International Journal of Otorhinolaryngology and Head and Neck Surgery
Latoo MA et al. Int J Otorhinolaryngol Head Neck Surg. 2020 Jun;6(6):1096-1101
http://www.ijorl.com
pISSN 2454-5929 | eISSN 2454-5937

Original Research Article

DOI: http://dx.doi.org/10.18203/issn.2454-5929.ijohns20202206

Hearing gain after tympanoplasty: a prospective study

Manzoor Ahmad Latoo, Romesh Bhat, Aleena Shafi Jallu*

Department of Otorhinolaryngology, Government Medical College, Srinagar, Jammu and Kashmir, India

Received: 28 February 2020
Revised: 10 April 2020
Accepted: 27 April 2020

***Correspondence:**
Dr. Aleena Shafi Jallu,
E-mail: aleenajallu@gmail.com

ABSTRACT

Background: The aim of the present study was to determine hearing improvement in different types of tympanoplasties by comparing mean preoperative air bone (AB) gap with mean postoperative AB gap. The study focused on reconstruction of tympanic membrane and ossicular apparatus by tympanoplasty alone or tympanoplasty with mastoid surgeries (canal wall up or canal wall down).
Methods: 60 patients of either sex having chronic otitis media with conductive hearing loss of >20 dB were included in the study. Each patient had to undergo preoperative and postoperative pure tone audiometry to calculate average AB gap. Patients underwent tympanoplasty, with or without mastoid exploration depending on the disease status. Pure tone audiometry (PTA) was done at 3 months and 6 months and compared with pre-operative PTA.
Results: Preoperatively PTA showed 29 (48.33%) patients had mild degree of hearing loss, followed by moderate degree of hearing loss in 18 (30.0%) patients. 10 (16.67%) patients had minimal hearing loss and moderately severe hearing loss was seen in 3 (5%) patients. Tympanoplasty alone was done in 52 patients (86.67%). Tympanoplasty with canal wall up mastoidectomy was done in 6 (10%) and tympanoplasty with canal wall down mastoidectomy was done in 2 (3.33%) patients. Type I tympanoplasty was performed in 37 (61.6%) patients, type-III tympanoplasty was the type of surgery in 15 (25.0%) patients. Type II and type IV tympanoplasties were performed in 4 (6.7%) patients each separately.
Conclusions: Hearing gain is better in type I tympanoplasty than in tympanoplasty type II, type III and type IV with or without mastoid surgeries.

Keywords: Hearing gain, Tympanoplasty, Pure tone audiometry

INTRODUCTION

Chronic otitis media (COM) is the chronic inflammation of mucoperiosteal lining of the middle ear cleft characterized by ear discharge, a permanent perforation of the tympanic membrane and impairment in hearing. It is a major cause of deafness in India.[1-3] COM in general causes a wide range of middle ear pathologies including irreversible mucosal damages, granulation tissue formation, cholesteatoma, ossicular destruction, tympanosclerosis and are classified accordingly into inactive mucosal, inactive squamous, active mucosal and active squamous type of chronic otitis media.[4]

Perforations cause a loss that depends on frequency, perforation size, and middle-ear air space volume.[5,6] Perforation size is an important determinant of the loss; larger perforations result in larger hearing losses. The volume of the middle-ear air space (combined tympanic cavity and mastoid air volume) is also an important parameter that determines the amount of hearing loss caused by a perforation. Other things being equal, for a given sound pressure in the ear canal and a given

perforation, the resulting sound pressure within the middle-ear cavity will vary inversely with middle-ear volume. Hence, the transtympanic membrane sound-pressure difference will be smaller (and the conductive loss correspondingly greater) with smaller middle-ear volumes.[5,7]

A good clinical evaluation with otoscope, an audiometric evaluation and a high resolution computed tomography (CT) of the temporal bone forms a reliable preoperative tool to assess the ossicular status and the disease extent. However, this can only be confirmed intra-operatively by checking for the ossicular continuity by means of Round window light reflex, which is produced even by the slightest movement of the stapes foot plate.

Tympanoplasty is the final step in the surgical conquest of conductive hearing losses and the goal of tympanoplasty is to restore sound pressure transformation at the oval window by coupling an intact tympanic membrane with a mobile stapes footplate via an intact or reconstructed ossicular chain and to provide sound protection for the round window membrane by a closed air containing and mucosa lined middle ear.[8] An intact ossicular chain is one of the most desirable attributes of a Tympanoplasty procedure and represents the most favourable hearing outcome.[9]

Before performing surgery, one assumes that the original insult responsible for the sequelae of perforation and the subsequent reasons for its persistence have been resolved. In many cases, this assumption will prove to be correct; but in some, persistence of causative factors may remain undetected and undefined with consequent late failure of the procedure. Follow-up period thus may play a role in reported outcome as well.[10]

The aim of the present study was to determine hearing improvement in different types of tympanoplasties by comparing mean preoperative air bone (AB) gap with mean postoperative AB gap. The study focused on reconstruction of tympanic membrane and ossicular apparatus by tympanoplasty alone or tympanoplasty with mastoid surgeries (canal wall up or canal wall down).

METHODS

This prospective observational study was conducted in the Postgraduate Department of Otorhinolaryngology, Head and Neck Surgery of SMHS Hospital an associated hospital of Govt. Medical College Srinagar from August 2016 to July 2018. Sixty patients of either sex in the age group 10 to 50 years having COM with conductive hearing loss of >20 dB was included in the study. Patients with sensorineural hearing loss, complicated COM, revision surgery, any malignancy or general condition not permitting surgery were excluded from the study

All the patients were thoroughly assessed preoperatively by detailed clinical and audiological examination. Each patient had to undergo preoperative and postoperative pure tone audiometry to assess degree of hearing loss as per WHO classification and calculate average AB gap. Patients underwent tympanoplasty, with or without mastoid exploration depending on the disease status and different types of tympanoplasties were tailored as per the ossicular status intra-operatively. The surgeries were performed either under local or general anesthesia using a microscope. Postoperatively patients were seen after 1 week for pack removal and sutures if any and then after 2 weeks to clean gel foam if any left, and then followed at 1 month, 3 months and 6 months. Pure tone audiometry (PTA) was done at 3 months and 6 months and compared with pre-operative PTA. The success rate was judged by standard parameters like gain in AB gap and graft uptake.

Statistical analysis

The recorded data was compiled and entered in a spread-sheet (Microsoft Excel) and then exported to data editor of SPSS Version 20.0 (SPSS Inc., Chicago, Illinois, USA). Continuous variables were expressed as Mean±SD and categorical variables were summarized as percentages. A repeated measure ANOVA was employed for comparing. Further student's independent t-test, Chi-square test and ANOVA were applied for comparing various parameters. P value of less than 0.05 was considered statistically significant.

RESULTS

Most of the patients in this study aged between 20 to 29 years with male to female ratio of 1.2:1. 43 patients (71.7%) in our study were from rural and low socioeconomic background. All the patients (i.e. 100%) had impaired hearing at the time of presentation and in addition 95% of these patients had history of ear discharge at the time of presentation. Traumatic perforation was present in 3 (5%) patients. Ear discharge was profuse in 40 (70.18%) patients, moderate ear discharge was present in 9 (15.78%) while as scanty discharge was present in 8 (14.04%) patients. History of impaired hearing for less than 1 year was present in 6 (10%) patients, followed by 1-3 years in 48 (80%) patients and >3 years in 6 (10%) patients.

Medium sized perforations were present in 27 (45%) patients, large size perforation was present in 19 (31.67%) patients while as small size perforation was present in 14 (23.33%). In terms of type of perforation, it was central in 37 (61.66%) patients, subtotal in 15 (25%) patients, marginal in 4 (6.67%) patients and total perforation in 4 (6.67%) patients. On otoscopic examination in addition to tympanic membrane perforation, myringosclerosis was present in 8 (13.3%) patients, cholesteatoma in 4 (6.6%) patients, granulation in 2 (3.3%) patients and polyp were seen in 2 (3.3%) patients. Pre-operative conductive hearing loss (mean AB gap) based on tuning fork test results (Rinne's test) in ears to be operated in study subjects using tuning fork of

256Hz, 512Hz and 1024Hz was done. 16 (26.67%) patients had 20-30 dB conductive hearing loss, 31 (51.67%) patients had 30 to 45 dB conductive hearing loss and 13 (21.66%) patients had 45 to 60 dB conductive hearing loss as per tuning fork tests. PTA showed 29 (48.33%) patients had mild degree of hearing loss, followed by moderate degree of hearing loss in 18 (30.0%) patients. 10 (16.67%) patients had minimal hearing loss and moderately severe hearing loss was seen in 3 (5%) patients.

Tympanoplasty alone was done in 52 patients (86.67%). Tympanoplasty with canal wall up mastoidectomy was done in 6 (10%) and tympanoplasty with canal wall down mastoidectomy was done in 2 (3.33%) patients. Intraoperatively myringosclerosis or tympanosclerosis was seen in 8 (13.3%) patients, cholesteatoma was seen in 4 (6.6%) patients, granulations were present in 2 (3.3%) patients and polyp was present in 2 (3.3%) patients. All ossicles were intact and mobile in 37 (61.7%) patients. Malleus was eroded in 4 (6.7%) patients and incus was found to be necrosed in 10 (16.7%) patients. IS joint was dislocated in 2 (3.3%) patients, malleus and incus necrosed in 3 (5%) patient and only stapes foot plate present in 4 (6.7%) patients.

Type I tympanoplasty was performed in 37 (61.6%) patients, Type-III tympanoplasty was the type of surgery in 15 (25.0%) patients. Type II and Type IV tympanoplasties were performed in 4 (6.7%) patients each separately. Postoperatively, Rinne's test in operated ears in study subjects showed 39 (65.0%) patients had 0-20 dB conductive hearing loss, 10 (16.67%) patients had 20 to 30 dB conductive hearing loss, 6 (10%) patients had 30 to 45 dB conductive hearing loss and 5 (8.33%) patients had 45 to 60 dB conductive hearing loss as per turning fork test results. In type 1 tympanoplasty, the mean preoperative AB gap was 30.7 dB while as post-operatively it was 9.3 dB and 9.1 dB at 3 months and 6 months follow up respectively. In type II tympanoplasty, the mean pre-operative AB gap was 41.7 dB while as post-operatively it was 23.7 dB and 22.5 dB at 3 months and 6 months follow up respectively. In type III tympanoplasty, the mean preoperative PTA was 47.1 dB while as post-operatively it was 34.5 dB and 33.4 dB at 3 months and 6 months follow up respectively. In type IV tympanoplasty, the mean preoperative PTA was 52.1 dB while as post-operatively it was 51.3 dB at 3 months and 50 dB at 6 months follow up respectively. 1 (1.67%) patient had infection (ear discharge) postoperatively on follow up and was treated by antibiotics. 2 (3.33%) had residual perforation found on otoscopy on follow up. 1 (1.67%) patient had reperforation found on otoscopy after 3 months of follow up period.

Table 1: PTA before and after type-I tympanoplasty in study ears (n=37).

PTA	Mean AB gap	SD	Range	Comparison	P value
Preop	30.7 dB	9.31	20-45	-	-
3 months	9.3 dB	6.45	0-25	Preop vs 3 months	<0.001*
6 months	9.1 dB	6.29	0-25	Preop vs 6 months	<0.001*

*Statistically significant difference (p value<0.05).

Table 2: PTA before and after type-II tympanoplasty in study ears (n=4).

PTA	Mean AB gap	SD	Range	Comparison	P value
Preop	41.7 dB	2.36	40-45	-	-
3 months	23.7 dB	3.69	20-28	Preop vs 3 months	0.002*
6 months	22.5 dB	5.69	15-28	Preop vs 6 months	0.001*

*Statistically Significant Difference (p value<0.05).

Table 3: PTA before and after type-III tympanoplasty in study ears (n=15).

PTA	Mean AB gap	SD	Range	Comparison	P value
Preop	47.1 dB	7.31	32-60	-	-
3 months	34.5 dB	11.91	16.6-55	Preop vs 3 months	<0.003*
6 months	33.4 dB	12.04	15-50	Preop vs 6 months	<0.001*

*Statistically Significant Difference (p value <0.05).

Table 4: PTA before and after type-IV tympanoplasty in study ears (n=4).

PTA	Mean AB gap	SD	Range	Comparison	P value
Preop	52.1 dB	7.13	43.3-60	-	-
3 months	51.3 dB	4.78	45-55	Preop vs 3 months	0.854
6 months	50 dB	4.08	45-55	Preop vs 6 months	0.632

DISCUSSION

COM is one of the most common ear diseases encountered in developing countries because of poor socioeconomic standards, poor nutrition, lack of health education and unhygienic habits. Tympanic membrane perforations are seen often in daily clinical practice and results from events such as: otologic infection, trauma, or after placing grommets. Decreased hearing and ear discharge are the most common symptoms that brings a patient of COM to clinics.

In the present study majority of patients i.e. 43 (71.7%) belonged to rural areas and 17 (28.3%) belonged to urban areas. Most of the patients aged between 20 to 29 years with a mean age of 27.8±9.15 years. Studies by Mudhol et al and Islam et al had reported a higher preponderance of chronic suppurative otitis media in patients from rural areas than urban area.[11,12] In the study done by Somashekara et al minimum age was 17 years and maximum age was 49 years with mean age of 31.68±9.19 years.[13] In our study, decreased hearing was the presenting symptom in all the patients (100%) and in addition history of ear discharge as presenting symptom was present in 57 patients (i.e. 95%) which is in accordance with the studies done by Shetty et al and Somashekara et al.[13,14] Olowookere et al in their study had reported 3% incidence of traumatic perforation.[15] Traumatic perforation was present in 3 (5%) of our subjects. History of profuse ear discharge was present in 70.18% of our subjects, moderate ear discharge was present in 15.78% subjects while as scanty discharge was observed in 14.04% subjects. Similar pattern of ear discharge has been reported in a study by Mondal et al.[16]

A simple perforation of the tympanic membrane, with no additional lesion of the middle ear transformer mechanism, has two different effects on the hearing. First, there is the diminished surface area of tympanic membrane on which sound pressure is exerted, resulting in dampened ossicular chain excursion. The larger the perforation, the greater the loss of surface area on which sound pressure can act. In addition, the site of the perforation influences the degree of hearing loss; posterior perforations produce more severe hearing losses.[17] A second effect of a simple perforation on hearing results from sound reaching the round window directly without the dampening and phase-changing effect of an intact tympanic membrane. Moreover, as the size of the tympanic membrane remnant decreases, the hydraulic advantage produced by a large tympanic membrane on a small oval window disappears, so that sound reaches both windows with more nearly equal force and at nearly the same time. The resultant cancellation of vibratory movement of the cochlear fluid column produces the maximum hearing loss observed in simple perforation, as much as 45 dB for the speech frequencies.[18,19] The tympanic membrane perforation in the study subjects was sized in accordance with study by Sarker et al with medium sized perforations being present in 27 (45%) patients, large size perforation present in 19 (31.67%) patients while as small size perforation was present in 14 (23.33%).[20] In terms of site the perforation was central in 37 (61.66%) patients, subtotal in 15 (25%) patients, marginal in 4 (6.67%) and total in 4 (6.67%) patients.

Preoperative pure tone audiometric calculations in the subjects showed 29 (48.33%) patients had mild degree of hearing loss, 18 (30.0%) patients had moderate degree of hearing loss, 10 (16.67%) patients had minimal hearing loss and moderately severe hearing loss was seen in 3 (5%) patients. Intraoperatively, 37 (61.7%) patients had intact and mobile ossiclular chain. Malleus was eroded in 4 (6.7%) patients, incus was necrosed in 10 (16.7%) patients. IS joint was dislocated in 2 (3.3%) patients, both malleus and incus necroses in 3 (5%) patient and only stapes foot plate present in 4 (6.7%) patients. These intraoperative findings explained could explain the pattern of hearing loss in our subjects preoperatively. Perforations of the tympanic membrane cause a conductive hearing loss that can range from negligible to 50 dB. The extent of hearing impairment in chronic otitis media is dependent primarily on the degree of ossicular disruption. A small perforation with a large audiometric air-bone gap likely reflects an ossicular chain problem and will most likely require correction by different degrees of hearing loss.[19] In the absence of cholesteatoma, a conductive loss of 20 dB or less usually indicates the ossicular chain is intact. Disruption or fixation of the chain results in an impairment of 30 dB or more. It is not unusual to find normal hearing in an ear with attic perforation and cholesteatoma. This may be an indication of an intact ossicular chain. However, this may indicate that sound transmission is accomplished through a mass of cholesteatoma that has replaced ossicular tissue (“cholesteatoma hearer” or “silent cholesteatoma”). A progressive hearing impairment in the absence of active disease suggests ossicular fixation. This may be due to tympanosclerosis or otosclerosis.

The type of tympanoplasty performed was finalised as per the intraoperative findings and hence Type I tympanoplasty was performed in 37 (61.7%) patients, type-III tympanoplasty was the type of surgery in 15 (25.0%) patients. Type II and type IV tympanoplasties were performed in 4 (6.7%) patients each, respectively.

When preoperative mean AB gap on PTA was compared with 3 months and 6 months follow up in type 1 tympanoplasty, the mean preoperative AB gap was 30.7 dB (SD 9.31) while as it was 9.3 dB (SD 6.45) and 9.1 dB (SD 6.29) at 3 months and 6 months postoperatively with a p value of <0.001 at 3 months and 6 months, which is statistically significant. The mean postoperative gain in AB gap was 21.6 dB in type 1 tympanoplasty (Table 1). Similarly in type II tympanoplasty, the mean preoperative AB gap was 41.7 dB (SD 2.36) while as it was 23.7 dB (SD 3.69) and 22.5 dB (SD 5.69) at 3 months and 6 months postoperatively with a p value of

0.002 at 3 months and 0.001 at 6 months follow up which is statistically significant. The mean postoperative gain in AB gap was 19.2 dB in type II tympanoplasty (Table 2). In cases of type III TP, the mean preoperative AB gap was 47.1dB (SD 7.31) while as postoperatively it was 34.5 dB (SD 11.91) and 33.4 dB (SD 12.04) at 3 months and 6 months follow up with a p value of <0.003 at 3 months and <0.001 at 6 months. The difference is statistically significant. The mean postoperative gain in AB gap was 13.7 dB in type III tympanoplasty (Table 3). No significant improvement in terms of hearing gain was seen in type IV tympanoplasty (Table 4). Mean preoperative AB gap was 52.1 dB (SD 7.13) while as it was 51.3 dB (SD 4.78) at 3 months and 50.0 dB (SD 4.08) at 6 months postoperatively. The mean postoperative gain in AB gap was 2.1 dB in type IV tympanoplasty. Similar results have been observed by Shetty and Kolo et al.[14,21] Babu et al in their study in type III tympanoplasty observed mean pre-operative and post-operative AB gap of 43.46 dB and 18.9 dB and gain in mean AB-gap was 24.56 dB.[22] Gupta et al conducted type IV tympanoplasty in 3 patients and observed mean preoperative and postoperative AB gap of 38.0 dB and 35.5 dB and gain in mean AB-gap was 2.5 dB.[23] Muqtadir et al conducted a study in which gain in mean AB gap was 1 dB in type IV tympanoplasty with modified radical mastoidectomy.[24]

In our study, 1 (1.67%) patient had infection (ear discharge) postoperatively on follow up and was treated by antibiotics. Two (3.33%) had residual perforation found on otoscopy on follow up. One (1.67%) patient had reperforation found on otoscopy after 3 months of follow up period. Three (5%) patients had no improvement of hearing results found on follow up. None of the patients had transient facial nerve injury, sensorineural hearing loss, vertigo postoperatively and during follow up period. Shetty in the study postoperatively found on follow up residual perforations in 3 (6%) patients.[14]

CONCLUSION

Tympanoplasty is an effective procedure that can lead to improvement in hearing function of patients and prevention of recurrent ear discharge. Functional success after tympanoplasty is only partly determined by a surgeon's technical skill. Other factors are some biological and pathological factors. In this study, postoperative hearing gain obtained was found to be better in patients operated upon with tympanoplasty alone than those operated with tympanoplasty with ossicular reconstruction or tympanoplasty with mastoidectomies eliciting the impact disease extent and ossicular status on postoperative hearing improvement. An intact ossicular chain is one of the most favourable attributes in tympanoplasty procedure for the desirable hearing outcome. Hearing gain is better in type I tympanoplasty than in type II and type III tympanoplasties. No significant hearing improvement is seen after type IV tympanoplasty and in some cases the hearing may actually worsen as in cases of cholesteatoma hearers.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Jung Timthy TK, Hanson J. Classification of Otitis Media and Surgical Principles. Otolaryngol Clin N Am. 1999;32(3):369-80.
2. Saha Ashok K, Munsi DM. Evaluation of improvement in hearing in Type-1 Tympanoplasty and its influencing factors. Indian J Otolaryngol Head Neck Surg. 2005;58(3):253-7.
3. Saminullah Chandra K. Combined effect of Eustachian tube function and middle Ear mucosa on Tympanoplasty. Indian J Otol. 2006;12:26-7.
4. George GB, Merchant SN, Kelly G, Swan IR, Canter R, Mckerrow WS. Chronic Otitis Media. In: Gleeson M, editor. Scott-Brown's Otorhinolaryngol Head Neck Surg. 7th ed. London: Edward Arnold Publishers; 2008: 3397-3438.
5. Voss SE, Rosowskii JJ, Merchant SN, Peake WT. How do tympanic membrane perforations affect human middle-ear sound transmission. Acta Otolaryngol (Stockh). 2001;121:169-73.
6. Voss SE, Rosowskii JJ, Merchant SN, Peake WT. Middle ear function with tympanic membrane perforations II:A simple model. J Acoust Soc Am. 2001;110:1445-52.
7. Mehta RP, Rosowskii JJ, Voss SE, O'Neil E, Merchant SN. Determinants of hearing loss in perforations of the tympanic membrane. Otol Neurotol. 2006;27:136-43.
8. Sismanis A. Tympanoplasty. In: Glascock ME 3rd, editor. Glasscock-Shambaugh Surgery of the Ear. 5th ed. Hamilton, Ontario: Decker BC, WB Saunders Company; 2003: 463-484.
9. Aslan FS, Islam A, Celik H, Demirci M, Samim E, Kose KS. The functional and anatomic results of Canal Wall down Tympanoplasty in extensive cholesteatoma. Acta Otolaryngol. 2009;129(12):1388-94.
10. Umpathy N, Dekker PJ. Myringoplasty: is it worth performing in children? Arch Otolaryngol Head Neck Surg. 2003;129:53-5.
11. Mudhol RS, Jaya KK. Descriptive study of complications of CSOM. Indian J Otol. 2000;12:34.
12. Islam MS, Islam MR, Bhuiyan MAR, Rashid MS, Datta PG. Pattern and degree of hearing loss in chronic suppurative otitis media. Bangladesh J Otorhinolaryngol. 2010;16(2):96-105.
13. Somashekara KG, Swathi RK, Nirwan S. A study of hearing improvement after tympanoplasty by means of pure tone audiometry. IJSR. 2014;3(12):2277-8179.

14. Shetty S. Pre-operative and Post-operative Assessment of Hearing following Tympanoplasty. India. J Otolaryngol Head Neck Surg. 2012;64(4):377-81.
15. Olowookere SA, Ibekwe TS, Adeosun AA. Pattern of tympanic membrane perforation in Ibadan:a retrospective study. Ann Ibadan Postgraduate Med. 2008;6(2):31-3.
16. Mondal S, Banerjee M, Das S. Evaluation of antimicrobial sensitivity pattern of chronic suppurative otitis media in a tertiary care hospital of West Bengal, India. Int J Basic Clin Pharmacol. 2017;6(4):891-4.
17. Yung MW. Myringoplasty:hearing gain in relation to perforation site. J Laryngol Otol. 1983;97:11-7.
18. Derlacki EL. Residual perforations after tympanoplasty: office technique for closure. Otolaryngol Clin North Am. 1982;15:861-7.
19. Payne MC, Githler FJ. Effects of perforations of the tympanic membrane on cochlear potentials. Arch Otolaryngol. 1951;54:666.
20. Sarker MZ, Ahmed M, Patwary K, Islam R, Joarder AH. Factors affecting surgical outcome of Myringoplasty. Bangladesh J Otorhinolaryngol. 2011;17(2):82-7.
21. Kolo ES, Ramalingam R. Hearing Results Post Tympanoplasty:Our Experience with Adults at the KKR ENT Hospital, India. Indian J Otolaryngol Head Neck Surg. 2012;66(4):365-8.
22. Babu MM, Ramabhadraiah AK, Srivastava T, Thirugnanmani R. Hearing improvement after type III tympanoplasty: a prospective observational study. Indian J Otolaryngol Head Neck Surg. 2019;71(2):1227-31.
23. Gupta S, Kalsotra P. Hearing gain in different types of tympanoplasties. Indian J Otol. 2013;19:186-93.
24. Muqtadir F, Rahul S. A study of hearing improvement gained after tympanoplasty using various methods in cases of CSOM. Int J Otorhinolaryngol Head Neck Surg. 2018;4(1):107-11.

Cite this article as: Latoo MA, Bhat R, Jallu AS. Hearing gain after tympanoplasty: a prospective study. Int J Otorhinolaryngol Head Neck Surg 2020;6:1096-101.