

CARTILAGE ISLAND TYMPANOPLASTY : THE RETROSPECTIVE STUDY OF ANATOMICAL AND AUDIOLOGICAL RESULTS

SHYAMAKANT PRASAD^a, BABITA AHLAWAT^b, ASHOK KUMAR^{c1}, ANIL AGRAWAL^d,
M. NAIKSULABHA^e AND NAVDHA CHAUDHARY^f

^{acc}Department of ENT, SHKM GMC, Nalhar, Mewat, Haryana, India

^bDepartment of Dentistry, SHKM GMC, Nalhar, Mewat, Haryana, India

^dDepartment of ENT, Shyam Shah Medical College, Rewa, Madhya Pradesh, India

^fDepartment of Pedodontics and Preventive Dentistry, Eklavya Dental College, Kotputli Distt. Jaipur, Rajasthan, India

ABSTRACT

The purpose of this study is to evaluate anatomical and audiological results after cartilage island tympanoplasty. A retrospective study was performed on 60 patients who underwent cartilage island tympanoplasty for repair of tympanic membrane from 2010 to 2014. Auditory function was analysed by performing preoperative and postoperative pure tone audiometry. Reviewed parameters were the graft uptake and change in pure tone audiometry air bone gap at each of four frequencies. Anatomical success and hearing assessment was done at 12 months. Postoperative pure-tone audiometric findings of the patients were obtained and hearing differences at 500, 1000, 2000, and 4000 Hz were assessed. Audiological outcome was assessed by gain in AB gap. The overall perforation closure was 88.33%. Residual perforation was seen in 7 cases. group. We did not find any statistical significance between site of perforation and graft uptake. Audiological improvement was 11.8 dB. There was improvement in the air-bone gap at all frequencies after surgery. The improvement in mean ABG was 9.9 dB at 500 Hz, 13.7 at 1000 Hz, 12.9 dB at 2000 Hz and 10.7 dB at 4000 Hz. These results are comparable to temporalis fascia graft. Cartilage tympanoplasty is a reliable and safe technique in the reconstruction of the tympanic membrane. Therefore, when indicated, a cartilage island graft can be used to reconstruct or strengthen tympanic membrane without fear of impairing hearing.

KEYWORDS : Tragal Cartilage, Conchal Cartilage, Anatomical Outcomes, Audiological Improvement

The goal of tympanoplasty is to reconstruct the tympanic membrane and the sound-conducting mechanism in a long-lasting way. Today fascia of the temporalis muscle is the most frequently used material for tympanoplasty owing to its translucency, low basal metabolic rate, anatomic proximity, and suppleness (Glasscock & House, 1968). However, graft displacement, improper placement, atrophy and reperforation of the graft have been noticed in cases of total perforation, chronic mucosal dysfunction, and eustachian tube dysfunction leading to atelectasis of graft (Milewski, 1993). In these cases, many surgeons have used cartilage as a grafting material on account of its increased stability and resistance to negative middle ear pressure, even in cases with chronic eustachian tube dysfunction. (Buckingham, 1992 and Duckert et al., 1995).

Cartilage was first used in middle ear surgery for ossicular chain reconstruction in 1958 by Jansen (Jansen, 1961). In 1963, Salen and Jansen first reported the use of cartilage composite grafts for tympanic membrane reconstruction (Salen, 1963 and Jansen, 1963). Cartilage has a low metabolic rate and good acceptance in the middle ear. Cartilage perichondrium graft being tougher and easily

neovascularized would theoretically work well in these conditions as the incorporated cartilage will provide mechanical stability and necessary stiffness to avoid retraction and reperforation (Dornhoffer, 2006). Nevertheless there may be some concern regarding poor hearing using this grafting material rather than fascia. The perceived disadvantage of the cartilage graft is that it creates an opaque tympanic membrane, which could potentially hide a residual cholesteatoma. There are many described techniques for cartilage tympanoplasty such as cartilage butterfly inlay technique, cartilage palisade technique, perichondrium cartilage island technique, cartilage mosaic technique and cartilage reinforcement technique (Neumann et al, 2003 and Dornhoffer, 2003). The aim of this study is to present our experience with cartilage island tympanoplasty and evaluate its success rate based on anatomical and audiological outcomes.

MATERIALS AND METHODS

This study was conducted in the Department of Otorhinolaryngology and Head and Neck Surgery, of a tertiary care centre for three years. A retrospective study was performed on 60 follow up patients of cartilage island

¹Corresponding author

tympanoplasty for repair of tympanic membrane perforation. All the patients had chronic otitis media with perforation in the pars tensa without cholesteatoma. The patients for the study were selected on the basis of inclusion and exclusion criteria. Inclusion criteria include patients of either sex having good general physical condition, no evidence of active infection in nose, throat or paranasal sinuses, dry ear for a minimum period of 3 weeks before the day of operation with good cochlear reserve. Patients having polyp, granulations or cholesteatoma, failed myringoplasty in the same ear, with otogenic intracranial complications in the past, evidence of otitis externa or otomycosis, per operative ossicular discontinuity, fixed foot plate, any pathology in nose, throat or nasopharynx and any skin disease in the post aural region, temporal region or in the skin of face in front of ear were excluded from the study.

Auditory function was analysed by performing preoperative and postoperative tuning fork test (256, 512, 1024 Hz) and pure tone audiometry. Age, gender, grade of perforation, quadrant of perforation, type of graft, preoperative and postoperative audiograms were obtained from the patient's chart. Reviewed parameters were the graft uptake and change in pure tone audiometry air bone gap at each of four frequencies (0.5, 1, 2, 4 kHz).

Surgical Technique

All patients underwent cartilage island tympanoplasty type I by the same team under local anaesthesia using either a transcanal or postauricular approach. The cartilage island flap was harvested from the tragus or conchal cartilage. Incision was given over the skin of the medial side of the tragus. A piece of cartilage, with attached perichondrium, was dissected free. A complete strip of cartilage was then removed vertically from the center of the cartilage to accommodate the entire malleus handle. The cartilage was used as a full thickness graft and

slightly less than 1 mm thick in most cases. Flap of perichondrium was produced posteriorly that will eventually drape the posterior canal wall. Graft was placed by underlay technique. Gel foam was packed in the middle ear space under the annulus to support the graft. External ear canal was packed with gel foam. Conchal cartilage has been used less frequently, but is harvested with ease through posterior approach with preservation of its associated perichondrium. Rest of the procedure is same as that of tragus cartilage. External ear canal was cleaned of gel foam after 21 days and status of the graft and the tympanic membrane assessed.

Anatomical success of tympanoplasty was defined as an intact graft without lateralization, retraction, inflammation or infection at the last follow-up visit with a minimum of 12 months. Hearing assessment was done at 12 weeks and again at 6 and 12 months. Postoperative pure-tone audiometric findings of the patients were obtained and hearing differences at 500, 1000, 2000, and 4000 Hz were assessed. Audiological outcome was assessed by gain in AB gap. Student's t test was used for the statistical analysis.

RESULTS

Patient Data

The study group consisted of 60 patients. The average age of the patients in the study group was 24.8 years (range, 14-45 yr). There were 24 (40%) male and 36 (60%) female patients. The indication for surgery in all cases was perforation in pars tensa of tympanic membrane. An underlay cartilage island tympanoplasty technique was performed in all cases. Tragal cartilage was used in 42 patients and conchal cartilage in 18 patients. The patients were kept in follow up for a minimum of 12 months. 55% of patients were operated in the left ear and 45% in the right ear.

Table 1 : Table Showing the Relation Between Age and Graft Uptake / Failure Rate

Age Group (years)	Graft uptake	Graft failure
11 to 20 yr	11	2
21 to 30 yr	12	1
31 to 40 yr	19	1
41 to 50 yr	11	3

Table 2 : Table Showing the Relation Between Quadrant of Perforation to Graft Uptake / Failure Rate

Quadrant of perforation	Graft uptake	Graft failure
Anterior	9	2
Posterior	17	3
Inferior	14	0
Subtotal	13	2

Table 3 : Table Showing Pre and Post Operative Audiological Results in Terms of AB Gap (dB)

AB GAP (dB)	Pre Operative	Post Operative
0 to 10dB	0	32
11 to 20dB	6	18
21 to 30dB	26	7
31 TO 40dB	28	3

Anatomical Success

The age of the patient was between 14-45 yrs. Out of 60 patients, 21.67% fall in 11-20yrs, 21.67% in 21-30 yr, 33.33% in 31-40 yrs and 23.33% in 41-50 yrs. Graft failure was seen in 2 patients in age group 11-20 yrs, 3 in 41-50 yrs and 1 each in age group 21-30 yrs and 31-40 yrs (Table 1). 4 male and 3 female patients had graft failure. There was no statistical significance in graft rejection related to age and gender ($p > 0.05$).

The overall perforation closure was 88.33% in cartilage island tympanoplasty. Residual perforation was seen in 7 patients. Out of 42 patients with tragal grafting 4 had graft failure and out of 18 patients with conchal grafting, 3 had graft failure.

In order of frequency the perforation was posterior in 33.33%, subtotal in 25%, inferior in 23.33% and anterior in 18.33%. The uptake of graft as compared with the site of perforation was as mentioned in Table 2; no statistical correlation was found between the site of perforation and graft uptake.

Audiological Outcomes

All the 60 patients had history of loss of hearing. Table 3 showed preoperative and postoperative audiologic results for all patients in the study. 43.33% patients had pre op AB gap in the range of 21-30 dB and 46.67% in the range of 31-40 dB. Twelve months after surgery, 83.33% had postop AB gap within 20 dB. 53.33% had postop AB gap of <10 dB (table 3). Mean audiological improvement was 11.8

dB. There was improvement in the air-bone gap at all frequencies after surgery. The improvement in mean ABG was 9.9 dB at 500 Hz, 13.7 dB at 1000 Hz, 12.9 dB at 2000 Hz and 10.7 dB at 4000 Hz.

DISCUSSION

Temporalis fascia is still the most commonly used graft for tympanoplasty, though many study concluded that the result of cartilage tympanoplasty is as good as temporalis fascia graft. Cartilage has been successfully used in middle ear procedures for 40 years (Kerr et al., 1973). Initially used for ossicular chain reconstruction, cartilage is now used for a wide range of procedures. Cartilage-perichondrium grafts are frequently the material of choice for reconstruction of the atelectatic tympanic membrane and recurrent perforations. Reports in the literature suggest favorable anatomic results and low recurrence rates.

Cartilage has been successfully used in middle ear procedures for first time used by Jansen and Salen. It has been shown in both clinical and experimental studies that cartilage is well tolerated with minimal resorption time and survives for a long period with good hearing results. Although one might anticipate a significant conductive hearing loss with cartilage owing to its rigidity and thickness, several studies showed that hearing results with cartilage were not different than those with fascia. Cartilage graft harvested from concha or tragus is easy to obtain and convenient for re-shaping according to the size of the

perforation (Usluet al, 2010 and Cavaliere et al, 2009). These grafts are nourished mainly by diffusion and become excellent incorporated in tympanic membrane. The donor area heals without significant deformity. A potential drawback of cartilage tympanoplasty is the graft opacity and detection of the residual or recurrent cholesteatoma may be more difficult. (Cavaliere et al, 2009)

In this study, success was evaluated as anatomical Intactness of tympanic membrane and Hearing improvement in postoperative air bone gap after a minimum follow up of 1 year and was compared to results found in literature.

Khan and Parab (Khan and Parab, 2011) achieved a success rate of 98.20% with the use of tragal cartilage perichondrium composite graft in tympanoplasty. Study done by Strahan et al (Strahan et al., 1971) showed take-up rate of 87.5% was achieved using temporalis fascia and 86% by tragal perichondrium by underlay technique.

Singh et al (Singh et al., 2009) had recorded a graft success rate of 95% for temporalis fascia and 90% for tragal perichondrium. Sprem et al. (Sprem et al., 2001) had reported a graft take-up rate of 91% with temporalis fascia and 92% using tragal perichondrium. These results are comparable to our study where overall perforation closure was 88.33% in cartilage island tympanoplasty.

Although Castro and Knapik reported best long-term audiological results with anterior perforations, the majority of authors found better results with posterior location (Olfa Ben Gamra et al., 2015). This is probably related to the scarcity of vascularization of the anterior half of the tympanic membrane, anteriorly lack of support for the graft and anatomical difficulties in that area. In our study no statistical correlation was found between the site of perforation and graft uptake and is comparable to study by Olalla Castro et al. where the rates of closure of central, posterior and subtotal perforations were 82.6%, 83.3%, and 76.9%, respectively (Castro et al., 2013.) Olfa Ben Gamra et al. also did not find any relationship between surgical success and perforation site.

Hearing results following cartilage-perichondrium tympanic membrane reconstruction have received less attention than anatomic results. The rigid nature of cartilage, while effective in preventing retraction, was theorized to be potentially detrimental to the sound conductive properties of the tympanic membrane. However, some studies have reported good or acceptable hearing with this technique. For example, Amedee et al reported an average postoperative air-bone gap of 4 dB, and Adkins reported that grafting the entire tympanic membrane with cartilage resulted in a 5 to 10 dB ABG (Amedee et al., 1989 and Adkins, 1990). Levinson reported that 65% of his patients had closure of the airbone gap to within 10 dB and 86% to within 20 dB (Levinson, 1987).

It is reasonable to expect that replacing a large portion of the tympanic membrane with cartilage would add stiffness and/or mass that would affect individual frequencies, but not significantly impact averaged audiometric data such as airbone gap. With that in mind, air and bone-conduction thresholds at 500, 1000, 2000, and 4000 Hz were examined. Post-operatively, audiological success criteria have not yet been standardized. In our study we relied on AB gap improvement. ABG reduction varies in the literature between 7.6 db and 12.6dB. In our study Twelve months after surgery, 83.33% had postop AB gap within 20 dB and 53.33% had postop AB gap of <10 dB. The mean audiological improvement was 11.8 dB. Although a tendency for better airbone gap closure at 1000 Hz was noted, this was not significant. These results are consistent with the literature.

CONCLUSION

These results demonstrate that the graft uptake and hearing results after cartilage island tympanoplasty are comparable to those after temporalis fascia tympanoplasty. Cartilage tympanoplasty is a reliable and safe technique in the reconstruction of the tympanic membrane. Therefore, when indicated, a cartilage island graft can be used to reconstruct or strengthen tympanic membrane without fear of impairing hearing.

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