

Original Research Article

Functional and anatomical results of inside out approach for cholesteatoma surgery

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ABSTRACT

Background: The objective of the study was to study the efficacy of inside-out approach in completely eradicating the cholesteatoma from middle ear and mastoid, preservation of hearing and quality of life post mastoidectomy with regards to recurrent discharge, wax, granulations.

Methods: Non-randomized prospective observational study performed at the Department of ENT in Bombay hospital Mumbai. The study involved 40 patients presenting with chronic suppurative otitis media with cholesteatoma. All of them underwent inside out mastoidectomy and were followed up till the end of the study to evaluate the efficacy of inside out mastoidectomy in eradicating the disease from the middle ear cleft, to assess preservation of hearing and to assess cavity problems.

Results: Of the 40 patients, 39 patients had a total clearance of disease by the inside out approach, and in 1 patient, we were doubtful of the clearance. All patients came for regular follow up and none of them had residual disease at the end of the study period. Thus, the overall success rate was 100% in this study. A significant improvement in the mean air conduction ($p < 0.01$) and the mean air bone gap ($p < 0.01$) postoperatively was seen in all in the postoperative 3rd month PTA. Only one patient had increased conductive hearing loss one and a half years postoperatively after initial improvement. A dry self-cleansing cavity was achieved in 95% of the patients and only 5% required regular cleaning of waxes the cavities.

Conclusions: Inside out mastoidectomy is a better alternative in canal wall down procedures as it not only clears the disease from the middle ear cleft, but also leaves behind a small postoperative cavity, which will preserve the hearing, decrease the cavity problems and increase the quality of life of such patients.

Keywords: Cholesteatoma from middle ear and mastoid, Cholesteatoma surgery, Inside-out approach surgery for cholesteatoma

INTRODUCTION

The treatment of chronic middle ear disease has undergone a series of technical advances within last 50 years, causing a shift in emphasis from extirpation of disease to preservation and reconstruction of middle ear structures.¹

The subject debated endlessly in the choice of surgical technique, open versus closed mastoidectomy. Generally,

open techniques provide good control of excision of the cholesteatoma, but facilitate the development of infections, require regular control and entail limitations for bathing. Closed techniques generate a lower rate of infection and do not limit bathing, but result in a higher percentage of residual and recurrent cholesteatomas, whilst also requiring periodic controls.^{2,3}

Also the proponents of the closed cavity procedures state the fact that the hearing results are disappointing with the

change in the anatomy and physiology after creation of an open mastoid cavity. Pathogenesis, surgery is aimed at interfering with the pathological process to stop the continuum of the disease and to establish the functions.

The purpose of these operations was to create a safe ear by exteriorizing the disease. The treatment of chronic middle ear disease has undergone a series of technical advances within last 50 years, causing a shift in emphasis from extirpation of disease to preservation and reconstruction of middle ear structures.¹

Also the proponents of the closed cavity procedures state the fact that the hearing results are disappointing with the change in the anatomy and physiology after creation of an open mastoid cavity.

Jansen was the first to adopt a combined anterior and posterior tympanotomy approach to surgically treat cholesteatoma and chronic infection. Since the introduction of combined approach tympanoplasty (CAT), various modifications have been suggested by different otologists.¹

Newer techniques adopted to make the ear disease free along with restoration of hearing mechanism and also minimizing the post operative problems.

An 'inside out' approach differs from the classical 'outside in' for cholesteatoma surgery by following the disease in the direction of its spread. This helps in limiting the extent of the cavity, ability to stop the operation as required. Otherwise this approach has the same incision and same exposure as the 'outside in'.

Here we study the 'inside out' approach of modified radical mastoidectomy, its functional and anatomical advantages.

METHODS

The study has been conducted in the Department of Otorhinolaryngology at Bombay Hospital, Mumbai from 2014 to 2016 after an approval of the same by the Institutional Ethics Committee. An informed and written consent was obtained from all patients involved in the study. A total number of 40 patients undergoing surgery for cholesteatoma under local or general anaesthesia were included in the study. Non randomized, prospective observational study.

Inclusion criteria

Inclusion criteria were any age; presence of cholesteatoma; presence or absence of complication.

Exclusion criteria

Exclusion criteria were congenital cholesteatoma; patients not able to understand the study or do not give

their consent; revision cases- residual/recurrent; extensive cholesteatoma (if already known in pre-op CT scan) in which case an outside in approach was done

Preoperative evaluation and preparation

The selected cases were subjected to detailed history taking and clinical examination. Complete examination of the ear was done. Nose, paranasal sinuses, oral cavity and pharynx were also examined to rule out any foci of infection. Systemic diseases unrelated to the ear disease were ruled out. Otoscopic, otomicroscopy and tuning fork tests were performed (Figure 1 and 2).



Figure 1: Posteriorsuperior retraction pocket.



Figure 2: Attic perforation.

The selected cases were then made to undergo appropriate investigations. Routine blood investigations like hemoglobin percentage, total and differential leucocytes count along with blood sugar levels and serum creatinine levels were done for all cases. HRCT temporal bone was done only for patients with complications (Figure 3 and 4).

Preoperative pure tone audiometry was done in a sound proof room for all cases. All patients underwent postoperative pure tone audiometry (3 months).

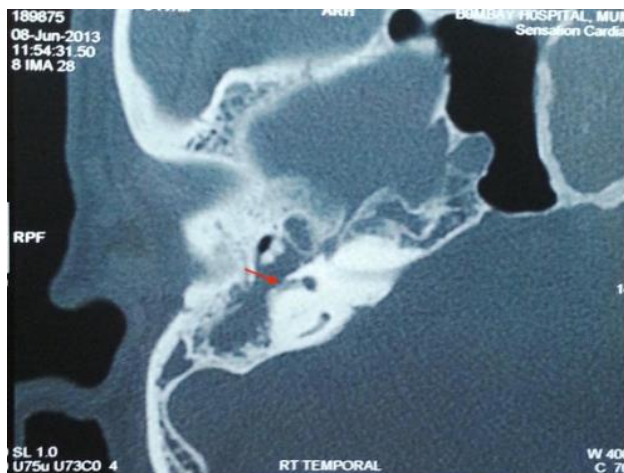


Figure 3: HRCT temporal bone axial view; red arrow showing the lateral semicircular canal fistula.



Figure 4: HRCT temporal bone coronal view: red arrow showing Tegmentum Erosion.

Pure-tone audiometry thresholds at 500, 1000, 2000, and 4000 Hz via air conduction (AC) and the air-bone gaps (ABGs) were calculated. Postoperative BC values were used to calculate the postoperative ABG. Mean preoperative and postoperative AC threshold, ABGs, and changes in AC and ABGs were recorded.

Patient counselling

Informed consent was obtained from each patient after counseling them and their relatives regarding the nature of the disease and surgery. Surgical procedure was explained. All patients were admitted to the hospital one day prior to surgery. All of them underwent “inside out” mastoidectomy by a postaural approach.

Operative technique⁴⁻⁶

Anaesthesia

Mastoidectomy was done under local or general anaesthesia.

Postauricular incision

The incision was begun at the upper attachment of the pinna at around 12 o’ clock position to the mastoid tip at 6 o’clock position along the post auricular groove or within 1 cm from it. The subcutaneous tissue and the muscles of the pinna were then cut using the knife.

Exposure of the mastoid area

The post auricular incision was made in two layers with the superficial tissues elevated anteriorly and the deep tissues incised separately in a ‘T’ shaped fashion with the superior border of the T paralleling the linear temporalis. This permits layered closure of non overlapping incision.

Posterior tympanotomy

After the post auricular incision was made, the posterior canal skin was elevated off the underlying bone and the canal entered by making an incision along the posterior canal wall skin. Then a standard vascular strip incision was made and a tympanomeatal flap designed.

Inside-out approach

Epitympanotomy

The first step was to enlarge the bony meatus with a 3-4 mm cutting burr to remove bone from the posterior and the superior walls of the external meatus at the isthmus, and including the Henle’s spine, so taking away the overhang from the outer bend and straightening the meatus before removing the outer epitympanic wall. The attic opening was then enlarged with a 2 mm burr and small curettes, working from within outwards, to expose the cholesteatoma fully and when necessary unto and flush with the tegmen superiorly. Anteriorly, bone removal was extended either beyond the limit of cholesteatoma or in flush with the anterior epitympanic wall. While drilling great care was taken not to make contact with an intact ossicular chain for the fear of inducing greater hearing loss (Figure 5).



Figure 5: Showing epitympanotomy –widening of bony meatus by drilling posterior and superior walls.



Figure 6: Showing epitympanomastoidectomy drilling in inside out fashion to uncap cholesteatoma

Epitympanomastoidectomy

Then a 4-5 mm cutting burr was used in a circular pattern as if enlarging the meatus until the whole cholesteatoma is uncapped. As the epitympanum is already opened and the incus is easily made out, the bone of the posterior wall can be lowered while uncapping to the level of this plane without endangering the facial canal. The burr was used from within outwards, away from the facial canal and the depth frequently assessed. If the body of the incus was not present, the position of the facial canal was ascertained either by lifting the epitympanic portion of the cholesteatoma to see it lying within its canal or by seeking the stapes remnant. Once the approximate position was known, the posterior canal wall was lowered to a suitable depth (Figure 6).

Removal of disease

The entire cholesteatomatous matrix was carefully removed. Cholesteatoma going into the eustachian tube can often be removed successfully without resorting to a radical mastoidectomy but occasionally if osteitis or diffuse disease is present, radical procedure may be necessary (Figure 7).



Figure 7: Showing drilling to follow the cholesteatoma and removing it.

Ossicular and middle ear reconstruction

The graft was placed from the anterior annulus over the middle ear space and draped over the horizontal semicircular canal. This reduced the middle ear space by more than halving its depth. Hence reconstruction of the middle ear and ossicular chain was done.

Meatoplasty

A meatoplasty was carried out whenever required in order to facilitate good marsupialisation of the attic and promote its self cleaning and adequate postoperative care. We employed another technique for meatoplasty called the superior slit. The superior slit is the vertical part of endaural incision extended laterally to open the meatus.

This provided a complete visualisation of the attic. Once the surgery was complete, the external part of the EAC was filled with gelfoam and merocel ear pack soaked in antibiotic solution, so as to facilitate patency and epithelialisation of the meatoplasty. Complete healing of meatoplasty takes about 4-6 weeks.

Postoperative care

Mastoid compression bandage was applied, which was loosened on the first postoperative day at the time of discharge. Postoperative antibiotics were continued for about ten days and sutures are removed on the 7-10th day.

The first cavity cleaning was done at 3 week postoperative visit and merocel ear pack is removed at this time. Steroid containing ear drops or regular application of gentian violet was used in patients with granulation tissue. Any superficial infections were controlled by topical antibiotics.

Postoperative evaluation

All patients were followed up weekly for one month, fortnightly for three months and then once in six Months till the end of the study. Also pure tone audiometry was done at three months or after the postoperative cavity had healed, whichever was later. At 6 months, one year and subsequent visits, cases were evaluated for healing of the epithelium, wax or collection of debris or any other complications which the patient has experienced.

Statistical methods

Data were statistically described in terms of mean (\pm SD), frequencies (number of cases) and percentages when appropriate. Data were tested first for normal distribution by Kolmogorov– Smirnov test. Pre and post comparison of quantitative variables (AC, BW, etc.) was done using Wilcoxon sign rank test due to non-normal distribution of quantitative data. All statistical calculations were done using computer programs Microsoft Excel 2007.

RESULTS

The results of these hearing assessments indicate a significant improvement in hearing gain following surgery.

Table 1: Gender wise distribution of patients.

Gender wise distribution	Number	Percentage (%)
Male	25	62.5
Females	15	37.5
Total	40	100

In our study of 40, male patients (62.5%) were predominant as compared to female patients (37.5%) (Table 1). Patients' ages ranged between 7 to 67 years. More patients were surgically treated for cholesteatoma in the age range of 11 to 20 years (30%) and 31 to 50 years (40%) than the other age groups (Table 2). 50% of the patients presented with sinus cholesteatoma (posterosuperior quadrant), 42.5% of them presented with attic cholesteatoma and remaining with a central perforation. Incus was found to be eroded in 67.5% cases. Stapes was involved in 30% cases in form of either suprastructure absent (15%) or engulfed (10%) or eroded (5%). Incus was found to be eroded in only one case (2.5%) in our study group. Occurrence of complications such as facial canal dehiscence (7.5%) and lateral semicircular canal dehiscence or fistula (7.5%) was low. Complete cholesteatoma clearance with the inside out approach for mastoidectomy, assessed intraoperatively, was as high as 97.5%. Ossiculoplasty was done in 65% of the cases and one case was planned for an ossiculoplasty later.

Table 2: Complaints.

Complaints	Number	Percentage (%)
Otorrhoea	40	100.0
Hearing loss	32	80.0

Table 3: Symptom indicating complications.

Symptoms	Number	Percentage (%)
Otalgia	8	20.0
Giddiness	2	5.0
Tinnitus	1	2.5
None	32	80.0

Table 4: Operative details.

Operative details	Number	Percentage (%)	
Anaesthesia	GA	21	52.5
	LA	19	47.5.0
Graft	TF	32	80.0
	TF,PR	8	20.0
Incision	Post-aural	40	100.0
Cortex drill	Inside	40	100.0

Table 5: Cholesteatoma clearance.

	Number	Percentage (%)	
Cholesteatoma removal	Doubtful	1	2.5
	Total	39	97.5

Table 6: State of posterior canal wall,material used for ossiculoplasty,type of meatoplasty

	Action	Number	%
Posterior canal wall	Intact	7	17.5
	Lowered	13	32.5
	Reconstructed	20	50.0
Ossiculoplasty	Auto Incus	17	42.5
	Cartilage	9	22.5
	None	14	35.0
Meatoplasty	Conchal	3	7.5
	Superior SLIT	18	45.0
	Conchal+sup Slit	1	2.5
	None	18	45.0

Table 7: Follow up after one month.

Discharge	Number	Percentage (%)
Present	0	0.0
Absent	40	100.0
Total	40	100.0

Table 8: Follow up after three months.

Follow-up	Number	Percentage (%)
Healed, visibility	38	95.0
Not healed	2	5.0
Total	40	100.0

Table 9: Follow up after six months.

Follow-up	Number	Percentage (%)
Healed	38	95.0
Healed, wax	2	5.0
Not healed	0	0.0
Total	40	100.0

Table 10: Follow up after one year.

Follow-up	Number	Percentage (%)
Healed	39	97.5
Irregular cavity	0	0.0
Meatal stenosis	0	0.0
Healed, wax+	1	2.5
Total	40	100.0

Meatoplasty was not required in 45% of the cavities. Patients were followed for a range of 14 months to 24 months. Postoperative audiogram was done at 3 months

and a significant improvement ($p < 0.01$) in the mean air conduction and mean air bone gap was seen postoperatively (Table 15 difference in pre and post operative (3 months) audiogram). One case was found to have increased conductive hearing loss one and a half year postoperatively.

Table 11: Complications in subsequent visits.

Subsequent visit	Number	Percentage (%)
Debris	2	5.0
Dry	38	95.0
Dry, ossic	1	2.5
Dry, chl	1	2.5
Total	40	100.0

Table 12: Postoperative adverse events.

Post op adverse events	Number	Percentage (%)
Superficial infection	1	2.5
Granulations	1	2.5
Meatal stenosis	0	0.0
Recidivism	0	0.0

Postoperative adverse events were seen in only 2 out of 40 cases (5%) and settled with topical antibiotic and topical steroid drops. There was no evidence of meatal stenosis in any case. No cases presented with recidivism in their follow up period. Only 2 cases (5%) had excessive debris in their subsequent visits and required regular cleanings every 2-3 month.¹

DISCUSSION

40 patients presenting with chronic suppurative otitis media with cholesteatoma were selected to study the efficacy of inside-out approach in completely eradicating the cholesteatoma from middle ear and mastoid, preservation of hearing and functionality of the ear and quality of life post mastoidectomy with regards to recurrent discharge, wax, granulations.

Age and sex

In our study of 40 patients, male predominance was noted with 25 males patients and 15 female patients i.e., a male to female ratio of 1.67:1.

The youngest patient in the present study was 7 years old and the eldest was 67 years old. The maximum number of patients were in the age range of 11 to 20 years (30%) which is in accordance with the study conducted by Gupta et al.⁷

Clinical picture

The commonest presenting symptom in our study was otorrhoea which was found in all 40 cases (100%). This

was followed by hearing loss which was found in 32 cases (80%).

Edelstein et al noted hearing loss in 85% and otorrhoea in 73% of cases.⁸ Other symptoms like otalgia in 8 cases (20%), giddiness in 2 cases (5%) tinnitus in 1 case (2.5%) and no complication in 32 cases (80%).

Edelstein et al noted otalgia, tinnitus and vertigo were found in 32%, 8% and 8% respectively. Sudden increase in the discharge and development of pain is often seen in cases going for complications.

Cholesteatoma was seen in the posterosuperior quadrant of the tympanic membrane in 20 (50%) cases, while attic cholesteatoma was seen in 17 (42.5%) cases. The remaining 3 cases (7.5%) had a central perforation.

Edelstein et al noted 32% in posterosuperior quadrant and 20% in attic.⁸ Central perforation was present in 9%. Type of hearing loss on tuning fork test was noted as conductive hearing loss 29 cases (72.5%), mixed hearing loss in 4 cases (10%) and no loss in 7 (17.5%). Vartiainen is shown type of hearing loss on tuning fork test was noted as conductive hearing loss (60%), mixed hearing loss in 40%.⁹

Operative findings

All the cases in this study underwent inside out mastoidectomy. 21 of them were operated under general anaesthesia and the 19 under local anaesthesia. Both have their own merits and demerits.

Post-aural incision and inside out cortex drilling in all cases. Temporalis fascia Graft used in 80% and rest besides temporalis fascia, perichondrium was also taken.

Intraoperatively malleus was eroded in 1 case (2.5%), intact in 38 cases (95%), and in 1 case (2.5%) was not exposed. Edelstein et al noted 25% eroded malleus.⁸ Manrique et al noted intact malleus (i.e. lesion of incus and stapes) in 7.1%.¹⁰

In our study stapes had a lesion in 12 cases, 35% similar to presence of stapes lesion in the studies by Edelstein (40%), Sade (40%) Manrique (26%).^{10,11}

Intraoperatively, occurrence of absent incus was in 3 cases (7.5%), erosion in 27 cases (67.5%), which was similar to Manrique et al where he noticed incus lesions in 69%, higher compared to Edelstein et al where it was 46% and was in accordance with Sade (1981) who noticed it in 80% of cases.^{8,11}

Facial nerve canal was dehiscence in 7.5% of our cases which was not noted in Manrique et al and Edelstein et al in their study.

Dural plate and sinus plate was not eroded in our study, and was not seen in Edelstein et al series. Erosion of the lateral semicircular canal bulge was seen in 3 cases i.e. 7.5%, the fistula was covered by a fascia graft. Postoperatively these patients did not have any complaints. 4.9% lateral semicircular canal fistulas were noted in Manrique et al.¹⁰

Ossiculoplasty was done with auto incus in 42.5%, 22.5% with cartilage. Manrique et al have not used auto incus for ossiculoplasty and have used cartilage in only 9.5% of cases.

In 45% superior slit was employed to make an adequate meatoplasty, 7.5% had conchal and 2.5% had conchal and superior slit.

Healing time

The patients in our series were regularly followed to assess the healing time of the postoperative cavity. No discharge was present in our series at the 1st month follow up. 95% cavities had healed by three month similar to Paparella and Kim (87%).¹²

By the end of six months all cases 40 (100%) had shown complete epithelialization, which was similar to that of Paparella and Kim who noted 95% success.¹² one of them had infected wax collection which was cleaned regularly, and the other was a large cavity with granulations. Both were treated with antibiotic Out of the two cavities that showed complete epithelialisation at 6 months steroid ear drop.

Postoperative adverse events and quality of life

Superficial infection and transient discharge was seen in 1 case (2.5%) which responded well to topical and systemic antibiotic. Granulations were noticed in 1 (2.5%), which responded well to topical antibiotic and steroid ear drops. There were no cases with recidivism or meatal stenosis during our follow up. So overall rate of postoperative adverse events was 5% which is comparable to the study by Chao-Yin Kuo et al who had total 8.8%.¹³

Table 13: Postoperative adverse events.

Post op adverse events	Kuo ¹⁶	Present series (2016) (%)
Superficial infection+ granulations	4.9%	5
Meatal stenosis	Not noted	0.0
Recidivism	3.9%	0.0

In 38 cases dry cavity was seen, debris present in 2 cases (5%) which required frequent follow ups for cleaning. One case (2.5%) had a Conductive hearing loss at postoperative 18 months in this series.

Thus, the results of the present study are comparable to any other study where outside in technique was followed. Drilling the bone from within the ear canal and limiting the dissection as far as the outer limit of cholesteatoma will not increase the failure rates. Thus, with respect to disease eradication, the inside out technique is as good as the outside in technique. In our series, recidivism was never seen but the recurrence rates are related to the length of follow-up.

Table 14: Mastoidectomy results.

Series	No. of cases	% of failure
Gristwood	141	17
Abramson et al ¹⁴	155	9
Sade et al ¹¹	65	20
Brown ¹⁵		13
Present series (2016)	40	0

Table 15: Difference in pre and post operative (3 months) audiogram.

Variables	Duration	Mean	SD	SEM	P value
Mean air conduction	Baseline	43.88	19.63	3.10	<0.01
	Follow up	39.23	19.76	3.12	
Mean air bone gap	Baseline	29.25	12.78	2.02	
	Follow up	25.68	12.49	1.98	

Postoperative audiometry

Postoperatively, the mean postoperative air conduction threshold was 39.23db hearing level (mean difference 4.65db; p<0.01) similar to Kuo study, who noted it as 48.58 db hearing level (mean difference 5.7 db; p<0.001).¹³

Postoperatively, the mean postoperative air bone gap was found to be 25.68 dB hearing level (mean difference 3.57 dB; p<0.01) which was similar to that of Kao who noted it as 22.25 dB hearing level (mean difference 6.96 dB; p<0.001 in his study).¹³

Another study by Kuo et al the postoperative mean AC thresholds was 33.55 dB HL (mean difference of 9.35 dB; p<0.001) and the postoperative mean ABG was 17.88 dB HL (mean difference of 12.35 dB; p<0.001).¹⁶

Cavity condition on follow - up

We inspected the cavities for any excessive accumulation of wax, fungal debris, and persistence of discharge.

38 patients i.e. 95.0% had dry self cleansing cavities and rarely needed regular cleaning on their follow up visits. 2 case had excessive accumulation of debris and wax and required regular cleanings every 3 to 6 monthly. Hence, only 5% patients had some effect on the quality of life due to regular visits to the clinic. One (2.5%) of them had

an increased Conductive hearing loss recorded at 18 months follow up.

Roth et al, performed Inside Out Mastoidectomy in 604 patients between 1992 to 2006 and noted 95% dry ears which is the same as our present series.¹⁷

Roth et al in a study of 126 patients noted that 89.2% of all cases had dry ear postoperatively.²

Shah in his 75 inside out mastoidectomies found 89% of his cavities to be dry which is similar to the present series. In his series, 6% of the cavities were problem cavities and there was persistent discharge in 4% of the cases.²

Yung performed inside out mastoidectomy in 39 cases and found 74% of their cavities to be dry.¹⁹

Lailach et al compared health related quality of life (HRQOL) after sequential cholesteatoma surgery including exclusively transcanal technique (ETC), combined transcanal transmastoidal technique (TCM) and canal wall down surgery with obliteration (CWD).²⁰ Patients receiving ETC tended to report lower restrictions in HRQOL. Patients receiving canal wall down surgery with obliteration showed equivalent limitations in HRQOL compared to closed techniques (ETC, TCM). This is quite similar to our study where only 5% patients were affected due to debris in the ear canal.

CONCLUSION

In 'inside out' technique removing the mastoid bone in the direction of spread of cholesteatoma, a smaller postoperative cavity is achieved which in the long run will help in minimizing problems of a large cavity. The postoperative hearing were also significantly improved. We undertook a prospective study comprising of 40 patients with chronic suppurative otitis media with cholesteatoma in whom the inside out mastoidectomy was performed, to study the efficacy of inside-out approach in completely eradicating the cholesteatoma from middle ear and mastoid, preservation of hearing and and quality of life post mastoidectomy with regards to recurrent discharge, wax, granulations. The hearing improvement has been found to be significant of patients had a problem free cavity while excessive wax and debris was seen in 5%. So overall quality of life provided by this technique was good.

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Conflict of interest: None declared

Ethical approval: The study was approved by the Institutional Ethics Committee

REFERENCES

1. Sonkhya N, Mittal P, Sonkhya D. Intact Canal Wall Tympanomastoid Surgery: 10 years experience.

- Indian J Otolaryngol Head Neck Surg. 2012;64(4):319–25.
2. Roth TN, Ziglinas P, Haeusler R, Caversaccio MD. Cholesteatoma surgery in children: long-term results of the inside-out technique. *Int J Pediatr Otorhinolaryngol.* 2013;77(5):843-6.
3. American Academy of Otolaryngology-Head and Neck Surgery Foundation Inc. Committee on hearing and equilibrium guidelines for the evaluation of results of treatment of conductive hearing loss. *Otolaryngol Head Neck Surg.* 1995;113(3):186–7.
4. Roland Peter, Mayerhoff William, Otitis media-surgical principles based on pathogenesis. *Otolaryngologic Clin N Am.* 1999;32(3):525-47.
5. Glasscock ME, Gulya AJ. *Surgery of the ear.* 5th Ed. B C Decker Inc. Elsevier Hamilton; 2003: 499-516.
6. Eugene M. *Operative otolaryngology, Head and neck surgery.* Vol II. Philadelphia: W. B. Saunders Company; 1997: 1280-1299.
7. Gupta V, Gupta A, Sivarajan K. Chronic suppurative otitis media: an aerobic microbiological study. *Indian J Otol.* 1998;4(2):79-82.
8. David ER, Simon P, Gurpreet A, Charles J, Patricia C, Shula W, et al. Cholesteatoma in the paediatric age group, *Ann Otol Rhinol Laryngol.* 1988;97:23-9.
9. Eero V. Changes in the clinical presentation of chronic suppurative otitis media from the 1970s to the 1990s. *J Laryngol Otol.* 1998;112:1034-7.
10. Manrique R, Sanhueza I, Manrique M. Attic exposure-antrum exclusion as an on demand surgical technique for cholesteatoma. *Acta Otorrhinolaryngol.* 2013;64(1):22-30.
11. Sade J. Treatment of retraction pockets and cholesteatoma. *J Laryngol Otol.* 1982;96(8):685-704.
12. Paparella M, Kim. Mastoidectomy update. *Laryngoscope.* 1977;87(12):1977-88.
13. Kuo CY, Huang BR, Chen HC, Shih CP, Chang WK, Tsai YL, et al. Surgical Results of Retrograde Mastoidectomy with Primary Reconstruction of the Ear Canal and Mastoid Cavity. *Bio Med Res Int.* 2015;2015:517035.
14. Abramson M, Peter L, Barry P, Brian M. Results of conservative surgery for middle ear cholesteatoma. *Laryngoscope.* 1977;87(8):1281-7.
15. James BS. A ten year statistical follow-up of 1142 consecutive cases of cholesteatoma: The closed vs. the open technique. *Laryngoscope.* 1982;92(4):390-6.
16. Kuo CL, Shiao AS, Liao WH, Ho CY, Lien CF. Can Long-Term Hearing Preservation be Expected in Children following Cholesteatoma Surgery? Results from a 14-year-Long Study of Atticotomy-Limited Mastoidectomy with Cartilage Reconstruction. *Audiol Neurotol.* 2012;17(6):386–94.
17. Roth TN, Haeusler R. Inside-out technique cholesteatoma surgery. *Otol Neurotol.* 2009;30(1):59-63.

18. Shah N. Cholesteatoma surgery; Trans canal approach, *Adv. Oto-Rhino-Laryng.* 1983;29:216-23
19. Yung MW. Small cavity mastoidectomy-5 year review. *Clin Otolaryngol.* 1996;21(1):24-9.
20. Lailach S, Kemper M, Lasurashvili N, Zahnert T, Neudert M. Health-related quality of life measurement after cholesteatoma surgery: comparison of three different surgical techniques. *Eur Arch Otorhinolaryngol.* 2015;272(11):3177-85.

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