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Outcome of Cymba-Concha Cartilage Shield Type I Tympanoplasty in Patients with Chronic Otitis Media - A Prospective Interventional Study

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Abstract

Background: Chronic otitis media (COM) continues to be a leading preventable cause of conductive hearing loss in the Indian subcontinent.

Cartilage taken from the cymba concha has gained popularity as a graft in Type I tympanoplasty because it resists retraction and re-perforation better than temporalis fascia. Focused Indian data on this graft-technique combination are still limited.

Aim: To study the anatomical and functional results of cymba-concha cartilage shield Type I tympanoplasty in patients with chronic otitis media.

Materials and Methods: This was a one-year prospective interventional study carried out in the Department of Otorhinolaryngology of a tertiary care teaching hospital. Eighty-one patients aged 12 to 60 years with mucosal or squamosal type COM were operated. Every patient underwent pre-operative otoendoscopy, pure tone audio metry, impedance audio

metry, X-ray of the mastoid in Law's view and, when indicated, high-resolution CT of the temporal bone. Graft uptake, complications, pure tone average (PTA) and air-bone gap (ABG) were reviewed at 1, 3 and 6 months. Pre- and post-operative means were compared with the paired t-test on SPSS version 26. A p-value below 0.05 was taken as statistically significant.

Results: Patients were spread across all decades with peaks in the 21 to 30 and 51 to 60 year groups (22.2% each). Women (53.1%) slightly outnumbered men. Mucosal disease was diagnosed in 69.1% of ears and squamosal disease in 30.9%. The graft took successfully in 77.78% of ears. Mean PTA fell from 34.69 ± 2.98 dB before surgery to 17.23 ± 4.58 dB at 6 months ($p < 0.001$), and the ABG narrowed from 24.62 ± 3.85 dB to 10.88 ± 3.74 dB over the same period ($p < 0.001$). Mean hearing gain rose steadily to 17.46 ± 5.34 dB by the end of follow-up. Post-operative infection (22.2%) was the commonest adverse event.

Conclusion: Cymba-concha cartilage shield Type I tympanoplasty gives satisfactory graft uptake and worthwhile hearing improvement in patients with chronic Otitis media. It is a useful option when fascia grafts are likely to fail, particularly in ears with poor Eustachian tube function or large perforations.

Keywords: Air-Bone Gap, Cartilage Shield Tympanoplasty, Chronic Otitis Media, Cymba-Concha Cartilage, Graft Uptake, Type I Tympanoplasty.

Introduction

Chronic otitis media (COM) is one of the commonest ear diseases seen in the ENT outpatient clinic in India, and it continues to be a leading preventable cause of hearing loss. A persistent perforation of the tympanic membrane is the hallmark of the disease. It gives rise to conductive deafness, recurrent ear discharge and difficulty with everyday hearing tasks.[1]

Surgery is directed primarily at closure of the perforation. A well-taken graft improves hearing, keeps the ear dry and reduces further episodes of infection. In patients with an intact and mobile ossicular chain, only the tympanic membrane needs to be reconstructed. This is the Type I tympanoplasty first described by Wullstein in 1956.[1,2]

Temporalis fascia has been the traditional graft. It is easy to harvest and vibrates in a way that is close to the native drum. In practice, however, fascia grafts are known to shrink during healing, and they do not always hold up well in ears with large perforations, active mucosal disease, poor Eustachian tube function or after a previous failed surgery. In such ears, retraction, medialisation and re-perforation remain a real problem.[3,4]

Because of these limitations, cartilage grafts came into use as a mechanically more stable alternative. Heermann first described a palisade technique in the late 1970s, and Dornhoffer later refined the shield configuration.[5,6] Cartilage resists resorption, holds up against negative middle-ear pressure and, when thinned to about 0.5 mm, does not appreciably blunt hearing on audiometric testing. Several authors have reported hearing outcomes similar to fascia with fewer graft failures, [7,8] and a meta-analysis by Mohamad and colleagues found a higher graft take rate with cartilage without any drop in audio logical results.[9]

Among the various donor sites, cymba concha cartilage has some particular advantages. Its thickness lies close to 0.7 to 1.1 mm, its shape follows the natural curvature of the drum, and a fairly large piece can be lifted through the same post auricular incision without any visible

deformity of the auricle. Sabaa et al. showed that sliced cartilage gave better hearing outcomes than full-thickness cartilage.[10] Indian patients often present late, with large perforations and a poorly ventilated middle ear, yet focused evidence on cymba-concha cartilage shield tympanoplasty in this population is still scarce.

The present study was therefore taken up to assess the anatomical and functional outcomes of this technique in a consecutive series of patients with chronic Otitis media, and to identify factors that influenced the results.

Materials and Methods

Study design and setting

This was a hospital-based prospective interventional study carried out in the Department of Otorhinolaryngology of Santosh Medical College & Hospital, Ghaziabad, over a period of one year. The Institutional Ethical Committee cleared the protocol before recruitment began. Written informed consent was obtained from every patient before surgery.

Study population

All patients with tubotympanic or atticoantral type COM who attended the ENT outpatient clinic during the study period were considered for inclusion. Patients between 12 and 60 years of age were eligible. Those with impending or overt intracranial or extra cranial complications, and those with severe sensor ineural hearing loss, were excluded from the study.

Sample size

The sample size was worked out using the standard formula for a single proportion, $n = Z^2P(1-P)/d^2$. A favourable outcome (graft uptake) of 70% was assumed from earlier published cartilage tympanoplasty series, with a 95% confidence level (Z = 1.96) and an absolute precision of 10%. The calculated minimum was 81 patients. Consecutive convenience sampling was used to recruit eligible patients until this number was reached.

Pre-operative evaluation

Every patient underwent a detailed history and clinical examination. This was followed by otoendoscopy, pure tone audio metry, impedance audio metry (tympanometry) and X-ray of both mastoids in Law's view. High-resolution CT of the temporal bone was ordered when the disease was atticoantral, when there was clinical suspicion of ossicular involvement or when the routine imaging was inconclusive.

Blood investigations and cardiac screening required for pre-anaesthetic clearance were done in every case. Only patients with an ear that had remained discharge free for at least six weeks and had a small to medium sized central perforation on otoscopy were taken up for surgery.

Surgical technique

Every operation was done under general or local anaesthesia through a post auricular approach. Examination under the operating microscope was performed first, followed by freshening of the perforation edges. A piece of cymba concha cartilage along with the attached perichondrium was harvested through the same post auricular incision. The cartilage was carefully thinned to approximately 0.5 to 0.7 mm and shaped into a shield large enough to cover the perforation with about 2 mm of overlap.

A tympanomeatal flap was raised and the middle ear cavity was inspected. Ossicular reconstruction was carried out whenever the ossicles were found to be eroded or fixed. The cartilage shield was placed as an underlay, or a modified underlay, with the perichondrium facing the external auditory canal and

supported below by absorbable gelatin sponge. The canal was packed and a mastoid dressing applied.

Post-operative assessment

Patients were reviewed at one month, three months and six months after surgery. At every visit the graft was inspected under the operating microscope and pure tone audio metry was repeated to calculate the mean PTA and the air-bone gap. Hearing gain was taken as the difference between the pre-operative PTA and the PTA at that follow-up visit.

Statistical analysis

Data were entered in Microsoft Excel and analysed with IBM SPSS Statistics version 26 (Armonk, NY, USA). Categorical variables were summarised as frequencies and percentages, while continuous variables were expressed as mean ± standard deviation. Pre- and post-operative means were compared using the paired t-test. Associations between categorical variables were tested with the chi-square test. A p-value below 0.05 was taken as statistically significant.

Results

A total of 81 patients were operated during the study period. Their demographic profile is set out in Table 1. Patients were spread fairly evenly across the decades, with the largest groups falling between 21 and 30 years and between 51 and 60 years (22.2% each). Women accounted for 53.1% of the cohort and men for 46.9%. Just over half of the patients (51.9%) came from a rural background, with 48.1% from an urban area.

Table 1: Demographic and residential profile of study participants (N = 81)

Variable	n	%
Age (years)		
≤ 20	16	19.8
21-30	18	22.2
31-40	15	18.5
41-50	14	17.3
51-60	18	22.2
Sex		
Female	43	53.1
Male	38	46.9
Residence		
Rural	42	51.9
Urban	39	48.1

The clinical picture at presentation and the radiological findings are shown in Table 2. Hearing loss was the leading complaint, present in 66 of 81 patients (81.5%), followed by ear discharge in 60 (74.1%) and ear pain in 38 (46.9%). Tinnitus (21.0%) and vertigo (17.3%) were less common. Mucosal type COM was diagnosed in 56 patients (69.1%) and squamosal type in 25 (30.9%). Tympanometry showed a Type B curve in 42.0% of ears, a Type A in 33.3% and a Type C in 24.7%.

On plain X-ray the mastoid was pneumatic in 38.3%, sclerotic in 34.6% and diploic in 27.2% of cases. HRCT of the temporal bone showed mastoid changes in 38.3% of patients and normal appearances in 35.8%. Imaging was not undertaken in the remaining 25.9% of cases, either because the disease was clearly mucosal or because HRCT was not clinically indicated.

Table 2: Clinical and radiological profile of study participants (N = 81)

Variable	n	%
Presenting symptom*		
Hearing loss	66	81.5
Ear discharge	60	74.1
Ear pain	38	46.9
Tinnitus	17	21.0
Vertigo	14	17.3
Diagnosis		
CSOM (mucosal)	56	69.1
CSOM (squamosal)	25	30.9
Tympanogram		
Type A	27	33.3
Type B	34	42.0
Type C	20	24.7
X-ray mastoid		
Pneumatic	31	38.3
Sclerotic	28	34.6
Diploic	22	27.2

*Multiple responses permitted; percentages therefore exceed 100.

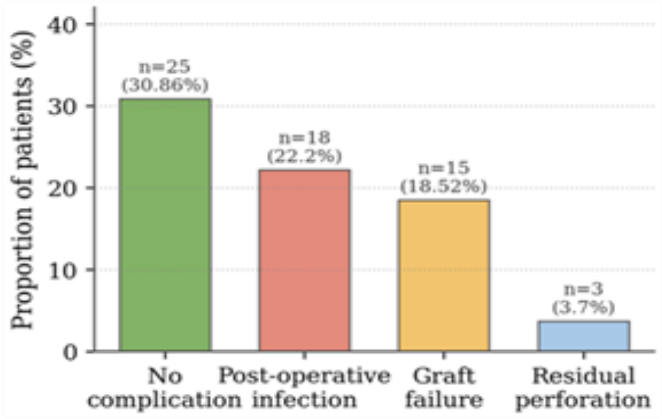
Anatomical outcome

The graft was taken up successfully in 63 patients (77.78%) and failed in the remaining 18 (22.22%). At final follow-up, 25 patients (30.86%) had no complications at all. The commonest adverse event was post-operative infection, seen in 18 patients (22.2%), followed by graft failure in 15 (18.52%) and residual perforation in 3 (3.70%) (Table 3, Figure 1).

Table 3: Graft uptake and post-operative complications (N = 81)

Outcome / complication	n	%
Graft uptake (successful)	63	77.78
Graft uptake (failure)	18	22.22
No complication	25	30.86
Post-operative infection	18	22.20
Graft failure	15	18.52
Residual perforation	3	3.70

Figure 1: Distribution of post-operative complications among study participants (N = 81).



Functional outcome

Hearing improved steadily over the follow-up period. The mean PTA fell from 34.69 ± 2.98 dB before surgery to 22.47 ± 4.24 dB at one month, 17.81 ± 4.63 dB at three months and 17.23 ± 4.58 dB at six months ($p < 0.001$) [Table 4, Figure 2]. The air-bone gap narrowed in parallel, from a pre-operative mean of 24.62 ± 3.85 dB to 15.31 ± 4.12 dB at one month, 11.42 ± 3.96 dB at three months and 10.88 ± 3.74 dB at six months ($p < 0.001$). Mean hearing gain rose from 12.23 ± 5.24 dB at one month to 16.88 ± 5.99 dB at three months and reached 17.46 ± 5.34 dB by the end of follow-up. Among the 63 ears with a well-taken graft, hearing had

improved subjectively in 32 patients (50.79%) and stayed the same in 15 (23.81%), while 16 patients (25.39%) felt their hearing had become worse in spite of an intact drum [Figure 3].

Table 4: Pre- and post-operative audio logical outcomes (N = 81)

Time point	PTA (dB)	ABG (dB)	Gain (dB)
Pre-operative	34.69 ± 2.98	24.62 ± 3.85	—
1 month	22.47 ± 4.24	15.31 ± 4.12	12.23 ± 5.24
3 months	17.81 ± 4.63	11.42 ± 3.96	16.88 ± 5.99
6 months	17.23 ± 4.58	10.88 ± 3.74	17.46 ± 5.34

PTA, pure tone average; ABG, air-bone gap. Values are mean ± SD; $p < 0.001$ for the comparison of pre-operative with all post-operative time points (paired t-test).

Figure 2: Trend of mean pure tone average (PTA) and air-bone gap (ABG) with standard deviation error bars across pre-operative and post-operative follow-up intervals (N = 81). A statistically significant reduction in both parameters was observed at every post-operative time point ($p < 0.001$, paired t-test).

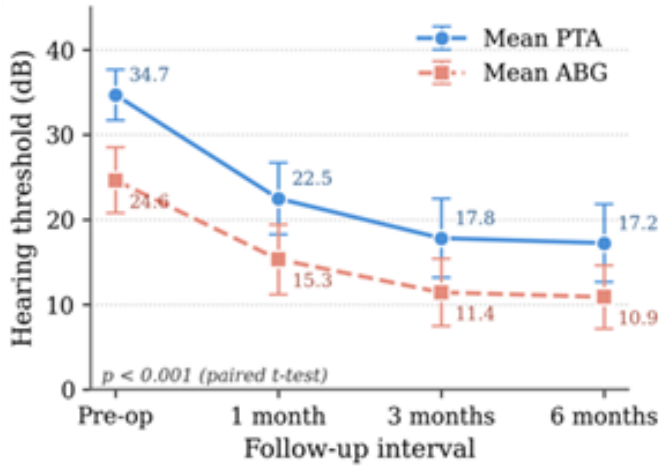
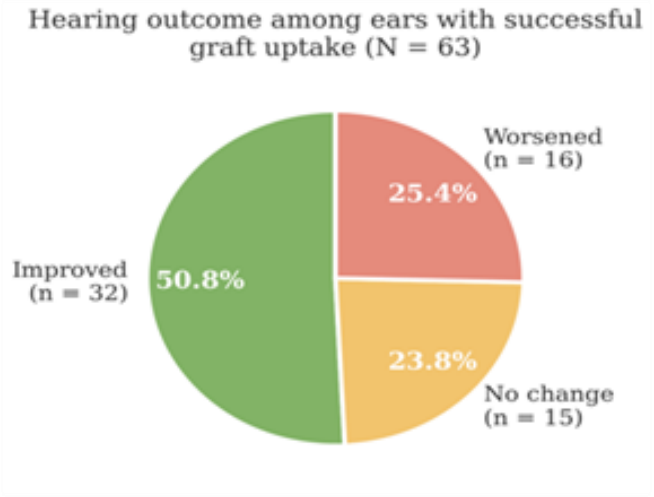


Figure 3: Distribution of subjective hearing outcomes among ears with successful graft uptake (N = 63). More than half of the patients reported clinical improvement in hearing after surgery.



Discussion

Chronic Suppurative otitis media continues to place a heavy burden on outpatient ENT services in India, and it is one of the most common causes of preventable hearing loss in the country. Type I tympanoplasty is expected to close the perforation and to restore useful hearing. Over the last two decades, various graft materials have been tried. Cartilage, and cymba concha cartilage in particular, has slowly gained ground because it holds its shape well, is not easily pushed inward by negative middle-ear pressure and gives dependable results in ears that would otherwise be considered high risk for a fascia graft.

Demographic and clinical profile

The patients in the present cohort were spread across all decades, with the largest groups in the third and sixth decades of life. This pattern matches earlier Indian cartilage tympanoplasty series. Singh et al. reported a mean age of 29.3 years, with most of their patients in the second and third decades of life.[11] The mild female predominance (53.1%) in our series is in keeping with the 55% female representation reported by Singh Nagi et al.[11] Better health-seeking behaviour among women, and

a greater willingness to come forward for corrective surgery when hearing is affected, are the usual explanations offered for this trend.

The near-equal rural to urban ratio (51.9% versus 48.1%) suggests that specialist ENT services are now reaching both populations, in contrast to the marked rural predominance described in older Indian series.

Hearing loss (81.5%) and ear discharge (74.1%) were the leading complaints in our patients. This is in line with the classical description of CSOM. Singh et al. reported hearing loss and ear discharge in more than 80% of cases in their series,[11] and Varshney et al. identified hearing loss as the single most consistent presenting symptom, with ear discharge peaking during acute exacerbations of the disease.[12] Our inclusion of a substantial proportion of squamosal disease (30.9%) means that our cohort was clinically more mixed than most published tympanoplasty series, and this needs to be borne in mind when the outcomes are being compared.

The predominance of Type B (42.0%) and Type C (24.7%) tympanograms points to a middle ear with poor compliance or persistent negative pressure. Several authors have argued that cartilage grafts are particularly well suited to such ears because of their resistance to retraction.[6,9] Our choice of a cymba concha shield in this group of patients was therefore in line with the published evidence.

Anatomical outcome

A graft uptake rate of 77.78% in the present study is lower than most of the reported cartilage tympanoplasty series. Singh et al. achieved 95% uptake in their cartilage shield group,[11] and Wadhera and Gupta reported 96% success even in revision cartilage shield surgery.[13] Ojha et al. found the take rate to be 98.46% with cartilage compared with 90% with temporalis fascia at three months.[14] Vadiya et al. and Khan and Parab reported comparably high uptake with the shield technique.[15,16] The relatively lower figure in our series likely reflects three factors: the inclusion of squamosal disease in almost one-third of the ears (30.9%), the higher post-operative infection rate (22.2%) observed in our patients, and the routine follow-up of every operated patient regardless of clinical status, which is closer to a real-world audit than a selected surgical series. Even so, an uptake rate of more than three-quarters of ears in a mixed mucosal and squamosal cohort supports the day-to-day applicability of the technique.

Functional outcome

Hearing improved to a statistically significant extent at every follow-up interval. The mean PTA fell from 34.69 ± 2.98 dB before surgery to 17.23 ± 4.58 dB at six months ($p < 0.001$), and the air-bone gap closed from 24.62 ± 3.85 dB to 10.88 ± 3.74 dB over the same period ($p < 0.001$). Wadhera and Gupta reported a mean hearing gain of 13.55 ± 5.52 dB following revision cartilage shield tympanoplasty,[13] and Kyrodimos et al. reported an average improvement of 11.22 dB, with 78.8% of their patients reaching an ABG of 25 dB or less.[17] Comparable ABG closure has been reported by Singh et al.[11] and Ojha et al.[14] Borkowski et al. found a mean gain of 10 to 12 dB after cartilage tympanoplasty and stressed that both graft thickness and technique play a decisive role in preserving sound conduction.[18] Neumann et al. reported PTA improvement in the range of 12 to 15 dB, with stable long-term results.[19]

The mean gain of 17.46 dB at six months in the present series is at least as good as most of the published cartilage tympanoplasty data. This supports the use of cymba concha cartilage as a dependable graft material

for tympanic membrane reconstruction in COM. One finding that deserves comment is that 25.39% of ears with a well-taken graft had a subjective perception of worse hearing. Anatomical success and functional satisfaction are not the same thing. The mismatch may be explained by residual middle ear pathology, changes in the ossicular chain that were not fully corrected at surgery, or post-operative sequelae such as adhesions that are not always captured by pure tone audio metry.

Complications

The post-operative infection rate of 22.2% in the present study is higher than what has been reported in most cartilage tympanoplasty series. Wadhera and Gupta noted very few complications after cartilage shield tympanoplasty.[13] The higher rate in our patients almost certainly contributed to the graft failures observed. It points to the need for tighter attention to asepsis, better patient selection in ears with active or borderline disease, and rigorous post-operative wound care.

Conclusion

Cymba concha cartilage shield Type I tympanoplasty proved to be a reliable technique for closing chronic tympanic membrane perforations in the present series of 81 patients. The graft was taken up in 77.78% of ears, mean PTA improved by 17.46 dB at six months and the air-bone gap fell to below 11 dB. Both changes were statistically significant and were sustained through the six-month follow-up period. These findings support the continued use of cymba concha cartilage as the graft of choice in ears that carry a higher risk of failure with temporalis fascia. Rigorous attention to asepsis is essential to keep post-operative infection rates down and to protect graft uptake.

Limitations

The study was carried out at a single tertiary care centre, and the sample size of 81 patients is modest. Both these factors limit how far the findings can be generalised. The cohort was clinically heterogeneous, with both mucosal and squamosal disease included. This may have influenced graft uptake and hearing outcomes. A longer period of follow-up would be needed to comment on the long-term stability of the graft and the durability of the hearing gain.

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