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Effects and Prognostic Factors of Acupuncture Treatment for Idiopathic Sudden Sensorineural Hearing Loss

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1. Introduction

Idiopathic sudden sensorineural hearing loss (ISSHL), sometimes called sudden sensorineural hearing loss (SSHL) is usually defined as loss of at least 30 dB in 3 contiguous frequencies over a period of 3 days or less.

It is difficult to estimate the efficacy of the various treatments and impact of prognostic factors for ISSHL because the natural history of ISSHL is still unknown (Fetterman et al., 1996). There have been many studies reported the effect of various treatment including systemic corticosteroids, tympanic corticosteroids injection, antiviral, anticoagulant, and vitamin etc. on ISSHL, but the results were controversial (Eisenman D., 2000).

There also have been several studies reported the prognostic factors of ISSHL (Mattox & Simmons, 1977; Shikowitz, 1991; Byl, 1984; Ceylan et al., 2007). However, the rate of spontaneous recovery of ISSHL is 45 to 65 percent (Mattox & Simmons, 1977; Eisenman D., 2000) and there is no improvement criterion that was universally accepted. Thus, the results of several studies for prognostic factors were also controversial.

Traditional Chinese Medicine (TCM) has long been widely used in East Asia. Acupuncture is frequently used for the treatment of neurological conditions (Lee et al., 2007). Since 1970s, there have been some studies which reported effect of acupuncture on ISSHL. Some studies reported positive results (Yoon et al., 2003; Ha & Choi, 2003), while the others reported the opposite trend (Vincent & Richardson, 1987; Borton, 1976).

In previous study, we demonstrated that the acupuncture treatment (AT) has some effect on ISSHL patients who did not respond to conventional therapy (Yin et al., 2010). However, the efficacy and prognostic factors of AT on ISSHL are still unclear.

This study was conducted to evaluate the effects and prognostic factors of AT for ISSHL. We analyzed variables which related to improvement in ISSHL by AT; these included gender, age, location of lesion, presence of vertigo, presence of disease (hypertension and diabetes mellitus), the time interval from the onset of hearing loss to the start of AT and severity of hearing loss on the day of the initial visit. We also analyzed our data to search the

prognostic factors affecting the improvement of ISSHL using feature selection analysis and decision tree model.

2. Materials and methods

2.1 Patients and eligibility

We reviewed the medical records of ISSHL patients who visited 'Tinnitus & Hearing loss clinic' in Kyung Hee Oriental Medical Hospital, Seoul, Korea from June 2006 to February 2011. Patients who met the definition of ISSHL, which is defined as an abrupt or rapidly progressing hearing loss of at least 25 dB in 3 contiguous frequencies over a period of no more than 3 days, were eligible to participate in this study. We excluded patients with sensorineural hearing loss caused by trauma, noise, tumors, otitis media or Meniere's disease. Additionally, patients were ineligible if they have hearing loss in both ears.

Of a total 117 patients, ten had Meniere's disease, two had senile progressive hearing loss, four had hearing loss in both ears, one had otitis media and twenty-eight failed to undergo a follow up audiogram. Therefore, 72 patients (40 males, 32 females) were enrolled in this study (Fig. 1). This study was approved by the Institutional Review Board of Kyung Hee Oriental Medical Hospital (KOMCIRB-2011-09).

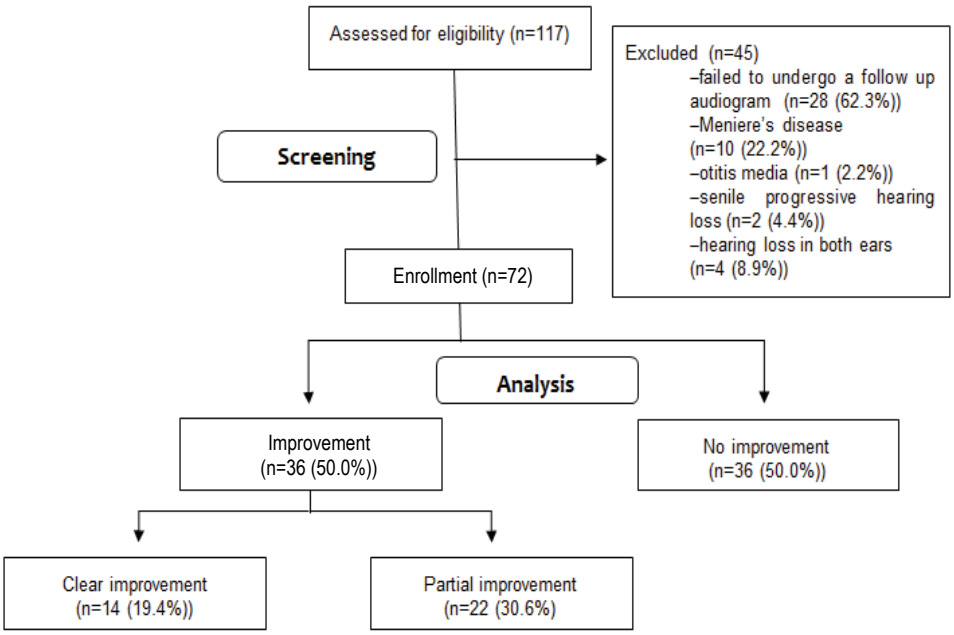


Fig. 1. Flow chart of the study

2.2 Audiological assessment

All patients underwent a full physical exam as well as a routine audiological evaluation and otolaryngologic history was also recorded. Magnetic resonance images were acquired if necessary. Pure tone audiograms were conducted using a *GSI 61 audiogram (Grason-Stadler, Inc., WI, USA)* on the day of the initial visit and the day of the follow-up measurement, which was usually after 10 rounds (1st follow-up) and 20 rounds (2nd follow-up) of AT. However, the follow-up measurement was performed before 10 or 20 rounds of acupuncture for some patients who request an earlier audiogram because they felt clear improvement. If partial improvement in the audiogram was observed at the time of the first follow-up measurement, AT was continued until the second follow-up measurement. The hearing results were evaluated based on the pure tone average (PTA) of 4 frequencies (250, 500, 1000, 2000 Hz). A clear improvement of hearing was defined as a final hearing level less than 25 dB and a partial improvement of hearing was defined as a final hearing level not less than 25dB but decreased in PTA of 10 dB or more.

2.3 Acupuncture treatment

All patients received the same method of AT from one TCM doctor. It was typically performed two times a week and the frequency was increased or decreased as necessary. The sterile acupuncture needles (length: 40 mm and diameter: 0.25 mm, Dondbang Co. Korea) were inserted to a depth of 10 - 30 mm until the patient felt the characteristic needling sensation of soreness, numbness or distension around the acupuncture point. Stimulated acupuncture points included GV14, GV15, GV16, GB20, GB21, BL10, SI4, SI15 and additional local points (TE21, TE22, SI19, GB2, ST7, BL2, LI20, GV20, EX-HN3) as necessary in the prone position, right after the 1st stimulated acupuncture were removed, and the liver tonification formula of Saam acupuncture theory (KI10, LR8, LU8 and LR4) (Yin CS et al., 2007) which were combined with contralateral LI4, LR3, and ST36 in the supine position. The needles were retained at each position for 10 minutes. Most patients were also administered herbal medicine individually to improve their body condition.

2.4 Statistical analysis

All continuous variables represented in this study were expressed as the means ± the standard deviation and all categorical variables were expressed as patient number and percentage (%). The differences between improvement and no improvement groups were analyzed by the independent-samples T test for all continuous variables if the distribution was normal. If the distribution was abnormal, the differences between groups were analyzed by the Mann-Whitney U test. In addition, categorical variables were analyzed using a Chi-square test or Fisher's exact test. These statistical analyses were conducted using SPSS 17.0 statistical software for windows.

We also analyzed our data using the feature selection model to classify the important variables. Then, based on these important variables, we analyzed our data using a decision tree model to identify and rank prognostic factors affecting the improvement of ISSHL by AT. These calculations were performed using SPSS Clementine version 12.0 statistical software for windows.

Probability values of 0.05 or less were considered statistically significant.

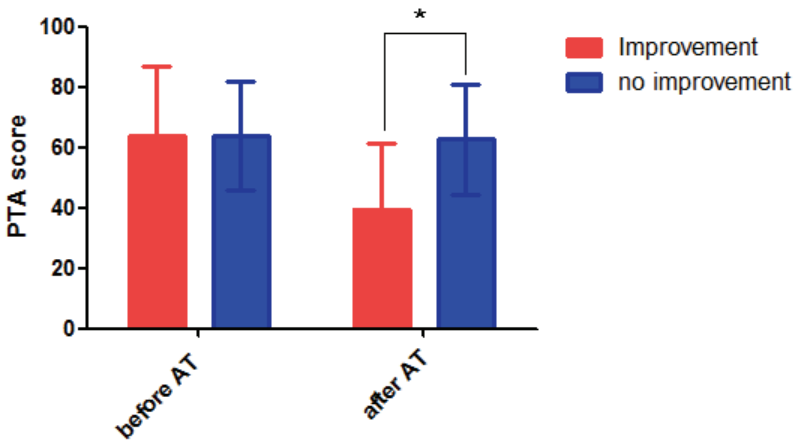
3. Results

3.1 Patient population

Seventy-two patient charts were reviewed (40 males, 32 females). The average age of the patients was 49.4 years (range, 8 to 76) and the average time interval from the onset of hearing loss to the start of AT was 109.1 days (range, 1 to 1460).

3.2 PTA changes before and after acupuncture treatment

Before acupuncture, mean PTA scores of improvement and no improvement groups were 63.92 ± 22.82 dB and 63.78 ± 17.99 dB, respectively and there was no statistical difference between groups (P = 0.977). After AT, mean PTA of improvement and no improvement groups were 39.55 ± 21.77 dB and 62.64 ± 18.23 dB, respectively and a significant difference between groups was evident (P = 0.000) (Fig. 2).



* : Statistically significant difference, P<0.05 using independent-samples T test

Fig. 2. Mean PTA before and after AT between Improvement and No Improvement Groups

3.3 Overall improvement rate

Overall, after completing the treatment, 36 patients (50.0%) showed improvement including a clear (14 patients, 19.4%) and partial (22 patients, 30.6%) improvement. In improvement group, the average age was 51.2 years (range, 19 to 76), the average time interval from the onset of hearing loss to the start of AT was 51.06 ± 69.39 days (range, 1 to 330) and the average improvement in PTA was 24.47 ± 14.85 dB (range, 9 to 63) including two cases which the average improvement in PTA was less than 10dB, but PTA was within 25dB.

3.4 Gender, age, location of lesion, vertigo, hypertension and diabetes mellitus

There was no significant difference in the gender distribution between improvement and no improvement groups. Also, no significant difference between groups was observed in regards to the occurrence of vertigo, the location of lesion, presence of hypertension and diabetes mellitus (Table 1).

	improvement			
	Yes	No	Total	*P**
Gender				
Male	20 (27.8%)	20 (27.8%)	40 (55.6%)	
Female	16 (22.2%)	16 (22.2%)	32 (44.4%)	1.000
Total	36 (50.0%)	36 (50.0%)	72 (100%)	
Age				
≤60	27 (37.5%)	31 (43.1%)	58 (80.6%)	
>60	9 (12.5%)	5 (6.9%)	14 (19.4%)	0.234
Total	36 (50.0%)	36 (50.0%)	72 (100%)	
Location of lesion				
Left	22 (30.6%)	24 (33.3%)	46 (63.9%)	
Right	14 (19.4%)	12 (16.7%)	27 (36.1%)	0.624
Total	36 (50.0%)	36 (50.0%)	72 (100%)	
Vertigo				
Yes	9 (12.5%)	7 (9.7%)	16 (22.2%)	
No	27 (37.5%)	29 (40.3%)	56 (77.8%)	0.571
Total	36 (50.0%)	36 (50.0%)	72 (100%)	
Hypertension				
Yes	11 (15.3%)	10 (13.9%)	21 (29.2%)	
No	25 (34.7%)	26 (36.1%)	51 (70.8%)	0.795
Total	36 (50.0%)	36 (50.0%)	72 (100%)	
Diabetes Mellitus				
Yes	0 (0%)	1 (1.4%)	1 (1.4%)	
No	36 (50.0%)	35 (48.6%)	73(98.6%)	1.000
Total	36 (50.0%)	36 (50.0%)	72 (100%)	

* Statistically significant difference, P<0.05 using χ^2 test or Fisher's Exact test

Table 1. Relationship of Character of Patients and Improvement of ISSHL

3.5 Time interval from the onset of hearing loss to the start of acupuncture treatment

The time intervals from the onset of hearing loss to the start of AT for improvement and no improvement groups were 51.06 days (±69.39 SD) and 167.22 days (±265.01 SD), respectively, which differed significantly (P=0.013) (Table 2).

	Improvement		
	Yes	No	*P**
Time interval from the onset of hearing loss to the start of acupuncture treatment	51.06 ± 69.39	167.22 ± 265.01	0.013*

* Statistically significant difference, P<0.05 using independent-samples T test

Table 2. Differences in the Time Interval from the Onset of Hearing Loss to the Start of Acupuncture Treatment between Improvement and No Improvement Groups

To analyze the relationship between ISSHL improvement and the time interval, we divided 72 patients into four groups (within 2 weeks, 2 – 6 weeks, 6 weeks – 6 months and over 6 months groups). In this analysis, 9 of 10 patients (90%) and 15 of 25 patients (60%) showed improvement with the time interval within 2 weeks and 2 - 6 weeks, respectively. Only 10 of 26 patients (38.5%) and 2 of 11 patients (18.2%) showed improvement with the time interval of 6 weeks – 6 months and greater than 6 months, respectively (Table 3).

Time interval	ISSHL improvement				
	Yes		No		*P*
	Clear	Partial		Total	
Within 2 weeks	5 (6.9%)	4 (5.6%)	1 (1.4%)	10 (13.9%)	
2 - 6 weeks	4 (5.6%)	11 (15.3%)	10 (13.9%)	25 (34.7%)	
6 weeks – 6 months	4 (5.6%)	6 (8.3%)	16 (22.2%)	26 (36.1%)	0.004*
6months or more	1 (1.4%)	1 (1.4%)	9 (12.5%)	11 (15.3%)	
Total	14 (19.4%)	22 (30.6%)	36 (50.0%)	72 (100%)	

* Statistically significant difference, P<0.05 using χ^2 test

Table 3. Relationship between the Time Interval and ISSHL Improvement

3.6 Severity of hearing loss on the day of initial visit as a prognostic factor

As mentioned earlier, there was no difference in mean PTA before and after AT between improvement and no improvement groups (Fig. 2).

To evaluate the co-relationship between severity of hearing loss and time interval with improvement, we divided patients with 2 groups; within 6 weeks and over 6 weeks. Within 6 weeks, there was no difference of severity of hearing loss on the day of initial between improvement and no improvement groups (P = 0.145). On the other hand, over 6 weeks, severity of hearing loss on the day of initial in no improvement group was higher than in improvement group. However, there was no statistical significance (P = 0.055) (Table 4).

Time interval from the onset of hearing loss to the start of acupuncture treatment	Improvement		*P**
	Yes	No	
Within 6 weeks	69.74 ± 22.03 (n = 24)	59.20 ± 18.36 (n = 11)	0.145
Over 6 weeks	52.29 ± 20.52 (n =12)	65.60 ± 17.82 (n = 25)	0.055

* Statistically significant difference, P<0.05 using Mann-Whitney U test

Table 4. Severity of Hearing Loss on the Day of Initial Visit as a Prognostic Factor

3.7 Important variables for ISSHL improvement

In the feature selection analysis to classify the most important variables to the improvement of ISSHL by AT, pure tone at each frequency (250, 500, 1000, 2000 Hz), PTA on the day of the initial visit and time interval (categorical variable) were determined to be important variables (Table 5).

Rank	Field	Importance	Value
1	pure tone at 500Hz (middle-low frequency range) on the day of the initial visit	Important	1.0
2	pure tone average on the day of the initial visit	Important	1.0
3	pure tone at 1000Hz (middle-high frequency range) on the day of the initial visit	Important	1.0
4	pure tone at 250Hz (low frequency range) on the day of the initial visit	Important	1.0
5	pure tone at 2000Hz (high frequency range) on the day of the initial visit	Important	0.993
6	time interval from the onset of hearing loss to the start of acupuncture treatment (categorical)	Important	0.988
7	age	Unimportant	0.727
8	presence of vertigo	Unimportant	0.217
9	location of lesion (right / left)	Unimportant	0.18
10	presence of hypertension	Unimportant	0.166
11	Gender	Unimportant	0.133

* 1 screened field: presence of diabetes mellitus

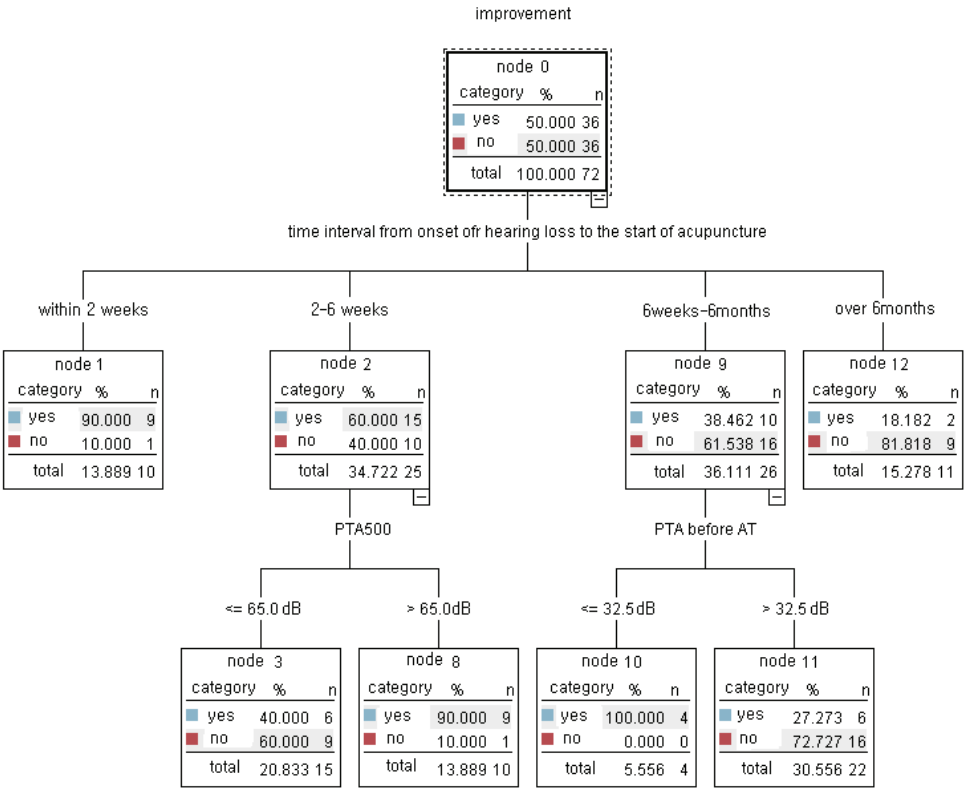
Table 5. Results of Feature Selection of Important Variables Contributing to the Improvement of ISSHL

3.8 Prognosis factors for ISSHL improvement

Based on the results of feature selection model, we identified the prognosis factors that affect ISSHL improvement by AT using a decision tree model. In patients who started AT within 2 weeks and over 6 months, the improvement was not affected by PTA on the day of the initial visit. Otherwise, in patients who started treatment 6 weeks - 6 months PTA on the day of the initial visit were found to be important variables to the prognosis for ISSHL improvement. Especially, in patients who started treatment between 2 and 6 weeks, pure tones at 500Hz (middle-low frequency range) were found to be important variables to the prognosis for ISSHL improvement (Fig. 3).

4. Discussion

Acupuncture is one of the most important tools in traditional Chinese Medicine (TCM). There are meridian and acupuncture point theory in TCM, and according this theory TCM doctors usually choose multiple acupuncture points and combine them for treatment. Since early 1970s, people have paid attention to acupuncture as a complementary therapy of western treatment (Eisenberg DM et al., 1998).



Abbreviation: PTA500=pure tone at 500 Hz on the day of the initial visit; PTA before AT=pure tone audiogram before acupuncture treatment

Fig. 3. Decision Tree Model of Important Variables as Prognosis Factors of ISSHL

Although there have been several studies about AT, it has not been fully explained how acupuncture works. Since gate-control theory, basic scientific research has focused on acupuncture theory from a neurobiologic perspective. Therefore, several studies have reported the effect of acupuncture on neurologic diseases, like seizure, cerebrovascular disorders, Parkinson's disease, etc. According to these studies, there is no evidence which is conclusive to support the use of acupuncture for a range of neurological disorders. (Lee H et al., 2007). The other study suggested that acupuncture have some effect on psychosomatic diseases, like pain, headache and smoking (Vincent CA., 1987).

Even though there was no strong scientific and clinical evidence, people have tried AT on the diseases which have unknown causes, for example, ISSHL.

There have been several studies to evaluate the effects of AT on ISSHL (Abel SM et al., 1976; Madell JR, 1975; Zhang CY & Wang Y, 2006; Zhang XZ et al., 2009; Yin CS et al., 2010; Yoon HS et al., 2003; Ha MK & Choi IH, 2003). Some studies have demonstrated that AT did not

produce significant shifts in hearing compared with sham groups (Abel SM et al., 1976) or there were no clinically important differences during and post treatment (Madell JR, 1975). However, other studies have reported that AT was effective to patients with ISSHL (Yin CS et al., 2010; Yoon HS et al., 2003; Ha MK & Choi IH, 2003).

In spite of these results, the efficacy of AT on ISSHL is still unknown, because these studies often lacked definite diagnostic standards. Therefore, we excluded patients who had sensorineural hearing loss not from ISSHL but from other diseases even if the patients had a good response to make strict diagnostic standards.

The acupuncture points, methods and depth of acupuncture methods and the depth of acupuncture are regarded as important things for the better effect.

On SSHL including ISSHL, common acupuncture points are as follows; GB20, TE21, SI19, GB2, TE17, LI4, GB43, TE3, GB20, GV23, GV20, EX-HN 1, TE5, KI1 and so on (Zhang CY & Wang Y, 2006; Zhang XZ et al., 2009; Yin CS et al., 2010; Yoon HS et al., 2003; Ha MK & Choi IH, 2003). Especially, TE21, SI19 and GB2 are main points on ISSHL. We combined with these acupuncture points with Samm acupuncture points. Saam acupuncture is a traditional Korean acupuncture theory that originated in the 17th century. This acupuncture system applies a five-phase theory in which each of five transport points in 12 meridians correspond to one of the five phases. Saam acupuncture also simultaneously modulates other relative channels, which are selected based on the theory of nourishing or suppressing cycle relationships, to ensure whole-body balance (Hwang DS et al., 2011; Yin CS et al., 2007).

Some studies revealed that deep needling is more significantly effective than shallow needling at TE21, SI19 and GB2 combined with body acupuncture (Zhang CY & Wang Y, 2006). According to these studies, acupuncture needles in our trial were inserted to a deep depth of 20-30 mm at TE21, SI19 and GB2 until the patient felt the characteristic needling sensation of soreness, numbness or distension around the acupuncture points.

ISSHL is one of the tough problems in ear diseases area because there is no definite answer for this disease. There is not even universally acceptable standard definition of ISSHL. Although many studies define ISSHL as loss of at least 30 dB in 3 contiguous frequencies over a period of 3 days (Shemirani et al., 2009, Xenellis J., 2006, etc), some studies defined as a >20 dB (Haberkamp & Tanyeri, 1999), and others defined ISSHL as a >25 dB loss. (BYL FM, 1984). We defined ISSHL as hearing loss of at least 25 dB in 3 contiguous frequencies over a period of no more than 3 days, because there were some patients who complained hearing disturbance even if they had PTA lower than 30 dB.

ISSHL is thought to be the clinical manifestation of diverse pathologic processes: viral infection, circulatory disorders, labyrinthine membrane rupture, and autoimmune reactions have been suggested to be possible causative factors (Eisenman D & Arts HA, 2000). Because of the multifactorial etiopathology, a number or different regimens have been used as therapy, including vasodilators, anticoagulants, corticosteroids, vitamins, plasma expander, histamine, antiviral agents, batroxobin, contrast media, stellate ganglion block, hyperbaric oxygen, and carbogen (Suzuki H et al., 2011).

Antiviral was selected because ISSHL is regarded as one of the viral infection diseases. However, use of antivirals had no impact on recovery time or improvement in hearing

(Shaikh JA & Roehm PC, 2011). Vasodilators which widen blood vessels and thus improve blood flow were selected because it has been frequently considered that ISSHL may have a vascular origin. However, the effectiveness of vasodilators in the treatment of ISSHL could not be proven (Agarwal L & Pothier DD, 2010). Usually, early use of high-dose systemic steroid therapy improves hearing recovery. However, persistent hearing losses after 2 weeks of oral treatment with steroids have a poorer prognosis (Ito et al., 2002). There have been several reports regarding the benefits of intratympanic steroids for the treatment of refractory ISSHL, but the efficacy of intratympanic steroids is still controversial (Haynes et al., 2007).

On the one hand, the controversial results for various therapies would be reasonable because the rate of spontaneous recovery of ISSHL is 45 to 65 percent (Mattox & Simmons, 1977; Eisenman D., 2000). On the other, the lack of universally accepted standard criterion of effect would make this controversial result. The standard criterion is very important factor for study, because the results on effectiveness and prognostic factors could be changed by this. Unfortunately, each study of ISSHL used different criterion of effect.

We decided the criterion valuation basis for effectiveness at least 10 dB decrease in PTA of contiguous 4 frequencies (250, 500, 1000, 2000 Hz) because most of patients visited our clinic after they failed to conventional therapies, so we considered that 10 dB was reasonable comparing other studies (Xenellis J et al., 2006; Rauch SD et al., 2011; Wu HP et al., 2011)

After completing the AT, 50% patients (36/72) showed clear or partial improvement. If the 10 patients within 2 weeks from the onset were excluded to eliminate the effect from nature spontaneous recovery, 43.5% patients (27/62) showed clear or partial improvement. These results were similar to or higher than average recovery rate of other studies especially considering the time interval from onset of ISSHL to start treatment(Xenellis J et al., 2006; Haynes DS et al., 2007; Raymundo IT et al., 2010; Wu HP et al., 2011; Rauch SD et al., 2011; Park MK et al., 2011).

Commonly, the time interval from onset to treatment was regarded as the most important factor for improvement of ISSHL. Therefore, most of studies of ISSHL were conducted with the patients within 2 weeks from onset. Even the studies that conducted with patients who failed to conventional therapy, the periods of ISSHL were only a few months. Haynes et al. (Haynes DS et al., 2007) conducted a retrospective review of 40 SSHL patients who failed systemic therapy and underwent intratympanic dexamethasone. They found that 27.5 % (11 patients) patients recovered (criteria for improvement: 20 -dB PTA or 20 % improvement in SDS), and that the average duration from onset of symptoms to intratympanic therapy was 40 days with a range of 7 days to 310 days. However, even in this study, no patient receiving intratympanic corticosteroids after 36 days recovered their hearing. Psifidis AD et al. (Psifidis AD et al., 2006) conducted a review of 15-year retrospective series of 80 patients diagnosed with SSHL and they concluded that any additional treatment after 2 months should not affect the outcome of the hearing.

In our study, 37 out of 72 (51.3%) patients started AT 6 weeks after onset of ISSHL, and 13 patients (35.1%) showed improvement, even 5 patients showed complete recovery. Yeo SW et al (Yeo SW et al., 2007) conducted retrospective study of 156 SSHL patients who were treated by 10-day course of admission therapy and followed for at least months. They concluded that delayed recovery occurred later than 1 month after discharge. The result of

this study is very interesting because this study was conducted in Korea, also. Almost of patients in our study visited our clinic after they had failed conventional therapies. Even though, Yeo SW et al hypothesized that conventional therapies for ISSHL might have long term effects, they didn't check if their patients had oriental medicine as the 2nd treatment or not. So, we hypothesized cautiously that the reason of delayed recovery in Yeo's study might be Oriental medicine, including acupuncture. Of course, we admit that our hypothesis is too much jump because there is no other study like Yeo's. From now, further studies were necessary to certify our hypothesis.

There have been several studies reported about the prognostic factors of ISSHL. Several factors, including gender, age, presence of vertigo, time interval from the onset to the start of treatment, severity of hearing loss, etc. have been suggested. Some studies have reported that the female gender was suggested to be poor prognostic factor for recovery of hearing loss (Ceylan et al., 2007) and male gender was related to better hearing outcomes (Xenellis J et al., 2006). In our study, correlation between gender and prognosis for recovery of hearing loss was not evident.

Standard age of prognosis on ISSHL is different according to each study. Wang L et al (Wang L et al., 2009) reported that the prognosis of patients under the age of 55 was better and Lee HN & Ban JH (Lee HN & Ban JH, 2010) proposed that the prognosis of patients under the age of 60 was better. In our finding, age was not a prognostic factor for recovery of hearing loss.

Location of lesion is regarded as an important factor in TCM. According to the TCM theory, the left side is controlled by *Blood-Liver* and the right side is controlled by *Qi-Lung*. From this theory, TCM doctors usually consider that the main reason of disease in left side is the stress and in right side is the deficiency of body-energy. However, location of lesion was not a prognostic factor for recovery of ISSHL in our study.

The presence of vertigo is one of important prognostic factors for recovery of hearing loss which many studies recommended (Kang D & Wan L, 2005; Suzuki H et al., 2011; Cvorović L et al., 2008). Some studies reported that BPPV in patients with SSHL, representing definitive vestibular damage, was closely related to poor prognosis (Lee NH & Ban JH, 2010). Other study revealed that the presence of vertigo was found to be significantly correlated with the lack of improvement in hearing, but only at the 8-kHz frequency (Ben-David J et al., 2002). But, our findings showed that the presence of vestibular damage such as vertigo or tinnitus was not related to improvement of ISSHL. These results were consistent with Wang L et al (Wang L et al., 2009).

Luo Y et al (Luo Y et al., 2010) reported that diabetes, hypertension, hyperlipidemia, high blood viscosity, cerebral blood supply insufficiency and liver disease were the risk factors of sudden hearing loss. Our findings showed that diabetes and hypertension was not related to recovery rate of hearing loss in accordance with some studies (Wang L et al., 2009; Kang D & Wan L, 2005).

Some studies have reported that the prognosis for recovery from hearing loss was better when the patients begin treatment within 2 weeks (Shikowitz, 1991; Byl, 1984; Wang L et al., 2009). In consistent with these findings, the most important prognosis variable in our study was also the time interval from the onset of hearing loss to the start of AT. Nine of 10

patients (90%) who started treatment for ISSHL within 2 weeks showed clear or partial improvement.

Many studies regarded the severity of hearing loss is one of the important prognostic factors for improvement of ISSHL(Byl FM., 1984; Fetterman BL et al., 1999; Psifidis AD et al, 2006; Cvorovic L et al., 2008; Ceylan A et al., 2007) However, the standard of severity which could affect the prognosis, was different in each study Moreover, some studies have reported that the initial hearing level had no statistical point on prognosis (Suzuki H et al., 2011; Wang L et al., 2009). In our study, there was no difference in severity of hearing loss between improvement and no improvement groups. However, in patients who started AT after 6 weeks of onset, no improvement group showed higher severity of hearing loss on the day of initial than improvement group. Even if there was no statistical significance, the difference was considerably high (P=0.055). Moreover, in feature selection analysis, PTA on the day of initial visit was one of the important variables contributing the improvement of ISSHL by AT.

Several studies reported that an upward-sloping audiogram pattern was related to better hearing outcomes (Xenellis J et al., 2006; Wu J et al, 2011). Wu J et al suggested that concave audiogram pattern as well as upward-sloping may be a favorable prognostic factor (Wu J et al, 2011). Cvorović L et al demonstrated that flat audometric curves had worse prognosis. To analysis of audiogram patterns, we divided frequency into low (250 Hz), middle-low (500 Hz), middle-high (1000 Hz), high (2000 Hz) frequency and analyzed each pure tone level according to each frequency. In patients who started treatment within 2 weeks, the improvement rate was not related to PTA on the day of the initial visit. Otherwise, in patients who started acupuncture treatment after 2 weeks, pure tones at 500Hz (middle-low frequency range) were found to be important variables to the prognosis for ISSHL improvement. These findings are very unique and our analysis method is the first trial combined to the time interval from the onset of hearing loss and audiogram.

In conclusion, our findings indicate that AT have some effects on ISSHL even for the patients who failed to respond to conventional therapies. It also demonstrated that favorable prognosis was directly related to the time interval from the onset of hearing loss to the start of AT. The severity of hearing loss, especially at middle-low frequency was also considerable as an important factor.

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Authored by 17 international researchers and research teams, the book provides up-to-date insights on topics in five different research areas related to normal hearing and deafness. Techniques for assessment of hearing and the appropriateness of the Mongolian gerbil as a model for age-dependent hearing loss in humans are presented. Parental attitudes to childhood deafness and role of early intervention for better treatment of hearing loss are also discussed. Comprehensive details are provided on the role of different environmental insults including injuries in causing deafness. Additionally, many genes involved in hearing loss are reviewed and the genetics of recessively inherited moderate to severe and progressive deafness is covered for the first time. The book also details established and evolving therapies for treatment of deafness.

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