

## CLINICAL ASSESSMENT OF THE PATIENTS SUBJECTED TO REVISION TYMPANOMASTOID SURGERY

Jairam Prasad<sup>1</sup>, Pawan Kumar Lal<sup>2</sup>

<sup>1</sup>Assistant Professor, Department of ENT, Sri Krishna Medical College, Muzaffarpur, Bihar, India. <sup>2</sup>Associate Professor, Department of ENT, Sri Krishna Medical College, Muzaffarpur, Bihar, India.

Received : 03/03/2023  
Received in revised form : 15/04/2023  
Accepted : 26/04/2023

**Keywords:**

COM, Mastoidectomy, Tympanoplasty, ossiculoplasty.

**Corresponding Author:**

**Dr. Pawan Kumar Lal,**  
Email: Drpwanlal21@gmail.com

DOI: 10.47009/jamp.2023.5.3.469

Source of Support: Nil,  
Conflict of Interest: None declared

*Int J Acad Med Pharm*  
2023; 5(3); 2390-2396



### Abstract

**Background:** The present study was under taken to identify the causes of failure of primary tympanomastoid surgery on the basis of pre-operative clinical examination and investigations and per-operative identification of shortcomings of previous surgery; its management and assessment of the result with special reference to subjective well-being and hearing outcome with regular follow up. **Materials and Methods:** It was Institution based Prospective Study, A total 32 patients getting admitted in the department of Otorhinolaryngology at Sri Krishna Medical College, Muzaffarpur, Bihar with Chronic Otitis Media with a past history of undergoing tympanomastoid surgery during the period January 2021 to December 2022. Patients of all age, sex, demographic and socio-economic strata coming to the Otorhinolaryngology Out-Patients' Department (OPD) and/or getting admitted in the Otorhinolaryngology Ward with Chronic Otitis Media with a past history of undergoing tympanomastoid surgery in the same institution or outside presently complaining of persistent ear discharge and impairment of hearing even after 6months of surgery. **Results:** In the paediatric age group (0 – 15 years), there had been 2 Modified Radical Mastoidectomy with Type III Tympanoplasty (stapes columella), and 3 Radical Mastoidectomy. Out of the three second time revision cases, two had undergone a Radical Mastoidectomy and one, a Modified Radical Mastoidectomy with Type III Tympanoplasty (PORP) for hearing reconstruction. There was no gain in hearing in the patients having pre-operative mixed hearing loss and the patients undergoing a Radical mastoidectomy as a revision surgery. **Conclusion:** A revision canal wall down surgery, if performed successfully following all the basic principles of tympanomastoid surgery, can help achieve a safe and dry ear and can significantly improve the subjective well-being of the patient.

## INTRODUCTION

Chronic otitis media (COM) is defined as a long-lasting otitis media. COM may be associated with a chronically draining ear, mastoiditis, and cholesteatoma. A chronically draining ear includes both COM as well as chronic external otitis.

The goals of surgery for otitis media are universal and have been clearly articulated in the past.<sup>1</sup> The mandates for the surgeon include removal of disease (e.g., infection and cholesteatoma) in the middle ear and in the mastoid cavity as well as reconstruction of the area in a manner designed to minimize the risk of recurrent disease. It is also desirable to maximize hearing postoperatively and to avoid injury to important neurovascular structures.

The literature is replete with reports on the merits of the two major surgical procedures that address these

problems: the canal-wall-down (open-cavity) techniques and the canal-wall-up (closed-cavity) techniques, with or without second-look surgery. What is sometimes overlooked in discussions of the various surgical approaches is the significant rate of failure or recidivism.<sup>1</sup> Failure might be the result of recurrent or persistent cholesteatoma or persistent infection and suppuration following surgery for chronic otitis media with or without cholesteatoma. The otologic literature contains a variety of reports describing the incidence of postoperative infection or drainage in the ear follow ingmastoidectomy.<sup>1,2</sup> The success of tympanomastoid surgery, therefore, has been defined as the attainment of a dry ear postoperatively. A number of articles have identified a subset of surgical factors that serve as hallmarks of a classic "problem cavity," or discharging mastoid bowl.<sup>3</sup> The problem cavity is likely to exhibit a number of findings that are believed to be

responsible for failure.<sup>[10]</sup> These findings include small meatus, a high facial ridge, a persistent bony canal wall, a partially removed attic wall; a deep mastoid cavity, and a failure of a drum graft attributable to diseased mucosa and/or active mucopurulent drainage.<sup>[4]</sup>

Revision surgery for chronic otitis media is clearly a more complicated and potentially risky undertaking than is primary surgery.

So the present study was under taken to identify the causes of failure of primary tympanomastoid surgery on the basis of pre-operative clinical examination and investigations and per-operative identification of shortcomings of previous surgery; its management and assessment of the result with special reference to subjective well-being and hearing outcome with regular follow up.

## MATERIALS AND METHODS

In the paediatric age group (0 – 15 years), there had been 2 Modified Radical Mastoidectomy with Type III Tympanoplasty (stapes columella), and 3 Radical Mastoidectomy. Out of the three second time revision cases, two had undergone a Radical Mastoidectomy and one, a Modified Radical Mastoidectomy with Type III Tympanoplasty (PORP) for hearing reconstruction. There was no gain in hearing in the patients having pre-operative mixed hearing loss and the patients undergoing a Radical mastoidectomy as a revision surgery.

### Inclusion Criteria

Patients of Chronic Otitis Media, who need revision tympanomastoid surgery by Canal Wall Down procedure for management of post-operative refractory discharge even after 6 months of previous surgery.

### Exclusion Criteria

- Patients who need revision tympanoplasty in case of Mucosal variety of Chronic Otitis Media
- Neoplastic disease of temporal bone
- Candidates for revision tympanomastoid surgery with sensorineural hearing loss

- Candidates for revision tympanomastoid surgery with intracranial complication

The patients were subjected to proper demographic and clinical evaluation in the form of history, clinical examination, examination under microscope and Otoendoscopy in the department of Otorhinolaryngology, in the OPD and indoor. Pre-operative Pure Tone Audiogram, X-Ray Mastoids both sides Lateral Oblique View and HRCT scan of the Temporal Bone were done.

Treatment plan was decided on the basis of the previous investigations and per-operative findings and the patients will be managed accordingly. Revision Canal Wall Down surgery was performed with use of microscope. The patients who had to undergo a Canal Wall Down mastoidectomy was included in the present study. After this the patients were followed up properly in the OPD basis in the post-operative period at 1st, 3rd, and 6th month by clinical examination and examination under microscope. Post-operative Pure Tone Audiogram at 3 months and 6 months was done to evaluate the hearing outcome.

### Plan for analysis of data

Data analysis was done manually and evaluated thereafter at the end of the study by SPSS (Statistical Package for Social Sciences) Software Version 24.0.0.0.

## RESULTS

The patients mostly belonged to the 41 – 50 years (34.4%), 31 –40 years (25%), 21 –30 years (21.9%), 11-20 years (15.6%) and only 1 patients (3.1%) were in the age group 0 –10 years of age group. The mean age of the sample size is 33.25 years. There were 14 male (43.8%) and 18 female (56.2%) amongst the 32 patients. 17 patients (53.1%) had undergone right and 15 patients (46.9%) had undergone left ear surgery in the present study. Most of the patients (28 patients, 87.5%) had Squamous variety of Chronic Otitis Media, whereas 4 of them suffered from Mucosal variety of Chronic Otitis Media (12.5%) as diagnosed at the time of initial surgery.

**Table 1: Distribution of patients according to type of previous surgery**

TYPE OF SURGERY		NO OF PATIENTS (PERCENTAGE)	TOTAL NO OF PATIENTS (PERCENTAGE)
MODIFIED RADICAL MASTOIDECTOMY	Type III Minor Columella Tympanoplasty with PORP	8 (25%)	17 (53.13%)
	Type III Major Columella Tympanoplasty with TORP	6 (18.75%)	
	Type III Stapes Columella	3 (9.4%)	
RADICAL MASTOIDECTOMY		6 (18.75%)	6 (18.75%)
ATTICOTOMY/ ATTICOANTROSTOMY WITH RECONSTRUCTION	Type III Minor Columella Tympanoplasty with PORP	4 (12.5%)	6 (18.75%)
	Type III Major Columella Tympanoplasty with TORP	2 (6.25%)	
CORTICAL MASTOIDECTOMY	Type III Tympanoplasty PORP	1 (3.13%)	2 (6.25%)
	Type I Tympanoplasty	1 (3.13%)	
TYPE I TYMPANOPLASTY (without mastoid exploration)		1 (3.13%)	1 (3.13%)

Amongst all 32 patients, 23 patients (71.88%) had past history of undergoing canal wall down mastoidectomy, amongst them 17 (53.13%) Modified Radical Mastoidectomy and 6 (18.75%) Radical Mastoidectomy were there. Out of 17 patients of Modified Radical Mastoidectomy, 8, 6 and 3 patients were associated with Type III Minor Columella Tympanoplasty with PORP (Partial Ossicular Replacement Prosthesis), Type III Major Columella Tympanoplasty with TORP (Total Ossicular Replacement Prosthesis) and Type III Stapes Columella, respectively.

Functional canal wall up procedure, i.e. Atticotomy/ Atticoantrostomy with attic reconstruction had been found in 6 patients, out of 32 (18.75%). There were 4 Type III Minor Columella Tympanoplasty with PORP, 2 Type III Major Columella Tympanoplasty with TORP amongst them.

There were also 2 patients (6.26%), with previous canal wall up i.e. Cortical Mastoidectomy, one with Type I Tympanoplasty and another with Type III Tympanoplasty PORP (Partial Ossicular Replacement Prosthesis), respectively. And lastly, 1 patient (3.13%) with previous history of tympanolasty was there.

**Table 2: Distribution patients according to HRCT Scan findings**

HRCT scan findings	No of patients (no of patients in total)	Percentage
Opacity	32 (32)	100
Ossicles	8 (32)	25
Surgically created cavity	31 (31) *	100
Scutum erosion	32 (32)	100
Facial canal dehiscence	5 (32)	15.6
LSCC dehiscence	5 (32)	15.6
Tegmen dehiscence	3 (32)	9.4
Sinus plate dehiscence	4 (32)	12.5

One of the patient had undergone Type I Tympanoplasty, without mastoid exploration, so the question of surgically created cavity is not applicable to that particular patient.

**Table 3: Distribution of patients according to surgical pitfalls in Group A**

Cause of failure	No of cases	Percentage
Recrudescence of cholesteatoma	21	95.5
Granulations	11	50
High facial ridge	21	95.5
Inadequately removed facial bridge	15	68.1
Bony overhang	17	77.3
Inadequate saucerization	15	68.1
Sump effect	15	68.1
Contracted conchomeatoplasty	18	81.8

Among all 22 patients of canal wall down mastoidectomy, the most important cause of surgical failure was recrudescence of cholesteatoma and high facial ridge, found in 21 patients (95.5%) in each category.

**Table 4: Distribution of patients (Group B) according to Intra-operative surgical pitfalls**

Type of surgery	No of cases total	Recrudescence	Granulations	Bony overhang
Atticotomy/ Atticoantrostomy + Reconstruction	7	7 (100%)	5 (71.4%)	2 (28.6%)
Cortical mastoidectomy	2	0	2(100%)	0
Tympanoplasty	1	0	1(100%)	0
Total	10	7 (70.0%)	8 (80.0%)	2 (20.0%)

The 2 patients with past history of cortical mastoidectomy and 1 patient with past history of Type I Tympanoplasty were found intra-operatively to have extensive granulations, even medial to ossicles, as a result of post-operative upper respiratory tract infection and eustachian tube blockage.

7 patients who had past history of Atticotomy/ Atticoantrostomy showed recrudescence as the major cause of failure (100%), followed by granulations (71.4%) and bony overhang (28.6%).

**Table 5: Corroboration of HRCT Scan and intra-operative findings**

Parameter	Intra-operative findings (no of cases)	HRCT scan Findings (no of cases)	Percentage of detection by HRCT scan
Ossicles	10	8	80
Bony Overhang	19	16	84.2
High Facial ridge	21	18	85.7
Inadequately removed facial bridge	15	12	80.0
Facial canal dehiscence	6	5	83.3
LSCC dehiscence	6	5	83.3

Tegmen dehiscence	4	3	75.0
Sinus plate dehiscence	5	4	80.0
Scutum erosion	32	32	100

**Table 5: Distribution of patients according to Final surgical outcome**

Type of surgery		No of cases	Percentage
MODIFIED RADICAL MASTOIDECTOMY	Type I Tympanoplasty	0	00
	Type II Tympanoplasty	0	00
	Type III Tympanoplasty with PORP (Minor Columella)	7	35.0
	Type III Tympanoplasty with TORP (Major Columella)	(4+ 1) = 5	25.0
	Type III Tympanoplasty with Stapes Columella	4	20.0
RADICAL MASTOIDECTOMY		(13 – 1) = 12	37.5

Surgical outcomes of specific cases:

- The patient who had undergone a staged hearing reconstruction had undergone a Type III major columellaossiculoplasty after 6 months of uneventful follow-up during the study period (Table 17).
- 2 patients, out of 32 patients had undergone facial decompression, one from Group A and one from Group B.
- Among the three second time revision surgeries, two had undergone Radical Mastoidectomy, and one had undergone a Modified Radical Mastoidectomy with Facial Decompression along with a Type III Tympanoplasty with TORP (major columella).
- Among the 5 paediatriccholesteatoma (0 - 15 years), 3 had undergone Modified Radical Mastoidectomy, with same stage Type III stapes columellaTympanoplasty in two patients, and second stage Type III major columellaTympanoplasty with TORP in one of them. 2 patients who had undergone Radical Mastoidectomy, who at the end of 6 months of follow-up have been planned for second stage ossiculoplasty.

Findings in radical mastoidectomy

5 previous Modified Radical mastoidectomy, 3 Radical Mastoidectomy, 3 Atticotomy/ atticantrostomy and 1 Cortical Mastoidectomy patients had undergone Radical Mastoidectomy as a final outcome. They had the following intra-operative findings:

- Facial canal dehiscence- 3 (25%)
- LSCC dehiscence- (50%)
- Tegmen dehiscence- 3 (25%)
- Sinus plate dehiscence- 3 (25%)
- Extensive cholesteatoma and granulation – 12 (100%)
- Facial recess- 5
- Sinus tympani- 3
- Anterior epitympanic recess- 6
- Supratubal recess- 6
- Protympanum- 5
- Perilabyrinthine cells- 1
- Mixed hearing loss- 10
- Round window-1
- Oval window- 4
- Severe mixed hearing loss- 10 (83.33%)

**Table 6: Distribution of patients according to hearing impairment in follow-up**

Complaints	Hearing impairment		
	1st Month	3rd Month	6th Month
Follow-up			
No of patients	11 (32)	12 (32)	13 (31)
Percentage	34.4%	37.5%	41.9%

Hearing loss was a problem in 34.4% patients in the 1st month follow-up, and continued to be so in subsequent follow-ups, with 37.5% and 41.9% patients in 3rd and 6th month follow-up, respectively.

**Table 7: Distribution of patients according to facial palsy in follow-up**

Complaints	Facial palsy		
	1st month	3rd month	6th month
Follow-up			
No of patients	6 (32)	6 (32)	5 (31)
Percentage	18.75 %	18.75 %	16.13 %

All over the entire follow-up period, 6 patients presented with facial palsy. 3 Grade III and 3 Grade IV palsy were there at 1st month, but at 3rd and 6th month all the patients were found to be Grade IV facial palsy.

**Table 8: Distribution of patients according to presentation with vertigo in follow-up**

Complaints	Vertigo		
	1 <sup>st</sup> month	3 <sup>rd</sup> month	6 <sup>th</sup> month
No of patients	4 (32)	2 (32)	1 (31)
Percentage	12.5%	6.25%	3.22%

Only 4 patients (12.5%) presented with vertigo at 1st month follow-up, which gradually decreased in subsequent follow-ups.

**Table 9: Distribution of patients with adequate conchomeatoplasty in follow-up**

Parameter	Adequate conchomeatoplasty		
	1st month	3rd month	6th month
No of patients	27 (32)	26 (32)	23 (31)
Percentage	84.4%	81.25%	74.19%

At the end of 1st month follow-up 27 patients had adequate conchomeatoplasty, the value was 26 at 3rd month follow-up, and 23 at 6th month follow-up

## DISCUSSION

In the present study, the combination of information gathered from pre-operative history taking, clinical examination and radiological investigation (HRCT Scan) and intra-operative findings helped to determine the cause of failure of previous surgery.

According to Wormald and Nilssen, they found the following significant findings in the chronically discharging cavities.<sup>[31]</sup>

- High facial ridge;
- Sump in cavity below floor of external auditory canal;
- Perforation in tympanic membrane
- Small external auditory meatus.

Megerian et al., in 2002, concluded from their study that, the most common probable causes for the failure of previous surgery was incomplete lowering of the facial ridge (94%). Other causes are persistent sinodural-angle air-cell disease (92%), persistent tegmental air-cell disease (88%), persistent mastoid-tip air-cell disease (62%), and persistent hypotympanic air-cell disease (56%) and inadequate meatoplasty (60%).<sup>[5]</sup>

The all the 32 patients had undergone a revision canal wall down mastoidectomy, either by a Modified Radical Mastoidectomy with hearing reconstruction or a Radical Mastoidectomy.

All the residual and recurrent cholesteatoma had been removed, meticulously, from all the visible as well as hidden sites, as assessed by a pre-operative otoendoscopy, including facial recess, sinus tympani, oval window, round window, protympanum, supratubal recess, anterior epitympanic recess etc. For complete clearance of disease, the canal wall down procedure was carried out under microscope in the present study; and otoendoscope had been used intra-operatively whenever necessary. Bone work had been done according to the basic principles of mastoid surgery, with adequate removal of facial bridge, lowering of

facial ridge, removal of all the buttresses and bony overhangs and adequate saucerization. Cavity obliteration was done routinely with Palva flap, cartilage, bone dust etc., in all patients, individually or in combination, with an appropriately wide conchomeatoplasty, for managing the long-term cavity problem.

Except the four absolute indications of radical mastoidectomy as described above.<sup>[51]</sup> rest of the patients scheduled for revision surgery, for all practical purposes, were managed with modified radical mastoidectomy. The only compelling situation of performing a radical mastoidectomy, is severe mixed hearing loss where there will be no benefit of the patient from a hearing reconstruction. A same sitting hearing reconstruction is preferred now-a-days, in every case of canal wall down mastoidectomy, provided complete clearance of all the disease pathology can be ensured, for better outcome.

There were 12 Radical Mastoidectomy and 20 Modified Radical Mastoidectomy in total in the present study. The choice of the surgical procedure was entirely individualised, depending on the age of the patient, extent of the disease as well as the disease clearance and type of pre-operative hearing loss. Among the patients undergoing Radical Mastoidectomy, two had severe granulation tissue involving the facial nerve with facial canal dehiscence and LSCC dehiscence with recrudescence and granulations in the perilyabyrinthine cells, making complete disease clearance impossible and severe mixed hearing loss in 10 patients, narrowing the scope of hearing reconstruction. In the paediatric age group (0 – 15 years), there had been 2 Modified Radical Mastoidectomy with Type III Tympanoplasty (stapes columella), and 3 Radical Mastoidectomy. Out of the latter group, one patient had undergone a second stage ossiculoplasty with PORP after 3 months of uneventful follow-up and the other two,

after 6 months of follow-up, is due to be posted for second stage ossiculoplasty.

Out of the three second revision cases, two had undergone a Radical Mastoidectomy and one, a Modified Radical Mastoidectomy with Type III Tympanoplasty (PORP) for hearing reconstruction.

According to a study by Yung et al. on revision mastoidectomy and hearing reconstruction, in the same sitting 95% of the cases became dry and water resistant after 1-year follow-up. 36.6% of the cases had a hearing gain of 10 dB or more and 50.9% of the cases had 20 dB or less hearing gain after 1-year follow-up.<sup>[7]</sup>

A quality of life assessment study by Jung et al., in 2010, showed that the objective outcome of primary and revision surgery is comparable, but the improvement in quality of life greater in the group undergoing primary surgery. This comparison had not been done in the present study.<sup>[7]</sup>

The post-operative results, in the present study, showed gradual decrease in all the complaints throughout the 6-month follow-up period. The complaints, like ear discharge due to chronic cavity problem were more in the patients undergoing Radical Mastoidectomy than Modified Radical Mastoidectomy. But at the end of 6-month follow-up, 29 out of 31 patients (93.6%) the patients had a well epithelised cavity without any evidence of crusts, granulations or discharge. This proves that in all patients all the residual as well as recurrent cholesteatoma had been removed properly. At 3rd month follow-up, 31 out of 32 cases showed adequate lowering of facial ridge, suggesting bone work had been adequate. The conchomeatoplasty had been adequate in 83.87% at the end of 6-month follow-up.

Hearing impairment was the only persistent problem in the present study. There was no gain in hearing in the patient having pre-operative mixed hearing loss and the patients undergoing a Radical mastoidectomy as a revision surgery. These patients were probably cholesteatoma hearer in the pre-operative period, and complete disease clearance without any hearing reconstruction during the surgical procedure resulted in worsening of Pure Tone average. But, in the 13 patients undergoing Modified Radical Mastoidectomy, who had pre-operative pure conductive hearing loss, a maximum 6 – 25% closure of A-B gap in 76.9% of patients in the 3rd month follow-up, and a maximum 26 -75% closure of A-B gap in 46.13% patients in the 6th month follow-up was there. At the end of 6-month follow-up, 58.6% patients were very satisfied with the outcome and 41.4% were moderately satisfied with the outcome.

HRCT Scan can detect opacity in the antrum, but cannot differentiate from cholesteatoma other soft tissues, such as granulation tissue or cholesterol granuloma.<sup>[8]</sup> Bone erosion of the scutum, evidence of remnant of ossicles can be demonstrated in HRCT Scan. HRCT Scan can often demonstrate dehiscence of the lateral semi-circular canal or

dehiscence of the facial nerve. But a negative CT does not rule out a fistula; in this case a MRI is required for confirmation.

According to Gerami et al., 32 out of 36 cases of both tympanic cholesteatoma and 32 out of 36 cases mastoid cholesteatoma had been diagnosed pre-operatively by HRCT Scan of Temporal bone, with a correlation co-efficient of 88%. They also showed 64% correlation in detection of ossicular erosion. But, HRCT could not diagnose LSCC Fistula, facial canal dehiscence of tegmen plate dehiscence. According to them, a preoperative HRCT scan helps by imaging of anatomic details, and loss of anatomical landmarks in case of a previous surgery.<sup>[48]</sup>

Yate et al. (2002) suggested that the CT scan imaging is necessary for anatomic determination of the chronic otitis media, suspicion of congenital anomalies and to detect any loss of surgical landmarks caused by prior operation.<sup>[9]</sup>

In the present study, opacity was seen in HRCT Scan in all of the 32 cases, but intra-operatively, recidivistic cholesteatoma was found in 84.3% and granulations without cholesteatoma in 15.7% patients. Again, the accuracy of detecting ossicles was 80%. Corroborating with the intra-operative findings, in the present study, it was found that, HRCT scan correctly diagnosed a high facial ridge, inadequately removed facial bridge and bony overhang in 85.7%, 80% and 84.21% cases respectively. Whereas the accuracy of detection of facial canal, LSCC, tegmen or sinus plate erosion was 83.33%, 83.33%, 75%, 80% respectively.

HRCT Scan has its definite role in pre-operative identification of cholesteatoma cavity, and determining the pitfalls of previous surgery in terms of inadequate bone work. The management planning for a revision surgery, specially a canal wall down surgery can be done by combining the clinical findings with HRCT Scan findings. That is why HRCT is considered to be the gold-standard radiological investigation while planning of revision tympanomastoid surgery.

## CONCLUSION

Meticulous surgical technique is required for complete clearance of cholesteatoma from all visible as well as hidden sites. Adequate bone work is needed in the form of facial bridge removal, facial ridge lowering, saucerization for a smooth, shallow cavity. Cavity obliteration and appropriately wide conchomeatoplasty are required to combat long-term cavity problems.

HRCT Scan of temporal bone is a useful tool for pre-operative evaluation of extent of disease process, ossicular status, anatomical landmarks in a revision surgery and signs of complications like facial canal dehiscence and LSCC dehiscence etc. Corroboration of intra-operative findings with pre-operative HRCT Scan will help in formulating the

management plan and will ensure a safe surgery with minimal complications.

A revision canal wall down surgery, if performed successfully following all the basic principles of tympanomastoid surgery, can help achieve a safe and dry ear and can significantly improve the subjective well-being of the patient.

## REFERENCES

1. Nadol JJ3. Jr. Causes of failure of mastoidectomy for chronic otitis media. *Laryngoscope* 1985;95:110-3.
2. Kinney SE. Intact canal wall tympanoplasty with mastoidectomy for cholesteatoma: Long-term follow-up. *Laryngoscope* 1985; 95: 1190—1.
3. Wormald PJ, van Hasselt CA. A technique of mastoidectomy and canaloplasty that minimizes factors associated with a discharging mastoid cavity. *Laryngoscope* 1999; 109:175-82.
4. Jackson CG, Glasscock IE III, Nissen AJ, et al. Open mastoid procedures: Contemporary indications and surgical technique. *Laryngoscope* 1985;95:1037-43.
5. Megerian CA, HConseza NJ, Meyer SE. Revision Tympanomastoid Surgery. *Ear Nose Throat*. 2002;81(10):718-20.
6. Yung M, Tassone P, Moumoulidis I, Vivekanandan S. Surgical management of troublesome mastoid cavities. *J Laryngol Otol*. 2011;125(3):221-6.
7. Jung KH, Cho YS, Hong SH, Chung WH, Lee GJ, Hong SD. Quality-of-life assessment after primary and revision ear surgery using the chronic ear survey. *Arch Otolaryngol Head Neck Surg*. 2010;134(4):358-65.
8. Timothy C. Hain, MD of Chicago Dizziness and Balance “Chronic Otitis Media” Page last modified: January 1, 2018.
9. Megerian CA, Cosenza MJ, Meyer SE (2002) Revision tympanomastoid surgery. *Ear Nose Throat J* 81:718–720, 722, 725–726.