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A comparative study of sequential vs. simultaneous type I tympanoplasty in patients with bilateral chronic otitis media – Mucosal type

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ABSTRACT

Background: Patients with bilateral chronic otitis media – mucosal type have been conventionally treated with sequential tympanoplasty. Bilateral simultaneous tympanoplasty is usually not preferred because of the theoretical risk of iatrogenic sensorineural hearing loss. With the advent of modern surgical instruments and surgical techniques, the risk is expected to be lower. This study compares the clinical outcomes in type I tympanoplasty performed simultaneously and sequentially.
Materials & methods: This randomized prospective study was carried out in a tertiary care hospital between August 2015 and July 2017. A total of 30 patients were divided into two groups of 15 each. This study analyzed the graft uptake, pure tone audiogram findings pre- and post-operatively, duration of surgery and number of hospital visit for each patient and the outcomes were compared between both the groups.
Result: Patients undergoing bilateral simultaneous tympanoplasty had significantly lesser mean duration of surgery and number of hospital visits than the patients undergoing sequential tympanoplasty. Graft uptake and postoperative wound infections were similar in both the groups. Postoperative hearing improvement was significantly better in the bilateral simultaneous tympanoplasty group. However, further studies are needed to authenticate this observation. None of the patients had a postoperative deterioration of hearing or sensorineural hearing loss.
Conclusion: Bilateral simultaneous tympanoplasty is not only feasible but also better than sequential tympanoplasty, especially in terms of operating time, follow-up and overall financial implications on the patient.

1. Introduction

Patients with chronic otitis media (COM) – mucosal type usually present with unilateral disease. However, bilateral disease is also known to occur with an incidence as high as 12% in the general population. The treatment of COM focuses on the mucosal infection in the tympanomastoid compartment. Surgical treatment is indicated when it is certain that a chronic discharging ear cannot be cured by conservative treatment and after ruling out tubal discharge resulting from nasopharyngeal or sinus suppuration or allergies. Based on the pure tone audiogram (PTA), the hearing loss of the patient is estimated to determine the severity of the disease. A tympanic membrane defect (central perforation) alone can lead to hearing loss of up to 45 dB. Hearing loss of more than 45 dB or the presence of granulation (Jayakumar et al., 2016) would indicate disease involving the ossicular chain. Hence, when no ossicular chain involvement is suspected and the middle ear mucosa is found to be normal, myringoplasty is performed, where only the defect in

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the tympanic membrane is repaired and the middle ear is not opened. Alternatively, in type I tympanoplasty the middle ear is inspected for ossicular chain integrity and mucosal status under the microscope and tympanic membrane is repaired. In cases of bilateral COM, sequential tympanoplasty is conventionally performed. Bilateral simultaneous tympanoplasty is not preferred because the risk of iatrogenic sensorineural hearing loss (SNHL) is 1.2%–4.5% after ear surgeries (Palva et al., 1973). However, with the advent of advanced instruments and modification of surgical techniques, the risk is found to be much lower. Many studies attempted to perform bilateral myringoplasty simultaneously and have found good surgical outcomes (Caye-Thomasen et al., 2007).

This study aims to compare the clinical outcomes in type I tympanoplasty performed simultaneously and sequentially in patients diagnosed with bilateral COM – mucosal type.

2. Methodology

This is a randomized prospective study carried out at the ENT department of a University hospital from August 2015 to July 2017. The study was approved by the institutional ethics committee. Using RAS software, 30 patients were randomly divided into two groups – Group A (simultaneous tympanoplasty) and Group B (sequential tympanoplasty). The objective of the study is to determine the graft uptake, to analyze the PTA findings pre- and postoperatively and compare the duration of surgery and the number of hospital visits in both the groups. Patients with bilateral COM – mucosal type with conductive or mixed hearing loss were included in the study. Other inclusion criteria considered were patients who underwent only type I tympanoplasty and had dry ears for atleast 4 weeks before the surgery. The study excluded patients undergoing revision surgeries, patients with granulation, or patients who presented with COM with complications. After obtaining a thorough history, the patients were subjected to otomicroscopy to assess the site and size of the perforation, middle ear status, and the presence of discharge or granulation. Anterior and posterior rhinoscopy was performed to rule out nasal and nasopharyngeal etiology of COM – mucosal type. Patients then underwent PTA. After preoperative evaluation, patients underwent Type I tympanoplasty either simultaneously or sequentially. The procedure was performed under general anesthesia and under the vision of a 0° endoscope. The graft used was a temporalis fascia graft harvested through a supra-aural incision. In patients undergoing simultaneous type I tympanoplasty, a large temporalis fascia graft was harvested on the side that was operated first. The temporalis fascia was divided into two as per the requirement of the tympanic membrane perforation. One portion of the temporalis fascia graft was used in the first ear. After securing hemostasis, the wound was closed with a sterile cotton pad. The head was turned to the other side. The other ear was painted and draped. With a change of gloves by the surgeon and scrub nurse, and a new set of tympanoplasty instruments, endoscopic tympanoplasty was performed in the other ear with the remaining part of the temporalis fascia, adhering to all universal precautions. The external auditory canals were packed with gelfoam bilaterally. Dressing was applied after closing the supra-aural wound. In Group B (Sequential group), the surgery was done in one ear with the use of an endoscope as described above. The second surgery was done after an interval of at least 3 months. For the second ear, during the surgery, the supra-aural incision was made on the ipsilateral side for harvesting the temporalis fascia graft and endoscopic tympanoplasty was carried out. The duration of the surgery was measured from the start of infiltration until the end of dressing.

The patients were started on intravenous antibiotics one day prior to surgery and the antibiotic cover was continued until one week after surgery along with antihistamines and nasal decongestants. Suture removal was done on the seventh postoperative day. The patients were followed up for three months. The post-aural wound was assessed at the end of one week. Patients were assessed for the graft uptake and postoperative PTA at the end of one and three months. Statistical analysis was carried out using IBM SPSS version 22. P-value <0.05 was considered statistically significant.

3. Results

48 patients were originally included in the study. 15 of them underwent simultaneous type I tympanoplasty (Group A). 15 patients underwent sequential type I tympanoplasty (Group B). The data of these 30 patients are included in the following results.18 patients were dropped from the study because 2 patients failed to turn up for follow-up in group A, and 16 patients in group B dropped out of the study after their first surgery citing various medical and personal reasons. Hence their data is not included in the following results.

The mean age of the patients in Group A was 42 years and that in Group B was 36 years. Group A had 9 male and 6 female patients and group B had 6 male and 9 female patients.

In group A, the mean preoperative PTA was 37.29 ± 11.3 dBHL. The mean 1 month postoperative PTA was 27.22 ± 10.7 dBHL. The mean 3 months postoperative PTA was 22.18 ± 9.01 dBHL. In group B, the mean preoperative PTA was 42.74 ± 10.55 dBHL. The mean PTA 1 month after surgery improved to 36.12 ± 9.13 dBHL and 30.08 ± 9.98 dBHL 3 months after the surgery.

The improvement in hearing at the end of one month in group A was 10.07 dB. Hearing improved by 15.11 dB at the end of 3 months after the surgery. In group B, the hearing improved by 6.62 dB at the end of 1 month and 12.66 dB at the end of 3 months after the surgery. The preoperative Air-Bone Gap (ABG) was found to be 21.72 ± 7.3 dB in group A and 29.86 ± 23.12 dB in group B. The postoperative ABG was found to be 15.28 ± 6.07 dB in group A and 24.38 ± 10.3 dB in group B at the end of 3 months.

There was a statistically significant improvement in postoperative hearing between group A and group B. Patients undergoing bilateral simultaneous tympanoplasty showed better improvement in hearing than patients undergoing bilateral sequential tympanoplasty.

The supra-aural wound was examined at the end of 1 week for wound infection. None of the patients in group A had wound infection. Two patients in group B had wound infection which was statistically insignificant.

The graft uptake was 96.7% in group A and 90% in group B. There was no statistical significance in the rate of graft uptake among both the groups ($p = 0.3$).

The mean duration of surgery in group A was 120.67 ± 31.840 min. The mean duration of surgery in group B was 195 ± 28.221 min. This difference in the duration of surgery between group A and group B was statistically significant.

The average number of hospital visits for each patient in group A was 4 ± 1 and in group B was 9 ± 2. This difference is the number of visits to the hospital is statistically significant ($p = 0.003$).

4. Discussion

It is imperative to treat COM because it may lead to serious complications if left untreated. It is necessary to rule out nasal and nasopharyngeal etiology of COM, especially when the patient presents with bilateral disease. Patients can be considered for simultaneous bilateral surgery if posterior rhinoscopy or diagnostic nasal endoscopy is normal. The incidence of iatrogenic SNHL has been

found to be 1.2%–4.5% (Palva et al., 1973) (Tos et al., 1984). Due to the theoretical risk of iatrogenic injury to the inner ear, bilateral surgeries were not advocated in the past. However, recent studies indicate that the incidence of SNHL following type I tympanoplasty is minimal. Tos et al. studied the nature of SNHL after otosurgery and found no case of severe high tone sensorineural damage after transcanal myringoplasty and tympanoplasty in ears with an intact chain (Tos et al., 1984). Better outcomes are also attributed to improved operating techniques and the availability of better instruments (Sharma and Saroch, 2013). There is also a theoretical risk of upper respiratory tract infection in the immediate postoperative period leading to simultaneous graft rejection on both sides. However, this is extremely unlikely with the routine postoperative effective use of antimicrobials (Raghuwanshi and Asati, 2013). Patients in this study also received nasal decongestants and antihistamines in the postoperative period. In this study, the temporalis fascia graft uptake was successful in 96.7% of patients undergoing bilateral tympanoplasty simultaneously and 90% of patients undergoing the procedure sequentially. In their study, Sharma and Saroch have obtained graft uptake rate of 90% following bilateral simultaneous myringoplasty (Sharma and Saroch, 2013). Rai et al. recorded a 93% success rate after bilateral tympanoplasty with autogenous temporalis fascia graft (Rai et al., 2014). Ihsan & Ranjana documented 86% graft uptake at the end of 3 months after bilateral ear surgery for COM- Mucosal type (Ihsan and Ranjana, 2017).

In this study, no patient had any deterioration in hearing or SNHL post-operatively in either groups.

The mean duration of surgery for patients undergoing bilateral simultaneous tympanoplasty was 120.6 min, and for patients undergoing sequential tympanoplasty, it was 195 min for both the ears. This difference is of statistical significance. The difference in time taken for the operation is mainly because of the need for harvesting temporalis fascia graft twice and the subsequent wound closure. The average time taken for bilateral surgery was 118 min in a study conducted by Rai et al. (2014). This is comparable to the time taken for bilateral surgery in our patients. Thus, patients undergoing bilateral simultaneous tympanoplasty need to be under general anesthesia for a much lesser time than patients undergoing sequential tympanoplasty.

The average number of hospital visits in group A was 4 and in group B, it was 8.7. There is a statistically significant difference in the number of hospital visits between both the groups mainly because patients undergoing sequential tympanoplasty had to visit the outpatient department for preoperative work up and postoperative follow-up twice. Patients undergoing bilateral simultaneous tympanoplasty had the advantage of going through the routine of surgical work up only once.

Patients in group A were explained about the possibility of transient loss of hearing in the immediate postoperative period because of the packing of the external auditory canal. However, the patients did not complain of occlusion in the postoperative period, despite the aural packing.

Few patients who were initially enrolled in group B were lost to follow up after the first surgery. Some patients refused surgery in the second ear once they started having improvement in hearing from the first surgery. This puts the patients in group A at advantage, and the surgeon also has reduced workload of scheduling surgeries.

Onal et al. had observed that tympanoplasty was less successful in patients with bilateral COM (Onal et al., 2012). But in our study, the outcome of tympanoplasty in bilateral COM has been comparable with that of tympanoplasty in unilateral COM.

We have observed in this study that bilateral simultaneous tympanoplasty is not only feasible, but also better than sequential tympanoplasty especially in terms of operating time, follow-up and overall financial implications on the patient.

5. Conclusion

The result of graft uptake in patients undergoing bilateral tympanoplasty is similar to that of patients undergoing tympanoplasty for unilateral disease. We have recorded a significant difference in the time spent by the patient in the operating theatre and the number of hospital visits. Thus, patients undergoing bilateral simultaneous tympanoplasty have an advantage. In our study, we have observed that bilateral simultaneous tympanoplasty is a feasible option and a good alternative to obviate multiple hospital visits for patients. However, more evidence-based research data are needed to authenticate the finding that bilateral simultaneous tympanoplasty is associated with a significant improvement in postoperative hearing compared with bilateral sequential tympanoplasty.

Declaration of competing interest

There is no conflict of interest among the authors. This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.joto.2019.12.005.

References

Caye-Thomasen, Per, DMSc, M.D., Torfinnur Rubek Nielsen, M.D., Mirko Tos, M.D., 2007 May. DMSc bilateral myringoplasty in chronic otitis media laryngoscope, 117 (5), 903–906.

Ihsan, A., Ranjana, K., 2017. Effectiveness of transperforation myringoplasty in bilateral chronic otitis media patients undergoing contralateral tympanoplasty. J. Laryngol. Otol. 131 (1), 64–68.

Jayakumar, C.L., Inbaraj, L.R., Pinto, G.J.O., 2016. Pre-operative indicators of ossicular necrosis in tubotympanic CSOM Indian. J Otolaryngol Head Neck Surg 68, 462.

Onal, K., Arslanoglu, S., Songu, M., Demiray, U., Demirpehlivan, I.A., 2012 Jan. Functional results of temporalis fascia versus cartilage tympanoplasty in patients with bilateral chronic otitis media. J. Laryngol. Otol. 126 (1), 22–25.

Palva, T., Karja, J., Palva, A., 1973. High-tone sensorineural losses following chronic ear surgery. Arch. Otolaryngol. 98, 176–178.

Raghuwanshi, S.K., Asati, D.P., 2013. Outcome of single-sitting bilateral type 1 tympanoplasty in Indian patients. Indian J. Otolaryngol. Head Neck Surg. 65 (Suppl. 3), 622–626.

Rai, A.K., Singh, G.B., Sahu, R., Singh, S., Arora, R., 2014 Apr. Evaluation of simultaneous bilateral same day tympanoplasty type I in chronic suppurative otitis media. Auris Nasus Larynx 41 (2), 148–152.

Sharma, R.C., Saroch, M., 2013. Our experience with single sitting bilateral myringoplasty. Indian J. Otol. 19, 59–61.

Tos, M., Lau, T., Plate, S., 1984 Jul-Aug. Sensorineural hearing loss following chronic ear surgery. Ann. Otol. Rhinol. Laryngol. 93 (4 Pt 1), 403–409.

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Endoscopic cartilage versus temporalis fascia grafting for anterior quadrant tympanic perforations — A prospective study in a tertiary care hospital

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ABSTRACT

Objective: Management of anterior perforations of tympanic membrane is a surgical challenge. The objective of this study is to analyse and compare the results of composite cartilage perichondrium island (CCPI) graft and temporalis fascia graft by endoscopic technique in anterior quadrant perforations.

Methods: A prospective study was conducted in a tertiary care centre from 2012–16. A total of 187 ear drums(n) in 168 patients with perforations involving anterior quadrant were included in the study. All the patients were operated completely by endoscopic technique. Tragal Composite cartilage perichondrium island (CCPI) graft was used in 87 ears and temporalis fascia in 100. Each group was categorised into A and B depending on perforation size. The outcome parameters assessed include graft success with regard to perforation size, pre- and postoperative ABG, mean improvement in ABG, ABG closure ratio and graft medialisation/lateralisation status.

Results: Cartilage group had 91.95% (80/87) success rate overall, while fascia had 79% (79/100). In category 1, the success rate for cartilage and temporalis fascia were 89.6% (26/29) and 68.9% (20/29) respectively ($p = 0.51788$). In category 2, the success rates were 93.1% (54/58) and 83.1% (59/71) respectively ($p = 0.86356$). The mean improvement in ABG for both groups were 17.52 ± 3.84 dB and 15.26 ± 5.56 dB respectively ($p = 0.04$). ABG closure ratio for both the groups were 62.84 ± 11.87 % and 53.6 ± 19.6 % respectively ($p = 0.0008$).

Conclusion: Endoscopic composite cartilage perichondrium island graft is an effective technique in managing perforations of anterior quadrant barring the expertise required for endoscopic ear surgeries.

1. Introduction

Temporalis fascia, perichondrium, cartilage, vein, fat and skin are commonly used autografts for reconstructing the tympanic membrane perforations [1]. Fascia is still the preferred graft material barring few circumstances. Advantages of fascia are low basal metabolic rate, availability from same incision and sufficient quantity [2]. In contrast, cartilage grafts

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are preferred in difficult circumstances like poor eustachian tube function, retraction pockets, infection, anterior perforations and revision surgeries [3,4].

Since the beginning of cartilage grafts use in middle ear by Utech [5] in 1959 and description of various techniques by Tos [6], cartilage has gained more popularity in last two decades with more and more techniques being described and studied in literature. Palisades, mosaic, composite island, shield and butterfly grafts [7,8,9] are few cartilage tympanoplasty techniques described in literature.

Closure of anterior quadrant perforations of tympanic membrane is considered challenging. The reasons for poor surgical outcomes include reduced vascular supply, limited anterior margin, poor visualization, and inadequate graft stabilization [10–12].

Microscopy is still the preferred tool for any ear surgery though endoscopic ear surgery is gaining more popularity in recent years. The advantages of endoscopes are wider field of view and better depth perception, thereby avoiding canalplasty and posterior meatotomy in selected cases. The wider view also enables the surgeon to visualize the anterior margins clearly which may be compromised with microscopes [13,14]. There are not many literature evidences that describe the role of endoscopes in cartilage tympanoplasty. This study is designed to evaluate the role of endoscopic cartilage tympanoplasty by composite cartilage perichondrium island graft technique and its comparison with temporalis fascia in repairing perforations involving anterior quadrant.

2. Materials and methods

2.1. Study design

A prospective interventional randomised case series study was conducted from 2012 to 2016 in a tertiary care hospital. A total of 187 ears in 168 patients who satisfied the inclusion and exclusion criteria were enrolled in the study. The inclusion and exclusion criteria were as follows,

A. Inclusion criteria
1. The patients requiring type 1 tympanoplasty.
2. Central perforations involving anterior quadrant, which may range from small to subtotal in size.
3. Minimum follow up of 1 year.

B. Exclusion criteria
1. Cholesteatoma and retraction pockets.
2. Perforations involving only posterior quadrant.
3. Age <10 years.
4. Revision surgeries.
5. Patients unwilling to participate in the study.

Institutional Ethical committee clearance was obtained for conducting the study. Informed consent was obtained from all the patients. In paediatric patients, consent was obtained from legal guardians. Photographs of ear drum were taken preoperatively. Only patients with perforations lying or extending anterior to the imaginary line along handle of malleus were included in the study. The tympanic membrane perforation was classified depending on its size as <50% and >50% of the total membrane area. Hearing was assessed a week before surgery using pure tone audiogram. Bone and air conduction thresholds were calculated at 0.5, 1 and 2 kHz. Mean Air Bone Gap at these frequencies were calculated.

The patients were randomly allocated into one of the groups by simple random sampling technique.

All the patients were operated under general anaesthesia.

2.2. Surgical procedure

2.2.1. For cartilage tympanoplasty

The external ear canal and tragal region were infiltrated with mixture of 2% lignocaine and 1:200,000 adrenaline. Karl Storz 18 cm long 4 mm diameter 0° nasal telescope and Smith & Nephew High Definition monitor system were used in all the cases. The left hand was used to hold the endoscopes and the right to perform surgery. The monitor system was placed on the other side of the patient opposite to the surgeon.

2.2.2. Preparation of graft

Tragal cartilage was harvested using a 10–15 mm long incision given just below the dome of tragus. In a single stroke, skin, posterior perichondrium, cartilage and anterior perichondrium was cut. Extra perichondrial dissection was done and entire cartilage with intact perichondrium on both sides was harvested. After removing perichondrium from one side, a round disk of cartilage depending on perforation size was marked. The position of disk was created such that anterior perichondrial flap was at least 5 mm. posterior perichondrial flap size was designed such a way that it gets underneath the tympanomeatal flap. The superfluous cartilage was then removed.

2.2.3. Technique of composite cartilage perichondrium island graft tympanoplasty

Margins of perforation was freshened. Tympanomeatal flap was raised as follows:

Two vertical incisions were made at 12'0 (Incision A) and 6'0 clock (Incision B) positions. Then a horizontal incision was made about 10 mm lateral to annulus connecting the previous 2 incisions (Incision C). After raising the tympanomeatal flap along with fibrous annulus in the abovementioned area, another horizontal incision was given from 6'0 to 1'0 clock position in the skin, just lateral to annulus (Incision D) (Fig. 1).

The fibrous annulus in anterior aspect was elevated then. After confirming the integrity of ossicular status, the graft designed was placed lateral to handle of malleus (HOM) by underlay technique. The surgeon placed the graft lateral to HOM, so that the middle ear space is adequate which is necessary for sound transmission. The anterior perichondrial flap of graft was then pulled and tucked anteriorly between the bone of EAC and anterior tympanomeatal flap. The posterior tympanomeatal flap was reposited back. The final look after repositing the flap is diagrammatically depicted in Fig. 2. Then external canal was packed with gelfoams. This technique makes sure that the graft is firmly stabilised all around and tucked. The authors preferred not suturing the site of graft harvest.

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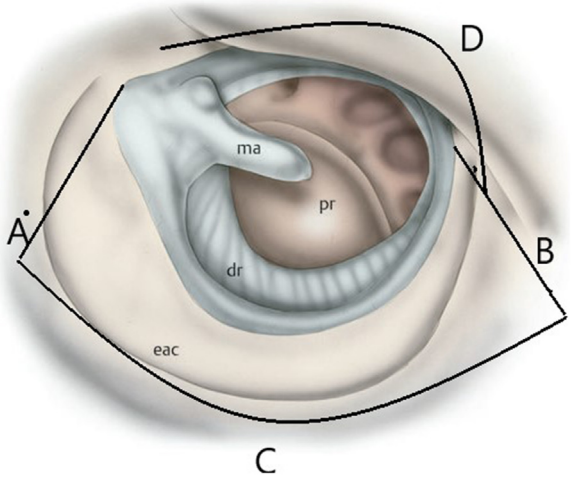

Fig. 1. Diagrammatic depiction of tympanomeatal flap incisions (A, B, C & D). ma—malleus, pr—promontory, eac—external auditory canal, dr—ear drum.

In Fig. 3, the authors have demonstrated the technique in a patient, with comparison of intraoperative and postoperative findings.

2.2.4. Technique of temporalis fascia tympanoplasty

Temporalis fascia graft of adequate size was harvested by giving 2–3 cm long supraaural incision. Rest of the surgical technique was similar to cartilage tympanoplasty except for the placement of graft medial to malleus handle in fascia technique. The supraaural incision was closed in 2 layers.

2.2.4.1. Outcome parameters. Postoperative assessments were done at 3rd month, 6th month and 1 year respectively. Parameters assessed include graft uptake, other otoscopy findings, comparison of preoperative and postoperative ABG, and ABG closure ratio. ABG closure ratio was calculated using the following formula,

$$\text{ABG Closure ratio} = (\text{preoperative ABG} - \text{postoperative ABG}) / \text{Preoperative ABG} \times 100$$

2.2.4.2. Statistical analysis. The data was entered in MS-Excel and analyzed by using SPSS software version 17. Qualitative data was expressed in percentages with 95% confidence interval and Quantitative data was expressed in mean + SD. Chi square test/Fisher's Exact test was used for qualitative variables. Cross tabulation was done to assess the relationship between dependent and independent variables. "p" value <0.05 was considered significant.

3. Results

A total of 187 ears were operated during the study period with 87 having had cartilage and 100 had temporalis fascia as their grafting materials.

The mean age of the study population in cartilage and temporalis fascia group were 31.3 ± 4.9 years and 30.2 ± 4.2 years respectively (range, 12–58 years) ($p = 0.65$).

Women were the majority in both the groups constituting 68.9% and 64% respectively ($p = 0.31$).

The mean operating time taken for cartilage and fascia tympanoplasty were 45.33 ± 7.43 min and 41.2 ± 6.54 min respectively ($p = 0.41$).

Depending on the perforation size, patients in each group were divided into 2 categories. Category 1 with <50% of tympanic membrane area and category 2 with >50% (Table 1).

The overall success rates of cartilage and fascia were 91.9% (80/87) and 79%(79/100) respectively.

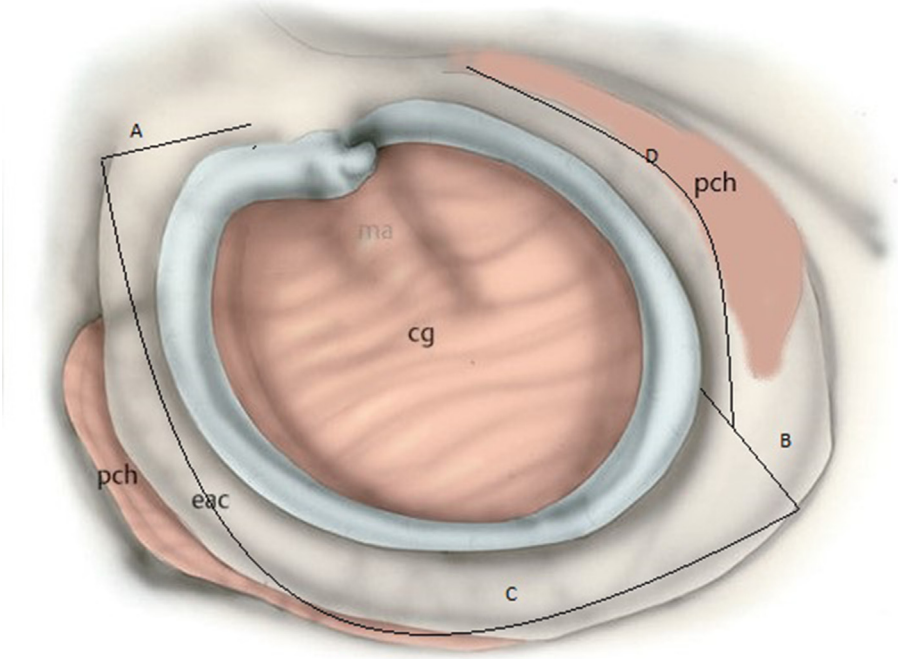

Fig. 2. The final look after repositioning the tympanomeatal flap. Note the perichondrium of graft tucked under both anterior and posterior eac.cg—cartilage grafts, pch—perichondrium, eac- external auditory canal, A, B, C & D—tympanomeatal flap incisions.

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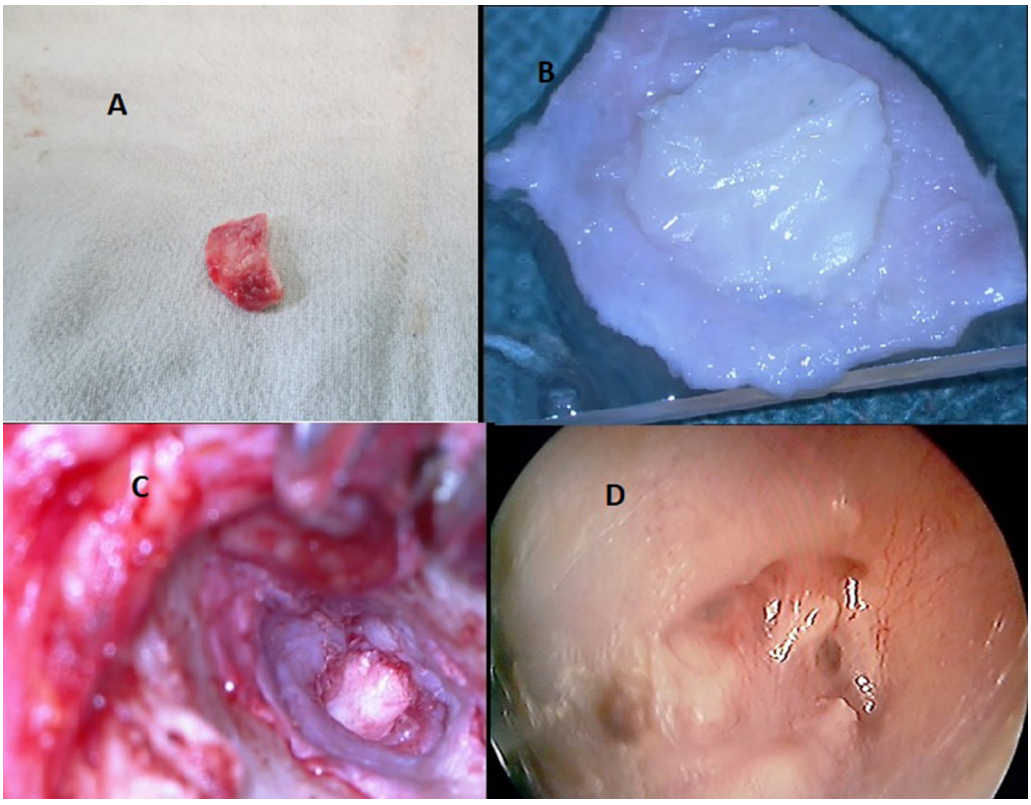

Fig. 3. Figure showing harvested tragal cartilage with intact perichondrium on both sides (A), reshaped composite cartilage perichondrium island graft (B), adequately secured graft all around after replacement of tympanomeatal flap (C) and 3rd month postoperative picture of neotympanum (D).

With respect to perforation size, category 1 in cartilage and fascia grafts had 89.6% (26/29) and 68.9% (20/29) success rates respectively. However, the results were not statistically significant ($p = 0.51788$).

In category 2, the success rates were 93.1% (54/58) and 83.1% (59/71) respectively. The results were not statistically significant again ($p = 0.86356$) (Fig. 4).

The mean preoperative ABG taken a week before surgery for both the groups were 27.7 ± 4.47 dB and 28.33 ± 4.48 dB respectively. Both the groups were comparable and not statistically different ($p = 0.34$).

The mean postoperative ABG at the end of 1 year for both the groups were 10.18 ± 3.21 and 13.87 ± 6.64 dB respectively (Fig. 5). The difference was statistically significant ($p = 0.000096$). The mean improvement in ABG was 17.52 ± 3.84 dB and 15.26 ± 5.56 dB respectively ($p = 0.04$).

ABG closure ratios of cartilage and fascia group were $62.84 \pm 11.87\%$ and $53.6 \pm 19.6\%$ respectively ($p = 0.0008$).

At the end of 1 year, none of patients in cartilage group, had graft medialisation or lateralisation, while 5/79 patients with intact graft had medialisation in fascia group.

The results are summarised in Table 2.

4. Discussion

Type 1 tympanoplasty is one of the most common otological procedures performed. The primary aim of type 1 tympanoplasty is to give a dry ear and restore hearing mechanism. This could be achieved only by creating a near normal tympanic membrane irrespective of underlying pathology and location of the defect.

Temporalis fascia is still the most commonly utilized graft material for tympanic membrane reconstruction [2]. The success rate of fascia graft ranges from 70 to 95% from various literature reviews. However, its success rate in difficult situations like atelectasis, revision surgeries, paediatric

Table 1
Categorization of patients with respect to size of perforation.

Size	Cartilage		Fascia	
	Number of patients (n)	Successful graft uptake(n)	Number of patients (n)	Successful graft uptake(n)
Category 1	29	26	29	20
Category 2	58	54	71	59
Total	87	80	100	79

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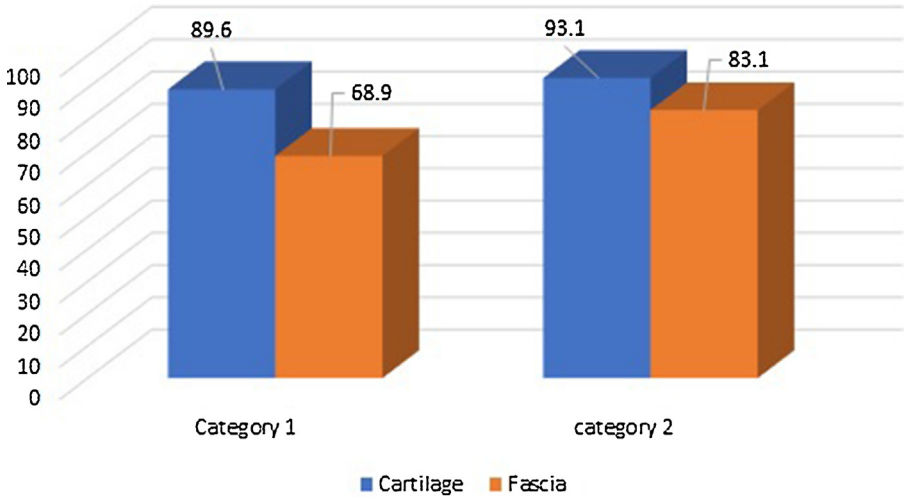

Fig. 4. Category wise comparison of success rates (%) in cartilage and fascia groups.

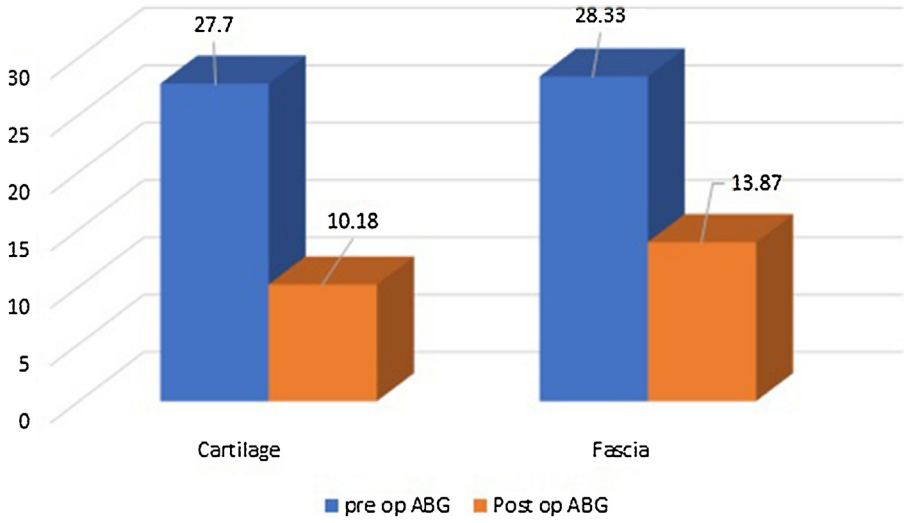

Fig. 5. Comparison of pre-and postoperative Air Bone Gaps (ABG) (dB) in cartilage and fascia group.

population and cholesteatoma surgeries is not encouraging, as the graft tends to resorb and retract in due course. Anterior perforations are also a difficult situation to deal with, due to difficult access, relative less vascularity and instability of grafts leading to medialisation and residual perforations. All these factors affect the outcome of tympanoplasty in anterior perforations, making it a surgical challenge.

Table 2
Summary of the results.

Parameters	Cartilage group	Fascia group	P value
Sample size	87	100	
Age	31.3 ± 4.9 years	30.2 ± 4.2 years	0.65
Male:female ratio	1:2.21	1:1.77	0.31
Mean operating time	45.33 ± 7.43 min	41.2 ± 6.54 min	0.41
Overall success rate	80/87 (91.9%)	79/100 (79%)	
Success rate in category 1	26/29 (89.6%)	20/29 (68.9%)	0.51
Success rate in category 2	54/58 (93.1%)	59/71 (83.1%)	0.86
Air Bone Gap			
Preoperative	27.7 ± 4.47 dB	28.33 ± 4.48 dB	0.34
Postoperative	10.18 ± 3.21 dB	13.87 ± 6.64 dB	0.000096
Mean ABG improvement	17.52 ± 3.84 dB	15.26 ± 5.56 dB	0.04
ABG closure ratio	62.84 ± 11.87%	53.6 ± 19.6%	0.0008
Graft medialisation rate	0	5/79 (0.06%)	0.12

The difficult access in most cases is due to bony canal overhang and narrow anterior tympanomeatal angle, when seen through an operating microscope. This restricted view could be addressed by either canalplasty, posterior meatotomy or endoscopes. Canalplasty requires drilling the anterior wall of external canal, with risk of glenoid fossa injury and more operating time. Posterior meatotomy is performed by post auricular incision thereby increasing the morbidity to patient. Endoscopes would be ideal in these situations, as it gives a wider field of vision and better depth perception, allowing optimal visualisation all around.

The other reasons for failure in anterior perforations as mentioned above include reduced vascularity and graft instability. These factors could be overcome by cartilage grafts. Cartilage as a graft material resists infection, lack of vascularization and resorption to a much greater degree than fascia, aside from its properties of rigidity and ability to resist retraction [15]. Thus a combined endoscopic cartilage tympanoplasty is a versatile and effective technique in

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managing perforations involving anterior quadrant. With lot of cartilage techniques being described, there is scope for further modifications and research in future.

The cartilage graft may be harvested from tragus or concha. We prefer and advice to use the tragal cartilage, because of its flat surface, ideal thickness, sufficient size and relatively hidden incisional scar. It can be used as cartilage perichondrium island graft with the perichondrium attached to one side, since its thickness is less than 1 mm, [16]. In this study, we have described a cartilage island graft with reflected perichondrium still attached to the other side. This enables the surgeon to have a larger perichondrium, that can be tucked under posterior as well as anterior tympanomeatal flap.

4.1. Comparison of results with other studies

In this study, though the graft success rates were not significantly different between the two groups, cartilage had better success (91.95%) than fascia (79%). Khan and Parab [17] and Eren et al. [18] have reported 97% and 95% success rates with endoscopic cartilage tympanoplasty in their studies.

This study shows no significant difference in graft success rate pertaining to size of perforation, though a difference of 20% was observed between the two groups in category 1 (size $< 50\%$). To surprise, Singh et al. [19] and Pignataro et al. [20] also reported same results in their respective studies.

Comparison of endoscopic versus microscopic tympanoplasty is not new. Studies in the past have showed significant decrease in operating time with endoscopic techniques without any difference in graft success rates. In this study the average time taken considering both the groups was 43.56 ± 6.98 min. This is comparable to Lade et al. [14] who had 44 min as their mean operating time using endoscopes. Cartilage tympanoplasty took a little longer time than fascia in our study. This could be attributed to the fact that cartilage needs remodelling and shaping according to the defect size and location. Cartilage island is created in such a way that the side facing middle ear is devoid of perichondrium. This step prevents adhesions between the graft and middle ear, which might be critical in surgical and hearing outcomes [21].

Mean improvement in ABG and ABG closure ratio are the better predictors of hearing outcome after tympanoplasties. ABG closure ratio $>50\%$ is considered as a successful outcome in type 1 tympanoplasty [22]. In this study, the mean ABG improvement in cartilage group was 17.52 ± 3.84 dB and 15.26 ± 5.56 dB in fascia group. This was not significant for cartilage when compared to fascia ($P = 0.04$). Though Demirpehlivan et al. [7] and Kazikdas et al. [23] have concluded no significant difference in ABG improvement, Vashishth et al. [21] have noticed a significant difference between the two grafts in their study. Solmaz et al. [24] have also reported 15 dB of hearing improvement in their perichondrium attached cartilage island technique [24].

ABG closure ratios of cartilage and fascia group in this study were $62.84 \pm 11.87\%$ and $53.6 \pm 19.6\%$ respectively ($p = 0.0008$). Though both had $>50\%$ closure, cartilage had a better and significant closure rate.

To surprise, in this study the outcomes of fascia group in category 1 was lower than category 2. The authors could not attribute any definitive cause for this adverse outcome, as the technique of tympanoplasty was same in both the groups. 7/9 patients who had adverse outcomes in category 1 had anterosuperior perforations. Henceforth we may consider that temporalis fascia grafts are more unstable in this quadrant and cartilage would be an ideal graft material in such cases. This is supported by D'Eradita and Lens [25] and Sakalli et al. [26] in their respective studies.

The technique of tucking the attached perichondrium of cartilage island beneath the anterior tympanomeatal flap with cartilage itself lying medial to bony annulus prevents the cartilage from getting medialised or lateralised. Such displaced grafts tend to vibrate less, and block the eustachian tube compromising the acoustic outcomes. Medialised grafts can decrease the aeration of middle ear and nonaerated ears have a poor ABG closure ratio because of reduced ossicular coupling and stapes motion. None of the group A patients in this study, had graft lateralisation or blunting, while 5 patients with intact grafts had medialisation in fascia group.

The disadvantages of cartilage island grafts are its opaque nature making visualization of middle ear postsurgery difficult. The practical possibilities of pus accumulating in middle ear cleft due to a resilient and resistant neotympanum leading to early complications in acute otitis media have to be considered, though is rare. But the advantages of this technique offset its disadvantages.

Its noteworthy to mention here about the instruments and telescopes used in endo ear surgeries. The authors prefer 18 cm scope because the surgeon's two hands will be at different distances from the ear canal and thus be less likely to interfere with one another during surgery. The standard micro ear instruments routinely used for microscopic ear surgeries can be used for endoscopic surgeries. In fact, the constraints of aural speculum can be overcome and the surgeon will have a wider angle of attack using instruments in endo ear surgeries. The other factors to be considered are haemostasis control and prevention of 'red out' of scopes. This could be achieved by meticulous injection of vasoconstrictors, frequent irrigation with saline and packing with cotton pledgets. The authors recommend high definition camera systems for ear surgeries as the analogue cameras are more prone for 'red outs' subsequently making identification of structures more difficult for surgeons.

The authors also emphasize the fact that endoscopic tympanoplasty is a singlehanded technique and requires considerable time and practice to expertise. These problems might be overcome partially with the use of endoscopic holders. However, they are in preliminary stages and further research is required in analysing its clinical applications in endoscopic ear surgery.

5. Limitations and recommendations

The obvious limitations of study are relative short follow up. As drum retractions and reperforations have been reported even years later, a longer follow up with a larger sample size is

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recommended. The authors have not included the middle ear mucosal status in results. This could be a confounding factor affecting the graft success, leading to lack of standardisation of results.

6. Conclusion

Endoscopic composite cartilage perichondrium island graft is an effective technique in managing perforations of anterior quadrant. The technique described can nullify the difficulties faced and improve the outcomes in such cases, barring the long and tough learning curve required to expertise the one handed endoscopic ear surgery.

References

[1] Heermann H. Tympanic membrane plastic with temporal fascia. Hals Nas Ohrenh 1960;9:136–9.
[2] Sheehy JL, Anderson RG. Myringoplasty. A review of 472 cases. Ann Otol Rhinol Laryngol 1980;89:331–4.
[3] Joynt JA. Repair of drum. Iowa Med Soc 1919;9:51.
[4] Heermann JJ, Heermann H, Kopstein E. Fascia and cartilage palisade tympanoplasty. Nine years experience. Arch Otolaryngol 1970;91 (March (3)):228–41.
[5] Utech H. About diagnostic and therapeutic possibilities of tympanotomy in sound conduction disturbances. J Laryngol Otol 1959;38:212–21.
[6] Tos M. Cartilage tympanoplasty methods: proposal of a classification. Otolaryngol Head Neck Surg 2008;139:747–58.
[7] Demirpehlivan IA, Onal K, Arslanoglu S, Songu M, Ciger E, Can N. Comparison of three different tympanic membrane reconstruction techniques in type I tympanoplasty. Eur Arch Otorhinolaryngol 2011;268:471–4.
[8] Lee JC, Lee SR, Nam JK, Lee TH, Kwon JK. Comparison of different grafting techniques in type I tympanoplasty in cases of significant middle ear granulation. Otol Neurotol 2012;33:586–90.
[9] Eavey RD. Inlay tympanoplasty: cartilage butterfly technique. Laryngoscope 1998;108:657–61.
[10] Applebaum EL, Deutsch EC. An endoscopic method of tympanic membrane fluorescein angiography. Ann Otol Rhinol Laryngol 1986;95(5):439–43.
[11] Schraff S, Dash N, Strasnick B. Window shade tympanoplasty for anterior marginal perforations. Laryngoscope 2005;115(9):1655–9.
[12] Peng R, Lalwani AK. Efficacy of hammock tympanoplasty in the treatment of anterior perforations. Laryngoscope 2013;123(5):1236–40.
[13] Harugop AS, Mudhol RS, Godhi RA. A comparative study of endoscope assisted myringoplasty and micrsoscope assisted myringoplasty. Indian J Otolaryngol Head Neck Surg 2008;60(4):298–302.
[14] Lade H, Choudhary SR, Vashishth A. Endoscopic vs microscopic myringoplasty: a different perspective. Eur Arch Otorhinolaryngol 2014;271(7):1897–902.
[15] Bernal-Sprekelsen M, Romaguera Lliso MD, Sanz Gonzalo JJ. Cartilage palisades in type III tympanoplasty: anatomic and functional long-term results. Otol Neurotol 2003;24:38–42.
[16] Gerber MJ, Mason JC, Lambert PR. Hearing results after primary cartilage tympanoplasty. Laryngoscope 2000;110:1994–9.
[17] Khan MM, Parab SR. Novel concept of attaching endoscope holder to microscope for two handed endoscopic tympanoplasty. Indian J Otolaryngol Head Neck Surg 2016;68(2):230–40.
[18] Eren SB, Tugrul S, Ozucer B, Veyseller B, Aksoy F, Ozturan O. Endoscopic transcanal inlay myringoplasty: alternative approach for anterior perforations. Otolaryngol Head Neck Surg 2015;153(5): 891–3.
[19] Singh GB, Sindhu TS, Sharma A, Singh N. Tympanoplasty type 1 in children—an evaluative study. Int J Pediatr Otorhinolaryngol 2005;69:1071–6.
[20] Pignataro L, Grillo Della Beta L, Cappacio P, Zaghis A. Myringoplaty in children: anatomical and functional results. J Laryngol Otol 2001;115:369–73.
[21] Vashishth A, Mathur NN, Choudhary SR, Bhardwaj A. Clinical advantages of cartilage palisades over temporalis fascia in type I tympanoplasty. Auris Nasus Larynx 2014;41(October (5)):422–7.
[22] Mathur NN, Manimaran V, Deka A. A short-term comparison of cartilage with temporalis fascia graft tympanoplasty in paediatric and adolescent population. Indian J Otolaryngol Head Neck Surg. https://doi.org/10.1007/s12070-017-1140-3.
[23] Kazikdas KC, Onal K, Boyraz I, Karabulut E. Palisade cartilage tympanoplasty for management of subtotal perforations: a comparison with the temporalis fascia technique. Eur Arch Otorhinolaryngol 2007;264:985–9.
[24] Solmaz F, Akduman D, Haksever M, Gündoğdu E, Yanılmaz M, Mescioğlu A. The audiological and take results of perichondrium attached cartilage island graft in tympanoplasty: PACIT. Acta Otorhinolaryngol Ital 2016;36(August (4)):275–81.
[25] D'Eradita R, Lens MB. Anterior tap flap versus standard underlay myringoplasty in children. Otol Neurotol 2009;30:777–81.
[26] Sakalli E, Celikyurt C, Biskin S, Erdurak SC. A novel myringoplasty technique: the placement of a complementary graft descending from the scutum to support an anterosuperior perforation. Eur Arch Otorhinolaryngol 2017;274(1):127–31.

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