Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/v0tcgm64

# CLINICO-AUDIOLOGICAL STUDY OF OTOENDOSCOPIC TYMPANOMEATAL DEGLOVING TECHNIQUE TYMPANOPLASTY IN KASHMIR - A PROSPECTIVE STUDY

**Dr. Radiya Manzoor (MD)[1], Dr. Showkat Ahmad Showkat (MS)[2], Dr. Bilal Shafiq Dar (MS)[3*]**

[1]Senior Resident, Department Of Anatomy, Government Medical College, Anantnag, Kashmir
[2]Professor, Postgraduate Department of ENT & HNS, Government Medical College, Srinagar Kashmir
[3*]Postgraduate Department of ENT & HNS, Government Medical College, Srinagar Kashmir

***Corresponding Author:** Dr. Bilal Shafiq Dar
*PG Scholar, Department of ENT, H&NS, GMC Srinagar Email: bilalshafiq16@gmail.com

## ABSTRACT

**Background:** Chronic suppurative otitis media (CSOM) constitutes a major public health problem in children and adults in the developing world. Tympanic membrane perforations are seen often in daily clinical practice and results from events such as: otologic infection, trauma, or after placing grommets. Different types of tympanic membrane perforation include (i) Central, (ii) Marginal, (iii) Attic, (iv) Subtotal, and, (iv) Total. Endoscopic management for perforations involving more than 50% is challenging but by the introduction of the newer degloving tympanomeatal flap technique the issue is solved.

**Objectives:** The present study was conducted to evaluate the outcome of otoendoscopic tympanomeatal degloving technique tympanoplasty in management of subtotal and total tympanic membrane perforations.

**Methods:** Patients having safe type of CSOM with tympanic membrane perforation involving more than 50% of pars tensa with conductive hearing loss for evaluation and management during the study period were taken for the study. Patients with safe type of CSOM with >50% tympanic membrane defect with conductive hearing loss were included in the study, and, the middle ear was dry for at least 6 weeks.

**Results:** Ear discharge and hearing loss were the presenting symptom in all studied subjects. Tinnitus and Otalgia were associated symptoms seen in 2 (4.4%) each. On pure tone audiogram (PTA), 31 (68.9%) patients had preoperative AB gap of 31-40dB and 14 (31.1%) had AB gap in the range of 21-30 dB. All patients underwent otoendoscopic Degloving technique tympanoplasty type I. Autogenous temporalis fascia graft was used in 43 (95.6%) patients whereas tragal perichondrium graft was used in only 2 (4.4%) patients. Postoperative AB gap closure was compared at 3 months and 6 months follow up with a mean AB gap closure of 24.8$\pm$1.752 at 3 months and 25.5$\pm$1.584 at 6 months follow up. Graft was intact in 42 (93.5%) patients at 3 months follow up. Small residual perforation was seen in 3 (6.7%) patients at 3 months follow up which healed spontaneously and graft was intact in all 45 (100%) patients at 6 months follow up. In postoperative period follow up, 2 of the study subjects developed infection which was managed conservatively.

**Conclusion:** Otoendoscopic tympanomeatal degloving technique for tympanoplasty is new technique which showed good results in terms of postoperative graft uptake and also has good

postoperative hearing results. It is cosmetically better as less tissue injury is involved in the procedure and recovery is fast.

**Keywords:** CSOM, Tympanoplasty, Tinnitus and Otalgia, Autogenous temporalis fascia graft, AB gap closure, Tragal perichondrium graft.

## INTRODUCTION

Chronic suppurative otitis media (CSOM) constitutes a major public health problem in children and adults in the developing world[1,2]. It is an infection characterized by recurrent middle-ear discharge through a persistent tympanic membrane perforation. However, in the developing world, risk factors such as malnutrition, over-crowding, substandard hygiene, frequent upper respiratory tract infections, and under-resourced healthcare compound the problems and make the disease prevalent among children and adults[1,3,4,5,6]. Tympanic membrane perforations are seen often in daily clinical practice and results from events such as: otologic infection, trauma, or after placing grommets[7]. Different types of tympanic membrane perforation include (i) Central, (ii) Marginal, (iii) Attic, (iv) Subtotal, and, (iv) Total. Marginal perforation is a perforation in which bone forms any of the edge of the perforation[8]. Tympanoplasty is the final step in the surgical conquest of conductive hearing losses and the goal of Tympanoplasty is to control the disease and to restore normal anatomy and hearing[9].

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[10]. Tympanoplasty can be performed under microscope or using otoendoscope.

For decades the use of endoscopes in ear surgery was primarily for anatomical studies of the middle ear and use was limited to simple observations of tympanic cavity through perforations and an adjunctive method to aid traditional microscopic procedures[11,12]. However, in the last two decades it has been used exclusively for otologic surgical procedures which were earlier classically performed under operating microscopes, such as myringoplasties, ossiculoplasties, stapedotomies and cholesteatoma surgeries[12,13]. Exclusive endoscopic approach during tympanoplasty has been applied to produce the concept of minimally invasive otologic surgery, a great improvement over the microscopic approach[14,15]. Endoscopic ear surgery first tried in the 1990s[16], has become popular with anatomic and physiologic concepts[17]. Advantages of endoscopic ear surgery compared to the conventional microscopic surgery include avoiding endaural vertical and postauricular incisions in securing the surgical field in the middle ear surgery[18,19].

Endoscopic management of subtotal and total tympanic membrane perforations is challenging but by the introduction of the newer degloving tympanomeatal flap technique the issue is solved. In this technique whole of the tympanomeatal flap is elevated round the clock with superiorly based pedicle so that whole of the bony annulus is exposed and as such any size of the perforation is reconstructed. Advantages with tympanomeatal degloving technique tympanoplasty: (i) Since whole flap is elevated around 360 degree angle, perforation of any size and any site can be taken care of. (ii) No chances of lateralization of graft. (iii) No chances of medialization of graft.

In the present study we used the otoendoscopic transcanal approach and the degloving technique to perform the tympanoplasty in patients having safe type of CSOM with any size of tympanic membrane perforations with conductive hearing loss.

## AIMS AND OBJECTIVES

The present study was conducted to evaluate the outcome of otoendoscopic tympanomeatal degloving technique tympanoplasty in management of subtotal and total tympanic membrane perforations with the aims and objectives:- (a) To evaluate the anatomical outcome i.e. uptake of tympanic membrane graft using otoendoscopic tympanomeatal degloving technique tympanoplasty.

(b) To evaluate the functional outcome in terms of hearing improvement (audiometrical results) and AB gap closure in patients undergoing tympanomeatal degloving technique tympanoplasty.

## MATRIAL AND METHODS

The present prospective study was conducted in the Postgraduate Department of Otorhinolaryngology and Head and Neck Surgery, Government Medical College, Srinagar from November 2017 to April 2019. Patients having safe type of CSOM with tympanic membrane perforation of >50% with conductive hearing loss who came to the Department of Otorhinolaryngology and Head and Neck Surgery SMHS hospital for evaluation and management during the study period were taken for the study.

**Inclusion Criteria:** Patients with safe type of CSOM with >50% tympanic membrane defect with conductive hearing loss were included in the study, and, the middle ear was dry for at least 6 weeks. Endoscopic examination included status of tympanic membrane remnants (pars tensa) and pars flaccida. Preoperative Endoscopic assessment of the middle ear was performed and findings of otoscopic examination confirmed or modified. The endoscope used was 2.7mm and 4mm in diameter, 10cm in length, $0^o$ and $30^o$ view angle. Procedure was done by using 3-Chip video camera and high definition monitor (Stryker). After preoperative assessment patients underwent transcanal otoendoscopic tympanomeatal degloving technique tympnoplasty under local or general anesthesia. Graft material was autogenous temporalis fascia (ATF) or tragal perichondrium graft. Infiltration of external auditory canal with 1:10000 Xylocaine / Adrenaline in four quadrants at 3, 6, 9, 12 O'clock position, 0.2ml each site. Margins of the perforation were freshened and squamous epithelium was removed from the inner surface of tympanic membrane margins. Endomeatal circumferential incision was made 6mm from the tympanic annulus, a single tympanomeatal flap was elevated from underlying bone and annulus was lifted from the sulcus. The entire flap had a superior based pedicle attached with the canal skin. Ossicular status and middle ear status was checked. Temporalis fascia graft was prepared and proper size cut and placed over the bony annulus. Tympanomeatal flap was repositioned back so that the temporalis fascia graft was sandwiched between the bony annulus and tympanomeatal flap. Canal was packed with gelfoam and antibiotic ointment applied. Patients were discharged on first post-operative day.

**Statistical Analysis:** Continuous variables were summarized as mean and standard deviation. Categorical variables were summarized as frequency and percentage. Change in continuous measurements over time was analyzed by paired t-test. Two tailed p-values was reported and a p-value $<0.05$ was considered statistically significant.

## RESULTS

Majority of patients 16 (35.6%) belonged to the age group of 20-29 years. The youngest patient was 14 years old and the eldest was 52 years. Females outnumbered males with 68.9% versus 31.1%. Majority of patients in the present study belonged to rural areas 31 (68.9%) and 14 (31.1%) belonged to urban area. Ear discharge and hearing loss were the presenting symptom in all studied subjects. Tinnitus and Otalgia were associated symptoms seen in 2 (4.4%) each. Tympanic membrane perforation having size about 80-90% of pars tensa was present in 24 (53.3%) patients, and tympanic membrane perforation having size of 70-80% of pars tensa was present in 14 (31.1%) while as tympanic membrane perforation having size of 90-100% of pars tensa was present in 7 (15.6%) patients. On pure tone audiogram (PTA), 31 (68.9%) patients had preoperative AB gap of 31-40dB and 14 (31.1%) had AB gap in the range of 21-30 dB.

All patients underwent otoendoscopic Degloving technique tympanoplasty type I. Majority of the patients i.e. 35 (77.8%) were operated under general anaesthesia whereas only 10 (22.2%) were operated under local anaesthesia. Autogenous temporalis fascia graft was used in 43 (95.6%) patients whereas tragal perichondrium graft was used in only 2 (4.4%) patients. At 3 months follow up 34 (76.0%) patients had AB gap between 0-10dB and 11 (24.4%) patients had AB gap between 11-20dB as recorded on pure tone audiogram (PTA). At 6 months follow up 37 (82.0%) patients had AB gap between 0-10dB and 8 (17.8%) patients had AB gap between 11-20dB as recorded on PTA. Preoperative AB gap i.e. 32.4$\pm$1.647dB had reduced to 7.6$\pm$1.194dB at 3 months and 6.9$\pm$0.953 dB at 6 months postoperative follow up which was statistically significant in both ($p < 0.001$). Postoperative AB gap closure was compared at 3 months and 6 months follow up with a mean AB gap closure of 24.8$\pm$1.752 at 3 months and 25.5$\pm$1.584 at 6 months follow up. Graft was intact in 42 (93.5%) patients at 3 months follow up. Small residual perforation was seen in 3 (6.7%) patients at 3 months follow up which healed spontaneously and graft was intact in all 45 (100%) patients at 6 months follow up. In postoperative period follow up, 2 of the study subjects developed infection which was managed conservatively.

**Table 1: Various characteristics of the study population**

| | | Frequency | Percentage |
|---|---|---|---|
| **Presenting Symptoms** | Ear discharge | 45 | 100 |
| | Hearing Loss | 45 | 100 |
| **Duration of Discharge (years)** | < 1 Year | 22 | 48.9 |
| | 1-2 Years | 23 | 51.1 |
| | > 2 Years | 0 | 0.0 |
| | Total | 45 | 100 |
| | Mean±SD (Range)=1.08±0.558 (6 Months-2 Years) | | |
| **Laterality of impaired hearing** | Bilateral | 3 | 6.7 |
| | Left | 23 | 51.1 |
| | Right | 19 | 42.2 |
| | Total | 45 | 100 |
| **Duration of impaired hearing (years)** | < 1 Year | 22 | 48.9 |
| | 1-2 Years | 23 | 51.1 |
| | > 2 Years | 0 | 0.0 |
| | Total | 45 | 100 |
| | Mean±SD (Range)=1.08±0.558 (6 Months-2 Years) | | |
| **Preoperative conductive hearing loss on PTA** | 0-10dB | 0 | 0.0 |
| | 11-20dB | 0 | 0.0 |
| | 21-30dB | 6 | 13.3 |
| | 31-40dB | 39 | 86.7 |
| | Total | 45 | 100 |
| **Preoperative AB gap (dB)** | 0-10dB | 0 | 0.0 |
| | 11-20dB | 0 | 0.0 |
| | 21-30dB | 14 | 31.1 |
| | 31-40dB | 31 | 68.9 |
| | Total | 45 | 100 |
| **Ear to be operated** | Right | 21 | 46.7 |
| | Left | 24 | 53.3 |
| | Total | 45 | 100 |
| **Type of graft used** | Autogenous temporalis fascia graft | 43 | 95.6 |
| | Tragal perichondrium graft | 2 | 4.4 |
| | Total | 45 | 100 |

| Table 2: Air conduction hearing threshold on PTA before and after otoendoscopic Degloving technique tympanoplasty type-I | | | | | |
|---|---|---|---|---|---|
| **Air conduction hearing thershold (dB)** | **Mean** | **SD** | **Range** | **Comparison** | **P-value** |
| **Preoperative** | 34.2 | 0.679 | 27-39 | - | - |
| **At 3 Months** | 8.7 | 0.719 | 8-14 | Preop vs 3 Months | <0.001* |
| **AT 6 Months** | 8.3 | 0.458 | 7-13 | Preop vs 6 Months | <0.001* |

| Table 3: A-B Gap before and after otoendoscopic Degloving technique tympanoplasty type-I | | | | | |
|---|---|---|---|---|---|
| **A-B gap** | **Mean** | **SD** | **Range** | **Comparison** | **P-value** |
| **Preoperative** | 32.4 | 1.647 | 25-34 | - | - |
| **At 3 Months** | 7.6 | 1.194 | 5-8 | Preop vs 3 Months | <0.001* |
| **AT 6 Months** | 6.9 | 0.953 | 4-7 | Preop vs 6 Months | <0.001* |

***Statistically Significant Difference (P-value <0.05)***

| Table 4: Postoperative A-B gap Closure in study patients at 3 and 6 months | | | | |
|---|---|---|---|---|
| **A-B gap Closure** | **Mean** | **SD** | **Min** | **Max** |
| **At 3 Months** | 24.8 | 1.752 | 20 | 26 |
| **AT 6 Months** | 25.5 | 1.584 | 21 | 28 |

| Table 5: Postoperative complications in study patients at 3 and 6 months follow up | | | | |
|---|---|---|---|---|
| **Postoperative complications** | **3 Months** | | **6 Months** | |
| | **No.** | **%age** | **No.** | **%age** |
| Infection | 2 | 4.4 | 0 | 0.0 |
| Residual perforation | 3 | 6.7 | 0 | 0.0 |
| Perichondritis | 0 | 0.0 | 0 | 0.0 |
| Worsening hearing results | 0 | 0.0 | 0 | 0.0 |
| Canal crusts | 0 | 0.0 | 0 | 0.0 |

## DISCUSSION

In our study, majority of patients 16 (35.6%) belonged to the age group of 20-29 years, and 13 (28.9%) patients belonged to 30-39 years age group. 10 (22.2%) patients belonged to age group of 10-19 years, 4 (8.9%) patients belonged to the age group of 40-49 years and 2 (4.4%) patients belonged to age group of 50-59 years. The youngest patient was 14 years old and the eldest was 52 years with mean age of presenting being 27.7 years. Our results are comparable with the findings Somashekara KG et al (2014)[20] who in their study found minimum age of 17 years and maximum age of 49 years with mean age of 31.68 years. Shetty S (2012)[21] did a study in which majority of patients were 11 to 40 years of age. In their study titled Kumari S et al (2017)[22] found mean age of 26.2 years in endoscopic group with youngest and eldest patients as 11 years and 42 years old. In their study mean age was 27.2 years in microscopic group with youngest and eldest patients as 12 years and 43 years old.

In this study majority of patients were females 31 (68.9%) and males were 14 (31.1%) with a male to female ratio of 2.2:1. Our observations were comparable with the findings of Kumari S et al (2017)[22] who in their study reported a male to female ratio of 1:1.5. Bunzen D et al (2006)[23] in their study titled had 68 (70.10%) women and 29 (29.90%) men. This is also similar to a study titled by Singh PP et al (2009)[24] where the females were 9 (60%) while as males were 6 (40%). Indorewala S et al (2015)[25] did a study found female preponderance with 335 (52.6%) females and 302 (47.4%). Hsu YC et al (2018)[26] also found female predominance with 31 (58.5%) and 22 (41.5%) females and males in their study.

Majority of patients in the present study belonged to rural areas 31 (68.9%) and 14 (31.1%) belonged to urban area. Our results are comparable with the findings of Mudhol RS et al (2000)[27] who reported a higher preponderance of patients from rural areas in their study. They had 60% patients from rural areas and 40% patients from urban areas. Similar observations were also found by Kumari S (2017)[22] where rural urban ratio was 3:1 in endoscopic group and 2.22:1 in microscopic group. Islam MS et al (2010)[28] assessed the pattern and degree of hearing loss in CSOM on 150 patients in which 98 (65.33%) patients were from rural areas and 52 (34.67%) patients belonged to urban areas.

In our study, ear discharge and hearing loss were the presenting symptom in all studied subjects. Tinnitus and Otalgia were associated symptoms seen in 2 (4.4%) each. Bhusal CL et al (2004)[29] in their study conducted on 50 patients found discharge and hearing loss as presenting symptoms in all 50 (100%) patients and tinnitus in 10 (20%) patients. Similar observations were made by Kumar S (2017)[22] in their study in which intermittent ear discharge and impaired hearing were the presenting complaint in all the studied patients.

Left ear was involved in 23 (51.1%) patients, right ear in 19 (42.2%) patients while as bilateral disease was seen in 3 patients (6.7%). Similar observations were found by Somashekara KG et al (2014)[20] who conducted a study "A study of hearing improvement after tympanoplasty by means of pure tone audiometry" on 50 patients in which 26 (52%) had left ear disease and 24 (48%) had right sided disease. Abdel-Naby Awad OG et al (2015)[30] conducted a study in which right sided disease was present in 50 (62.5%) patients while as left sided diseases was seen in 30 (37.5%).

In our study, autogenous temporalis fascia graft was used in 43 (95.6%) patients whereas tragal perichondrium graft was used in only 2 (4.4%) patients. Kumari S et al (2017)[22] conducted a study in which autogenous temporalis fascia graft was used in 15 (75%) patients whereas tragal perichondrium graft was used in 5 (25%) patients.

Postoperative pure tone audiometry was done at 3 months and 6 months of follow up. At 3 months follow up, 34 (76.0%) patients had AB gap between 0-10dB and 11 (24.4%) patients had AB gap between 11-20dB as recorded on PTA. At 6 months follow up, 37 (82.0%) patients had AB gap between 0-10dB and 8 (17.8%) patients had AB gap between 11-20dB as recorded on PTA. Preoperative AB gap i.e. 32.4 with standard deviation of 1.647dB had reduced to 7.6 with standard deviation of 1.194dB at 3 months and 6.9 with standard deviation of 0.953 dB at 6 months postoperative follow up which was statistically significant at both ($p < 0.001$). There was a mean AB gap closure of 24.8 with a standard deviation of 1.752 at 3 months and 25.5 with a standard deviation of 1.584 at 6 months follow up. Kolo ES, Ramalingam R (2014)[31] conducted study on Type I Tympanoplasty in which mean pre-operative and post-operative AB-Gap was 46.47 dB and 34.65 dB respectively and gain in mean AB-Gap was 11.82 dB. Aslam N et al (2001)[32] did a study and found preoperative and postoperative mean AB gap of 30.0dB and 15.0dB respectively. In a study done by Shetty S (2012)[21] on 50 patients type I tympanoplasty was done in 37 patients in which mean pre-operative and post-operative AB - gap observed by him was 39.87 dB and 21.07 dB, respectively. Swamy KM et al (2018)[33] also observed mean preoperative and postoperative AB gap of 30.56 dB and 16.53 dB respectively in type 1 tympanoplasty in their study. Tegnoor MS et al (2017)[34] studied audiometric evaluation of type 1 tympanoplasty for hearing results in which mean preoperative and postoperative AB gap was 23.92 dB and 13.10 dB, respectively.

In our study, postoperative otoendoscopic examination was carried out at 3 months and 6 months follow up and it was found that graft was intact in 42 (93.5%) patients at 3 months follow up. Small residual perforation was seen in 3 (6.7%) patients at 3 months follow up which healed spontaneously and graft was intact in all 45 (100%) patients at 6 months follow up. Gulsen S et al (2019)[35] did a study and compared the surgical and audiological outcomes of endoscopic transcanal and conventional microscopic approach in type 1 tympanoplasty. The graft success rate in their study was 94.8% and 92.9% in endoscopic transcanal group and conventional microscopic group, respectively. Tseng CC et al (2017)[36] in their study observed graft success rates of 85.1%. Choi N et al (2017)[37] compare the outcome of endoscopic and microscopic tympanoplasty in their study of 73

patients with 100% graft success rate in endoscopic group and 95.8% in microscopic group in their study. Escalderon JRDJ et al (2018)[38] did a study and compared surgical outcomes obtained by endoscopic transcanal tympanoplasty and microscopic post-auricular tympanoplasty in patients with inactive chronic otitis media. Their study demonstrated 100% post-operative tympanic membrane graft uptake among both groups of patients with inactive chronic otitis media.

## CONCLUSION

Tympanoplasty is an effective procedure that can lead to improvement in hearing function in patients and prevent recurrent ear discharge. Endoscopic tympanoplasty gives comfort to the patient during postoperative period and is time saving. It is a minimally invasive surgical technique to repair tympanic membrane perforations. Otoendoscopic tympanomeatal degloving technique for tympanoplasty is new technique which showed good results in terms of postoperative graft uptake and also has good postoperative hearing results. It is cosmetically better as less tissue injury is involved in the procedure and recovery is fast. Further, tympanic membrane perforation of any size and site can be addressed by this technique. In this study follow up was only 6 months, so further evaluation of this technique is required to confirm the outcomes of this technique on long term basis.

## REFERENCES

1. Adoga A, Nimkur T, Silas O. Chronic suppurative otitis media: Socio-economic implications in a tertiary hospital in Northern Nigeria. Pan Afr Med J. 2010; 4(3).
2. Acuin JM. Chronic suppurative otitis media: a disease waiting for solutions. Comm Ear Hearing H 2007; 4(6):17–19.
3. Okafor BC. The chronic discharging ear in Nigeria. J Laryngol Otol 1984; 98(2): 113–9.
4. Olusesi AD, Opaluwah E, Hassan SB. Subjective and objective outcomes of tympanoplasty surgery at National Hospital Abuja, Nigeria 2005-2009. Eur Arch Otolaryngol 2011;268(3):367–72.
5. Lasisi AO, Sulaiman OA, Afolabi OA. Socio-economic status and hearing loss in chronic suppurative otitis media in Nigeria. Ann Trop Paediatr 2007;27(4):291–6.
6. Akinpelu OV, Amusa YB, Komolafe EO, Adeolu AA, Oladele AO, Ameye SA. Challenges in management of chronic suppurative otitis media in a developing country. J Laryngol Otol 2008; 122(1): 16–20.
7. Bento RF, Minti A, Marone SAM. Tratado de Otologia. Sao Paulo: Editora da Universidade de Sao Paulo: Fundacao otorrhinolarin-gologia: FAPESP 1998; P.220-225.
8. Shah NP. Chronic Suppurative Otitis Media. In: Shah NP (Editor). Clinical ENT. First Edition, Bhalani Book Depot 2004; Page 44.
9. Sade J. Myringoplasty: Long term and Short term results in a training program. Journal of Laryngology and Otology 95: 653-65.
10. Sismanis A. Tympanoplasty. In: Glascock ME 3rd editor. Glasscock-Shambaugh Surgery of the Ear. 5th ed. Hamilton, Ontario: Decker BC, WB Saunders Company; 2003; p.463-84.
11. Marchioni D, Molteni G, Presutti L. Endoscopic anatomy of the middle ear. Indian J Otolaryngol Head Neck Surg. 2011; 63: 101-13.
12. Tarabichi M. Endoscopic transcanal middle ear surgery. Indian J Otolaryngol Head Neck Surg. 2010; 62: 6-24
13. Mohindra S, Panda NK. Ear surgery without microscope: is it possible? Indian J Otolaryngol Head Neck Surg. 2010; 62: 138-41.
14. Dundar R, Kulduk E, Soy FK, Aslan M, Hanci D, Muluk NB, et al. Endoscopic versus microscopic approach to type 1 tympanoplasty in children. Int J Pediatr Otorhinolaryngol. 2014; 78(7): 1084-9.

15. Kozin ED, Gulati S, Kaplan AB, Lehmann AE, Remenschneider AK, Landegger LD et al. Systematic review of outcomes following observational and operative endoscopic middle ear surgery. Laryngoscope. 2015; 125(5): 1205-14.
16. Thomassin JM, Duchon-Doris JM, Emram B, Rud C, Conciatori J, Vilcoq P. Endoscopic ear surgery: initial evaluation. Ann Otolaryngol Chir Cervicofac. 1990; 107(8): 564-70.
17. Marchioni D, Alicandri-Ciufelli M, Piccinini A, Genovese E, Presutti L. Inferior retrotympanum revisited: an endoscopic anatomic study. Laryngoscope. 2010; 120(9): 1880-6.
18. Ayache S, Tramier B, Strunski V. Otoendoscopy in cholesteatoma surgery of the middle ear: what benefits can be expected? Otol Neurotol. 2008; 29(8): 1085-90
19. Migirov L, Shapira Y, Horowitz Z, Wolf M. Exclusive endoscopic ear surgery for acquired cholesteatoma: preliminary results. Otol Neurotol. 2011; 32(3): 433-6.
20. 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.
21. Shetty S. Pre-operative and Post-operative Assessment of Hearing following Tympanoplasty. India. J Otolaryngol Head Neck Surg 2012; 64(4): 377-381.
22. Kumari S, Qazi SM, Kamal K. A Comparative Study of Transcanal OTO Endoscope Assisted Myringoplasty Vis-a-vis Conventional Myringoplasty. Int J Contemp Surg 2017; 5(1): DOI: 10.5958/2321-1024.2017.00015.0
23. Bunzen D, Campos A, Fabiana SZ, Silvio CN. Intraoperative findings influencing myringoplasty anatomical results. International Archives of Otorhinolaryngology 2006; Vol. 10, No. 4.
24. Hsu YC, Kuo CL, Huang TC. A retrospective comparative study of endoscopic and microscopic tympanoplasty. Journal of Otolaryngol – Head and Neck Surgery 2018; 47: 4.
25. Mudhol RS, Kumar JK. Descriptive study of complication of CSOM. Indian Journal of Otology 2000; 12: 34.
26. Islam MS, Islam MR, Bhuiyan MAR, Rashid MS, Datta PG. Pattern and degree of hearing loss in chronic suppurative otitis media. Bangladesh J Otorhinolaryngology 2010; 16(2): 96-105.
27. Bhusal CL, Gurgain RPS, Shrivastav RP. Correction of hearing impairment with site of tympanic membrane perforation. http://JIOM.com. Np-2004.
28. Singh PP, Goyal A, Sethi S, Sharma M. Comparison of tympanomeatal degloving technique with conventional underlay technique in myringoplasty for subtotal perforations. 2009; 15: 12-17.
29. Indorewala S, Adedeji TO, Indorewala A, Nemade G. Tympanoplasty Outcomes: A Review of 789 Cases. Iranian Journal of Otorhinolaryngology 2015; Vol. 27(2): Pg 101-108.
30. Abdel-Naby Awad OG, Hamid KA. Endoscopic type I tympanoplasty in pediatric patients using tragal cartilage. JAMA Otolaryngol HNS 2015; 141(6): 532-38.
31. 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.
32. Aslam N, Iqbal J, Mehmood K. Type I tympanoplasty - underlay technique and results. Proceeding S.Z.P.G.M.I 2001; Vol. 15(2): pp. 77-80.
33. Swamy KM, Ganiger A. Audiological evaluation in between patients with type 1 tympanoplasty alone and type 1 tympanoplasty with cortical mastoidectomy. Int J Otorhinolaryngol Head Neck Surg. 2018 Jan; 4(1): 45-49.
34. Tegnoor MS, Ali K, Mithun S. Audiometric evaluation of type 1 tympanoplasty for hearing results. Int J Otorhinolaryngol Head Neck Surg. 2017 Apr; 3(2): 332-335.
35. Gulsen S, Baltaci A. Comparison of endoscopic transcanal and microscopic approach in type 1 tympanoplasty. Braz J Otorhinolaryngol 2019; http://doi.org/10.1016/j.bjorl.2019.07.005.
36. Tseng CC, Lai MT, Wu CC, Yuan SP, Ding YF. Comparison of the efficacy of endoscopic tympanoplasty and microscopic tympanoplasty: a systematic review and meta-analysis. Laryngoscope. 2017; 127: 1890-6.

37. Choi N, Noh Y, Park W, Lee JJ, Yook S, Choi JE, Chung WH, Cho YS, Hong SH, Moon J. Comparison of endoscopic tympanoplasty to microscopic tympanoplasty. Clinical and Experimental Otorhinolaryngology 2017; Vol. 10, No. 1: 44-49.
38. Escalderon JRDJ, Lim WL. Operative Time and Tympanic Membrane Graft Uptake in Endoscopic Transcanal versus Microscopic Post-Auricular Tympanoplasty for Chronic Otitis Media. Philippine Journal of Otolaryngology-Head and Neck Surgery 2018; 33(1): 25-29.