Anterior Attico-antrostomy with Cortical Mastoidectomy and Attic Reconstruction with or without Ossiculoplasty Versus Canal Wall Down Mastoidectomy with Ossiculotympanoplasty using Tragal Cartilage shielded by Temporalis fascia

Priyanka Gupta[*], Shiv Kumar[**]
[*&**]*(Department of Otorhinolaryngology, Govt. Medical College, Kota, Rajasthan/RUHS, India)*

DOI: 10.29322/IJSRP.9.08.2019.p92126
http://dx.doi.org/10.29322/IJSRP.9.08.2019.p92126

Abstract : *The aim of this study was to evaluate hearing and compare the hearing results of anterior atticoantrostomy with cortical mastoidectomy with attic reconstruction with or without ossiculoplasty to canal wall down mastoidectomy with ossiculotympanoplasty using tragal cartilage shielded by temporalis fascia. This was a prospective, analytical and longitudinal study which was conducted in the Department of Otorhinolaryngology, MBS Hospital kota, (Raj) From 1st Dec. 2015 to 30th Nov. 2016, included the patients with squamosal disease in age group of 15-45 years, having conductive hearing loss of 30 dB or more. 50 patients who were operated for squamosal disease were randomly selected, 25 patients in each group as named Group A and Group B. Outcome were measured in terms of Post-op ABG, ABG closure, extrusion or rejection of material used for ossiculoplasty, residual or recidivism rate of disease, patient's acceptability for procedure, and post-operative difficulties faced by patient. The study included 50 patients out of which 25 patients were male and 25 were female with a mean age of 27.62 yr. Maximum no of cases were in age group of 15-24 years (42%). ABG closure within 25 dB in Group A (ICW+A&R) who undergo anterior atticoantrostomy with attic reconstruction were in 18 (75%) patients while in Group B(CWD) who undergo canal wall down mastoidectomy with ossiculotympanoplasty were in 10 (43.47%) patients. Patients of Group A had a significant improved hearing outcome in compare of Group B patients. TORP rejection was seen in 1 case in follow-up period of 3 months, as cartilage was absorbed due to cavity infection.*

Keyword: *Atticoantrostomy, Cholesteatoma, Mastoidectomy, Ossiculotympanoplasty,*

I. INTRODUCTION

Acquired attic cholesteatoma is due to retraction of Sharpnell's membrane caused by Eustachian tube dysfunction, proliferation of basal layer of Sharpnell' membrane, immigration of squamous epithelium, or metaplasia of inflamed middle ear epithelium into keratinizing squamous epithelium. An attic cholesteatoma develops from Prussack's space of the pars flaccida; it usually extends laterally to the mastoid cavity and medially to the mesotympanum. Cholesteatoma invading the mesotympanum appear to destroy the ossicles and to induce frequent complication. The major surgical techniques for attic cholesteatoma are the 'Canal Wall Down' (CWD) and 'Intact Canal Wall' (ICW) tympanomastoidectomy procedures. The CWD approach can give improved exposure but produces significant clinical problems after surgery, such as late healing, postoperative hearing loss and the need for long-term care of the mastoid cavity. The advantages of the ICW technique are rapid wound healing and avoidance of the need to clean the ear periodically. However, residual and recurrent cholesteatomas are common after this approach because it is difficult to access the epitympanum. With opening of the attic (atticotomy), the epitympanic space can be visualized. If the atticotomy can be performed widely enough to expose the whole extent of the cholesteatoma (atticoantrostomy), the mass can be removed without leaving any residual matrix. However, the opened epitympanic area will act as a space for postoperative retraction and might allow the development of a recurrent cholesteatoma. Consequently, procedure that can reconstruct or obliterate the epitympanic space are needed to prevent recurrence and complications. Attic reconstruction can be performed with cartilage shielded by temporalis fascia. If disease or cholesteatoma is extensive then canal wall down mastoidectomy will be done. It includes cortical mastoidectomy along with removal of posterior wall of external auditory meatus and reconstruction of eroded ossicles with tragal cartilage shielded by temporalis fascia. In place of tragal cartilage TORP (Total ossicular replacement prosthesis) or PORP (Partial Ossicular Replacement Prosthesis) can be used. Reconstruction of eroded ossicles is usually done by homologous ossicles (most frequently used ossicle is the body of incus; the head of

malleus; a cortical bone graft or a cartilage i.e, chonchal or tragal or septal cartilage) or synthetic prosthesis made up of plastipore; hydroxyapatite; gold; titanium etc.

II. MATERIAL & METHODS

This is a prospective, analytical, and longitudinal study was performed in The Department of Otorhinolaryngology, MBS Hospital & attached Medical College Kota, Rajasthan from 1st Dec. 2015 to 30th Nov. 2016.
It was a hospital based study, as patients having chronic otitis media with cholesteatoma admitted in the ENT ward for ear surgery were our study population. During study period total mastoid surgery conducted in our institute were 180, out of which in 75 patients intact canal wall procedure and in 105 patients canal wall down procedure were performed.
After approval of study protocol by the local ethical committee and obtaining fully informed patient's written consent, 50 patients of age group 15-45yr having chronic otitis media with cholesteatoma operated for anterior atticoantrostomy with cortical mastoidectomy with attic reconstruction with or without ossiculoplasty and canal wall down mastoidectomy with ossiculotympanoplasty using tragal cartilage schielded by temporalis fascia, 25 patients in each category are included in this study.
The cases selected for this study will undergo thorough clinical examination including examination under microscope. For hearing assessment pure tone audiometry (PTA) test performed within 7 days prior to operation. The air and bone conduction threshold to be recorded both pre and post operatively. Threshold averages were calculated by taking averages of 500, 1000, 2000, & 4000 Hz frequencies.
The patients would therefter evaluated post surgery at periodic intervals on 7 days, 1 month, 3 month and 6 months as well.

Sampling Method:
The technique used was non-probability convenience method of **Random Sampling.**

Inclusion criteria:

a) Patient having squamosal chronic otitis media with written and informed consent for the study.
b) Patient in the age group of 15-45 yr.
c) Patient with hearing loss of 30db or more.
d) Patient with no active discharge from more than 4wk.

Exclusion criteria:

a) Patient with poor cochlear reserve or severe SNHL.
b) Patient with acute exacerbation of chronic otitis media.
c) Patient having intracranial complication.
d) Patient age <15 or >45 yr.
e) Patient with bilateral chronic otitis media where the ear to be operated was the only hearing ear.
f) Patient who underwent mastoid surgery as an approach to other surgery such as cochlear implant, translabyrinthine approach for acoustic neuroma etc.

The study was carried out under the following headings:

a) History Taking
b) Clinical Examination including Examination under Microscope
c) General physical examination
d) Investigations (Routine investigations, ECG, LFT, RFT, Coagulation profile, Pure tone audiogram, Radiology including skiagram bilateral mastoid lateral oblique view and HRCT Temporal bone and pus culture sensitivity)
e) Operative Procedure
f) Follow ups.

III. OPERATIVE TECHNIQUES

After taking fully informed consent with hair shaved 1 inch above and behind the pinna and nil per orally for at least 6 hr's patient was taken to OT room, where surgery was started under general anaesthesia. External auditory canal and post-auricular incision site was injected with 2% lignocaine in 1:100,000 adrenaline to achieve haemostasis. The ear was prepared by pouring povidone-iodine solution into the ear canal and scrubbing the auricle and post-auricular area with povidone-iodine. A post-auricular incision was made about .5 cm behind the post-auricular crease and a plane was developed between the subcutaneous tissue and the temporalis muscle and the periosteum of mastoid. External auditory canal skin incision was made in the direction of 6 o'clock to 12 o'clock at a distance of about 3mm from tympanic ring. A tympanomeatal flap was elevated and the mesotympanum was exposed. The status of ossicular chain and the extent of the cholesteatoma in the middle ear were both evaluated. The lateral epitympanic wall was removed with drill burrs to make a wide opening into the to make a wide opening into the epitympanum and thus visualize the extent of the cholesteatoma. If necessary, the malleus head and/ or incus were also removed. Simple mastoidectomy was performed to expose the antrum. The whole matrix of cholesteatoma was removed as completely as possible from the epitympanum, mesotympanum and mastoid cavity. Patient's tragal cartilage and temporalis fascia were harvested under the sterile conditions. To reconstruct the lateral bony wall of Prussack's space, harvested cartilage was cut into a piece of adequate size for coverage over the attic space. If the malleus head, short process or incus remained intact, the reconstructed cartilage can be supported by the ossicles. However, when there was only the malleus handle without short process or no ossicle at all, the attic was obliterated with cartilage. In this procedure, small pieces of cartilage are packed into the epitympanum to prevent any retraction of tympanic membrane. Defects of tympanic membrane were repaired with temporalis fascia graft. If necessary, ossiculoplasty was performed with TORPs or PORP. Synthetic prosthesis made-up of porous plastic (Polycel) may be used for ossicular reconstruction. While for extensive cholesteatoma canal wall down mastoidectomy was performed by removing posterior wall of external auditory meatus and mastoidectomy was done up to posterior to facial ridge but not beyond the anterior end of horizontal canal with possible reconstruction of hearing. An adequate size of chonchomeatoplasty was done for easy postoperative drainage, aeration and regular periodic cleaning of collected.

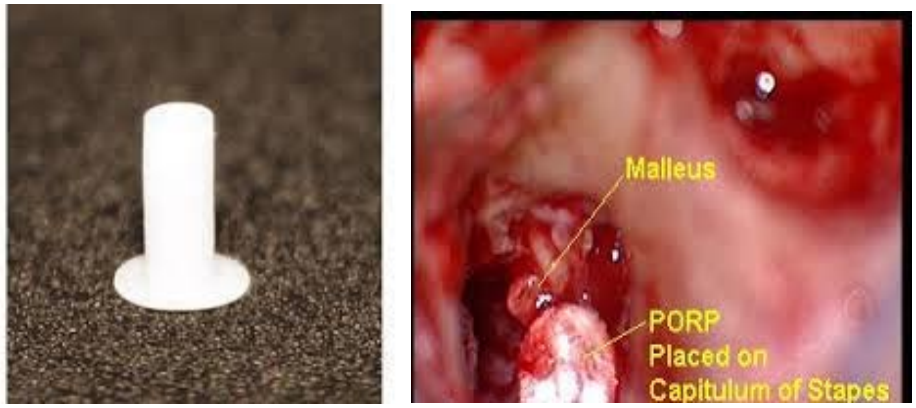


Fig 01: Material Used for Ossiculoplasty as TORP or PORP

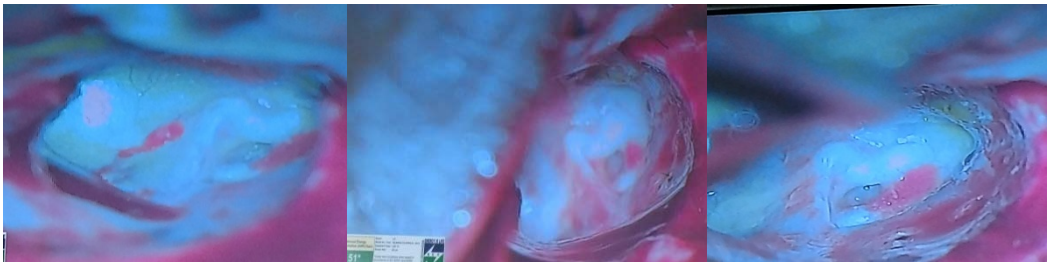


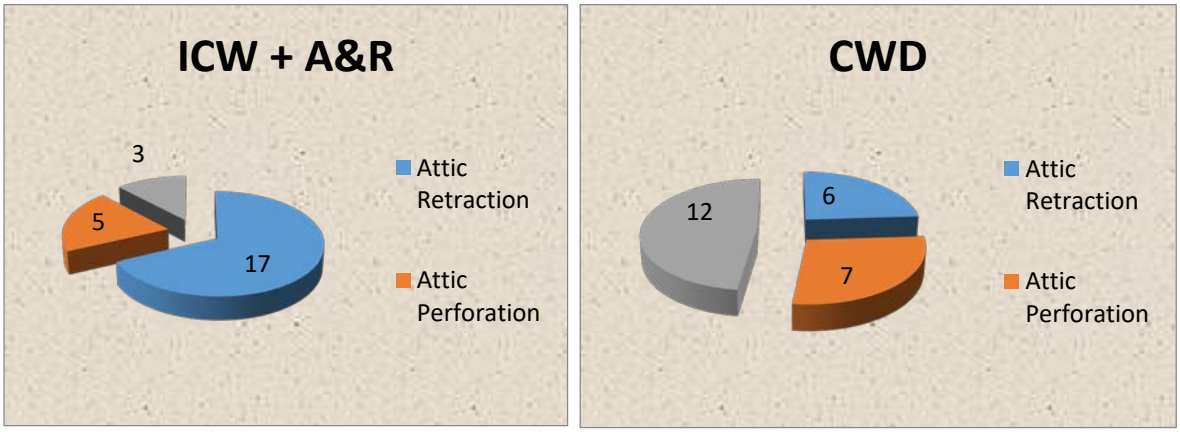
Fig 02: Attic Perforation and Attic Reconstruction

IV. OBSERVATIONS & RESULTS

Table No. 1

Distribution of the patients according to tympanic membrane status

TM Status	ICW + A&R	CWD	Total
Attic Retraction	17	6	23
Attic Perforation	5	7	12
Postero-superior Perforation	3	12	15

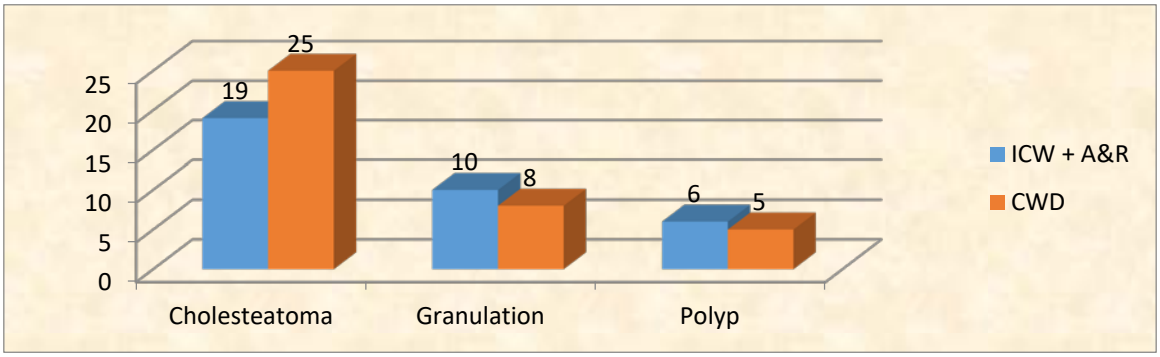


In our study we found that Attic Retraction was more commonly associated with limited disease as compare to postero-superior perforation associated with extensive disease. In total no. of 50 patients 46% had an attic retraction, 30% had a posterior-superior perforation and 24% had an attic perforation.

Table No. 2

Distribution of patient according to middle ear pathology

Clinical Finding	ICW+A&R	CWD	Total
Cholesteatoma	**19**	**25**	**44**
Granulation	**10**	**8**	**18**
Polyp	**6**	**5**	**11**

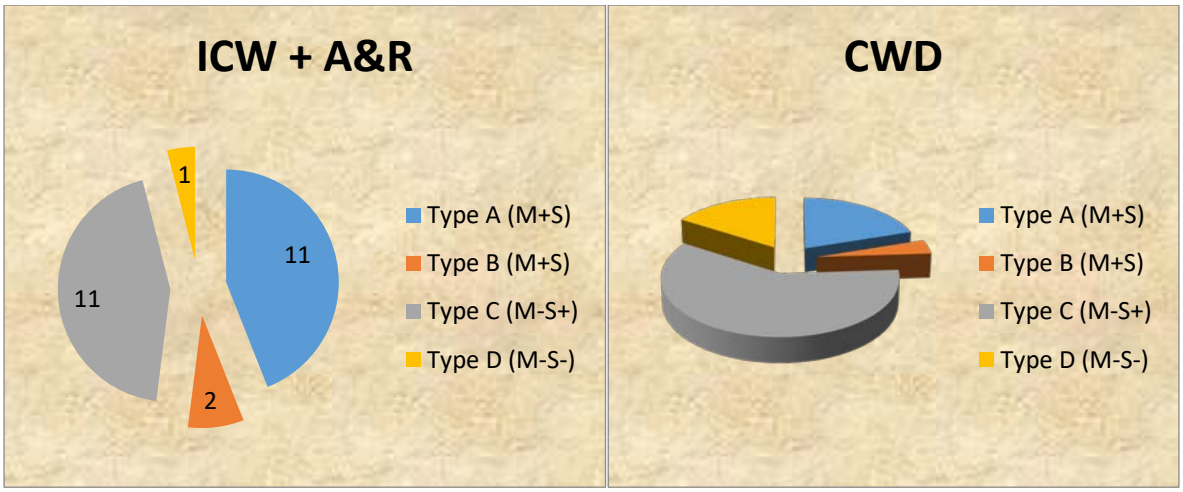


Most common pathological finding was cholesteatoma, followed by granulation and aural polyp.

Table No. 3

Distribution of patient according to the status of ossicles (Austin Classification)

Status of ossicles	ICW+A&R	CWD	Total
Type A (M+S+)	11	5	16
Type B (M+S-)	2	1	3
Type C (M-S+)	11	15	26
Type D (M-S-)	1	4	5
Total	25	25	50

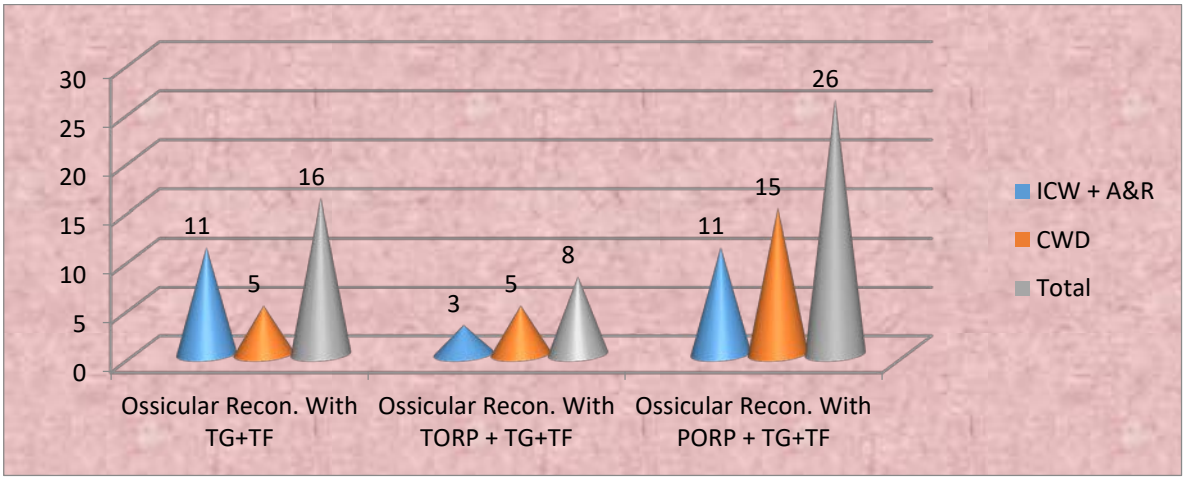


Type A (M+S+) and Type C (M-S+) were the most common ossicular finding for which ICW + A&R surgery done. CWD was done more commonly in Type C (M-S+) ossicular status.

Table No. 4

Distribution of the patients according to Surgical Technique used for Ossicular Reconstruction

Surgical Technique	Ossicular Recon. With TG+TF	Ossicular Recon. With TORP + TG+TF	Ossicular Recon. With PORP + TG+TF
ICW+A&R	11	3	11
CWD	5	5	15
Total	16	8	26

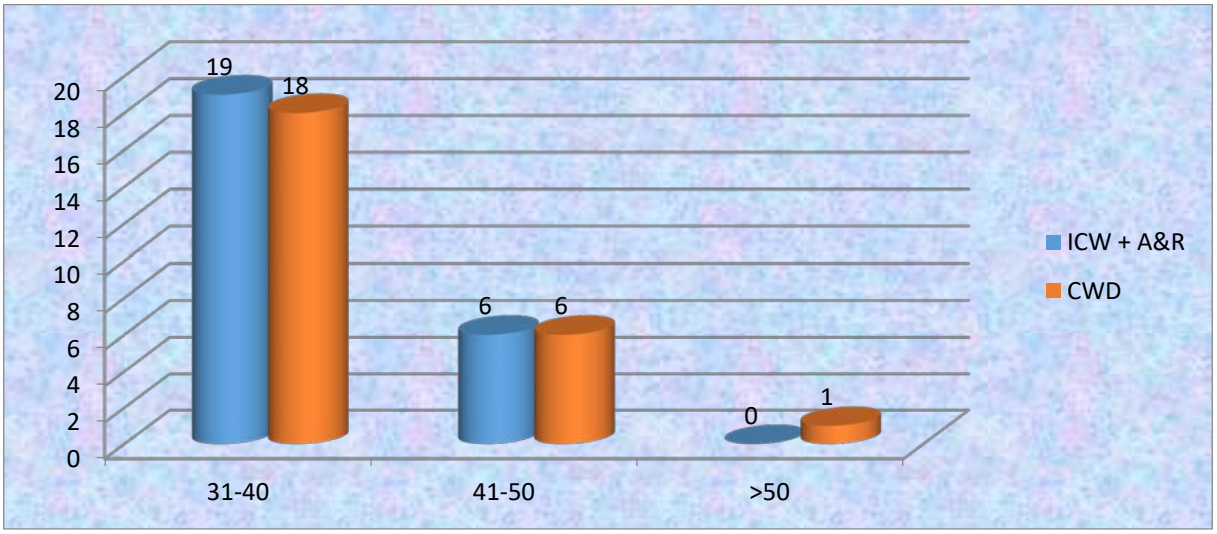


In 16 patients (ICW+A&R 11; CWD 5) tragal cartilage along with temporalis fascia were used for reconstruction. In 8 (ICW+A&R3; CWD5) patients we use TORP with tragal cartilage and temporalis fascia; in 15 patients of Group CWD and 11 patients of Group ICW+A&R we use PORP with tragal cartilage and temporalis fascia.

Table No. 5

Pre-Op ABG Comparison

Pre-Op ABG	ICW+A&R	CWD	Total
31-40	19	18	27
41-50	6	6	12
>50	0	1	1
Total	25	25	50

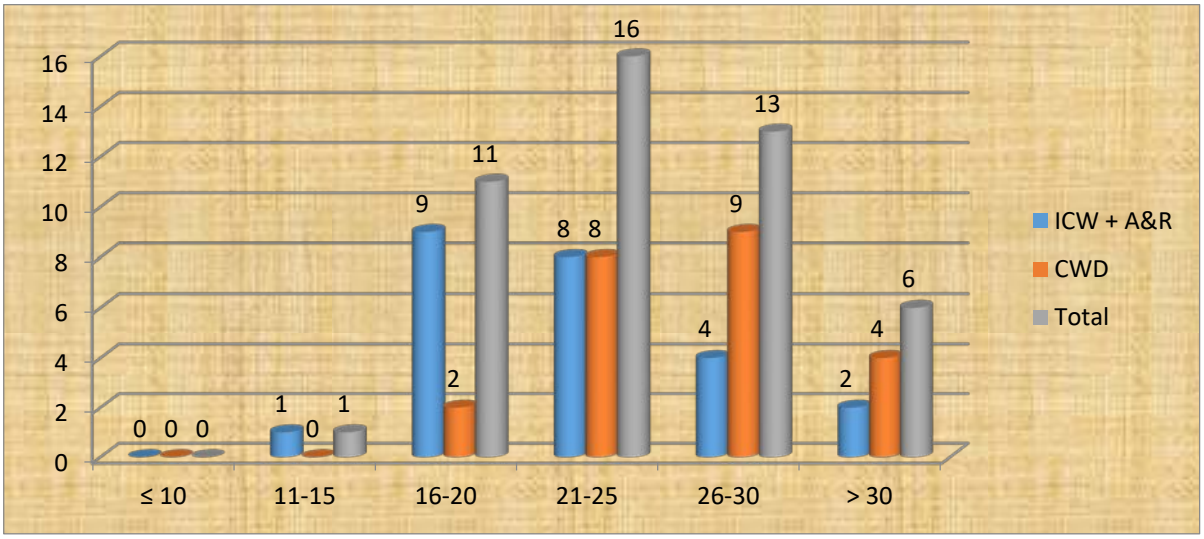


Maximum number of cases were having an AB gap between 31-40 dB in both groups. No patient had having an AB gap of <30 dB in both groups.

Table No. 6

Post-Op ABG Comparison

Post-Op ABG	ICW+A&R	CWD	Total
≤ 10	0	0	0
11-15	1	0	1
16-20	9	2	11
21-25	8	8	16
26-30	4	9	13
> 30	2	4	6
Loss of follow- up	1	1	2
Prosthesis extrusion	0	1 (TORP)	1
Total	25	25	50

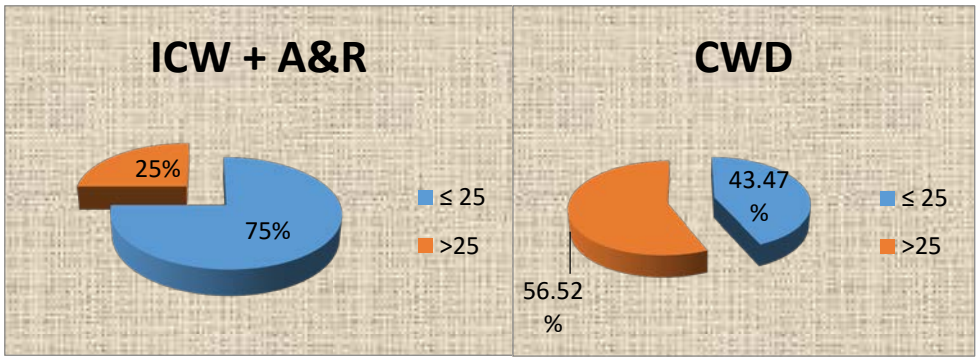


Maximum number of cases had a post-op AB gap between 21-25 dB with loss of follow-up of 2 cases, one in each group and extrusion of prosthesis (TORP) in 1 case of Group CWD.

Table No. 7

Comparison of AB Gap Closure Post Operatively

Post-Op ABG	ICW+A&R	CWD
≤ 25	18/24(75%)	10/23 (43.47%)
>25	6/24 (25%)	13/23 (56.52%)



Post-op remaining AB gap ≤25 dB in Group ICW+A&R was in 18 (75%) patients and in Group CWD was in 10 (43.47%) patients.

Table No. 8

Evaluation of Pre and Post-Operative PTA-ABC

Parameter	Group	N	Mean ± SD	P Value
ICW+A&R	Pre-operative ABG 500 Hz	**24**	**40.62±4.73**	**<.0001**
	Post-operative ABG 500 Hz		**20.62±3.98**	
	Pre-operative ABG 1000 Hz		**38.54±7.4**	**<.0001**
	Post-operative ABG 1000 Hz		**20.62±5.38**	
	Pre-operative ABG 2000 Hz		**35.83±7.89**	**<.0001**
	Post-operative ABG 2000 Hz		**16.66±3.80**	
	Pre-operative ABG 4000 Hz		**35.62±6.64**	**<.0001**
	Post-operative ABG 4000 Hz		**17.5±7.22**	
	Pre-operative ABG Average		**37.34±4.41**	**<.0001**
	Post-operative ABG Average		**18.69±3.97**	

Table No. 9

Evaluation of Pre and Post-Operative PTA-ABC

Parameter	Group	N	Mean ± SD	P Value
CWD	Pre-operative ABG 500 Hz	**23**	**41.30±6.94**	**<.0001**
	Post-operative ABG 500 Hz		**23.26±6.50**	
	Pre-operative ABG 1000 Hz		**38.69±8.00**	**<.0001**
	Post-operative ABG 1000 Hz		**23.69±6.94**	
	Pre-operative ABG 2000 Hz		**39.13±10.40**	**<.0001**
	Post-operative ABG 2000 Hz		**20.86±7.33**	
	Pre-operative ABG 4000 Hz		**38.47±7.60**	**<.0001**
	Post-operative ABG 4000 Hz		**20.43±7.37**	
	Pre-operative ABG Average		**39.40±4.92**	**<.0001**
	Post-operative ABG Average		**21.95±5.83**	

V. DISCUSSION

In our study maximum no of cases were in age group 15-24 year (42%) followed by 25-34 year (30%). Minimum age was 15 year and maximum age was 45 yr. The mean age in Group ICW+A&R was 27 years and in Group CWD was 28.24 yr. The studies done by BL Shrestha (2010)[36] also had the maximum no of cases in the age group 25-35 year and average age was 24.88 ± 5.82.

According to available literature (Lee and Schuknecht 1971)[37] age has no significant role in success of Tympanoplasty. The studies of Russel and kloid 1991, states that failure rates are higher in patients below 10 years and above 55 year of age. This is due to poor compliance regarding procedure and audiometric recording below 15 yr. Hence in our study, we had selected patients in range of minimum age of 15 year and maximum age of 50 yr. Age does not alter the success of ossiculoplasty as seen from the studies of Iliana Fukuchi et al[5].

The sex distribution was males 40% (10), females 60% (15) in Group ICW+A&R (n=25) and males 56% (14), and females 44 % (11) in Group CWD. As per literature available (Scott Brown otology) the success of middle ear surgery for chronic otitis media is not dependent on sex of pt.
In our study right ear were operated in 54 % (27), and left ear in 46 % (23) patients. The side of the disease was of no significance in assessing the hearing outcome for surgery.
The maximum number of cases were of service class i.e. 30 % followed by house wives i.e. 24 %. This can be explained by the fact that ladies and educated members came forward for getting hearing improvement. Uneducated and Rural population came only when there was severe hearing loss, thus we can say that education play a great role in seeking early advice regarding disease and treatment. This study is similar to Gupta J.P. (1978), in his study the maximum number of cases were house wives (36.3%) and students (23.4%) and minimum (13.3%) cases were in labour group.
The common symptoms in patients who presented with chronic otitis media, as seen in this study were hearing loss (100%) followed by ear discharge 92%, otalgia 30 %. Mac fadyean CA and colleagues in their study reported hearing impairment, aside from the disability from recurrent ear discharge, as the most frequent symptom of COM.
In this present study, the pre-operative assessment of patients included an otoscopic examination, oto-microscopic examination, assessment of hearing and radiological evaluation.
In our study we found that attic retraction (46 %) was the most common finding of tympanic membrane on otoscopic and oto-microscopic examination, followed by posterior- superior perforation (30%), and attic perforation (24%).
Middle ear pathology was cholesteatoma 76% (19), granulation 40% (10), aural polyp 24% (6) in Group ICW+A&R (n=25) and cholesteatoma 100% (25), granulation 32% (8), aural polyp 20% (5) in Group CWD (n=25)
The Austin classification of ossicular erosion is based upon the presence or absence of malleus handle (M+M-) and stapes suprastructure (S+S-). According to this classification, there are four types of ossicular defect: Type A (M+S+), Type B (M+S-), Type C (M-S+), and Type D (M-S-). Stapes suprastructre was present in total 42 cases, out of which in 22 cases ICW+A&R; in 20 cases CWD surgery was performed. Stapes suprastructure was not present in 8 (3 ICW+A&R; 5 CWD) Cases, out of which in 3 (2 ICW+A&R; 1 CWD) cases handle of malleus was present and in 5 (1 ICW+A&R; 4 CWD) cases handle of malleus was also absent.
Pre-operative X-Ray Law's view of both mastoids of all patients were taken and reported. The mastoid showing a cellular pattern were reported as Cellular; those showing no cells, showing only white pattern were labelled as Sclerotic; and those showing mixed pattern were labelled as Diploic. In this study, X-Rays in 68% of patients were sclerosed; in 20% diploic; and in 12% cavity was present.
In a study of Tiwari et al, in cases having Cholesteatoma, 92.5% patients X-Rays are sclerotic. Welin stated that radiology provides detailed description of the anatomy of temporal bone, state of pneumatisation and bone structure. This is of importance to the operating surgeon.
Williams in 1938, Goodhill in 1960 and Tiwari et al in 1991 stated that sometime sclerosis might be the only radiological manifestation of cholesteatoma.
Out of 25 cases in which ICW+A&R was done, ossicular reconstruction was done with tragal cartilage and temporalis fascia in 11 cases; and with TORP, tragal cartilage, and temporalis fascia in 3 patients and with PORP, tragal cartilage, temporalis fascia in 11 patients. Whereas 25 patients in which CWD was done, ossicular reconstruction was done with tragal cartilage and temporalis fascia in 5 cases; TORP, tragal cartilage and temporalis fascia in 5 cases; PORP, tragal cartilage and temporalis fascia in 15 cases.
Pre-operatively in Group ICW+A&R, 76% of patients had an AB gap between 31-40 dB, 24% of patients between 41-50dB. Similarly in Group CWD, 72% of patients had an AB gap between 31-40 dB, 24% of patients between 41-50 dB, and 4% of patients between >50dB.
No patient had an AB gap of <30 dB in both group.
Post-operatively at 03 months, Group ICW+A&R showed an improved an AB gap having post-op AB gap of 11-15 dB range in 4% of patients, 16-20 dB range in 36% of patients, 21-25 dB range in 32% of patients, 26-30 dB range in 16% of patients, and >30 dB in 8% of patients, with loss of follow-up in 1 (4%) case. No prosthesis extrusion was seen in Group ICW+A&R during follow-up period of 3 months. In Group CWD 8% of patients had an AB gap between 16-20 dB; 32%

of patients had an AB gap between 21-25 dB; 36% of patients had an AB gap between 26-30 dB; 16% of patients had an AB gap >30 dB; with loss of follow-up of 1 (4%) case; and prosthesis (TORP) extrusion in 1 case out of 20 cases (TORP+PORP). There were no patients in both group having remaining AB gap <10dB.

Post-op remaining ABG ≤25 dB in Group ICW+A&R was in 18 (75%) and in Group CWD was in 10 (43.47%) patients. As it suggests that hearing improvement was better with ICW+A&R surgery.

In our study the average PTA-ABG for frequencies 500Hz, 1000Hz, 2000Hz, and 4000Hz of Group ICW+A&R (n=24), pre-operatively was 37.34±4.41 dB and post-operatively was 18.69±3.97dB. The difference of pre and post-operative PTA ABG results was statistically significant (p<.0001). The mean PTA ABG improvement was 18.90dB. These results are consistent with the study done by Kyrodimos et al[38] (2007) and BL Shrestha et al[36] (2010).

Average PTA-ABG for frequencies 500Hz, 1000Hz, 2000Hz, and 4000Hz of Group CWD (n=23), pre-operatively was 38.64±4.45 dB and post-operatively was 21.30±5.02dB. The difference of pre and post-operative PTA ABG results was statistically significant (p<.0001). The mean PTA ABG improvement was 17.44dB.

VI. CONCLUSION

The analysis revealed the following results:

1. There was significant improvement in hearing after Ossiculotympanoplasty in both groups at the end of 03 months.
2. At the end of 3 months there was an ABG CLOSURE of ≤25 dB in 75% patients of Group ICW+A&R as compared to 43.47% in Group CWD demonstrating better improvement in hearing after Atticotomy and Attic Reconstruction.

LIMITATIONS OF THE STUDY

1. The sample size of 50 was taken from a confined population of IPD patients admitted in ENT ward for tympanomastoid surgery in MBS Hospital Kota.
2. The study period was a total of Three Month for each subject; however, a longer duration could have shown more significant response.

RECOMMENDATIONS

1. Similar studies may be carried out with a larger sample size and a more diverse population.
2. Future studies may be carried out over a longer duration to assess the long term success rate of surgery.
3. The analysis of various other diseases related and surgical factors affecting the outcome of surgery may be incorporated in future studies to enable better management of patients.

VII. REFRENCES

[1] Austin DF." Ossicular reconstruction",*Otolaryngology Clinics of North America.* 1972; 5:689-714.
[2] Nicholas J. Frookto, "Reconstruction of middle ear", Scott Brown's Otolaryngology, vol .3,6th ed. Otology. Butterworth Heinemann, 1997:1-26
[3] Glasscock-Shambhauget. al. Surgery of the Ear, Fifth edition, Elsevier, Chap 24, page 463-483.
[4] Iliana Fukuchi, DafnePatríciaCerchiari, Eduardo Garcia, Carlos Eduardo BorgesRezende, et.al. "Tympanoplasty: surgical results and a comparison of the factors that may interfere in their success", Braz J Otorhinolaryngol. 2006;72(2):267-71
[5] Glasscock-Shambhauget. al. Surgery of the Ear, Fifth edition, Elsevier, Chap 2, page 35-57 and Chap 3 page 59-80
[6] Dornhoffer JL, "Prognostic factors in ossiculoplasty: a statistical staging system", OtolNeurotol. 2001 May;22(3):299-304.
[7] Glasscock- Shambhaug. al. Surgery of the ear, Sixth ediion, Chap 2, page 40, pneumatization.
[8] Glasscock- Shambhaug. al. Surgery of the Ear, Sixth edition, Chap 3, page 53-55, Sound transmission in the middle ear
[9] Glasscock-Shambhaug. al. Surgery of the Ear, Sixth edition, Chap3, page 54, Diagram ……, "Transformer action of middle ear".
[10] Gray AF, Groves J. Eds: A Synopsis of Otolaryngology, 4thed. Bombay: KM Verghesecompany. 1985: 38-45.
[11] Austin DF: "Acoustic mechanisms in middle ear sound transfer", *OtolaryngolClinNorth Am* 27:641, 1994
[12] Kim HH, Battista RA, Kumar A, Wiet RJ, "Should Ossicular Reconstruction Be Staged Following Tympanomastoidectomy", Laryngoscope 2006; 116: 47-51.
[13] SohilVadiya • AnujaKedia. Atticotomy, "Attic Reconstruction, Tympanoplasty with or without Ossiculoplasty, Canal Plasty and Cortical Mastoidectomy as Part of Intact Canal Wall Technique for Attic Cholesteatoma", Indian J Otolaryngol Head Neck Surg.(Apr–Jun 2015) 67(2):128–131; DOI 10.1007/s12070-015-0821-z
[14] JiHeui Kim, MD SeungHyo Choi, MD Jong Woo Chung, MD.Department of Otolaryngology, Asan Medical Center, College of Medicine, University of Ulsan, Seol, Kore, "Clinical Results of Atticoantrotomy with Attic Reconstruction or Attic Obliteration for Patients with an Attic Cholesteatoma", Clinical and Experimental Otorhinolaryngology.march2009:2(1): 39-43; DOI 10.3342/ceo.2009.2.1.39
[15] DRowe A1, Stein G, Fishman G, Berco E, Avraham S, Landsberg R, SadéJ, "Long-term outcome of atticotomy for cholesteatoma in children", OtolNeurotol .2005 May:26(3);472-5.
[16] Uyar Y1, Oztürk K, Keles B, Arbağ H, Ulkü CH, "Anterior atticoantrostomy for cholesteatoma surgery", Ann OtolRhinolLaryngol. Feb2006:115(2);150-5
[17] Lee WS1, Choi JY, Song MH, Son EJ, Jung SH, Kim SH, "Mastoid and epitympanic obliteration in canal wall up mastoidectomy for prevention of retraction pocket", OtolNeurotol. Nov2005 :26(6);1107-11
[18] Slobodan Spremo, MirjanaGnjatic, SanjaSpiric, PredragSpiric, DmitarTravar, Mira Spremo, "Hearing results of tympanoplasty with attic reconstruction vs. obliteration in attic cholesteatoma", http://dx.doi.org/10.14748/ssm.v47i4.1431
[19] Dr.NafisaParveen, "Hearing outcome in canal wall down mastoidectomy with type III Tympanolasty", STATE JOURNAL OF OTOLARYNGOLOGY .21-23
[20] A. ARTUSO, W. DI NARDO, E. DE CORSO, M.R. MARCHESE, N. QUARANTAInstitute of Otorhinolaryngology, "A. Gemelli" Polyclinic, Catholic University "SacroCuore", Rome, Italy, "Canal wall down tympanoplasty surgery with or without ossiculoplasty in cholesteatoma: hearing results", p.2-7
[21] Asmabinti Abdullah, MS ORL HNS, ShaharudinMohamadHashim, MS ORL-HNS, Muhammad AlmyzanAwang,B.Aud (Hons), LokmanSaim, MS ORL-HNS, "Outcome of Canal Wall Down Mastoidectomy: Experience in Sixty Three Cases", Med JMalaysia. june2013:68(3); P.217-221
[22] Leonard P. Berenholz, Franklin M. Rizer, John M. Burkey,Arnold G. Schuring, William H. Lippy, "Ossiculoplasty in canal wall down mastoidectomy", The American Journal of Otolaryngology-head and neck surgery.2000;123(l):30-31
[23] Sohit P. Kanotra, MD ;Andrian L. James, DM, FRCS, "Pediatric Otolaryngology: Attic reconstruction in paediatric Canal wall-up mastoidectomy": oto.sagepub.com
[24] Austin DF, "Single-stage surgery for cholesteatoma: an actuarial analysis", Am J Otol. 1989 Nov;10(6):419-25.
[25] James A. Cook, MA, FRCS, Surya Krishnan, MB, BS, Paul A. Fagan, MD, FRACS, "Hearing Results following Modified Radical versus Canal-up Mastoidectomy", Annals of Otology, Rhinology and Laryngology.Published May 1, 1996
[26] Andrea Bacciu, Enrico Pasanisi, Vincenzo Vincenti, Filippo Di Lella,Salvatore Bacciu, "Reconstruction of outer attic wall defects using bone paté: long-term clinical and historical evaluation", European Archives of Oto-Rhino-Laryngology and Head & Neck. November 2006, Volume 263, Issue 11, pp 983–987

[27] Stankovic M, "Follow-up of cholesteatoma surgery: open versus closed tympanoplasty", ORL J OtorhinolaryngolRelat Spec. 2007;69(5):299-305. Epub 2007 Jul 10.
[28] BL Shrestha, H Bhattarai, CL Bhusal; "Comparision of pre and post operative hearing results after Cartilage augmentation Type III Tympanoplasty"; Nepalese journal of ENT & Head & Neck Surgery vol 1 issue 2 july-dec 2010
[29] Lee k, Schuknecht HF (1971) "Results of tympanoplasty and mastoidectomy at the Massachusetts Eye and EAR Infirmary", Laryngoscope 81 :529-543 12.
[30] Kyrodimos E, Sismanis A, Santos D, "Type 3rd cartilage shield tympanoplasty: an effective procedure for hearing improvement", Otolaryngol Head Neck Surg 2007, 136:982:5