

## The effect of various treatment modalities in idiopathic sudden sensorineural hearing loss: A retrospective evaluation

Şeyda Belli<sup>1\*</sup>

### Abstract

**Objective:** In this study, we retrospectively evaluated the effects of treatment modalities on healing in patients diagnosed with idiopathic sudden sensorineural hearing loss.

**Material and Method:** In this study, we retrospectively reviewed the records of 65 patients diagnosed with idiopathic sudden sensorineural hearing loss and treated as inpatients. The treatment modalities applied to the patients were determined randomly.

**Results:** The effect of intra-tympanic steroid and / or hyperbaric oxygen therapy in addition to intravenous steroid on 500, 1000, 2000 and 4000 Hz frequencies and improvement in bone conduction was not statistically significant.

**Conclusion:** Although intra-tympanic steroid or hyperbaric oxygen therapy in addition to intravenous steroid therapy, which is the standard treatment of idiopathic sudden sensorineural hearing loss, does not increase the rate of improvement and speed, it may help to reduce the undesirable effects of the steroid dose.

**Key Words:** Idiopathic sudden sensorineural hearing loss, intravenous steroid, intra-tympanic steroid, hyperbaric oxygen treatment

### Introduction

Idiopathic sudden sensorineural hearing loss (ISSHL) is a sudden decrease in sensorineural hearing sensitivity of unknown etiology (1, 2). For ISSHL, hearing impairment may range from 30 dB at three frequencies to 120 dB losses at higher frequencies (3). ISSHL is diagnosed when an audiometry approves 30 decibel (dB) hearing loss at three consecutive frequencies and no underlying condition has been detected (3). Several theories explaining ISSHL have been recommended, including viral infection (4), vascular occlusion, and breakage of the labyrinth membranes, immune-mediated mechanisms, and abnormal cellular stress responses within the cochlea. However, none of these hypotheses has been convincingly proven (5). For smaller losses, natural route may be favorable due to limited repair capacity of cochleas; however, the chance of full recovery in deep cases is quite low (6).

The treatment of patients with ISSHL continues to vary between autological centers. There is no universally accepted standard protocol. The currently accepted treatment for ISSHL is the use of systemic steroids (7), despite the result of the Cochrane meta-analysis, which claims that the efficacy of steroids remains unproven in the treatment of ISSHL (8).

Intra-tympanic steroid injection and hyperbaric oxygen therapy are also used in combination with oral steroid therapy or alone, in many otology clinics for different treatment methods of ISSHL (9).

Possible side effects of systemic steroids limit its use in treatment in some cases. In 2000, intra-tympanic administration of steroid directly into the middle ear began to be used in the treatment of ISSHL. In this method; since it is delivered directly to the middle ear by trans-tympanic and transmitted to the inner ear through a round window, the steroid concentration in the perilymph can reach higher levels than in systemic use and may be of greater benefit (10,11,12,13,14).

The cochlea is an organ with impressive activity; therefore, it is always dependent on adequate oxygen levels in the blood (15). However, due to the protected position of the cochlea in the temporal bone, blood supply is limited (16). One of the possible mechanisms that play a role in ISSHL is of vascular origin: oxygen deficiency. This vascular etiology was defined by Ruben et al. in ISSHL (17). Some authors have also found a vascular etiology for sudden deafness (18,19,20,21,22). Hyperbaric oxygen treatment (HBOT) can increase the oxygen load to the cochlea by eliminating hypoxia (23).



In recently, HBOT has been used for ISSHL; however, due to the lack of randomized controlled trials, the role of HBOT in the treatment protocol for acute hearing loss remains unclear (23).

In this study, we aimed to compare the efficacy of intra-tympanic steroid or HBOT in addition to intravenous steroid and intravenous steroid in patients hospitalized in our clinic.

## Material and Methods

The study was approved by the local Ethics Committee and carried out in accordance with the ethical principles described by the Helsinki Declaration (2019.10.2.04.077).

This study; the patient presented to our clinic within the first 10 days after the onset of his complaints, between January 2017- December 2019. The diagnosis of ISSHL was made by audiometric examination and hospitalized and treated. The records of 65 patients without tumor diseases were retrospectively reviewed. Diabetic patients, concomitant disease with contraindicated steroid treatment, bilateral sudden hearing loss, patients with hearing loss from the onset of treatment more than 10 days were excluded from the study.

Routine examinations for patients and investigations (blood tests, pure tone audiogram, speech audiometry, acoustic impedance and radiological imaging examinations). Included in the study the patients age, gender, risk factors, hearing loss presence of concomitant tinnitus and / or vertigo; and treatments were evaluated.

The choice of treatment applied to patients; patients which referred to the clinic and the start of treatment randomly determined by day. Patients were divided into three groups: systemic steroid therapy group, steroid therapy and intra-tympanic steroid therapy group and hyperbaric oxygen therapy and systemic steroid treatment group.

All patients received intravenous steroid ( 1mg/kg metilprednisolone) treatment. In addition to intravenous steroid treatment, 10 patients received 1cc intra-tympanic steroid treatment (1 cc metilprednisolone) once a day for 5 days. In addition to intravenous steroid treatment, the number of patients receiving HBOT in 20 sessions was 14. Hearing tests were performed by the same audiologist. In pure tone audiometry, pure tone thresholds were examined at 500-1000-2000-4000 Hertz (Hz) frequencies.

In audiological examinations before and after treatment, the threshold frequency of 500, 1000, 2000 and 4000 and the resulting SSO changes were found in all three groups. These differences were also analyzed according to factors such as age, sex, vertigo, tinnitus, time to start treatment.

**Statistical Analyses:** Mean, standart deviation, median, minimum and maximum values were given for the statistical definition of the groups. In comparison of groups, Independent t-test, a parametric test, was used for variables with normal distribution. For the variables that do not show normal distribution, the Mann-Whitney U test, which is an anti-parametric Independent t-test, was used. The significance of the difference between the groups was evaluated at  $p < 0.05$ .

## Results

The mean age of the intravenous steroid group, intravenous steroid+intra-tympanic steroid group and intravenous steroid+hyperbaric oxygen treatment group were  $44.07 \pm 12.13$ ,  $52.18 \pm 18.01$  and  $39.5 \pm 18.45$ , respectively. There was no difference between the three groups in terms of age, sex, time to sudden onset of hearing loss (Table 1). When tinnitus and dizziness were questioned, there was no significant difference between the groups (Table 2).

Bone pathway improvement was observed in audiometric tests in all treatment groups compared to pretreatment, and a statistically significant difference was observed (Table 3). 500, 1000, 2000 and 4000 Hz frequencies separately examined bone pathway improvement intravenous steroid and intravenous steroid + hyperbaric O<sub>2</sub> treatment were statistically significant compared to pre - treatment. Intravenous steroid + intra-tympanic steroid treatment areas only bone at a frequency of 2000 Hz pathway was not statistically significant, but it was statistically significant at other frequencies (Table 3).

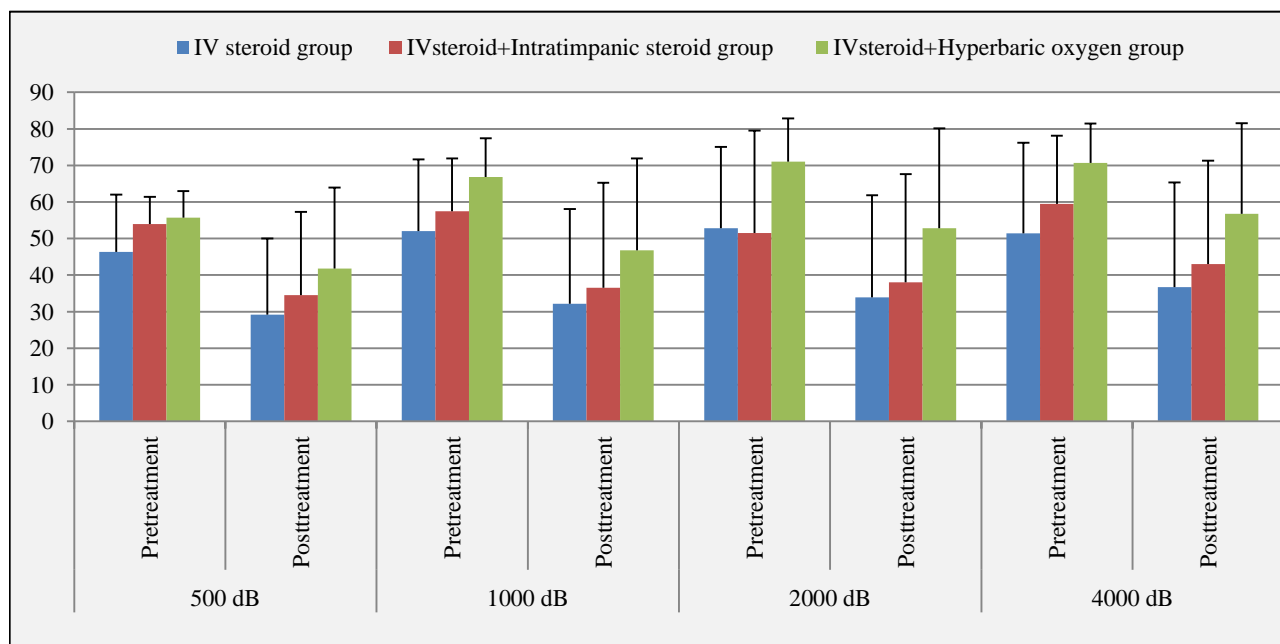
Bone path thresholds; In 41 patients receiving intravenous steroid therapy, a mean improvement of 17.68 dB; intravenous steroid + intra-tympanic steroid treatment in 10 patients, mean 17.63 dB improvement; intravenous steroid + HBOT in 14 patients, mean 16.52 dB improvement was seen. There was no significant difference between the three treatment groups in terms of improvement in bone pathway (Table-4).

**Table 1:** Evaluation of the groups in terms of age, sex and time to sudden onset of hearing loss

	IV steroid group (n:41)	IVsteroid+Intra-tympanic steroid group (n:10)	IVsteroid+Hyperbaric oxygen group (n:14)	p
Age	44,07± 12,13	52,18± 18,01	39,5±18,45	0,111
Sex Male	19 46,34%	5 50,00%	8 57,14%	0,783
Female	22 53,66%	5 50,00%	6 42,86%	
Time to sudden onset of hearing loss	3,39±2,11	4,2±2,53	5±4,9	0,208

**Table 2:** Accompanying symptoms and affected ear

		IV steroid group (n:41)		IVsteroid+Intra-tympanic steroid group (n:10)		IVsteroid+Hyperbaric oxygen group (n:14)		p
<b>Tinnitus</b>	No	3	7,32%	1	10,00%	1	7,14%	0,956
	Yes	38	92,68%	9	90,00%	13	92,86%	
<b>Dizziness</b>	No	31	75,61%	8	80,00%	9	64,29%	0,630
	Yes	10	24,39%	2	20,00%	5	35,71%	
<b>Side</b>	Right	23	56,10%	2	20,00%	5	35,71%	0,082
	Left	18	43,90%	8	80,00%	9	64,29%	

**Table 3:** Bone pathway improvement was observed in audiometric tests in all treatment groups compared to pretreatment**Table 4:** Improvement rates according to average and speech frequencies in all groups

	IV steroid group (n:41)	IVsteroid+Intra-tympanic steroid group (n:10)	IVsteroid+Hyperbaric oxygen group (n:14)	p
Average improvement (dB)	17,68±16,31	17,63±18,42	16,52±19,82	0,976
Improvement per frequency 500	17,2±16,17	19,5±18,78	13,93±21,68	0,738
Improvement per frequency 1000	19,88±19,28	21±21,32	20±21,39	0,987
Improvement per frequency 2000	18,9±21,05	13,5±21,22	18,21±19,96	0,763
Improvement per frequency 4000	14,76±17,43	16,5±22,37	13,93±21,68	0,948

## Discussion

Successful treatment of a disease depends on the underlying cause of etiopathogenesis. Although there are many hypotheses about the causes of ISSHL, it is still unclear at present (24). In the study conducted by Chau et al., 71% idiopathic, 13% infection, 5% primary otologic events, 4% trauma, 3% vascular and hematologic, 2% neoplastic and 2% other causes were detected in the etiology (25).

In the treatment of ISSHL; many different treatment methods are used such as steroids, antivirals, vitamins, antioxidants, vasodilators, heparin, HBOT and intra-tympanic steroids. Systemic steroid therapy is the most frequently used and accepted treatment for sudden hearing loss (25,26).

In sudden hearing loss, the inflammatory response occurs as part of pathophysiology and therefore it is considered necessary to stop the inflammatory response (9). In the treatment of ISSHL, the study on the use of corticosteroids was conducted by Wilson and his colleagues, and according to the group used in the placebo, improvement in the corticosteroid group was statistically significant (27). Moskowitz and Cole have also reported that systemic steroid use is successful in the detection of ISSHL (28,29). In our study, the improvement was statistically significant in the group where we used intravenous steroids.

Inflammatory response plays a role in the pathophysiology of sudden hearing loss (9). Therefore, it is necessary to stop the inflammatory reaction.

Corticosteroids increase oxygen consumption by mobilizing amino acids for gluconeogenesis. This reduces the partial oxygen pressure in the perilymph. This has shed light on the literature in the literature investigating the combined use of HBOT and corticosteroids. In the study of D'Aldin et al., combination therapy was found to be statistically more successful than the control group using only corticosteroids (30). Alimoglu et al. have achieved higher hearing gains in patients treated with combination therapy compared to monotherapies (31). In another study conducted by Capuano et al. reported that combination therapy with HBOT and intravenous corticosteroids had significantly higher mean gains at 0.5, 1, 2, and 4 kHz compared to both HBOT and intravenous corticosteroids as monotherapies in ISSHL patients (32). In our study, in the group where we administered intravenous steroid and HBOT, hearing gains were found to be statistically significant compared to the pre-treatment group.

Intra-tympanic steroid therapy is recommended as a redemptive treatment in cases where it cannot be used in the literature due to side effects of systemic steroid therapy (1,7,14). It is also reported that intra-tympanic steroid administration will help reduce the dose of systemic steroids to be used (10). In the study conducted by Kargin Kaytez et al., the patient who administered intra-tympanic steroid therapy in combination with systemic steroids, only received systemic steroid therapy, and the recovery started earlier, but in the long term hearing there was no statistically significant difference between earnings (10). Bae et al. reported that they could not find a statistically significant difference in recovery between the group given by the intra-tympanic steroid in combination with systemic steroids and the group in which they gave a single systemic steroid (33). In their study, Battaglia et al. found improvement higher in the study where intra-tympanic steroids were combined with systemic steroids, but this difference was not statistically significant (34). In our study, the improvement in 2000 Hz frequencies was not statistically significant in the group where the intra-tympanic steroid was given in combination with systemic steroids, and the improvement in other frequencies was statistically significant. In line with the literature, we could not find a statistically significant difference between the combined treatment group and the combined treatment group compared only to the group given systemic steroids.

Cho et al. compared the group receiving systemic steroids and intra-tympanic steroids and the group receiving additional HBOT for this treatment, and the higher improvement in discrimination scores in the group receiving additional HBOT but did not detect this improvement at a statistically significant level in terms of hearing thresholds (35). In our study, we found no significant difference between the two groups, although the improvement in hearing thresholds was statistically significant in both treatment groups compared to pre-treatment. Overall hearing improvement was higher for patients treated with HBOT and systemic steroids than those treated with only systemic steroids or systemic and intra-tympanic steroids. In our study, the rate of

improvement between all three groups was not statistically significant.

## Conclusion

In this study, we retrospectively examined the effect of intra-tympanic steroids and HBOT in addition to basic systemic steroid therapy. However, the differences between the numbers of groups led to a limitation in the statistical evaluation of our results. It is more appropriate to refresh this study with larger sample groups.

Consequently, systemic steroid therapy is the main treatment for ISSHL. In addition to systemic steroid therapy, the addition of intra-tympanic steroids and/or HBOT may result in further improvements in hearing thresholds, although not statistically significant. It also reduces the likelihood of side effects by providing lower doses of systemic steroids.

Author Belli S declares that she has no conflict of interest. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.

**Informed consent:** Informed consent was obtained from all individual participants included in the study.

**Acknowledgements:** None

**Conflict of Interest:** The authors declare no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

**Author's Contributions:** SB; Research concept and design, Research the literature, preparation of the article, Revision of the article.

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