ORİJİNAL ARAŞTIRMA ORIGINAL RESEARCH

DOI: 10.24179/kbbbbc.2022-94258

Long-Term Effects of Tinnitus and Vertigo Symptoms on Quality of Life in Patients with Idiopathic Sudden Sensorineural Hearing Loss

İdiyopatik Ani Sensörinöral İşitme Kayıplı Hastalarda Uzun Dönemde Tinnitus ve Vertigo Semptomlarının Yaşam Kalitesine Etkisi

Deniz Uğur CENGİZ[a], Emre Akgün ÖZDEMİR[b], Hayriye ARIK[c], Beyza BAKAR[c], Nergiz NUR[c], İsmail DEMİR[a]

[a]Department of Audiology, İnönü University Faculty of Health Sciences, Malatya, Türkiye
[b]Department of Audiology, İnönü University Institute of Health Sciences, Malatya, Türkiye
[c]İnönü University Faculty of Health Sciences, Malatya, Türkiye

ABSTRACT Objective: To determine the effect of tinnitus and vertigo symptoms on quality of life in the long term after medical treatment in individuals with idiopathic sudden sensorineural hearing loss. **Material and Methods:** The study included 18-65 years old 63 patients (20 women-43 men) who were diagnosed with idiopathic sudden hearing loss at Ear Nose and Throat Diseases Polyclinic of İnönü University Turgut Özal Medical Center and had at least 20 dB HL improvement in the mean pure tone threshold as a result of the medical treatment. A Demographic Data Form, the Dizziness Handicap Inventory, the Tinnitus Handicap Inventory, and the Multidimensional Index of Life Quality were administered to all participants. The patients were assigned into two groups as those with dizziness and tinnitus symptoms (n=33) and those without symptoms (n=30). **Results:** No statistically significant difference was found between the symptomatic and non-symptomatic groups according to age, time from diagnosis and gender (p>0.05). The groups show a homogeneous distribution according to age, time since diagnosis and gender. Index of Life Quality Scale physical health scores, mental health scores, interpersonal relations scores, and total score were significantly higher in the non-symptomatic group than in the symptomatic group (p<0.05). There was no statistically significant difference between the two groups in terms of access to health personnel scores, financial status scores, and social function scores (p>0.05). **Conclusion:** Although there was an improvement in hearing thresholds after treatment in individuals with idiopathic sudden sensorineural hearing loss, tinnitus and vertigo symptoms could persist in the long term and these symptoms had a serious negative impact on the individual's quality of life. These individuals should be followed up after treatment and holistic evaluations should be made with audio-vestibular tests. The quality of life of individuals can be increased by applying appropriate treatment/rehabilitation with a multidisciplinary approach.

Keywords: Sudden hearing loss; vertigo; tinnitus

ÖZET Amaç: Araştırma, idiyopatik ani sensörinöral işitme kayıplı bireylerde medikal tedavi sonrası uzun dönemde tinnitus ve vertigo semptomlarının yaşam kalitesine etkisini tespit etmek amacıyla yapılmıştır. **Gereç ve Yöntemler:** Çalışmaya İnönü Üniversitesi Turgut Özal Tıp Merkezi Kulak Burun Boğaz Hastalıkları Polikliniğine Mart 2019-Mart 2021 tarihleri arasında idiyopatik ani sensörinöral işitme kaybı tanısı almış ve uygulanan medikal tedavi sonucunda saf ses eşik ortalamasında en az 20 dB HL iyileşme gözlenen, 18-65 yaş aralığında 63 (20 kadın-43 erkek) hasta dâhil edildi. Tüm katılımcılara Demografik Veri Formu, Baş Dönmesi Engellik Envanteri, Tinnitus Engellilik Envanteri ve Çok Boyutlu Yaşam Kalitesi Ölçeği uygulandı. Hastalar baş dönmesi ve tinnitus semptomu olanlar (33 kişi) ve semptomu olmayanlar (30 kişi) olarak 2 gruba ayrıldı. **Bulgular:** Çalışmaya alınan katılımcılarda yaşa, tanıdan itibaren geçen süreye ve cinsiyete göre semptom olan ve olmayan gruplar arasında istatistiksel olarak anlamlı farklılık saptanmamıştır (p>0,05). Gruplar yaş, tanıdan itibaren geçen süre ve cinsiyet değişkenlerine göre homojen dağılım göstermektedir. Yaşam Kalitesi Ölçeği fiziksel sağlık puanları, ruhsal sağlık puanları, kişiler arası ilişkiler puanları ve ölçek toplam puanı semptom olmayan grupta semptom olan gruba göre istatistiksel olarak anlamlı seviyede yüksek bulunmuştur (p<0,05). Sağlık personeline erişim puanları, finansal durum puanları ve sosyal fonksiyon puanları için 2 grup arasında istatistiksel olarak anlamlı bir farklılık bulunmamıştır (p>0,05). **Sonuç:** İdiyopatik ani sensörinöral işitme kayıplı bireylerde tedavi sonrası işitme eşiklerinde düzelme olsa da uzun dönemde tinnitus ve vertigo semptomlarının devam edebildiği ve bu semptomların bireyin yaşam kalitesi üzerinde ciddi olumsuz etki oluşturduğu bulundu. Bu bireylerin tedavi sonrası takip edilerek odyo-vestibüler testlerle bütüncül değerlendirmeleri yapılmalıdır. Multidisipliner yaklaşımla uygun tedavi/rehabilitasyon uygulanarak bireylerin yaşam kaliteleri artırılabilir.

Anahtar Kelimeler: Ani işitme kaybı; vertigo; tinnitus

Correspondence: Deniz Uğur CENGİZ
Department of Audiology, İnönü University Faculty of Health Sciences, Malatya, Türkiye
E-mail: deniz.cengiz@inonu.edu.tr

Peer review under responsibility of Journal of Ear Nose Throat and Head Neck Surgery.

Received: 08 Nov 2022 ***Accepted:*** 09 Dec 2022 ***Available online:*** 15 Dec 2022

Idiopathic sudden sensorineural hearing loss (ISSHL) is a pathology that develops suddenly within three days and has no clinically known cause. This is a process that keeps at least three adjacent frequencies and develops at a minimum of 30 dB HL.[1-3] Although the annual incidence of ISSHL is as low as 5-30/100,000, it is one of the most common emergencies in otolaryngology outpatient clinics. Cases are mostly unilateral and have additional symptoms such as tinnitus, dizziness, and aural fullness.[4] The pathophysiology of sudden hearing loss is not clear and a consensus has not been reached yet. However, the most frequently cited theories are viral infection, ischemia, autoimmune reaction, and pathogens such as rupture of the basilar membrane or Reissner's membrane.[5-9]

About 40% of patients with sudden hearing loss complain of vestibular symptoms that sometimes occur with the onset of hearing loss or sometimes days later. These symptoms are explained by the close anatomical and phylogenetic relationship between the cochlea and the vestibular labyrinth.[10,11] Vertigo is a symptom that occurs as a result of dysfunction of the vestibular, visual, and proprioceptive systems or dysfunction of the vestibular organs. Recently, some studies have used objective vestibular function tests such as caloric testing, cervical vestibular evoked myogenic potentials (cVEMP), and ocular VEMP (oVEMP) to determine the etiology of ISSHL.[2,12]

Caloric testing can be used to investigate lateral semicircular canal function and superior vestibular nerve integrity.[13] cVEMP is used to evaluate saccular function and inferior vestibular nerve pathway, and oVEMP is used to evaluate utricular function and the superior vestibular nerve pathway.[14,15] Vestibular functions of individuals with sudden hearing loss are adversely affected.[10,12,16,17] Although vestibular symptoms are generally seen in patients with severe hearing loss in patients with sudden hearing loss, the prognosis of hearing is worse in patients with vestibular symptoms.[12] Recently, however, some researchers have noted that hearing recovery does not differ significantly between patients with sudden hearing loss with and without vertigo.[18,19] However, among the factors that can affect the prognosis, the age of the patient, the time between the onset of hearing loss and treatment, and the initial severity are of great importance.[10] Although sudden hearing loss is not a disease, uncertainties remain about the approach to be applied, and little is known about the effectiveness of the approach and its impact on the quality of life. However, intratympanic steroid administration is accepted as a valid treatment option.[20]

Most of the studies in the literature include audio-vestibular test results alone, but there are limited studies examining the effect of audio-vestibular symptoms on the quality of life of patients in the long term. The aim of this study was to investigate the effect of tinnitus and vertigo symptoms on the long-term quality of life of patients with ISSHL after intratympanic steroid therapy.

MATERIAL AND METHODS

RESEARCH DESIGN

In this study, a complementary cross-sectional study design was used to obtain information about the long-term effects of vertigo and tinnitus on quality of life in patients with ISSHL.

INDIVIDUALS

The records of 96 patients who were diagnosed and treated for ISSHL between March 2019 and March 2021 at the Otorhinolaryngology Outpatient Clinic of İnönü University Turgut Özal Medical Center were retrospectively reviewed. Patients who complained of unilateral acute hearing loss within 72 hours, had at least 30 dB HL increase in pure tone thresholds at 3 consecutive frequencies, and had at least 20 dB HL improvement in pure tone threshold mean after medical treatment were included in the study. Participants were divided into two groups as 33 patients with both tinnitus and vertigo symptoms and 30 patients without any symptoms after treatment. Patients with either vertigo or dizziness were excluded from the study.

DATA COLLECTION

Research data were collected between March 2022 and April 2022. Patients were contacted to fill in the scales. Detailed information about the scales was

given to each patient over the phone. Afterwards, the questions of the Dizziness Handicap Inventory, the Tinnitus Handicap Inventory, and the Multidimensional Index of Life Quality were read by the researchers and the patients provided the answers verbally.

DATA COLLECTION TOOLS

The Dizziness Handicap Inventory is a 25-item questionnaire consisting of functional subscale (0-36 points), emotional subscale (0-36 points), and physical (0-28 points) subscale. It is used to evaluate the physical, emotional, and functional disabilities that affect the quality of life of individuals with dizziness. Patients were asked to answer each question as Yes (4 points), No (0 points), or Sometimes (2 points).

The Tinnitus Handicap Inventory is a 25-item scale that investigates the physical, mental, social, and emotional reactions of patients to tinnitus. Patients were asked to answer each question as Yes (4 points), No (0 points), or Sometimes (2 points).

The original ***Multidimensional Index of Life Quality*** is a scale consisting of 35 items and 9 sub-dimensions. The answers in the scale were arranged according to a 7-point Likert. Responses on the scale range from 1 to 7, from "not at all satisfied" to "very satisfied". The nine sub-dimensions covered by the scale are: mental health, physical health, physical function, cognitive function, sexual function, social function, productivity, access to health personnel, and financial situation. In the Turkish validity and reliability study of the scale, it was converted into six sub-dimensions and adapted to Turkish. In the new format of the scale, the sub-dimensions are physical health, mental health, access to health personnel, interpersonal relationships, financial status, and social function. Patients were asked to answer all items by scoring between 1 and 7 points.

STATISTICAL ANALYSIS

Data of the research were analyzed with the IBM SPSS version 25.0 (International Bussiness Machines, New York, USA) program. Compliance with the given normal distribution was evaluated with the Kolmogorov-Smirnov test.[21] The significance level (p) in the analysis was determined as 0.05. Since the normal distribution was not provided in the analyses, it was evaluated with the Mann-Whitney U test. In the analysis of categorical data, cross tables were created and evaluated by chi-square (χ^2) analysis.

ETHICAL PRINCIPLES

This study was conducted in accordance with the principles of the Declaration of Helsinki. Approval was obtained from the İnönü University Health Sciences Institute Non-interventional Clinical Researches Ethics Committee (date: March 29, 2022, no: 2022/3316) and from all individuals participating in the study.

RESULTS

The patients with ISSHL were divided into two groups as the group with both tinnitus and vertigo symptoms (n=33) and the group with no symptoms (n=30). The comparison of demographic variables according to their distribution between groups is shown in Table 1. Among the patients with ISSHL, the asymptomatic group consisted of 6 females (20%) and 24 males (80%), while the symptomatic group consisted of 14 females (42.4%) and 19 males (57.6%). The age at diagnosis ranged from 18 to 65 years. The mean age of the group without symptoms was 44.7 years, and the mean age of the group with symptoms was 47 years. No statistically significant difference was found between the groups according to the variables of gender, age, and time since diagnosis (p>0.05, Table 1). The groups showed a homogeneous distribution according to gender, age, and time since diagnosis.

The scale scores of the patients with ISSHL who had symptoms of dizziness and tinnitus are shown in Table 2. Among the patients with ISSHL, the group with dizziness and tinnitus symptoms had a Dizziness Handicap Inventory physical handicap score of 8.91±7.37, an emotional handicap score of 8.06± 7.71, a functional handicap score of 13.88±12.28, a Dizziness Handicap Inventory total score of 30± 24.73, and their Tinnitus Handicap Inventory score was 53.76±22.38 (Table 2).

The comparison of Multidimensional Index of Life Quality scores of the patients with ISSHL with

TABLE 1: Comparison of demographic variables by distribution between groups.

		Dizziness and tinnitus status			
Variable		**No n (%)**	**Yes n (%)**	**Total n (%)**	**p value**
Gender	Female	6a (20.0)	14a (42.4)	20 (31.7)	0.061[a]
	Male	24a (80.0)	19a (57.6)	43 (68.3)	
		X̄±SD (Minimum-Maximum)	**X̄±SD (Minimum-Maximum)**	**p value**	
Age		47.0±11.51 (19-65)	44.7±13.52 (18-65)	0.070[b]	
Time since diagnosis (month)		19.7±6.23 (12-33)	17.2±4.49 (12-27)	0.131[b]	

p[a]Chi-square test value (χ^2); pbMann-Whitney U test; p<0.05; SD: Standard deviation.

TABLE 2: Scale scores of the group with dizziness and tinnitus symptom.

Dizziness Handicap Inventory	**X̄±SD**	**Minimum-Maximum**	**Cronbach α**
Physical sub-dimension	8.91±7.37	0-24	
Emotional sub-dimension	8.06±7.71	0-26	
Functional sub-dimension	13.88±12.28	0-36	0.93
Total score	30.85±24.73	0-72	
Tinnitus Handicap Inventory	53.76±22.38	20-94	0.89

SD: Standard deviation.

and without the symptoms of dizziness and tinnitus is shown in Table 3. When the Multidimensional Index of Life Quality scores of the groups were compared, the scores of physical health, mental health, and interpersonal relations were statistically significantly lower in the symptomatic group (p<0.05), there was no significant difference in access to health personnel, financial status, and social function scores between the two groups (p>0.05). On the other hand, Multidimensional Index of Life Quality total scores were significantly higher in the asymptomatic group compared to the symptomatic group (Table 3).

DISCUSSION

ISSHL is a disorder characterized by hearing loss of 30 dB HL and above in at least 3 consecutive frequencies within 72 hours. It is known that vertigo and tinnitus symptoms accompany hearing loss in people suffering from sudden hearing loss.[1,4] Vertigo is a symptom that can be caused by more than one pathology. There is no consensus on the pathophysiology of sudden hearing loss, but the most cited mechanisms are viral infection and ischemia.[5-7]

Viral infection in the inner ear or disruption of the inner ear blood supply may explain the co-occur-

TABLE 3: Intergroup comparison of Multidimensional Index of Life Quality scores.

	Dizziness and tinnitus status					
Multidimensional Quality of	**Yes**		**No**			
Life Scale total and sub-dimensional scores	**X̄±SD**	**M (Minimum-Maximum)**	**X̄±SD**	**M (Minimum-Maximum)**	**Test#**	**p value**
Physical health	78.07±19.97	85.5 (25-104)	69.12±12.08	71 (49-91)	304.00	0.010*
Mental health	21.3±5.21	23 (11-28)	17.76±4.68	16 (9-28)	308.00	0.010*
Access to health personnel	26.7±7.18	29.5 (9-35)	25.58±5.76	27 (14-35)	412.50	0.250
Interpersonal relations	28.23±5.93	30 (11-35)	25.7±5.41	26 (11-34)	342.50	0.040*
Financial status	12.67±5.61	13.5 (3-21)	13.42±4.49	13 (6-21)	472.50	0.760
Social function	9.53±3.21	10 (2-14)	9.21±2.43	9 (3-14)	445.00	0.490
Total score	176.5±40.07	188 (63-237)	160.79±26.59	161 (124-220)	330.00	0.020*

#Mann-Whitney U test; *p<0.05; SD: Standard deviation; M: Median.

rence of the cochlear and vestibular labyrinth damage. For this reason, vestibular symptoms can also be seen in patients with sudden hearing loss. Liu et al. applied cVEMP, oVEMP, and caloric test to patients with sudden hearing loss and stated that there were various degrees of vestibular involvement.[1] Similarly, Wang et al. in their study conducted with patients with sudden hearing loss, reported that 66% had abnormal oVEMP, 60.9% abnormal caloric response, and 39.7% abnormal cVEMP results.[2] The higher rate of abnormality in caloric test and oVEMP compared to cVEMP in both studies may be associated with the superior vestibular nerve being more sensitive to ischemic labyrinth changes due to its narrower passage than the inferior vestibular nerve.[22] In contrast, Fujimoto et al. found that the percentage of abnormal response was highest in cVEMP in patients with sudden hearing loss, followed by oVEMP and caloric testing. The higher abnormality in cVEMP is explained by the fact that the saccule is in closer anatomical relationship with the cochlea than with the lateral semicircular canal and utricle.[12] Abnormal VEMP responses in patients with sudden hearing loss have been attributed to a saccular labyrinth lesion or brainstem hyperperfusion.[16,23,24] Korres et al. reported that magnetic resonance imaging findings of all patients in the study group were normal, and therefore, abnormal VEMP responses indicated a saccular labyrinth lesion.[10] Tinnitus refers to a subjective sound that an individual feels in the ear or brain, without any sound or electrical stimulation.[25] The incidence of tinnitus in sudden hearing loss is approximately 78.2%-91%. Some patients with sudden hearing loss recover completely or partially after treatment, but tinnitus persists for a long time or intermittently, seriously impairing quality of life.[26] Zhao et al., in their study with 1,024 patients with sudden hearing loss, stated that 90.04% of the patients suffered from tinnitus. They also stated that in the tinnitus matching test, tinnitus was mostly in a low-frequency character and that this group was the group that responded best to treatment for hearing loss.[27] Diao et al. investigated the long-term effect of tinnitus in 161 patients with sudden hearing loss after treatment. They found that residual tinnitus tended to resolve spontaneously and that short-term tinnitus prognosis was related to psychological factors caused by hearing recovery. However, they stated that the long-term tinnitus prognosis was directly related to the initial tinnitus severity and the mean recovery time was approximately 2 years.[28] Although studies in the literature generally include audiovestibular test results, there are very few studies examining the effects of these symptoms on quality of life. Nogueira-Neto et al. in their study in patients with ISSHL, reported that tinnitus symptoms continued before and after the treatment based on the Tinnitus Handicap Inventory results, but the tinnitus symptom decreased statistically after the treatment.[29] In addition, Hwang et al. in their study with 101 patients with ISSHL, reported that they administered the Dizziness Handicap Inventory in 34 patients with vertigo, and they found no statistical difference in patients whose hearing levels improved and those with no improvement after treatment.[30] In our study, unlike the literature, we investigated the quality of life of groups with and without tinnitus and vertigo symptoms. In our study, physical health, mental health, and interpersonal relations subscores and the total score of the Multidimensional Index of Life Quality were significantly lower in the group with symptoms compared to the group without symptoms. Based on these results, even if the hearing thresholds of individuals with sudden hearing loss improve after treatment, it is seen that the ongoing symptoms have a serious negative impact on the quality of life in the long term. Dallan et al. reported that 3 patients had vertigo and 7 patients had tinnitus symptoms based on the Glasgow Benefit Inventory in 14 patients in whom the long-term quality of life was investigated after ISSHL treatment. In addition, they stated that 3 out of 7 patients with tinnitus continued to have vertigo symptoms. Contrary to our study, Dallan et al. reported that there was no significant difference in quality of life scores between patients with and without dizziness and tinnitus.[20]

CONCLUSION

In this study, it was found that patients with ISSHL could experience vertigo and tinnitus symptoms in addition to hearing loss, and these symptoms had a serious negative impact on the patients' quality of life. It is recommended that patients who receive

ISSHL treatment are followed up and not only their hearing is evaluated after medical treatment, but also a holistic evaluation should be made with audiovestibular tests. Based on these test results, patients' quality of life can be improved via appropriate treatment/rehabilitation programs. At the same time, patients requiring a multidisciplinary approach could be identified and related departments could be consulted. Thus, the prognosis of the disease is positively affected, and it will be possible to support the individual for them to be able to overcome this process more easily and to positively affect their quality of life.

Acknowledgements

We would like to thanks, our patients who participated in our study for their contribution to the studies.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

Idea/Concept: *Deniz Uğur Cengiz, İsmail Demir, Emre Akgün Özdemir;* ***Design:*** *Deniz Uğur Cengiz, Emre Akgün Özdemir, Hayriye Arık, Nergiz Nur, Beyza Bakar;* ***Control/Supervision:*** *Deniz Uğur Cengiz, İsmail Demir, Emre Akgün Özdemir;* ***Data Collection and/or Processing:*** *Emre Akgün Özdemir, Hayriye Arık, Nergiz Nur, Beyza Bakar;* ***Analysis and/or Interpretation:*** *Deniz Uğur Cengiz, İsmail Demir;* ***Literature Review:*** *Deniz Uğur Cengiz, Emre Akgün Özdemir, Hayriye Arık, Nergiz Nur, Beyza Bakar;* ***Writing the Article:*** *Deniz Uğur Cengiz, Emre Akgün Özdemir;* ***Critical Review:*** *Deniz Uğur Cengiz, İsmail Demir;* ***References and Fundings:*** *İsmail Demir, Deniz Uğur Cengiz;* ***Materials:*** *Deniz Uğur Cengiz, İsmail Demir, Emre Akgün Özdemir.*

REFERENCES

1. Liu J, Zhou RH, Liu B, Leng YM, Liu JJ, Liu DD, et al. Assessment of balance and vestibular functions in patients with idiopathic sudden sensorineural hearing loss. J Huazhong Univ Sci Technolog Med Sci. 2017;37(2):264-70. [Crossref] [PubMed]
2. Wang Y, Wang L, Jing Y, Yu L, Ye F. Association between hearing characteristics/prognosis and vestibular function in sudden sensorineural hearing loss with vertigo. Front Neurol. 2020;11:579757. [Crossref] [PubMed] [PMC]
3. Young YH. Contemporary review of the causes and differential diagnosis of sudden sensorineural hearing loss. Int J Audiol. 2020;59(4):243-53. [Crossref] [PubMed]
4. Schreiber BE, Agrup C, Haskard DO, Luxon LM. Sudden sensorineural hearing loss. Lancet. 2010;375(9721):1203-11. [Crossref] [PubMed]
5. Schuknecht HF, Kimura RS, Naufal PM. The pathology of sudden deafness. Acta Otolaryngol. 1973;76(2):75-97. [Crossref] [PubMed]
6. Belal A Jr. Pathology of vascular sensorineural hearing impairment. Laryngoscope. 1980;90(11 Pt 1):1831-9. [Crossref] [PubMed]
7. Gussen R. Sudden deafnfess of vascular origin: a human temporal bone study. Ann Otol Rhinol Laryngol. 1976;85(1 Pt 1):94-100. [Crossref] [PubMed]
8. McCabe BF. Autoimmune sensorineural hearing loss. Ann Otol Rhinol Laryngol. 1979;88(5 Pt 1):585-9. [Crossref] [PubMed]
9. Simmons FB. Theory of membrane breaks in sudden hearing loss. Arch Otolaryngol. 1968;88(1):41-8. [Crossref] [PubMed]
10. Korres S, Stamatiou GA, Gkoritsa E, Riga M, Xenelis J. Prognosis of patients with idiopathic sudden hearing loss: role of vestibular assessment. J Laryngol Otol. 2011;125(3):251-7. [Crossref] [PubMed]
11. Yu H, Li H. Vestibular dysfunctions in sudden sensorineural hearing loss: a systematic review and meta-analysis. Front Neurol. 2018;9:45. [Crossref] [PubMed] [PMC]
12. Fujimoto C, Egami N, Kinoshita M, Sugasawa K, Yamasoba T, Iwasaki S. Involvement of vestibular organs in idiopathic sudden hearing loss with vertigo: an analysis using oVEMP and cVEMP testing. Clin Neurophysiol. 2015;126(5):1033-8. [Crossref] [PubMed]
13. Shepard NT, Jacobson GP. The caloric irrigation test. Handb Clin Neurol. 2016;137:119-31. [Crossref] [PubMed]
14. Kantner C, Gürkov R. Characteristics and clinical applications of ocular vestibular evoked myogenic potentials. Hear Res. 2012;294(1-2):55-63. [Crossref] [PubMed]
15. Welgampola MS, Colebatch JG. Characteristics and clinical applications of vestibular-evoked myogenic potentials. Neurology. 2005;64(10):1682-8. [Crossref] [PubMed]
16. Iwasaki S, Takai Y, Ozeki H, Ito K, Karino S, Murofushi T. Extent of lesions in idiopathic sudden hearing loss with vertigo: study using click and galvanic vestibular evoked myogenic potentials. Arch Otolaryngol Head Neck Surg. 2005;131(10):857-62. [Crossref] [PubMed]
17. Niu X, Zhang Y, Zhang Q, Xu X, Han P, Cheng Y, et al. The relationship between hearing loss and vestibular dysfunction in patients with sudden sensorineural hearing loss. Acta Otolaryngol. 2016;136(3):225-31. [Crossref] [PubMed]
18. Wen YH, Chen PR, Wu HP. Prognostic factors of profound idiopathic sudden sensorineural hearing loss. Eur Arch Otorhinolaryngol. 2014;271(6):1423-9. [Crossref] [PubMed]
19. Cho CS, Choi YJ. Prognostic factors in sudden sensorineural hearing loss: a retrospective study using interaction effects. Braz J Otorhinolaryngol. 2013;79(4):466-70. [Crossref] [PubMed] [PMC]
20. Dallan I, Fortunato S, Casani AP, Bernardini E, Sellari-Franceschini S, Berrettini S, et al. Long-term follow up of sudden sensorineural hearing loss patients treated with intratympanic steroids: audiological and quality of life evaluation. J Laryngol Otol. 2014;128(8):669-73. [Crossref] [PubMed]

21. Alpar R. Spor Sağlık ve Eğitim Bilimlerinden Örneklerle Uygulamalı İstatistik ve Geçerlik-Güvenirlik. 4. Baskı. Ankara: Detay Yayıncılık; 2016.
22. Kim JS, Lopez I, DiPatre PL, Liu F, Ishiyama A, Baloh RW. Internal auditory artery infarction: clinicopathologic correlation. Neurology. 1999;52(1):40-4. [Crossref] [PubMed]
23. Hong SM, Byun JY, Park CH, Lee JH, Park MS, Cha CI. Saccular damage in patients with idiopathic sudden sensorineural hearing loss without vertigo. Otolaryngol Head Neck Surg. 2008;139(4):541-5. [Crossref] [PubMed]
24. Chen CN, Young YH. Differentiating the cause of acute sensorineural hearing loss between Ménière's disease and sudden deafness. Acta Otolaryngol. 2006;126(1):25-31. [Crossref] [PubMed]
25. Fournier P, Cuvillier AF, Gallego S, Paolino F, Paolino M, Quemar A, et al. A new method for assessing masking and residual inhibition of tinnitus. Trends Hear. 2018;22:2331216518769996. [Crossref] [PubMed] [PMC]
26. McCormack A, Edmondson-Jones M, Somerset S, Hall D. A systematic review of the reporting of tinnitus prevalence and severity. Hear Res. 2016;337:70-9. [Crossref] [PubMed]
27. Zhao H, Dong H, Cheng Y, Ma Y, Lin P, Zhong S, et al; Chinese sudden hearing loss multi-center clinical study group. [Multi-center study on the treatment of sudden deafness accompanied with tinnitus]. Zhonghua Er Bi Yan Hou Tou Jing Wai Ke Za Zhi. 2015;50(6):453-7. [PubMed]
28. Diao T, Ma X, Li J, Lai JT, Yu L, Zhang J, et al. Long-term prognosis of tinnitus associated with idiopathic sudden sensorineural hearing loss. Audiol Neurootol. 2021;26(6):461-9. [Crossref] [PubMed]
29. Nogueira-Neto FB, Gallardo FP, Suzuki FA, Penido Nde O. Prognostic and evolutive factors of tinnitus triggered by sudden sensorineural hearing loss. Otol Neurotol. 2016;37(6):627-33. [Crossref] [PubMed]
30. Hwang GH, Joo JW, Song IS, Rah YC, Choi J. Questionnaires in patients with unilateral sudden sensorineural hearing loss. J Int Adv Otol. 2017;13(2):211-6. [Crossref] [PubMed]