Association Between Vertigo and Hearing Prognosis in Patients with Sudden Sensorineural Hearing Loss: a Systematic Review and Meta-analysis

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Abstract

ABSTRACT *Objective.* Our aim was to explore the relationship between vertigo symptoms and the prognosis of hearing indicators in patients with sudden sensorineural hearing loss. *Data Source.* Eligible studies were identified from the "PubMed", "EMBASE", and "Web of Science" databases from January 2000 to September 2023. *Study Selection.* Studies were selected from all original and retrospective or prospective studies that focused on the relationship between vertigo and hearing prognosis in patients with sudden sensorineural hearing loss. *Data Extraction and Synthesis.* Observational metrics for data extraction included type of study, number of subjects with or without vertigo, treatment regimen, definition of pure tone hearing thresholds, criteria for hearing improvement, treatment duration, follow-up time, and age distribution of subjects. Meta-analysis was performed using Stata 15 software. *Main Outcome and Measure.* Association of vertigo symptoms and the prognosis of hearing indicators in patients with sudden sensorineural hearing loss. *Results.*A total of 4290 patients with sudden sensorineural hearing loss were identified in 23 studies. The hearing recovery rate was 40.8% in the group with vertigo and 53.76% in the group without vertigo. Vertigo was significantly associated with poorer hearing recovery (OR = 2.13; 95% CI, 1.63-2.79; $I^2 = 68.3\%$). Subgroup analyses revealed similar results for medication (OR=2.65; 95% CI, 1.84-3.83; $I^2 = 50.8\%$). However, an attenuated association between vertigo and the prognosis of sudden sensorineural hearing loss was observed in the subgroups treated with drugs combined with hyperbaric chambers (OR= 1.76; 95% CI, 0.75-4.15; $I^2 = 84.9\%$) and drugs combined with intratympanic injections (OR= 1.62; 95% CI, 1.02-2.58; $I^2 = 65.6\%$). *Conclusions and Relevance.* Our study suggested that vertigo may be a negative factor in sudden sensorineural hearing loss.Based on the results of the subgroup analysis,the combined treatment regimen has better efficacy in patients with sudden sensorineural hearing loss with vertigo.

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Key Points

· A total of 4290 patients with sudden sensorineural hearing loss from 23 studies were included in this meta-analysis.Vertigo may be a negative factor in sudden sensorineural hearing loss. Vertigo was significantly associated with poorer hearing recovery (OR = 2.13)

* the combined treatment regimen has better efficacy in patients with sudden sensorineural hearing loss with vertigo. The association was attenuated in the subgroup treated with hyperbaric oxygen chamber therapy(OR= 1.76) and intracameral steroid injections(OR= 1.62).

More original literature is required to clearly evaluate the patient's age, underlying disease, and initial level of hearing loss in order to quantify the specificity of the sudden sensorineural hearing loss population. Furthermore, it elucidates the impact of vertigo on the prognosis of sudden sensorineural hearing loss.

ABSTRACT

Objective. Our aim was to explore the relationship between vertigo symptoms and the prognosis of hearing indicators in patients with sudden sensorineural hearing loss.

Data Source. Eligible studies were identified from the "PubMed", "EMBASE", and "Web of Science" databases from January 2000 to September 2023.

Study Selection. Studies were selected from all original and retrospective or prospective studies that focused on the relationship between vertigo and hearing prognosis in patients with sudden sensorineural hearing loss.

Data Extraction and Synthesis. Observational metrics for data extraction included type of study, number of subjects with or without vertigo, treatment regimen, definition of pure tone hearing thresholds, criteria for hearing improvement, treatment duration, follow-up time, and age distribution of subjects. Meta-analysis was performed using Stata 15 software.

Main Outcome and Measure. Association of vertigo symptoms and the prognosis of hearing indicators in patients with sudden sensorineural hearing loss.

Results. A total of 4290 patients with sudden sensorineural hearing loss were identified in 23 studies. The hearing recovery rate was 40.8% in the group with vertigo and 53.76% in the group without vertigo. Vertigo was significantly associated with poorer hearing recovery (OR = 2.13; 95% CI, 1.63-2.79; I^2 = 68.3%). Subgroup analyses revealed similar results for medication (OR=2.65; 95% CI, 1.84-3.83; I^2 = 50.8%). However, an attenuated association between vertigo and the prognosis of sudden sensorineural hearing loss was observed in the subgroups treated with drugs combined with hyperbaric chambers (OR= 1.76; 95% CI, 0.75-4.15; I^2 = 84.9%) and drugs combined with intratympanic injections (OR= 1.62; 95% CI, 1.02-2.58; I^2 = 65.6%).

Conclusions and Relevance. Our study suggested that vertigo may be a negative factor in sudden sensorineural hearing loss.Based on the results of the subgroup analysis,the combined treatment regimen has better efficacy in patients with sudden sensorineural hearing loss with vertigo.

Keywords. Sudden sensorineural hearing loss, ISSNHL, vertigo, steroid, intratympanic injection, hyperbaric oxygen chamber, meta-analysis

INTRODUCTION

Sudden sensorineural hearing loss(SSHL)referred to a 72-hour hearing loss of 30 dB at least, in 3 consecutive frequencies within a period of 72 hours. The etiology of most cases is unknown, and 71% of cases are categorized as idiopathic[1]. In addition, the underlying pathologic mechanisms are not fully understood, and currently proposed hypotheses include viral infections, microcirculatory disorders, and autoimmune diseases[2]. The ambiguous etiology has led to a failure to develop uniform standards for its treatment options. The heterogeneity of sudden sensorineural hearing loss itself has led to discussions focused on treatment options and the prognosis of this disease being fraught with contradictions.

One way to characterize vertigo is as a feeling of movement, usually with rotation. It is considered a sign of vestibular impairment[3]. Among the discussions of SSHL, vertigo is widely reported to be a negative predictor of hearing recovery[4]. One possible hypothesis is that vertigo is due to disease of the vestibular portion of the inner ear. SSHL with vertigo has a worse prognosis in patients in whom the inner ear vestibule and cochlea are involved than in patients with only cochlear involvement and sudden sensorineural hearing loss without vertigo[5]. However, at the same time, some researchers hold the opposite opinion: they do not consider vertigo a sign of poor prognosis for SSHL and believe that vertigo is not significantly related to hearing recovery[6-8].

To verify whether vertigo is a poor prognostic sign of SSHL, in 2018, YU et al. reported their meta-analysis of the literature related to SSHL. The literature included 10 studies involving 4814 patients suffering from SSHL. These authors found that vertigo was obviously connected with poorer hearing recovery (OR=2.22;

95% CI, 1.54-3.20; I^2 = 74%) [9]. This report seems to argue what everyone expected before, but it does not represent a definitive conclusion. With the passage of 5 years, research on SSHL has improved, and interventions involving the Intratympanic injection of steroid hormones (ICs) and hyperbaric oxygen chamber therapy (HBOT) for treating SSHL have gained increasing amounts of attention. Therefore, our research group conducted an update of the meta-analysis of Yu et al. taking into account these new studies.

METHODS

This study was reported in accordance with the PRISMA (2020)[10] statement and was successfully registered on the Systematic Evaluation Register (CRD42024496989).

2.1 Data sources and search strategy

We screened for researches in Web of Science, PubMed, EMBASE, and other databases from January 1st, 2000 to September 1st, 2023 that involved assessment of the prognostic relationship between vertigo and sudden sensorineural hearing loss. The search terms used were "sudden hearing loss OR deafness, sudden OR sudden deafness OR hearing loss, sudden; vertigo OR vertical OR spinning sensation OR sensation, spinning OR sensations, spinning OR spinning sensations; and the third, both strings."

2.2 Criteria for inclusion

The criteria for the article to be included were: 1) retrospective, original or prospective researches involving the effect of vertigo on the hearing prognosis in people with SSHL; 2) researches reporting on the outcome of PTA in patients and the number of patients who improved; 3) studies involving a clear treatment plan; and 4) studies involving a patient population with or without vestibular symptoms. Studies that did not include hearing recovery rates or vertigo and studies with pregnant women were eliminated, as were practice guidelines, letters, reviews, editorials, theories, reports, and cases.

2.3 Data Extraction

Data extraction and efficacy evaluation criteria: Researches and statistics were extracted and assessed independently by two researchers (LUO and CHEN). The two researchers extracted the following data from each selected study: type of study, number of subjects with or without vertigo, age distribution, male/female ratio, treatment regimen, treatment period, definition of the average pure tone hearing threshold, standards for hearing amelioration, PTA or improvement rate after treatment, and follow-up time. The criteria for effective treatment were adopted according to the Siegel criteria: impaired hearing improvement >15 dB was considered an effective treatment, and impaired hearing improvement <15 dB was considered an ineffective treatment. We also compared the hearing recovery rate of patients suffering from SSHL among those with vertigo and those with SSHL among those free from vertigo and the rate of hearing recovery between each subgroup.

2.4 Quality Assessment and Sensitivity Analysis

The Newcastle–Ottawa scale was applied to evaluate the quality of the included studies and their risk of bias, and all of them had Newcastle–Ottawa scores between 7 and 8, which ensured that they all had high quality. We also performed sensitivity analyses to assess the robustness of the findings and investigated the heterogeneity of the included studies, assessing the impact of each study on the pooled results and treating a study as a causation of high heterogeneity if it was excluded because of its significantly lower I^2.

2.5 Data analysis

Stata 15.0 was applied to conduct meta-analysis, and the research results are presented as forest plots with 95% confidence intervals. The combined correlation between the rate of hearing recovery and incidence of vertigo was assessed by means of the Mantel–Haenszel method as dichotomous data, combined with the estimation of the ratio of the two groups of patients. The data from all the eligible studies in this research were quantitatively combined. The studies' statistical variability was analyzed by the P value (P [?] .05 implying obvious heterogeneity) and the I2 statistic as a derived Cochran Q statistic ([?]50%, high level of

heterogeneity; 25% to <50%, moderate level of heterogeneity; and <25% means slight level of heterogeneity). When I2 < 50% and/or P [?]0.05, a fixed-effects model was applied; otherwise, a random-effects model was applied. The funnel plots, which do not have sufficient power with fewer than 10 researches involved, were applied to visually evaluate the publication bias and potential asymmetry.[9]

2.6 Subgroup analysis

The article performed the following subgroup analyses using treatment regimen as a variable: medication alone, medication combined with hyperbaric chamber therapy, and medication combined with intradural steroid injection. Changes in recovery rates and changes in ORs in people with SSHL suffering or free from vertigo were compared across treatment regimens. Unfortunately, we tried to quantify the heterogeneity of the study population to determine the relationships between hearing age, degree of hearing loss, hearing graph, treatment regimen, and level of hearing benefit; however, we had to abandon these subgroups because of the paucity of studies that could provide relevant information.

RESULTS

3.1 Literature search and screening results

The literature search spanned from September 1, 2000, to September 1, 2023, and the literature search and screening were completed according to the systematic article collection flowchart (Figure 1), with a total of 1,072 retrieved studies, including 13 duplicate articles. By reading the titles and reviews, 996 irrelevant articles were excluded. Of the 63 articles, two had unavailable full text, and 61 papers in total were ultimately included. 38 of the 61 papers were excluded for a variety of reasons: 22 studies did not specify the recovery of vertigo, and 12 researches failed to satisfy the criteria for inclusion because of improvements and outcome indicators. One study included pregnant women, and 3 studies had missing data. A total of 23 studies and 4290 patients were selected for the meta-analysis[3,4,6-8,11-28].

3.2 Basic features of the included researches

Table 1 shows the clinical features of the included researches. Of the 4290 participants, 1720 were categorized into the SSHL with vertigo group, 2507 were categorized into the SSHL without vertigo group, and the follow-up time to the beginningof deafness were between 1-11.4 months. In 23 studies, Siegel's criteria was applied to assess the degree of hearing improvement, and hearing improvement >15 db was judged to be effective. Fourteen studies[4,8,11-17,19] and fourteen studies[4,8,11-17,19,20,22,26,28] used steroid-based systemic medication; seven studies[3,7,21,23-26] used a combination of medication and intratympanic steroid injections; four studies[6,24,26,27] used medication in combination with HBOT; and two studies used intratympanic steroid injections alone. Among them, Hideaki Suzuki[24] divided the study population into two groups: one receiving a combination of medication with intradermal injection of steroid hormones and one receiving a combination of medication with HBOT. Seiji Hosokawa[26] divided the study population into three groups: those receiving medication alone, those receiving a combination of medication with intradermal injection of steroid hormones, and those receiving a combination of medication with HBOT.

The included researches' quality and risk of bias were assessed by the Newcastle–Ottawa scale, and the total score of the 23 studies[3,4,6-8,11-28] ranged from 7–8 (Table 2).

All the studies depicted the incidences of better hearing outcomes in a dichotomous pattern (groups without and with vertigo). The meta-analysis of the data was conducted (Figure. 2A), and it presented a high degree of heterogeneity, with I^2=68.3%. For the analysis, a random effects model was applied, and the meta-analysis showed that the hearing recovery rate for SSHL without vertigo was 53.76%, and the hearing recovery rate for SSHL with vertigo was 40.8%. A pronounced difference (P = 0.000), OR = 2.13 (95% CI, 1.63-2.79; I^2 = 68.3%) was found. In addition, the patients were classified into three subgroups according to treatment regimens (Figure 2B). A total of 12 studies[4,8,11-17,22,26,28]were conducted, and 1552 patients were included in the subgroup receiving medication alone. In this subgroup, there were 544 patients with vertigo and 1008 patients free from vertigo. The rate of hearing recovery was 56.75% for SSHL free from vertigo and 35.48% for SSHL suffering from vertigo (P = 0.018; OR = 2.65; 95% CI, 1.84-3.83; I^2 = 50.8%).

A total of 4 studies[6,24,26,27] with 847 people were contained in the subgroup analysis of patients with medical treatment combined with hyperbaric chamber therapy. In this subgroup, there were 375 patients with vertigo and 472 patients free from vertigo. The rate of hearing recoverywas 65.25% for SSHL with vertigo and 62.13% for SSHL with vertigo (P = 0.018; OR = 1.76; 95% CI, 0.75-4.15; I^2 = 84.9%). In a total of seven[3,7,21,23-26] studies, 1372 patients were enrolled in the pharmacologic therapy combined with intracameral steroid injection therapy subgroup, which included 663 patients with vertigo and 709 patients free from vertigo. The rate of hearing recoverywas 47.53% for SSHL without vertigo and 35.74% for SSHL with vertigo; these two groups were significantly different (P = 0.008), OR = 1.62 (95% CI, 1.02-2.58; I^2 = 65.6%).

The existence of publication bias was evident in our data from 23 studies,and according to the omission regulation, sensitivity analyses were further conducted to assess and correct for publication bias, with the following results (Figure 3).

DISCUSSION

This paper included 23 research papers and 4290 patients, including 1720 patients with SSHL with vertigo and 2507 patients with SSHL free from vertigo. The rate of hearing recovery was 53.76% in the group with SSHl without vertigo and 40.8% in the group with SSHL with vertigo. According to the statistical analysis, vertigo was obviously connected with worse hearing recovery (OR = 2.13; 95% CI, 1.63-2.79; I^2 = 68.3%). These findings were consistent with those of Yu[9] et al.

In the subgroup with medication alone, the rate of hearing recovery was 56.75% in the SSHL without vertigo group and 35.48% in the SSHL with vertigo group. An obvious difference (P = 0.018), OR = 2.65 (95% CI, 1.84-3.83; I^2 = 50.8%) was found. In the subgroup treated with medication combined with hyperbaric chamber therapy, the rate of hearing recovery was 65.25% in the group with SSHL without vertigo and 62.13% in the group with SSHLwith vertigo; these values were significantly different (P = 0.018), OR = 1.76 (95% CI, 0.75-4.15; I^2 = 84.9%). In the subgroup treated with medication combined with intracameral steroid injection, the rate of hearing recoverywas 47.53% in the group with SSHL without vertigo and 35.74% in the group with SSHL with vertigo; these values were significantly different (P = 0.008, OR = 1.62; 95% CI, 1.02-2.58; I^2 = 65.6%). In both subgroups of patients treated with combination therapy, we found a significant reduction in the prognostic association between vertigo and sudden sensorineural hearing loss, which may suggest improved efficacy of combination therapy. In the subgroup treated with pharmacological treatment combined with intracameral steroid injection, the rate of hearing recovery was significantly lower in people suffering from SSHL than in patients in the other subgroups. We reviewed the seven papers included in this subgroup and found that, in these seven papers, the level of initial hearing loss in the target population was predominantly severe to profound degree of hearing loss and that the degree of initial hearing impairment in the population was greater than that in the other subgroups, which might explain the lower rate of improvement in this subgroup than in the other subgroups.

Sudden sensorineural hearing loss has always been a controversial medical phenomenon and has subsequently become a research hotspot attracting numerous people. Moreover, there is extensive heterogeneity in terms of initial hearing loss, accompanying symptoms, and hearing recovery in patients in clinical practice, which further exacerbates the difficulty of related research. Clinicians have observed that patients with severe hearing loss often have vertigo, which has been empirically recognized as a negative factor in hearing recovery. Many researchers have studied this issue. Anestis D.[12] reviewed the hearing changes and long-term prognosis of 80 patients over a 15-year period in a retrospective analysis. The study showed that treatment was ineffective in 80.6% of people suffering from SSHL accompanied by vertigo; however, the ineffectiveness was only 56.1% in people suffering from SSHL not accompanied by vertigo. Y-J TSA et al.[29] concluded vertigo was a negative prognostic indicator for SSHL in a follow-up research of 128 people suffering from SSHL for an average of up to 11.4 months. Ryosuke Kitoh[30] et al. conducted a multicenter, large-sample epidemiological survey that investigated the clinical features of 3,419 people suffering from SSHL and statistically analyzed the correlation between the degree of severity of hearing loss and patient prognosis. Vertigo symptoms were found to be significantly associated with poor prognosis. Similarly, Jae Ho Chung et al.[4] concluded that

vertigo is a negative predictor of hearing recovery in people suffering from SSHL and that the labyrinth damage degree may be correlated with the severity of cochlear impairment, with the likelihood of hearing recovery decreasing with increasing labyrinth involvement. However, several scholars have shown the opposite results. S HOSOKAWA et al.[6] studied 334 patients suffering from SSHL and reported that the rate of hearing improvement was 62.4% in people suffering from vertigo and 72.8% in people free from vertigo; moreover, no statistically obvious difference in the difference between the two recovery rates (p=0.062) was found. Suphi Bulğurcu et al.[31] studied 154 patients with a mean follow-up of up to 7.4 months and found that patients with vertigo had a lower but not statistically significant treatment success rate. According to multivariate analysis, Adriana Perez Ferreira Neto[28] et al. reported that the level of statistical significance between vertigo and a poor prognosis for hearing restoration was marginal (p=0.088). These studies suggest that whether vertigo serves as a poor prognostic element for SSHL remains controversial.

Yu et al. (2018) published a meta-analysis discussing whether vertigo is a poor prognostic element for SSHL. This meta-analysis included 10 articles with 4814 patients. They found that vertigo was obviously connected with poorer hearing improvement (OR = 2.22; 95% CI, 1.54-3.20; I^2 = 74%) [9]. With the continuous updating of relevant researches, the meta-analysis was conducted again, updating the previous articles and screening the included literature to improve the stability of the conclusions. In the end, we obtained the same conclusion as Yu et al.: vertigo is a negative prognostic factor for SSHL.

Limitations of the article

At the beginning of this study, we attempted to analyze patient subgroups for the presence of tinnitus, degree of hearing loss, frequency band of hearing loss, frequency band of hearing loss, and level of hearing benefit. We attempted to use subgroup analysis to quantify the specificity of the SSHL population and in order to clarify the appropriateness of the treatment regimen for a specific population. However, we had to abandon these subgroups because of the paucity of literature that could extract the relevant metrics.

Moreover, there is no standardization of treatment protocols among studies on sudden sensorineural hearing loss. The means of intervention, drug dosage, hormone type, duration of intervention, and severity of hearing loss varied significantly among researchers, all of which may have skewed the final results. This is a problem that cannot be avoided in this study. Therefore, additional clinical studies are needed to support subsequent researchers and obtain new conclusions.

CONCLUSION

Vertigo may be a negative factor in the hearing prognosis of people suffering from SSHL. Moreover, the correlation between poor prognosis and vertigo according to the SSHL became significantly reduced in both subgroups after the combined treatment. The combination of hyperbaric oxygen chamber therapy, intradermal injection of steroid hormone therapy and medication had a significant effect on hearing prognosis in patients with SSHL with vertigo.

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Table 1. Characteristics of Selected Studies in the Meta-analysis.

Source	**Research Type**	**Treatment**	**Number of patients recovering from treatment/headcount With Vertigo**	**Number of patients recovering from treatment/headcount Without Vertigo**	**Definition of PTA, kHz**	**Follow-up Period**
JaeHo Chung[4], 2015	Retrospective	iv: CS, dextran	23/72	129/241	Average at 0.5, 1, 2	no data
Daniel Weiss[11], 2017	Retrospective	iv: CS po:pentoxifyllin	16/59	51/128	Average at 0.125,0.5,1,2,3,4,6,8	no data
S HOSOKAWA[6], 2017	Retrospective	iv: CS and HBOT	158/217	73/117	Average at 0.25、0.5、1、2、4	2m
Yu-Hsuan Wen[7], 201	Retrospective	Iv: CS and IC	94/300	78/276	Average at 0.5, 1, 2,4	2m
Anestis D.Psifdis[12], 2006	Retrospective	Iv: CS and piracetam	7/36	18/41	Average at 0.5, 1, 2,4	No data
Jacob Ben-David[8], 2002	Prospective	Po: CS	5/17	29/50	Average at 0.5, 1, 2,8	no data

Tiong TS[13], 2007	Retrospective	Iv: CS po: Naftidrofuryl	3/10	38/43	Average at 0.5,1,2,3,4,6,8	3-12m
Yixu Wang[3], 2021	Retrospective	iv: batroxobin and IC	59/112	84/121	No data	3m
Yan-Hong Li[14], 2021	Prospective	Iv: CS Po: CS and GBE	6/18	9/11	Average at 0.5, 1, 2, 4,8	1m
Gaelle Vofo[15], 2021	Observational	po: CS	7/17	13/18	Average at 0.25、0.5、1、2、4、6、8	6m
Zhong Zheng[16], 2021	Prospective	Iv: CS and batroxobin	17/38	34/97	Average at 0.25、0.5、1、2、4、6、8	2m
Dondu Bentul Kizkapan[17], 2022	Prospective	Po: CS, betahistin and LAN	7/17	20/29	Average at 0.25、0.5、1、2、4、6	1m
Lingyun Lv[18], 2022	Prospective	IC or PSI	25/84	36/89	Average at 0.25、0.5、1、2、4、6、8	3m
Zhuang Jiang[19], 2021	Retrospective	iv: CS, vasodilators, neurotrophic drugs	10/29	11/21	Average at 0.25、0.5、1、2、4、6、8	1m
Marie N Shimanuki Park[20],2021	Retrospective	Iv: CS, dextran, ATP, B12	13/88	84/208	Average at 0.25、0.5、1、2、4	No data
Špela Kordiš[21], 2020	Prospective	iv:CS po:PPI and IC	14/24	31/39	Average at 0.5、1、2、4	6m
Kang Hyeon Lim[22], 2020	Retrospective	iv: CS po: CS	65/96	145/167	Average at 0.25、0.5、1、3	1m
Jin Woong Choi[23], 202	Retrospective	iv: CS po:CS and IC	8/55	13/48	Average at 0.5、1、2、4	2m
Hideaki Suzuki[24], 2019	Retrospective	GroupA: iv: CS and HBOT groupB: iv: CS and IC	52/79	169/223	Average at 0.25、0.5、1、2、4	No data
Mohsen Rajati[25], 2022	Retrospective	po: CS, ASA,acyclovir and IC	26/122	48/112	Average at 0.25,0.5, 1, 2, 4,8	1m
Seiji Hosokawa, 2018[26]	Retrospective	GroupA: iv: CS and HBOT groupB: iv: CS and IC groupC: iv: CS	61/149	133/207	Average at 0.25、0.5、1、2、4	No data
Shaobing Xie, 2018 [27]	Retrospective	HBOT and steroids	11/56	55/122	Average at 0.5、1、2、3	No data
Adriana Perez Ferreira Neto, 2021[28]	Retrospective	Po: steriod	24/88	47/98	Average at 0.5、1、2、3	6m

Abbreviation Description: iv, intravenous injection; po, per-oral;CS,corticosteroids; IC, Intratympanic injection of steroid hormones; HBOT, hyperbaric oxygen therapy; GBE, Ginkgo Biloba Extract; LAN, lansoprazole; ATP, Adenosine triphosphate; B12, vitamin B12; PSI, Intratympanic injection behind the ear; ASA, aspirin.	Abbreviation Description: iv, intravenous injection; po, per-oral;CS,corticosteroids; IC, Intratympanic injection of steroid hormones; HBOT, hyperbaric oxygen therapy; GBE, Ginkgo Biloba Extract; LAN, lansoprazole; ATP, Adenosine triphosphate; B12, vitamin B12; PSI, Intratympanic injection behind the ear; ASA, aspirin.	Abbreviation Description: iv, intravenous injection; po, per-oral;CS,corticosteroids; IC, Intratympanic injection of steroid hormones; HBOT, hyperbaric oxygen therapy; GBE, Ginkgo Biloba Extract; LAN, lansoprazole; ATP, Adenosine triphosphate; B12, vitamin B12; PSI, Intratympanic injection behind the ear; ASA, aspirin.	Abbreviation Description: iv, intravenous injection; po, per-oral;CS,corticosteroids; IC, Intratympanic injection of steroid hormones; HBOT, hyperbaric oxygen therapy; GBE, Ginkgo Biloba Extract; LAN, lansoprazole; ATP, Adenosine triphosphate; B12, vitamin B12; PSI, Intratympanic injection behind the ear; ASA, aspirin.	Abbreviation Description: iv, intravenous injection; po, per-oral;CS,corticosteroids; IC, Intratympanic injection of steroid hormones; HBOT, hyperbaric oxygen therapy; GBE, Ginkgo Biloba Extract; LAN, lansoprazole; ATP, Adenosine triphosphate; B12, vitamin B12; PSI, Intratympanic injection behind the ear; ASA, aspirin.	Abbreviation Description: iv, intravenous injection; po, per-oral;CS,corticosteroids; IC, Intratympanic injection of steroid hormones; HBOT, hyperbaric oxygen therapy; GBE, Ginkgo Biloba Extract; LAN, lansoprazole; ATP, Adenosine triphosphate; B12, vitamin B12; PSI, Intratympanic injection behind the ear; ASA, aspirin.	Abbreviation Description: iv, intravenous injection; po, per-oral;CS,corticoste IC, Intratympanic injection of steroid hormones; HBOT, hyperbaric oxygen therapy; GBE, Ginkgo Biloba Extract; LAN, lansoprazole; ATP, Adenosine triphosphate; B12, vitamin B12; PSI, Intratympanic injection behind the ear; ASA, aspirin.

Table 2. Assessment of Study Quality

Source	**Selection**	**Comparability**	**Outcome**	**NOS Score**
JaeHo Chung[4],2015	3	2	3	8
Daniel Weiss,2017	3	2	2	7
S HOSOKAWA[6],2017	3	2	2	7
Yu-Hsuan Wen[7],2013	3	2	3	8
Anestis D.Psifidis[12],2006	3	2	2	7
Jacob Ben-David[8],2002	3	2	2	7
Tiong TS[13],2007	3	2	3	8
Yixu Wang[3],2021	3	2	2	7
Yan-Hong Li[14],2021	3	2	2	7
Gaelle Vofo[15],2021	3	2	3	8
Zhong Zheng[16],2021	3	2	3	8
Dondu Betul Kizkapan[17],2022	2	2	3	7

Lingyun Lv[18],2022	3	2	3	8
Zhuang Jiang[19],2021	4	2	2	8
Marie N Shimanuki Park[20],2021	3	2	3	8
Špela Kordiš[21],2020	3	2	2	7
Kang Hyeon Lim[22],2020	3	2	3	8
Jin Woong Choi[23],2020	3	2	2	7
Hideaki Suzuki[24],2019	4	2	2	8
Mohsen Rajati[25],2022	3	2	3	8
Seiji Hosokawa[26],2018	4	2	2	8
Shaobing Xie[27],2018	3	2	2	7
Adriana Perez Ferreira Neto[28],2021	3	2	2	7