Sudden Sensorineural Hearing Loss: Comparative Study of Different Treatment Modalities

Ahmed Khater[1] Mohammad Waheed El-Anwar[1] Ahmad Abdel-Fattah Nofal[1] Atef Taha Elbahrawy[1]

[1] Department of Otorhinolaryngology, Head and Neck Surgery, Faculty of Medicine, Zagazig University, Zagazig, Egypt

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Address for correspondence Ahmad Abdel-Fattah Nofal, MD, Department of Otorhinolaryngology, Head and Neck Surgery, Faculty of Medicine, Zagazig University, Zagazig 46166, Egypt (e-mail: nofal_9999@hotmail.com).

Abstract

Introduction Idiopathic sudden sensorineural hearing loss (ISSNHL) is hearing loss of at least 30 dB in at least 3 contiguous frequencies within at least 72 hours. There are many different theories to explain it, and many different modalities are used for its management, such as: systemic steroids (SSs), intratympanic steroid injection (ITSI), hyperbaric oxygen therapy (HOT), antiviral drugs, and vasodilators or vasoactive substances.

Objectives This study aims to evaluate the efficacy of the combination of the most common treatment modalities of ISSNHL and to compare the results if HOT was not one of the treatment modalities administered.

Methods The study was conducted with 22 ISSNHL patients with ages ranging from 34 to 58 years. The patients were divided into 2 groups; group A included 11 patients managed by SSs, ITSI, antiviral therapy, and HOT simultaneously, and group B included 11 patients exposed to the aforementioned modalities, with the exception of HOT.

Results After one month, all of the patients in group A showed total improvement in hearing in all frequencies, with pure tone average (PTA) of 18.1 $\pm$ 2.2, while in group B, 5/11 (45.5%) patients showed total improvement, and 6 /11 (54.5%) patients showed partial improvement, with a total mean PTA of 28.1 $\pm$ 8.7.

Conclusion The early administration of HOT in combination with other clinically approved modalities (SSs, ITSI, antiviral therapy) provides better results than the administration of the same modalities, with the exception of HOT, in the treatment of ISSNHL.

Keywords

- hearing loss
- hyperbaric oxygen therapy
- steroids
- intratympanic injection

Introduction

Idiopathic sudden sensorineural hearing loss (ISSNHL) is defined as rapid hearing loss of at least 30 dB in at least 3 contiguous frequencies within 72 hours or less.[1,2] It was first described by De Kleyn in 1944.[3] Occasionally, it is associated with vestibular dysfunction, tinnitus and/or pressure sensation in the affected ear.[4]

Detailed investigations can determine the cause in only 10% of the patients with sudden sensorineural hearing loss (SSNHL), while the term idiopathic is used to describe the other patients.[5]

There are different theories to explain the pathophysiology of ISSHL; viral infection, alteration in inner ear microcirculation, and immune-mediated disease are the most popular theories.[6]

The most common treatment modalities for ISSHL are one or more of the following: systemic steroids (SSs), intratympanic steroid injection (ITSI), hyperbaric oxygen therapy (HOT), antiviral drugs, and vasodilators or vasoactive substances.[7] However, the empirical uses of all of these modalities are mainly based on improving the blood circulation and restoring oxygen tension within the inner ear.[8]

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There are only a few studies that investigate the adjuvant use of HOT in the management of ISSHL with other therapies such as SSs,[7,8] and this highlights the importance of studying the added value of HOT in cases of ISSHL, particularly in prospective and comparative studies.

The aim of this study is to assess the efficacy of the combined administration of four treatment modalities (SSs + ITSI + antiviral therapy + HOT) and to compare the results with another group of patients who was exposed to the same treatment modalities, with the exception of HOT.

Material and Methods

This prospective study was performed between February 2013 and August 2014 on 22 patients who suffered from SSNHL without detected cause after detailed examination and investigations. All of the patients provided written informed consent forms to participate in the study, and we obtained the approval of the ethics committee of our institution. All patients began the treatment within the first week of the onset of the symptoms.

Patients with history of middle ear surgery, acoustic trauma or barotrauma, fluctuating hearing loss, radiotherapy to the head and neck region, chemotherapy, exposure to an ototoxic agent, pregnant patients and patients who underwent treatment for ISSHL before entering the study protocol were excluded.

Audiological Assessment

All of the patients were evaluated for diagnosis and baseline measurements by standard methods of pure tone audiometry, air and bone conduction, as well as speech audiometry, using a GSI 61 clinical audiometer (Grason-Stadler Inc., Eden Prairie, MN US) before the treatment, and at 1 week, 2 weeks, and 1 month after the beginning of the treatment. Pure tone average (PTA) was calculated as an average of the threshold measured at 0.5 KHz, 1.0 KHz, 2.0 KHz, and 4.0 KHz (as described by Haynes et al[9]). Speech discrimination was tested by calculating the percentage of correct answers from a phonetically balanced, monosyllabic word list (Arabic version).[10]

Retrocochlear lesion was excluded in all patients by auditory brainstem response (ABR) (GSI Audera, Grason-Stadler Inc., Eden Prairie, MN US) and magnetic resonance imaging (MRI) with contrast of the internal auditory canal and cerebellopontine angle.

Reporting of Hearing Recovery

Total improvement was considered when the PTA at 0.5 KHz, 1.0 KHz, 2.0 KHz, and 4.0 KHz returned within 20 dB or to the same level of the unaffected contralateral ear. Partial improvement was considered when the improvement of the PTA at 0.5 KHz, 1.0 KHz, 2.0 KHz, and 4.0 KHz was $\geq$ 30 dB and the threshold was not within 20 dB or did not reach the level of the unaffected contralateral ear. Otherwise, the PTA was considered as not improving.

The patients were randomly allocated into 2 groups: group A (11 patients) was exposed to 4 simultaneous treatment modalities (SSs, ITSI, antiviral therapy, and HOT); and group B (11 patients) was exposed to 3 simultaneous treatment modalities (SS, ITSI, and antiviral therapy), without exposure to HOT.

Systemic steroids (SSs): in the form of oral prednisolone 1 mg/kg (maximum dose 80 mg) for 10 days, gradually decreasing the dose in the next 10 days (25% of the dose in the first 3 days, then 25% in the next 3 days, then 25% in the last 4 days, then cease to administer the medicine).

Intratympanic steroid injection (ITSI): it is administered under local anesthesia while the patient is in supine position with the head turned $\sim$ 30 degrees away from the surgeon. Using a syringe connected to a 22- (3.5 IN; 0.7 $\times$ 90 mm) or 25-gauge spinal needle, a 0.4-0.6 ml of methylprednisolone (Depo-medrol 40 mg/ml, EIPICO, Tanta, Gharbia, Egypt, and Pharmacia & Up John, Kalamazoo, MI, US) was injected into the tympanic cavity through the posterior-inferior quadrant of the tympanic membrane, under direct visualization through an operating microscope. The solution was heated to body temperature before the injection to avoid vertigo. The patient was kept in the described position for $\sim$ 30 minutes after the injection. The intratympanic injection was administered immediately once the patient was evaluated and diagnosed audiologically and after the radiological exclusion of retrocochlear lesion. One dose was administered, and the patient was evaluated after one week. If there was no improvement or partial improvement, another dose was administered.

Antiviral drug: acyclovir 500 mg TDS for 1 week.

Hyperbaric oxygen therapy (HOT): the patient breathed 100% oxygen through a mask delivery system for 60 minutes in a multiplace hyperbaric chamber (NHC-412-A, Nakamura Tekko-Sho, Tokyo, Japan) with pressurized air at 2.0 atmospheres absolute (ATA) for 20 sessions, with 1 daily session.

Bed rest and a diet with a salt restriction were advised to all patients in both groups. All patients took proton pump inhibitors (omeprazole in a dose of 40 mg/day) for gastroduodenal prophylaxis while taking the steroid.

The statistical analysis was performed using the Statistical Package for the Social Sciences (SPSS, SPSS, Inc., Chicago, IL, US) software, version 18.0. The chi-squared (χ^2) test was used for the comparison of the non-parametric data, and the *t*-test was used for the parametric data. Values of $p < 0.05$ were considered statistically significant; 95% confidence intervals (95%CI) and 80% power were used.

Results

This study was conducted with 22 patients with ages ranging from 34 to 58 years (mean = 45.86 $\pm$ 6.85), 10 females and 12 males. Group A was composed of 11 patients with ages ranging from 36 to 58 years (mean = 45.9 $\pm$ 6.9), 6 females and 5 males. Group B comprised 11 patients with ages ranging from 34 to 55 years (mean = 45.8 $\pm$ 7.14), 4 females and 7 males. Therefore, both groups were matched regarding age (t = 0.0136, $p = 0.9892$) and sex ($\chi^2 = 0.733$, $p = 0.39$) (►**Table 1**). In addition to hearing loss, 5 patients presented with vertigo, and 8 patients presented with tinnitus.

Table 1 Age and sex of the two studied groups

		4 lines of treatment (group A)	3 lines of treament (group B)	
Age	Range	36 to 58 years	34 to 55	t = 0.0136 $p = 0.9892$
	Mean	45.9 ± 6.9	45.8 ± 7.14	
Sex	Females	6	4	$\chi^2 = 0.733$ $p = 0.39$
	Males	5	7	

Abbreviation: χ^2, Chi-squared test; t, Student's *t* test.

Two weeks after the beginning of the treatment, 10 patients from group A (10/11, 90.9%) had an improvement in hearing in all frequencies (8 total improvements and 2 partial improvements), while 1 case (9.1%) showed no improvement. The mean post-treatment PTA at 0.5 KHz, 1.0 KHz, 2.0 KHz, and 4.0 KHz in group A was 18.1 ± 2.2.

In group B, total improvement in hearing in all frequencies was reported by 5/11 (45.5%) patients, and partial improvement in hearing in all frequencies was reported by 6/11 (54.5%) patients, with a total mean PTA of 28.1 ± 8.7.

Therefore, in group A, in the beginning of the treatment, more improvements in hearing were observed ($\chi^2 = 0.819$, $p = 0.66$) in comparison with group B (►**Table 2**).

Both groups showed highly significant improvements in hearing level in the first week post-treatment hearing assessment ($p < 0.0001$ for both groups) (►**Table 3**). The improvement continued to be statistically significant in the one-month post-treatment assessment ($p < 0.0001$ for group A, and $p = 0.0076$ for group B), with significant better results for group A ($p = 0.0014$) (►**Table 3**).

Discussion

The most common therapies to treat ISSNHL include one or more of the following: SSs, ITSI, HOT, antiviral drugs, and vasodilators or vasoactive substances.[7,11]

The ITSI reaches the perilymph through the semipermeable round window.[12] Although it seems to be less effective than the SS, it may be used as an additive to the SS, or even an alternative to it, especially in groups of patients with contraindications to SS (such as those suffering from peptic ulcer disease, viral hepatitis and brittle diabetes).[13] Dexamethasone or methylprednisolone are the traditional safe and effective treatments for SSNHL, with no significant difference between them. In the current study, intratympanic methylprednisolone was administered to both groups to fix all administered treatment lines except HOT, in order to study its effect.[14,15]

Table 2 Statistical results of the hearing improvement 2 weeks after the beginning of the treatment

After 2 weeks of treatment	Total improvement at all frequencies	Partial improvement at all frequencies	No improvement	*p*
4 lines of treatment (group A)	8 (72.7%)	2 (18.2%)	1 (9.1%)	0.66* ($\chi^2 = 0.819$)
3 lines of treatment (group B)	6 (45.5%)	3 (27.3%)	2 (18.2%)	

Abbreviation: χ^2, Chi-squared test.
Note: NS, not significant.

Table 3 PTA results of 4 lines and 3 lines of treatment; before the treatment, 1 week and 1 month post-treatment

	PTA before the treatment (mean [SD])	PTA Post-treatment by one week (mean [SD])	PTA Post-treatment by one month (mean [SD])	*p*
4 lines of treatment (group A)	72.86 (1.43)	34.1 (5.6)	18.1 (± 2.2)	Before and 1 week after: $p < 0.0001$,** t = 22.2421; 1 week and 1 month after: $p < 0.0001$,** t = 8.8199
3 lines of treatment (group B)	71.94 (2.1)	39 (8.53)	28.1 (8.7)	Before and 1 week after: $p < 0.0001$,** t = 12.9842; 1 week and 2 weeks after: $p = 0.0076$,* t = 2.9671
p	0. 2438,*** t = 1.2010	0.1269,*** t = 1.5927	0.0014* t = 3.6959	

Abbreviations: PTA, pure tone average; t, Student's *t* test.
Notes:* significant; ** highly significant; *** not significant.

Hyperbaric oxygen therapy has been investigated as a treatment for hearing loss since the 1970s.[16,17] The effect of HOT in ISSNHL is mostly related to its ability to correct the perilymph hypoxia by increasing the partial oxygen pressure, the oxygen concentration in the inner ear, and by improving the microcirculation and the blood profile.[18] Hyperbaric oxygen therapy has also a complex effect on the immunity due to its anti-inflammatory and anti-edematous effect, and because it blunts the ischemia reperfusion injury.[7,19]

The addition of HOT improves ISSNHL outcomes, especially when administered early.[14] In three Cochrane meta-analyses; the administration of HOT significantly improved the hearing in cases of ISSNHL, especially among patients who presented as soon as the onset of the symptoms.[20–22]

Many viruses have been postulated as possible causes of SSNHL, and this supports the viral therapy for the pathogenesis, even though the serological, epidemiological, and histopathological data are not conclusive.[23]

The effect of vasodilators and vasoactive substances in the treatment of ISSHL was not proven in a Cochrane review,[24] so we excluded it in the present study.

In the current study, we administered a combination of all clinically approved drugs in patients with ISSNHL within the first week of the onset of the symptoms. The patients in group A were exposed to 4 simultaneous treatment modalities (SSs, ITSI, antiviral therapy, and HOT), and the patients in group B were exposed to the same treatment modalities, with the exception of HOT. Although there was an extremely significant improvement in hearing after one month in both groups, group A showed a more significantly improvement in hearing by PTA ($p = 0.0124$) in comparison with group B.

In the study by Ohno et al,[25] although HOT showed no statistical difference in the control group when it was administered after the conventional treatment, this was mostly due to the late administration (more than 4 weeks after the onset of ISSNHL). Therefore, we recommend the early and simultaneous administration of HOT with other clinically approved drugs. Similarly, there are many studies that showed better hearing outcomes with HOT if the therapy is administered along with the onset of the symptoms.[16,18,20–22,26]

In many studies,[25,27,28] HOT was administered as a salvage treatment after an ineffective previous treatment of ISSNHL, but in the present study we administered it since the beginning of the treatment in combination with other clinically approved modalities (SSs, ITSI and antiviral drugs) in patients who presented as soon as the onset of ISSNHL symptoms.

Although there are some studies[18,29,30] that report a high incidence of spontaneous recovery rates for ISSNHL, because of its serious bad influence in the quality of life, we cannot just wait and see, or treat it with laxity. Therefore, we recommend the management of ISSNHL with all possible clinically approved methods, including the early administration of HOT. However, further studies with larger samples are still needed.

The current study found that the combination of HOT with other treatment modalities, such as SSs, ITSI, and antiviral therapy, showed better results in restoring hearing.

Conclusion

Although the early combined administration of SSs, ITSI, and antiviral therapy significantly improved the hearing levels of patients with ISSNHL, the combination of HOT with these treatment modalities showed better results.

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The authors have no financial support or conflicts of interest to declare.

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