up. However, despite these limitations, we observed clinically beneficial results with our treatment methods.

Ⅴ. CONCLUSION

LF had completely different clinical features from HF; patients with LF complained of various symptoms such as hearing loss, ear fullness, tinnitus, and vertigo. On the contrary, patients with HF complained mainly of HL. The prognosis of LF was better than that of HF. Among three different treatment methods (oral steroid, IT, and combination therapy), oral steroid therapy was most effective in LF, and IT tended to be the most effective in HF.

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- 국문요약 -

저음역 난청 및 고음역 난청에서 치료 방법에 따른 임상 양상 및 예후에 대한 고찰

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연구 목적 및 가설 : 본 연구의 목적은 저음역 혹은 고음역에 국한된 돌발성 난청에서 두 그룹의 임상적 양상 및 예후를 비교하고, 세가지 치료방법에 따른 치료 효과를 분석하고자 하였다

연구 방법 : 저음역 혹은 고음역 돌발성 난청의 기준을 만족하는 외래 내원환자 111명을 대상으로 하여, 각 그룹에 환자들을 3가지 치료법으로 무작위로 배치하였다. 치료법에 따라 oral steroid 군 , intratympanic dexamethasone injection 군 , combination therapy 군으로 분류하였다. 그룹간의 임상양상은 나이,성별,부위,발생시간, 경과기간들을 비교하였고 초진시의 주증상을 비교하였다. 또한 치료효과는 청력역치 및 recovery rate 등을 비교하였다.

결과 : 저음역 난청군에서는 난청과 이충만감을 주로 호소하였고 치료전 평균 PTA 44.3dB에서 치료 후 24.5 dB로 호전 되었다. 고음역 난청군에서는 주로 난청을 호소하였으며 치료전 평균 PTA 56.5dB에서 치료후 44.3dB로 호전되었다. recovery rate에서는 저음역 그룹에서 74.1%(40/54)이, 고음역 그룹에서는 45.6%(26/57)의 치료율을 보였다. 치료방법에 있어서는 oral steroid 가 저음역그룹에서 가장 효과가 있었고(p= .017) 고음역그룹에서는 세가지 방법이 비슷한 결과를 나타내었지만 intratympanic dexamethasone injection이 가장 효과적인 양상이었다.(p= .390)

결론: 결론적으로 저음역 및 고음역에 국한된 돌발성난청은 그 임상양상과 치료에 대한 반응이 서로 다르다. 각각 oral steroid 또는 intratympanic dexamethasone injection에 잘 반응하였다. 둘은 달팽이관에 비슷한 손상을 주는 것으로 보이지만 병태생리학적 기전은 다른 것으로 보인다.

핵심어 : 돌발성 난청, 주파수, 치료, 스테로이드, 덱사메타손, 청력