eISSN (Online): 2598-0580

Bioscientia Medicina: Journal of Biomedicine & Translational Research

Journal Homepage: www.bioscmed.com

Factors Affecting Intratympanic Corticosteroids Injection Therapy Results in Sudden Deafness Patients at Dr Mohammad Hoesin Hospital Palembang

Abla Ghanie[1,2], Listya Paramita[1,2*], Fiona Widyasari[1,2], Ahmad Hifni[1,2], Erial Bahar[3]

[1] Department of Ear Nose Throat Head and Neck Surgery, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

[2] Department of Ear Nose Throat Head and Neck Surgery, Dr Moh Hoesin Hospital, Palembang, Indonesia

[3] Department of Anatomy, Faculty of Medicine, Universitas Sriwijaya, Palembang, Indonesia

ARTICLE INFO

Keywords:
Sudden deafness
Result of therapy
Intratimpani corticosteroid injection

***Corresponding author:**
Listya Paramita

E-mail address:
listyaparamita011189@gmail.com

All authors have reviewed and approved the final version of the manuscript.

https://doi.org/10.32539/bsm.v5i11.364

ABSTRACT

Background. Sudden deafness is an emergency in the Ear Nose Throat Department, a subset of sensorineural hearing loss within a 72-hour window period and consists of a decrease in hearing of 30 decibels affecting at least three consecutive frequencies. The therapy given is corticosteroids, systemic corticosteroids or intratympanic corticosteroids injection, or both. The prognosis of sudden deafness depends on several factors. Patient with sudden hearing loss does not always have the same result in hearing improvement. This study was aimed to determine the factors that affect the results of intratympanic corticosteroid injection therapy in patients with sudden deafness. **Methods.** This study is an observational study with a cross-sectional design. The data were collected using medical records on 96 ears given intratympanic corticosteroid injection therapy at Dr. Mohammad Hoesin Hospital Palembang from July 2018 to February 2021. **Results.** From 96 ears conducted in the study, the improvement of therapeutic results on intratympanic corticosteroid injection in patients with sudden deafness was 72.9%. The study found factors that influenced the outcome of therapy, namely age (p=0.002), the onset of therapy (p = 0.003), and the use of a combination of systemic steroids (p=0.010). From the logistic regression test, it was found that the factors that most influenced the results of intratympanic corticosteroid injection therapy were young age 18-40 years (p=0.016) with (OR) 6.654 (CI95% 1.418-31.222) and therapy onset less than two weeks (p=0.027) with (OR) 3.108 (95% CI 1.134-8.515). **Conclusions.** The factors associated with the improvement in the outcome of intratympanic corticosteroid injection therapy in patients with sudden hearing loss were patient age and early onset of therapy.

1. Introduction

Sudden deafness is a sensorineural hearing loss of 30 dB or more, occurring at least three consecutive frequencies on audiometric examination and lasting less than 72 hours. In the United States, the incidence of sudden deafness is found to be around 5 to 27 per 100,000 population, with 66,000 new cases per year, and the incidence increases with age. At RSUP Dr. Mohammad Hoesin Palembang, from 2015 to 2016, there were 52 cases of sudden deafness. The etiology of sudden deafness is still unknown, and the majority occur unilaterally (96-99%). Management of sudden deafness cases should be treated based on the underlying etiology. Sudden deafness may resolve spontaneously in 32% to 65% of cases.[1,4]

According to the American Academy of Otolaryngology-Head and Neck Surgery Foundation (AAO-HNSF) guidelines, the main therapy for sudden deafness is the administration of corticosteroids, either systemic corticosteroids or intratympanic corticosteroid injections. In general, oral steroids are the first choice. However, intratympanic steroids may be an alternative, particularly if systemic therapy fails or avoids the side effects of systemic steroids. In patients, we judge to be at risk for systemic steroids. An intratympanic corticosteroid injection can be used as a single initial therapy, in combination therapy with

systemic steroids and salvage therapy. In cases of sudden deafness, Salvage therapy can be used during the onset of 2 weeks to 6 weeks from the occurrence of sudden deafness experienced by the patient.[2,3,5,6]

Treatment for every sudden deaf patient does not always have the same hearing improvement results. Several factors that influence the outcome of therapy for sudden deafness are the age of the patient, the presence of comorbid risk factors in the patient (vascular disorders), the presence or absence of vestibular symptoms such as vertigo, the degree of hearing loss, and the time between the onset of sudden deafness and the administration of therapy. Delay in starting treatment will give a poor prognosis for the patient's hearing improvement. There are not many studies in Indonesia that discuss intratympanic corticosteroid injection as a treatment option in patients with sudden deafness. This study aims to determine the factors that influence the results of intratympanic corticosteroid injection therapy in patients with sudden deafness to be considered for early administration of intratympanic corticosteroid injection therapy and can be a basis for patient education.

2. Methods

This study is an observational study with a cross-sectional design. The research was conducted at Dr. RSUP. Mohammad Hoesin Palembang. The research sample was all patients with sudden deafness who were given intratympanic corticosteroid injection therapy at Dr. Mohammad Hoesin Palembang from July 2018 to February 2021 and met the research criteria. Sampling in this study was carried out by total sampling.

The inclusion criteria in this study were all patients with sudden deafness at Dr. Mohammad Hoesin Palembang who received intratympanic corticosteroid injection therapy during the study period, patients with type A tympanometry, and sudden deafness patients who received six injections of intratympanic corticosteroids within six weeks from onset. Exclusion criteria were sudden deaf patients treated with intratympanic corticosteroid injections with incomplete medical records and sudden deaf patients who were not subjected to post-therapy audiometric examination.

The variables in this study included independent variables, namely age, tinnitus, vertigo, diabetes mellitus, hypertension, dyslipidemia, hypercoagulation, degree of hearing loss at diagnosis, the onset of therapy, and systemic steroids dependent variable was the outcome of therapy.

Processing and data results are assisted by SPSS software for windows version 24.0. Statistical analysis to examine the relationship between factors that influence the outcome of intratympanic corticosteroid injection therapy was performed using the Chi-Square test or Fisher's exact test. This research has been considered ethically worthy and approved by the Health Research Ethics Committee of Dr. RSUP. Mohammad Hoesin Palembang. Ethical permits are carried out following applicable procedures and rules.

3. Result

A total of 83 sudden deaf patients who met the inclusion criteria were included as study subjects, consisting of 45 male patients (54.2%) and 38 female patients (45.8%). Most of the research subjects were in the age group of more than 40 years, namely 56 patients (67.5%), with an average age of 49.19±14.37 years with a median age of 51 years in the age range of 18 years to 80 years. From the study results, 70 patients experienced sudden unilateral deafness (84.3%), and as many as 13 patients experienced sudden bilateral deafness (15.7%) so that 96 ears were used as research samples for analysis.

Of 83 patients, there were vestibular symptoms experienced by patients in the form of vertigo complaints in 34 patients (41%). Forty-three patients (51.8%) had comorbidities, and 40 patients (48.2%) had no comorbidities. One patient can have more than one comorbid. The comorbid diseases found in the research subjects were hypertension, diabetes mellitus, dyslipidemia, and hypercoagulation. Diabetes mellitus was found in 12 patients (14.5%), hypertension was found in 16 patients (19.3%), hypercoagulation was found in 6 patients (7.2%), while dyslipidemia was present in quite a several patients, namely in 26 patients (31,3%). A total of 46 patients (55.6%) were

treated with an onset of fewer than two weeks, and 37 patients (44.6%) were treated with an onset of 2 to 6 weeks. In this study, out of 83 patients who were given intratympanic corticosteroid injections, 57 patients (68.7%) were given additional systemic steroids.

Table 1. Characteristics of subjects (n = 83)

Variable	N	%	$\bar{X}$ ± SD
Ages			
18-40 y.o.	27	32,5	49,19±14,37
>40 y.o.	56	67,5	
Gender			
Male	45	54,2	
Female	38	45,8	
Affected ear			
Unilateral	70	84,3	
Bilateral	13	15,7	
Vertigo			
Yes	34	41,0	
No	49	59,0	
Comorbid disease			
Diabetes mellitus	12	14,5	
Hypertension	16	19,3	
Dyslipidemia	26	31,3	
Hypercoagulation	6	7,2	
Onset of therapy			
< 2 weeks	46	55,4	
2-6 weeks	37	44,6	
Systemic steroid			
Yes	57	68,7	
No	26	31,3	
Total	83	100,0	

The audiometric examination was carried out before the patient was given therapy and was re-examined after the patient was given 6 injections of intratympanic corticosteroids. Audiometry was performed to assess the degree of hearing loss in patients with sudden deafness. Audiometry was aimed to assess the success of therapy, too. Based on the degree of hearing loss at the time of diagnosis, the majority of the samples experienced severe hearing loss experienced by 36 samples (37.5%), followed by mild hearing loss by 21 samples (21.9%), the moderate and moderate-severe hearing loss experienced by every 18 samples (18.8%) and only three samples had very severe hearing loss (3.1%). Tinnitus symptoms were found in almost all samples, namely, 86 samples (89.6%). According to the results of the study, data on patients who were given intratympanic corticosteroid injection therapy showed that the results of corrective therapy were 70 samples (72.9%) with the results of therapy according to Siegel's criteria in the form of partial recovery in 33 samples (34.4%), minimal recovery in 20 samples (20.8%) and fully recovered which was only experienced by 17 samples (17.7%). There were 26 samples (27.1%) who did not experience an improvement in therapy outcome.

Table 2. Characteristics of Research Subjects Based on Degree of Hearing Loss and Intervention (n = 96)

Variables	N	%
Deafness degree		
Mild	21	21,9
Moderate	18	18,8
Moderate-severe	18	18,8
Severe	36	37,5
Very severe	3	3,1
Tinnitus		
Yes	86	89,6
No	10	10,4
Therapy outcome		
Good	70	72,9
Poor	26	27,1
Recovery criteria (*Siegel*)		
Full recovery	17	17,7
Part recovery	33	34,4
Minimal recovery	20	20,8
None	26	27,1
Total	96	100,0

In this study, out of 96 samples, the age categories were divided into 18-40 years and those over 40 years of age. In the 18-40 year age group category, it was found that there were far more samples with hearing improvement (93.5%) than those without improvement (6.5%). This is also seen in more than 40 years in the age group, where more samples experienced improvement (63.1%) than did not improve (36.9%). The percentage of samples that experienced improvement after therapy in the age group of more than 40 years was smaller than 18-40 years. The analysis results using Chi-square obtained a significant relationship between age and the results of intratympanic corticosteroid injection therapy (p = 0.002).

Tabel 3. Relationship of age with outcome of intratympanic corticosteroid injection therapy

Age	Therapy result(n%)		Total
	Recovery	No recovery	
18- 40 y.o.	29 (93,5)	2 (6,5)	31 (100,0)
> 40 y.o.	41 (63,1)	24 (36,9)	65 (100,0)
Total	70 (72,9)	26 (27,1)	96 (100,0)

Pearson Chi-square, p=0,002, OR=8,488, CI95%=1,858-38,764

The group with tinnitus symptoms had a smaller percentage of treatment success (72.1%) than the group without tinnitus symptoms (80%). Based on the analysis using Fisher exact, there was no significant relationship between tinnitus and the results of intratympanic corticosteroid injection therapy (p=0.724). The improvement in the results of corticosteroid injection therapy was found to be greater in the group that did not experience vertigo (75.4%) than the group that experienced vertigo (69.2%). Data analysis using Chi-square showed no significant relationship between vertigo symptoms and the results of intratympanic corticosteroid injection therapy (p=0.501).

The group with no comorbid had a higher percentage of successful therapy than the comorbid group. From the results of the analysis, no significant relationship between the history of comorbidities experienced by patients with the results of intratympanic corticosteroid injection therapy, namely diabetes mellitus (p = 0.194), hypertension (p = 0.772), dyslipidemia (p = 0.319), and hypercoagulation

(p=0.108).

Table 4. Relationship between symptoms and comorbidities with the outcome of intratympanic corticosteroid injection therapy

Variables	Therapy outcome (n%)		Total	*p* value	OR (CI 95%)
	Recovery	No recovery			
Tinnitus	62 (72,1)	24 (27,9)	86	0,724	1,548(0,307-7,821)
Vertigo	27 (69,2)	12 (30,8)	39	0,501	1,365(0,550-3,388)
Diabetes mellitus	8 (57,1)	6 (42,9)	14	0,194	2,325(0,720-7,509)
Hypertension	14 (77,8)	4 (22,2)	18	0,772	0,727(0,216-2,453)
Dyslipidemia	22 (66,7)	11 (33,3)	33	0,319	1,600 (0,633-4,044)
Hypercoagulation	9 (100,0)	0 (0,0)	9	0,108	0,701 (0,611-0,804)

In the group with the classification of mild, moderate, moderate-severe, and severe hearing loss, more groups experienced hearing improvement than those without hearing improvement. In the group with a very severe degree of hearing loss, 66.7% of the patient did not experience an improvement in therapy results. From the analysis results, there was no significant relationship between the degree of hearing loss and the outcome of therapy (p=0.288).

Table 5. Correlation between degree of hearing loss and outcome of intratympanic corticosteroid injection therapy

Hearing loss degree	Therapy outcome (n%)		Total
	Recovery	No recovery	
Mild	14 (66,7)	7 (33,3)	21 (100,0)
Moderate	15 (83,3)	3 (16,7)	18 (100,0)
Moderate-severe	15 (83,3)	3 (16,7)	18 (100,0)
Severe	25 (69,4)	11 (30,6)	36 (100,0)
Very severe	1 (33,3)	2 (66,7)	3 (100,0)
Total	70 (72,9)	26 (27,1)	96 (100,0)

Pearson Chi-square, p=0,288

Early-onset of therapy (less than two weeks) showed higher therapeutic efficacy (84.9%) than the group that received therapy more than two weeks from symptom onset (58.1%). From the analysis results, it was found that there was a significant relationship between the onset of therapy and the improvement in the results of intratympanic corticosteroid injection therapy (p=0.003).

Table 6. Relationship between therapy onset and outcome of intratympanic corticosteroid injection therapy

Therapy onset	Therapy outcome (n%)		Total
	Recovery	No recovery	
< 2 weeks	45 (84,9)	8 (15,1)	53 (100,0)
2-6 weeks	25 (58,1)	18 (41,9)	43 (100,0)
Total	70 (72,9)	26 (27,1)	96 (100,0)

Pearson Chi square, p=0,003, OR=4,050, CI95%=1,542-10,638

The percentage of success in the group that received additional systemic steroids (80.6%) was more significant than the group that did not receive additional systemic steroids (55.2%). The analysis results found a significant relationship between the addition of systemic steroids with the results of intratympanic corticosteroid injection therapy (p = 0.010).

Table 7. Relationship of systemic steroid use with intratympanic corticosteroid injection therapy results

Systemic steroid	Therapy outcome (n%)		Total
	Recovery	No recovery	
Yes	54 (80,6)	13 (19,4)	67 (100,0)
No	16 (55,2)	13 (44,8)	29 (100,0)
Total	70 (72,9)	26 (27,1)	96 (100,0)

Pearson Chi square, p=0,010, OR=3,375, CI95%=1,305-8,725

Multivariate analysis was performed using logistic regression. The data will be selected gradually until the last stage, namely the independent variable, which is considered the most influential on the dependent variable, in this case, the success of intratympanic corticosteroid injection therapy. Age has a significant effect on therapy success with a p-value = 0.016, and the chance of success in the younger age group, namely 18-40 years, is (OR) 6.654 with 95% CI 1.418-31.222. Early-onset therapy had a significant effect with p=0.027, and the probability of successful therapy (OR) was 3.108 times with 95% CI 1.134-8.515. The younger sudden deaf patients (less than 40 years old) were given intratympanic corticosteroid injections as early as less than two weeks from the onset of symptoms. The probability of successful therapy can reach 96%.

Table 8. Multivariate analysis of results of intratympanic corticosteroid injection therapy

Variables	**B**	**p-value**	**OR**	**CI 95%**	
				Min	**Max**
Age	1,895	0,016	6,654	1,418	31,222
Therapy onset	1,134	0,027	3,108	1,134	8,515
Constant	0,057	0,864	1,058		

4. Discussion

In this study, 83 patients who met the inclusion criteria were included as research subjects, 45 male patients (54.2%) and 38 female patients (45.8%). The results of this study are by the literature, which states that the distribution of sudden deafness for male and female sexes is almost the same. In Korea, Kim et al. found 106 cases of sudden deafness, with 47 cases being male and 59 cases being female. Hara et al. also stated in their study that there was no significant difference between male (54.7%) and female (45.3%) sex in patients with sudden deafness. Research conducted by Tsounis et al. found that the age of patients experiencing sudden deafness ranged from 18 to 80 years, with an average age of 54.4 years.

Of the 83 study subjects, 70 patients experienced sudden unilateral deafness (84.3%), and 13 patients experienced sudden bilateral deafness (15.7%) so that the final data for the study sample was 96 samples. Thus, the results of this study are following the literature, which states that the majority of sudden deafness occurs unilaterally in about 96-99% of cases. In addition, Ghanie et al. found sudden deafness that occurred unilaterally in 88.5% of cases and bilateral in 11.5% of cases.

According to the study results, from 96 samples, data obtained from patients who were given intratympanic corticosteroid injection therapy had hearing improvement therapy results of 72.9%. Barreto et al., in their study, stated that hearing improvement was obtained by 76.7% in patients who were given intratympanic corticosteroid injection therapy as salvage therapy in patients who had failed therapy using systemic steroids. According to Swamy et al.,

hearing improvement was found in 68% of cases given an intratympanic injection of dexamethasone, not much different from the study conducted by Sung et al., which stated that hearing improvement in patients with sudden deafness based on Siegel's criteria was 66.7%.[10,11,12]

In this study, there was an improvement in therapy results according to Siegel's criteria, where the most results obtained were partial recovery in 33 samples (34.4%), minimal recovery in 20 samples (20.8%), and complete recovery, which was only experienced by 17 samples (17.7%). A total of 26 samples (27.1%) did not get any improvement in hearing after therapy using intratympanic corticosteroid injection. According to the research of Sung et al., improvement according to Siegel's criteria was obtained by most patients experiencing a complete recovery of 55.6% in patients treated with intratympanic corticosteroid injections every day for four days. A study conducted by Patar et al. found that 50% of cases experienced a complete recovery after intratympanic corticosteroid injection therapy. Various factors influence the difference in therapeutic results.[12,13]

In this study, out of 96 samples conducted by the study, the age categories were divided into 18-40 years of age and those of more than 40 years of age. In the 18-40 year age group category, it was found that there were far more samples with hearing improvement, namely 93.5% than those without improvement, and the results of corrective therapy were more found at the age of fewer than 40 years compared to samples with an age of more than 40 years. Thus, from the results of the study, there was a significant relationship between age and the results of intratympanic corticosteroid injection therapy ($p = 0.002$).

In this study, 89.6% of patients experienced tinnitus symptoms. Based on the study results, there was no significant relationship between tinnitus and the results of intratympanic corticosteroid injection therapy ($p=0.724$). Tinnitus is the most common symptom accompanying sudden deafness. Shewel et al. also stated no significant relationship between tinnitus and hearing improvement ($p=0.427$). The presence of tinnitus after cochlear damage indicates the presence of functioning hair cells. In addition, 40.6% of the sample experienced vertigo symptoms. There was no significant relationship between vertigo symptoms and the outcome of therapy ($p=0.501$). From the literature, vertigo is the second most common clinical symptom found after tinnitus. The presence of vertigo has a worse prognosis than not accompanied by vertigo because the presence of vertigo indicates extensive damage that has affected the balance system.

This study reported no significant difference between the degree of hearing loss in patients when diagnosed with sudden deafness and the outcome of treatment improvement ($p=0.288$). In the group with the classification of mild, moderate, moderate-severe, and severe hearing loss, more groups experienced hearing improvement than those without hearing improvement. In contrast to the group with very severe degrees of hearing loss, more samples did not experience an improvement in therapy outcomes. Research conducted by Cheng et al. stated that patients with very severe hearing loss, if treated in less than 14 days from onset, can still experience improvement in treatment outcomes. In their study, Mirian et al. and Tsounis et al. stated that the best time of onset for sudden deafness therapy was less than seven days. Attanasio et al. stated that intratympanic injection therapy showed a hearing improvement rate of 47.2%.

In this study, an analysis was conducted on the relationship between additional systemic steroids and therapy success. A total of 67 samples were given additional systemic steroids. A more significant percentage of success was found in the group using systemic steroids; the analysis obtained a significant relationship between the addition of systemic steroids and improved therapeutic outcomes ($p=0.010$). According to the AAO-HNSF guidelines, intratympanic corticosteroid injections are effective as salvage therapy when oral steroids have failed and patients with comorbidities such as diabetes mellitus. Corticosteroids work by reducing inflammation, edema, modulating the immune system in the inner ear, increasing the microcirculation of the inner ear, having an antioxidant effect, and playing a role in ion and

water homeostasis.[2,22,24] Corticosteroids also aim to improve nerve function. Corticosteroids reach the inner ear via a systemic route via intratympanic steroid injection and increase blood flow to the inner ear. The systemic actions of steroids include decreasing the number of circulating leukocytes and inhibiting inflammatory mediators in the systemic circulation. The combination of intratympanic injection therapy and systemic steroids can increase the effectiveness of therapy.[6,10,25]

To see the strength of the relationship between the independent variables and the dependent variable, namely the factors that influence intratympanic corticosteroid injection therapy results, a multivariate analysis was carried out on the variables that had a p-value of <0.25. The results of logistic regression showed that the age and onset of therapy had a significant effect on therapy success. Age had a significant effect on the success of intratympanic corticosteroid injection therapy (p=0.016), with the chance of success in the younger age group (18-40 years) 6.654 times better than in the old age (over 40 years). Early-onset therapy (less than two weeks) had a significant effect (p=0.027) with a 3.108 times better chance of successful therapy than patients who were given therapy more than two weeks from symptom onset. Sudden deaf patients who are young (less than 40 years old), if given intratympanic corticosteroid injections early, i.e., less than two weeks from symptom onset, have a 96% probability of successful therapy. This study follows research conducted by Hara et al., who stated that age and rapid onset of therapy affect the prognosis of hearing improvement in patients with sudden deafness.[24,26]

5. Conclusion

Sudden deaf patients who were given intratympanic corticosteroid injection therapy had hearing improvement therapy results of 72.9%. The factors associated with improved therapeutic outcomes were age and the onset of treatment. The chances of successful therapy in the younger age group (18-40 years) are 6.654 times better than those over 40 years old.

6. References

1. Rauch SD, Dobie R, Doyle KJ. Idiopathic sudden sensorineural hearing loss. In: Ballenger's otorhinolaryngology head and neck surgery. 18th ed. Wackym PA, editors. 2016. USA: PMPH. 317-21.
2. Chandrasekhar SS. Clinical practice guideline: sudden hearing loss (update). Otolaryngology - head and neck surgery. American Academy of Otolaryngology-Head and Neck Surgery Foundation, 2019, 161: 1-45.
3. Marx M, Younes E, Chandrasekhar SS, Ito J, Plontke S, et al. International consensus (ICON) on treatment of sudden sensorineural hearing loss. Eur Ann Otorhin Head Neck Dis, 2018, 135: 23-8.
4. Ghanie A, Bahar E, Adiarti W. Predictor factors that influence the result of sudden deafness therapy. J Res Med Dent Sci, 2017, 5: 107-12.
5. Attanasio G, Russo FY, Porto E, Cagnoni L, Masci E, et al. Prediction of hearing recovery in sudden deafness treated with intratympanic steroids. Acta Otorhin Ita, 2018, 38: 453-9.
6. Eftekharian A, Amizadeh M. Pulse steroid therapy in idiopathic sudden sensorineural hearing loss: a randomized controlled clinical trial. Laryngoscope, 2016, 126: 150-5.
7. Kim YJ, Jang SU, Lee HH, Kwon JH. Comparison of the effect of intratympanic steroid injection medications in patients with idiopathic sudden sensorineural hearing loss. Korean J Otorhin Head Neck Surg. 2017, 60: 441-8.
8. Hara JH, Zhang JA, Gandhi KR, Flaherty A, Barber W, et al. Oral and intratympanic steroid therapy for idiopathic sudden sensorineural hearing loss. Laryngosc Invest Otolaryngol, 2018, 3: 73-7.
9. Oliver ER, Hashisaki GT. Sudden sensory hearing loss. In: Bailey's head and neck surgery otolaryngology. 5th ed. Hirsch BE, Jackler RK, editors. Philadelpia: Lippincott Williams and Wilkins. 2014: 2589-95.
10. Barreto MA, Ledesma AL, Oliveira CA, Bahmad

F. Intratympanic corticosteroid for sudden hearing loss: does it really work. Bra J Otorhinolaryngol, 2016, 82: 353-64.

11. Swamy KM, Ganiger A. Effect of intratympanic dexamethasone injection in sudden idiopathic sensorineural hearing loss. Int J Otorhinol Head Neck Surg, 2016, 2: 258-62.
12. Sung HK, Kang JC, Shin KH, An YS. Comparison of the effects of intratympanic steroid injection at different intervals in sudden sensorineural hearing loss. J Audiol Otol, 2020, 24: 24-8.
13. Patar M, Sangma R. Intratimpanic metylprednisolone in as first line therapy for idiopatic sudden sensorineural hearing loss. Bengal J Otolaryngol Head Neck Surg, 2017, 25: 69-74.
14. Tsounis M, Psillas G, Tsalighopoulos M, Vital V, Maroudias N, et al. Systemic, intratympanic and combined administration of steroids for sudden hearing loss: a prospective randomized multicenter trial. Eur Arch Otorhinolaryngol, 2018, 275:103-10.
15. Edizer DT, Celebi O, Hamit B, Baki A, Yigit O. Recovery of idiopathic sudden sensorineural hearing loss. J Int Adv Otol, 2015, 11: 122-6.
16. Bogaz EA, Maranhã AS, Inoue DP, Suzuki FA, Penido NO. Variables with prognostic value in the onset of idiopathic sudden sensorineural hearing loss. Braz J Otorhinolaryngology, 2015, 81: 520-6.
17. Niu X, Zhang Y, Zhang Q, et al. The relationship between hearing loss and vestibular dysfunction in patients with sudden sensorineural hearing loss. Acta Otolaryngol, 2016, 136: 225-31.
18. Sugihara EM, Evans MA, Neumann M, Babu SC. The effect of intratympanic steroid injection frequency in idiopathic sudden sensorineural hearing loss. Am J Otolaryngol, 2018, 39: 688-92.
19. Tahir E, Keseroglu K, Er S, Ocal B, Ozdek A, et al. The outcome of intratympanic steroid therapy as a salvage treatment for sudden sensorineural hearing loss. Tr-ENT, 2019, 29: 79-85.
20. Xie Y, Orabi NA, Zwolan TA, Basura GJ. Outcomes of unilateral idiopathic sudden sensorineural hearing loss: two decades of experience. Laryngosc Invest Otolaryngol, 2019; 4: 693–702.
21. Cheng YF, Chu YC, Tu TY, Shiao AS, Wu SL, et al. Modified Siegel's criteria for sudden sensorineural hearing loss: Reporting recovery outcomes with matched pretreatment hearing grades. J Chinese Med Assoc, 2018, 1-5.
22. Mirian C, Ovesen T. Intratympanic vs systemic corticosteroids in first-line treatment of idiopathic sudden sensorineural hearing loss. JAMA Otolaryngol Head Neck Surg, 2020,1-8.
23. Hobson CE, Alexander TH, Harris JP. Primary treatment of idiopathic sudden sensorineural hearing loss with intratympanic dexamethasone. Curr Opin Otolaryngol Head Neck Surg, 2016, 24:407-12.
24. Yang W, Li X, Zhong J, Mei X, Liu H, et al. Intratympanic versus intravenous corticosteroid treatment for sudden sensorineural hearing loss in diabetic patients: proposed study protocol for a prospective, randomized superiority trial. BMC, 2020, 21:135.
25. Piu F, Bishop KM. Local drug delivery for the treatment of neurotology disorders. Front Cell Neurosci, 2019, 13: 1-11.
26. Kang WS, Yang CJ, Shim M, Song CI, Kim TS, et al. Prognostic factors for recovery from sudden sensorineural hearing loss: a retroscpective study. J Audiol Otol, 2017, 21: 9-15.