

## Original Research Article

# Hearing results in modified radical mastoidectomy with type III tympanoplasty

Yash D. Lavana, Ajay J. Panchal\*, Vaibhav B. Hapalia, Manit M. Mandal, Shivani D. Shah

Department of Otorhinolaryngology, Surat Municipal Institute of Medical Education and Research, Surat, Gujarat, India

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**\*Correspondence:**

Dr. Ajay J. Panchal,

E-mail: [ajshef@yahoo.in](mailto:ajshef@yahoo.in)

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### ABSTRACT

**Background:** The objective of the study was to hear the results in patients with atticoantral-chronic otitis media who undergone canal wall down mastoidectomy with different types of tympanoplasty.

**Methods:** 86 cases of CSOM-AA were included. Patients were divided in 3 groups according to intra-operative ossicular chain status and reconstruction. Group A were patients having intact stapes superstructure and the graft kept over the stapes head covering middle ear and mastoid cavity. Group B patients were with intact superstructure of stapes and graft kept over cartilage graft kept on mobile stapes head. Group C patients were with absent superstructure of stapes with intact, mobile footplate and graft kept over autologous or homologous cartilage kept on footplate of stapes. On 10<sup>th</sup> week and 24<sup>th</sup> week after surgery, PTA was carried out to compare pre and post-operative hearing status. The study was conducted at SMIMER Hospital, Surat (a tertiary health care hospital) from September 2016 to September 2017.

**Results:** In 86 patients, average mean preoperative AC threshold was 48.16 ( $\pm$ 15.15) dB, mean pre-operative BC was 8.96 ( $\pm$ 7.85) dB and mean pre-operative air bone gap was 40.11 ( $\pm$ 12.92) dB. The mean post-operative AC threshold was 43.17 ( $\pm$ 13.72) dB, mean post-operative BC was 11.34 ( $\pm$ 9.44) dB and postoperative air bone gap was 32.06 ( $\pm$ 11.62) dB. The mean air bone gap closure was 8.76 ( $\pm$ 11.86). This hearing gain was statistically highly significant ( $p$ <0.001). Among 86 patients, cartilage was used in total 60 patients. Mean ABG was 8.6 dB, 11.05 dB and 8.43 dB respectively for tragal, conchal and homologous septal cartilage.

**Conclusions:** Hearing improvement can be achieved with appropriate reconstruction in CWD mastoidectomy.

**Keywords:** Canal wall down mastoidectomy, Tympanoplasty, Atticoantral chronic otitis media

### INTRODUCTION

Cholesteatoma surgery is still the subject of lively discussion in the medical literature. The ideal goal of cholesteatoma surgery should be the permanent removal of disease and the preservation of good hearing function. Radical mastoidectomy ensures disease eradication but sacrifices hearing function. Historically, the canal wall down procedure did not ensure good restoration of auditory function. However, the preservation of both middle-ear cavity and sound transmission function could

be possible using the numerous new techniques which have been developed over recent years.<sup>1</sup>

Hearing outcomes following canal all down (CWD) mastoidectomy in patient with chronic suppurative otitis media (CSOM) depend on several factors like extent of pathology, ossicular erosion and ossicular reconstruction. In the past, eradication of disease was the primary target in the treatment of cholesteatoma. Therefore, radical mastoidectomy was the most popular procedure in cases of extensive cholesteatoma. Since the first half of the 20<sup>th</sup>

century, hearing protection or restoration has also become a priority of treatment. But this goal is not always attainable because inadequate or improper surgery can cause residual or recurrent disease.<sup>2</sup>

Various autogenous and allogeneous materials are available for ossiculoplasty. Autologous ossicles and cartilage are the first choices for ossiculoplasty. In the absence of autologous ossicles, several different types of prostheses can be used, both biological (homologous cartilage, cortical mastoid bone and homologous ossicles) and synthetic (plastipore, hydroxyapatite, gold, titanium, etc).<sup>1</sup>

The aim of the observational study was to evaluate hearing results following the use of autologous cartilages (tragal and conchal cartilage) and homologous septal spur cartilage in subjects undergoing CWD mastoidectomy and tympanoplasty for middle-ear cholesteatoma.

### **Objective**

The objective of the study was to hear the results in patients with atticointral-chronic otitis media who undergone canal wall down mastoidectomy with different types of tympanoplasty in our institute.

### **METHODS**

This was a prospective observational study conducted at SMIMER Hospital, Surat (a tertiary health care hospital) from September 2016 to September 2017. The study was designed to evaluate the hearing results in CWD mastoidectomy with tympanoplasty using autologous or homologous cartilage depending upon ossicular status found during surgery. The procedure was explained to the patients and their relatives and written informed consent was taken.

### **Inclusion criteria**

Patients of both sexes and more than 5 years of age coming to ENT OPD were diagnosed atticointral-chronic otitis media with conductive loss who are willing for CWD mastoidectomy with tympanoplasty and ready for regular follow up.

### **Exclusion criteria**

Patients with a history of trauma to the ear or temporal bone, all patients who refuse for participation in study and patients with chronic otitis media with poor cochlear reserve.

Detailed history, clinical and otomicroscopic examination were carried out. X-ray mastoids Schuller's view in all patients and HRCT of temporal bone whenever required were done to know the status of mastoid air-cell system, extent of the disease, position of dural and sinus plates and any impending complications.

Preoperative PTA was carried out in 1 week or less before surgery on OPD basis. It was performed in acoustically treated room with Advanced Digital Audiometer, "Elkon eda 3 n 3 multi". The hearing was tested at frequencies 250-8000Hz, for each ear separately. The air conduction and bone conduction threshold averages were calculated by taking the averages of 0.5, 1, 2 and 4 KHz frequencies. The air bone gap (ABG) was calculated taking the differences between air conduction and bone conduction threshold.

After G/A fitness and consent for surgery, CWD mastoidectomy was performed in every patient. In all cases ossiculoplasty was performed in one stage with CWD mastoidectomy using postaural approach. Temporalis fascia or fascia lata was used as the graft material for tympanic membrane reconstruction.

Patients were divided in groups according to intra-operative ossicular chain status and ossicular reconstruction. Surgical findings were noted in terms of extent of the disease, presence or absence of stapes superstructure, mobility of stapes footplate and type of tympanoplasty performed. Based on the presence of superstructure or its absence with mobile footplate, the patients were categorized into three groups.<sup>3,4</sup>

### **Group A**

Necrosed or absent incus with intact mobile stapes superstructure. After CWD mastoidectomy, the fascia graft was placed in contact with the stapes head and covering middle ear and mastoid cavity (Stapes columella).

### **Group B**

Necrosed or absent incus with intact superstructure of stapes, underwent ossicular reconstruction with autologous or homologous cartilage kept between temporalis fascia graft and mobile stapes head (Minor columella).

### **Minor columella**

#### *Minor columella using conchal/tragal cartilage*

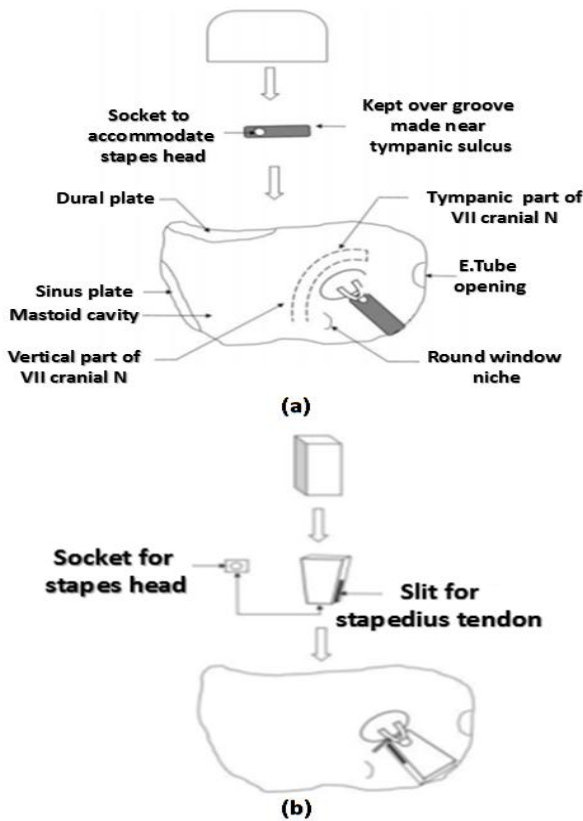
At one end of strip, small socket is made to accommodate stapes head. Other end of cartilage strip is kept in groove made near tympanic sulcus lateral to annulus. TFG kept over this assembly.

#### *Minor columella using homologous septal cartilage*

Homologous septal cartilage is sculptured in conical shape with drilling socket at bottom and slit for stapedius muscle tendon at one end to accommodate stapes head and stapedius muscle tendon.

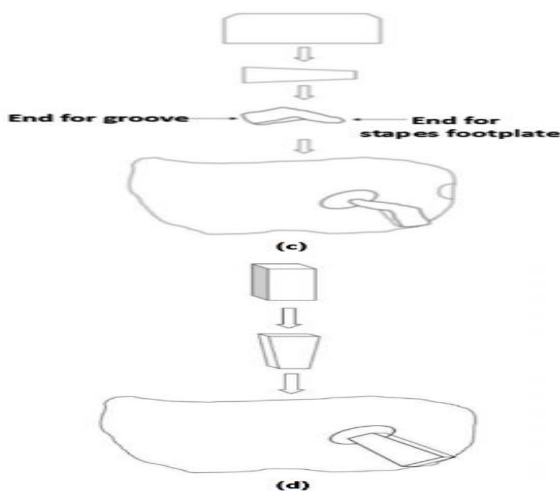
**Group C**

Absent incus and superstructure of stapes with intact, mobile footplate. Ossicular reconstruction with autologous or homologous cartilage kept between Temporalis fascia graft and footplate of stapes (Major columella).



**Figure 1: Minor columella (a) using tragal cartilage and (b) septal spur cartilage.**

**Major columella**



**Figure 2: Major columella (c) using tragal cartilage and (d) septal spur cartilage.**

**Major columella using conchal or tragal cartilage**

Strip is cut with one end slightly broader than other. Then narrow end is kept on stapes foot plate after putting the small piece of TFG to stabilize the cartilage graft and other end in groove near tympanic sulcus, lateral to annulus in boomerang shape.

**Major columella using homologous septal cartilage**

Conically sculptured cartilage is kept over stapes footplate as shown in figure and supported with gel foam.

We used autologous conchal/tragal cartilage or thick homologous septal spur cartilage near maxillary crest for reconstruction of ossicular chain after sculpturing them appropriately. Conchal or tragal cartilage was harvested with perichondrium preserved on one side and homologous thick septal cartilage was harvested during septoplasty from near the maxillary crest which was then preserved in 70% ethyl alcohol.<sup>5</sup>

Patients were followed-up postoperatively on 7<sup>th</sup> day for stitch removal and after 3 weeks, 2, 3 and 6 months for cavity cleaning and assessment of graft take-up. Postoperative pure tone audiometric thresholds were recorded on 10<sup>th</sup> week and 24<sup>th</sup> week. Pure tone average was calculated as the mean of 0.5, 1, 2, and 4 KHz. Postoperative mean air bone gap (ABG) was calculated from air conduction (AC) and bone conduction (BC) thresholds in each patient. Postoperative ABG closure was calculated by taking the difference between the average preoperative ABG and postoperative ABG.

**Ethical approval**

All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards.”

**Informed consent**

Informed consent was obtained from all individual participants included in the study.

**Statistical analysis**

Patients distributed amongst three groups namely A, B and C and their p-value calculated which if >0.05 suggests there is no significant difference in between mean of hearing improvement in Group A, Group B and Group C which is followed by application of ANOVA test.

**RESULTS**

Total patients enrolled for study were 98, in which 2 patients having sensorineural hearing loss, were excluded

from study and 10 patients were lost to follow up. Majority of patients belong to age group (in years) 11-20 (n=32; 37.20%), followed by age group of 21-30 (n=31; 36.04%). Out of 86 Patients, 51 patients were males and 35 patients were females. All patients presented with complain of ear discharge, in which 61 patients also had decreased hearing, 35 patients had earache, 3 patients had giddiness and 4 patients had ringing in ear. 2 patients had positive fistula test.

**Table 1: Distribution of patients according to groups and sex.**

Distribution of patients	Males	Females	Total
Group A	16	10	26
Group B	22	11	33
Group C	13	14	27
			86

Among 86 patients, 37 patients were diagnosed as attic cholesteatoma, 23 patients diagnosed as PSQ cholesteatoma, 8 patients diagnosed as PSQ+attic cholesteatoma, 4 patients diagnosed as central perforation with attic cholesteatoma and 5 patients diagnosed as central perforation with PSQ cholesteatoma on otoscopic and microscopic examination findings. 9 patients having polyp in EAC on otoscopic finding which were diagnosed as cholesteatoma intra operatively after polyp removal under G/A.

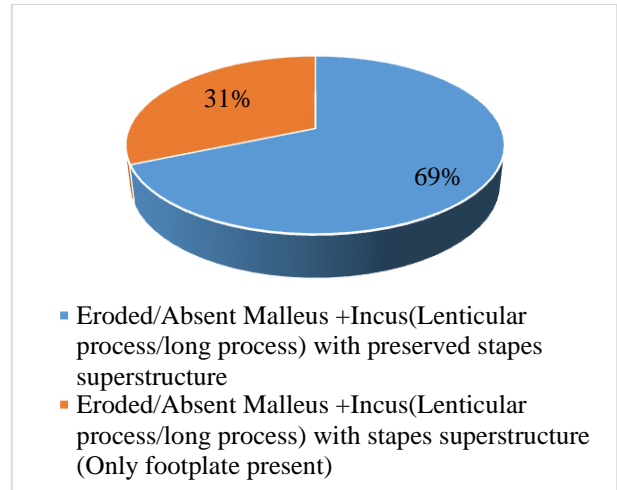
Among 86 patients, malleus-head and incus-long process/lenticular process were eroded in all patients & in 27 patients stapes suprastructure was also eroded. In X ray mastoid schuller’s view, mastoid was sclerosed in all patients on diseased side.

**Table 2: Comparison of hearing results in Group A, Group B and Group C.**

	Group	N	Air conduction threshold	Std. deviation	Mean ABG	Std. deviation	P-value
<b>Preop_PTA</b>	A	26	46.49	15.03	37.64	11.49	0.06
	B	33	45	14.95	38.18	13.59	
	C	27	56.20	13.32	44.86	12.54	
<b>@10<sup>th</sup> week</b>	A	26	48.05	13.71	37.34	11.75	0.0003
	B	33	38.25	13.59	28.58	10.69	
	C	27	52.56	12.71	40.75	12.95	
<b>@24<sup>th</sup> week</b>	A	26	43.46	11.11	32.30	10.23	0.016
	B	33	36.74	11.56	28.13	11.65	
	C	27	50.75	14.84	36.64	11.51	
<b>Hearing results</b>	A	26			6.72	11.11	0.43
	B	33	-		10.69	11.38	
	C	27			8.35	13.14	

**Hearing results**

In 86 patients, average mean preoperative AC threshold was 48.16 (±15.15) dB, mean pre-operative BC was 8.96 (±7.85) dB and mean pre-operative air bone gap was



**Figure 3: Distribution of patients according to ossicular status.**

Among 86 patients, ossiculoplasty using tragal cartilage was done in total 26 patients, in which cartilage kept over stapes head in 18 patients and kept over stapes footplate in 8 patients. In total 26 patients, conchal cartilage was used for ossiculoplasty, in which it was kept directly over footplate in 15 patients and over stapes head in 11 patients. In 4 patients homologous septal cartilage was directly kept over stapes footplate and in another 4 patients, it was kept directly over the stapes head. Homologous septal cartilage was made strut shaped, in which slit was made for stapedia tendon and facet made for stapes head. Similarly tragal cartilage and conchal cartilage were made slice shape with facet over it, to accommodate stapes head in it. In other patients they were kept in palisade technique and boomerang shape.

40.11 (±12.92) dB. The mean post-operative AC threshold was 43.17 (±13.72) dB, mean post-operative BC was 11.34 (±9.44) dB and postoperative air bone gap was 32.06 (±11.62) dB. The mean air bone gap closure

was 8.76 ( $\pm 11.86$ ). This hearing gain was statistically highly significant ( $p < 0.001$ ).

Average pre-operative ABG in Group A was 37.64 dB, in Group B was 38.18 dB and in Group C was 44.86 dB. Average Post-operative ABG after 10 weeks in Group A was 37.34 dB, in Group B was 28.58 dB and Group C was 40.75 dB. Average post-operative ABG after 24 weeks in Group A was 32.30 dB, in Group B was 28.13 dB and Group C was 36.64 dB. Average hearing result in Group A 5.34 dB improvement, in Group B 10.05 dB improvement and Group C 8.22 dB improvement.

### **ANOVA test applied**

In this study, we have also calculated hearing results with use of different cartilages i.e., tragal/conchal/homologous septal cartilage. Among 86 patients, cartilage was used in total 60 patients. Mean ABG was 8.6 dB, 11.05 dB and 8.43 dB respectively for tragal, conchal and homologous septal cartilage. Statistically there is no significant difference in hearing results with use of different cartilages.

### **DISCUSSION**

In type III tympanoplasty operation, ossicular reconstruction can be done depending on intact stapes superstructure or footplate only using different materials and techniques.<sup>3,4</sup>

Luetje et al introduced cartilage ossiculoplasty in 1987 especially suited for atelectatic retraction problems with no fear of extrusion. Pandharinath et al in 1988 solved the problems of cartilage ossiculoplasty like displacement, loss of stiffness of the graft and maintenance of firm contact with the ossicles by creation of perichondrial pocket on one side which accommodates remnants of the incus or the handle of malleus.<sup>6</sup>

Allogeneous nasal septal cartilage was introduced by Jansen for ossiculoplasty 7 various studies have been conducted to study the morphology of alcohol preserved nasal septal cartilage grafts in middle ear. Kerr et al studied nasal septal cartilage allografts (alcohol preserved) for middle ear reconstruction and concluded that in most of the grafts, morphology of the graft is maintained.<sup>8</sup> In a study by Iwanaga, the fate of homologous nasal septal cartilage implanted in middle ear was studied by means of enzyme digestion.<sup>9</sup> Homologous cartilages showed depletion of mucopolysaccharides but hyaluronic acid and collagen remained intact. It was concluded that homologous nasal septal cartilages could be used in tympanoplasty.

In ossicular reconstruction, the choice of the method to be implemented is based on the presence of stapes superstructure.<sup>10</sup> Hearing outcomes of reconstruction is directly correlated with the amount of damage incurred on the ossicular chain. In the series of Cook et al, the air-

bone gap was shown to have decreased to 20 dB in 69% of the patients with intact stapes undergoing CWDM. In cases with absent stapes, the corresponding rate of hearing gain was observed in 30% of the cases.<sup>11</sup> On the contrary, the respective rates were determined as 57% and 54% in the case series of Shelton et al.<sup>12</sup> We evaluated our patients in the post-operative 6<sup>th</sup> months and hearing gain in Group A is 6.72, in Group B is 10.69. These both group have intact stapes head. In Group C hearing gain is 8.35. In our study, there were no significant differences between cases with or without stapes superstructure in terms of hearing gains.

De Corso et al performed CWDM in 142 patients in the period between 1995 and 2002.<sup>1</sup> Preoperative mean threshold for air conduction was reported as 50.97 dB, while the mean threshold for bone conduction was indicated as 22.14 dB. Following the operation, the mean threshold for air conduction was determined as 37.62 dB and the mean threshold for bone conduction was designated as 23.37 dB. In the same trial, ABG decreased from 28.83 to 13.94 dB, with a hearing gain of 14.89 dB.<sup>1</sup> In our study pre-operative mean threshold for air conduction was 48.96 dB, while the mean threshold for bone conduction was 8.96 dB. After operation, the mean threshold for air conduction was 43.17 dB and mean threshold for bone conduction was 11.34 dB. ABG decreased from 40.11 dB to 32.06 dB.

Berenholz et al, from a series of staged canal wall down tympanoplasty with ossiculoplasty procedures, reported an average postoperative ABG of 17.8 dB.<sup>13</sup> Babighian reported that, following single stage canal wall down tympanoplasty with ossiculoplasty for cholesteatoma, the average post-operative ABG was 25.4 dB.<sup>14</sup> In our study an average post-operative ABG after 6 months was 32.06 dB.

Artuso et al, reported improvement in mean preoperative ABG from 28.44 dB to 24.06 dB with ABG gain of 4.3 dB in Group A (CWDM with Type III or IV tympanoplasty).<sup>15</sup> The mean ABG in Group B (CWDM with ossiculoplasty) was decreased by 3.48 dB (from 30.14-33.54dB). In his study, ABG gain was 5.52 dB in cases where ossiculoplasty was done using autologous cartilage. As compare to this study, in our study in 86 patients improvement in mean preoperative ABG from 40.11 ( $\pm 12.92$ ) to 32.06 ( $\pm 11.62$ ) dB with ABG gain was 8.76 ( $\pm 11.86$ ) dB. In Group A patients, improvement of mean pre-operative ABG from 37.64 ( $\pm 11.49$ ) dB to 32.30 ( $\pm 10.23$ ) dB with improvement in ABG 6.72 ( $\pm 11.11$ ) dB. In Group B improvement of mean pre-operative ABG from 38.18 ( $\pm 13.59$ ) to 28.13 ( $\pm 11.65$ ) dB with ABG gain 10.69 ( $\pm 11.38$ ) dB. In Group C, improvement in pre-operative ABG from 44.86 ( $\pm 12.54$ ) dB to 36.64 ( $\pm 13.14$ ) dB with ABG gain 8.35 ( $\pm 13.14$ ) dB.

Shrestha et al, in their study had average ABG of 37.8 dB preoperatively and 29.8 dB post operatively with a net

gain of 8.0 dB, which was also in accordance of our study where a net gain of 5.05 dB after 10 weeks and 8.76 ( $\pm 11.86$ ) dB after 6 months.<sup>16</sup>

Uyar et al, in their study found mean pre-operative ABG 38.6 ( $\pm 4.95$ ) dB and mean post-operative 26.6 ( $\pm 7.91$ ) dB and mean gain 11.9 dB. In our study mean pre-operative ABG was 40.11( $\pm 12.92$ ) dB and post-operative ABG was 32.06 ( $\pm 11.62$ ) dB with ABG gain was 8.76 ( $\pm 11.86$ ) dB.<sup>2</sup>

## CONCLUSION

The type III tympanoplasty method provides favorable results in the reconstruction of hearing in ears with damaged ossicles with use of various types of cartilage and modern prostheses. Modern prostheses are costly and there are chances of extrusion. Autologus and homologus cartilage is easily obtained and of no cost.

In our study most commonly eroded ossicles found were long process of incus, stapes superstructure and head of malleus. So most common reconstruction done was type III i.e., stapes columella, minor columella or major columella. Reconstruction between neoTM and stapes head or stapes footplate provides way to transmit sound energy from neoTM to inner ear and hence may improve hearing in post-operative period. Reconstruction of ossicular chain also creates air filled middle ear space.

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

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