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ORIGINAL ARTICLE

Cartilage Island Graft Tympanoplasty in Advanced Middle Ear Disease: Anatomic and Audiologic Results

Cagatay Han Ulku

Selcuk University School of Medicine Department of Otolaryngology Head and Neck Surgery, Konya – TURKEY

Objective: To present the experience in cartilage island graft tympanoplasty for advanced middle ear pathologies and evaluate its success rate and audiologic results.

Materials and Methods: The charts of patients who underwent cartilage island graft tympanoplasty for advanced middle ear disease from September 2006 to March 2009 were reviewed and only oto-endoscopy assisted intact canal wall (ICW) / type 3 tympanoplasty procedures have been included in this study. Reviewed parameters were graft take, change between the pre- and post operative pure tone average air bone gap (PTA-ABG) and complications. Audiologic evaluation was made among the patients whom complete ear drum closure was achieved

Results: Of the 36 procedures, 63.9% were for chronic otitis media with cholesteatoma, 11.1% for chronic otitis media with polyp, 25% for adhesive otitis/retraction pocket with or without cholesteatoma. TORP was used in 14 cases and PORP in 22. Graft take was achieved 88.9% of the patients. There were two attic perforation with cholesteatoma and two anterior perforation. The overall pre-and postoperative PTA-ABG were 28.91± 8.73 dB and 10.42±6.10 dB. PORP subgroups had a statistically signifcant better hearing results at 0.5 kHz, 4.0 kHz and average.

Conclusion: Results in our study indicate that cartilage island graft is a reliable material in advanced middle ear pathologies with satisfactory anatomical - functional outcomes and it reduces the risk of retraction pockets which can lead to recurrent cholesteatoma.

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Introduction

Cartilage has proved to be a reliable graft material for reconstruction of the tympanic membrane even in advanced middle ear pathologies, such as atelectatic retraction pockets, adhesive otitis and subtotal tympanic membrane defects, either in chronic suppurative otitis media or in cholesteatoma[1]. 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[1-3].

The aim of this study is to present the experience in cartilage tympanoplasty with island technique for advanced middle ear pathologies and evaluate its success rate and audiologic results.

Material and Methods

The charts of patients who underwent cartilage island graft tympanoplasty for advanced middle ear disease from September 2006 to March 2009 were retrospectively reviewed and only oto-endoscopy assisted intact canal wall technique (ICW) / type 3 tympanoplasty procedures have been included in this study. These 36 cases had atelectatic retraction pockets, adhesive otitis and / or cholesteatoma in association with an ossicular chain defect. Middle Ear Risk Index (MERI) was used for determination of the disease severity. All surgery was perfomed by the same surgeon as a single stage procedure. 30° and rarely 70° oto-endoscopes were utilized for control of the sinus tympani / anterior epitympanum. Ossiculoplasty was performed with total (TORP) or partial ossicular replacement prosthesis (PORP). Middle ear pathology, age, sex, type of the used prostheses, pre- and postoperative audiograms, postpostoperative findings and follow-up time were obtained from the patient's chart. Reviewed parameters were the graft take, change in PTA-ABG at each of four frequencies (0.5,1,2,4 kHz) and

Corresponding address:
Cagatay Han Ulku
Selcuk University School of Medicine, Department of Otolaryngology Head and Neck Surgery, TR - 42100, Konya - TURKEY
Telephone: +90 – 332 - 2237250; Fax: + 90 - 332-3232643; E-mail:chanulku@yahoo.com

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complications such as reperforation, recurrent retraction pockets or cholesteatoma. Audiologic evaluation was made among the patients whom complete tympanic membrane closure was achieved. Statistical comparisons of the audiometric data were performed using Wilcoxon Signed Ranks and Mann-Whitney U tests.

Technique

Tragal cartilage was used as a graft material in all cases. In the dome of the tragus, 2 mm cartilage strip was left intact for cosmetic purpose and an insicion was made through the skin and cartilage on the medial side (Figure 1a). It was harvested with perichondrium on both surfaces. Cartilage island graft was prepared by elevating the perichondrium from the convex side of the cartilage. Using a round knife, cartilage was removed to produce a disc of cartilage about 6 to 9 mm in diameter for subtotal TM reconstruction. A notch can be made on the cartilage for manibrium mallei (Figure 1b). A rim of tissue was removed from the perforation edge and posterior tympanomeatal flap was then elevated. Long process of the malleus was cleaned from epithelial remnants. After ICW mastoidectomy and oto-endoscopic (Figure 1c) control of the sinus tympani / anterior epitympanum, the cartilage island graft was placed over the malleus and under the annulus (over-underlay technique). TORP or PORP was interpositioned between stapes superstructure or foot plate and graft. Prostheses were placed in direct contact with the cartilage island graft, minimizing the risk of extrusion. A flap of perichondrium was draped over the posterior canal wall. The middle ear and external auditory canal were packed with gelfoam. Follow-up examinations were made by 0° oto – endoscope (Figure 1d) or oto - microscope.

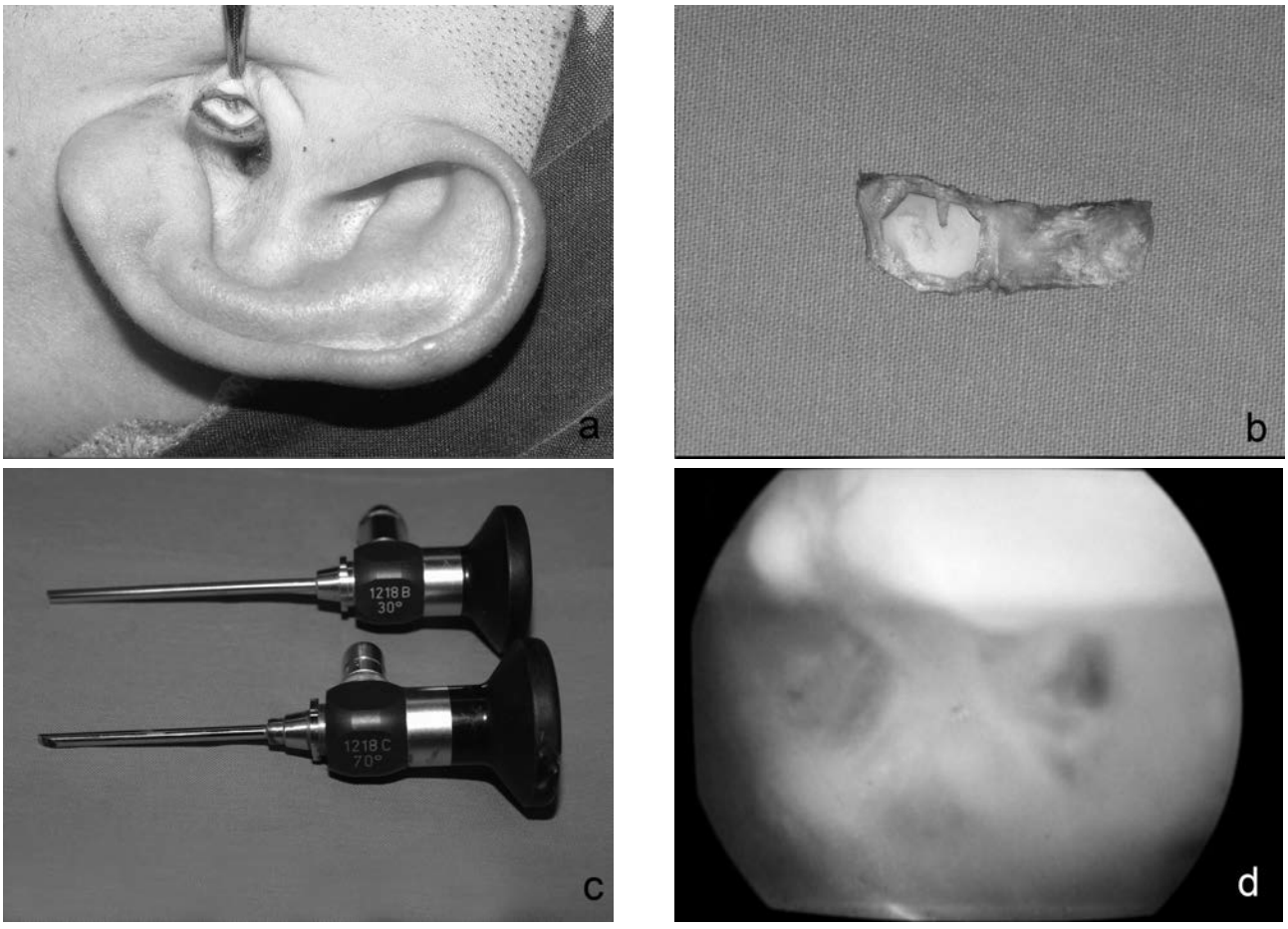

Figure 1.
a. Tragal insicion was made through the skin and cartilage on the medial side,
b. Cartilage island graft,
c. 30° and 70° oto-endoscopes,
d. Post-operative, 0° oto-endoscobic view of the tympanic membrane.

Results

The mean age of the patients consisted of 22 men and 14 women were 27.92±17.10 years (range, 7-58 years). The mean follow up period was 24.8 months (range, 12-48 months). Of the 36 procedures, 23 (63.9%) were for chronic otitis media with cholesteatoma, 4 (11.1%) for chronic suppurative otitis media with polyp, 9 (25%) for adhesive otitis / retraction pocket with or without cholesteatoma (Table 1). Values of MERI were between 8 to 12. Two types of tympanoplasty with ICW mastoidectomy were performed; type 3 using cartilage island grafts with TORP in 14 cases and type 3 using cartilage island grafts with PORP in 22 cases. Graft-take was achieved in 32 patients (88.9%). In remaining 4 patiets, there were two attic perforation with residual / recurrent cholesteatoma and two simple anterior perforations. Among the cholesteatoma cases, rate of the residual / recurrent disease were 6.9% (2/29). Prosthesis extrusion or retraction pocket recurrence was not observed. The overall (n=32) pre-and postoperative (least 12 months after surgery) four frequency PTA-ABG were 28.91± 8.73 dB and 10.42±6.10 dB ($p<0.0001$) (Wilcoxon Signed Ranks Test) respectively (Figure 2, Table 2). In the TORP subgroup (n=13), pre-op PTA-ABG was 32.40±8.12 dB, and post-op PTA-ABG was 14.02±4.16 dB ($p<0.0001$) (Wilcoxon Signed Ranks Test) (Figure 3). In the PORP subgroup (n=19), pre- and postoperative PTA-ABG were 26.51±8.51 dB and 7.96±6.07 dB ($p<0.0001$) (Wilcoxon Signed Ranks Test) respectively (Figure 4). Comparis of the two groups, PORP subgroups had a statistically signifcant better postoperative hearing result at 0.5 kHz, 4.0 kHz and average ($p<0.05$) (Mann Whitney U Test) (Figure 5, Table 3) .

Discussion

Surgical treatment in advanced middle ear disease such as adhesive otitis / retraction pocket with or without cholesteatoma or chronic otitis media with cholesteatoma have been discussed for several decades, but residues and recurrences still occur because of the hidden pathologies and/or chronic Eustachian tube dysfunction often associated with disease[4]. Residual disease is that which is left behind during initial surgery and 75% of all residual disease is thought to be manifested within 2 years after surgery[5]. On the other hand, recurrent cholesteatoma is caused by recurrent retractions from the reconstructed tympanic membrane[6]. It is difficult to assess the exact origin of the existing cholesteatoma without close follow-up. As an alternative technique to posterior tympanotomy or canal wall down techniques, oto-endoscopic procedures allow a better visualisation and eradication of residual disease from hidden areas not yet reachable by the surgical microscope. The sinus tympani is the most common site of residual disease[7]. All visible cholesteatoma is

Table 1. Surgery Indications

Surgery Indications	n=36
Chronic suppurative otitis media with cholesteatoma	23
Chronic suppurative otitis media with polyp	4
Adhesive otitis / retraction pocket with cholesteatoma	6
Adhesive otitis / retraction pocket without cholesteatoma	3

Table 2. The overall (n=32) pre-and postoperative four frequency PTA-ABG ($p<0.0001$). (Wilcoxon Signed Ranks Test).

Frequency	Preoperative PTA-ABG	Postoperative PTA-ABG	p
500	32.03±14.13 dB	11.25±8.9 dB	< 0.0001
1000	31.56±12.85 dB	8.91±6.92 dB	< 0.0001
2000	21.72±9.38 dB	5.31±4.90 dB	< 0.0001
4000	30.31±10.15 dB	16.09±8.95 dB	< 0.0001
Average	28.91±8.73 dB	10.42±6.10 dB	< 0.0001

Table 3. PORP subgroups had a statistically signifcant better postoperative hearing result at 0.5 kHz, 4.0 kHz and average ($p<0.05$) (Mann Whitney U Test).

Frequency	Postoperative PTA-ABG (TORP) (n=13)	Postoperative PTA-ABG (PORP) (n=19)	p
500	16.15±8.45 dB	7.89±7.87 dB	< 0.05 (0.012)
1000	11.15±5.83 dB	7.37±7.33 dB	> 0.05 (0.080)
2000	7.31±5.63 dB	4.00±3.93 dB	> 0.05 (0.087)
4000	21.15±4.63 dB	12.63±9.62 dB	< 0.05 (0.012)
Average	14.02±4.16 dB	7.96±6.07 dB	< 0.05 (0.007)

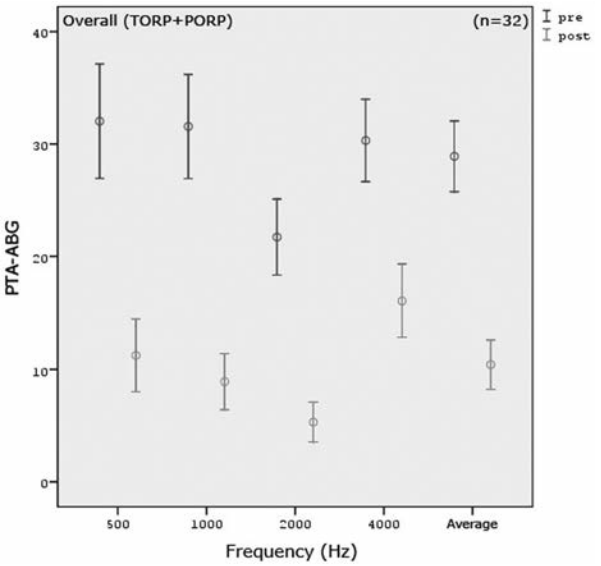

Figure 2. The overall (TORP+PORP) (n=32) pre-and postoperative four frequency PTA-ABG (p<0.0001) (Wilcoxon Signed Ranks Test).

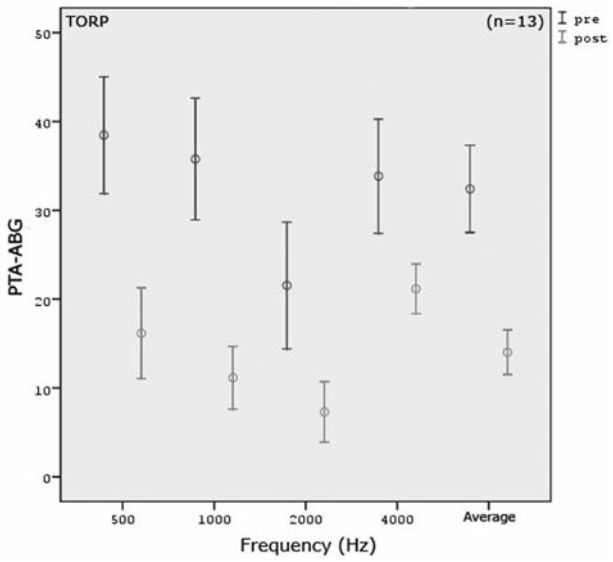

Figure 4. In the PORP subgroup (n=19), pre-and postoperative four frequency PTA-ABG (p<0.0001) (Wilcoxon Signed Ranks Test).

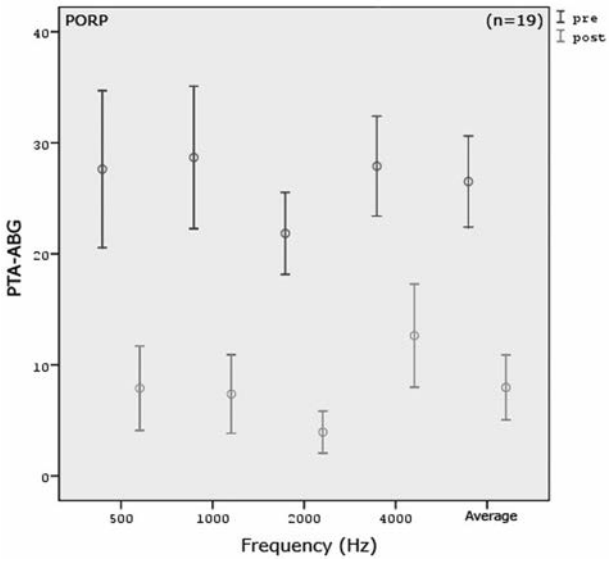

Figure 3. In the TORP subgroup (n=13), pre-and postoperative four frequency PTA-ABG (p<0.0001) (Wilcoxon Signed Ranks Test).

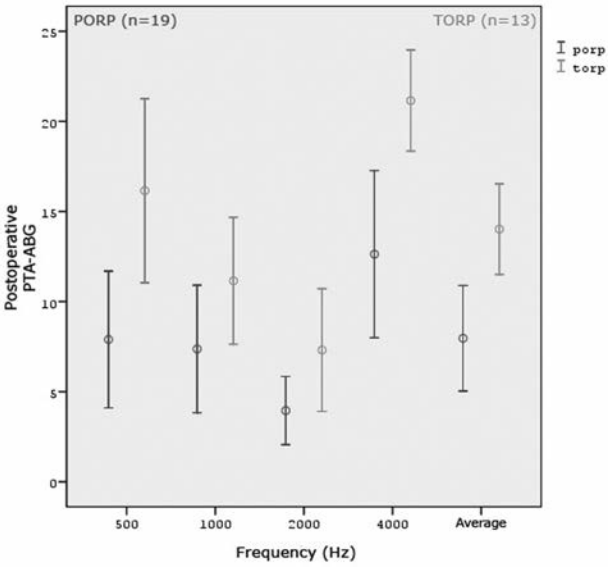

Figure 5. Comparision of the two groups, PORP subgroups had a statistically signifcant better postoperative hearing result at 0.5 kHz, 4.0 kHz and average (p<0.05) (Mann Whitney U Test).

removed under the surgical microscope and 2.7 mm 30° / 70°, oto-endoscopes are used for identifying any peroperative residual disease[8]. This minimally invasive surgical procedure, significantly decreases the frequency of canal wall down mastoidectomy and recourse to posterior tympanotomy with excellent access to cholesteatoma by the transmeatal approach[7,8,9]. Oto-endoscopy does not eliminate but reduces the risk of residual cholesteatoma [10].

Cartilage tympanoplasty has been well described for the management of the atelectatic retraction pockets, adhesive otitis and high risk perforations, either in chronic otitis media or in cholesteatoma with satisfactory anatomic and audiologic outcomes[11-14]. The stiffness of

the cartilage is resistant to the potential infections and to anatomic deformation caused by negative middle ear pressure[11,12]. Furthermore, many surgeons have found that the thickness of the cartilage does not impair the audiologic results[13-16].

Because of the pre- and peroperative risk factors have a significant effect on prognosis in tympanoplasty[17], we used the MERI. Of the 36 procedures, 23 (63.9%) were for chronic otitis media with cholesteatoma, 4 (11.1%) for chronic suppurative otitis media with polyp, 9 (25%) for adhesive otitis / retraction pocket with or without cholesteatoma. Six ears were diagnosed with combined presence of adhesive otitis and cholesteatoma. In this report, values of MERI were between 8-12 (severe disease).

The perichondrium - cartilage island graft and cartilage palisades graft with perichondrium on both sides, are two main types of perichondrium cartilage composite graft[18,19]. Mürbe et al reported that cartilage island grafts are suitable for improving the acoustic transmission characteristics of the reconstructed TM in the experimental study. They have recommended this technique for patients who has TM perforations with adequate surrounding membrane remnants[15]. Its acoustic properties are comparable to those of fascia[12].

Cartilage graft harvested from concha or tragus is easy to obtain and convenient for re-shaping according to the size of the perforation[3,12]. These grafts are nourished mainly by diffusion and become excellent incorporated in tympanic membrane. The donor area heals without significant deformity[11,16]. A potential drawback of cartilage tympanoplasty is the graft opacity and detection of the residual or recurrent cholesteatoma may be more difficult[12]. Nevertheles, as the cartilage island graft does not cover all parts of the tympanic membrane, residual or recurrent cholesteatoma is detectable[11]. However, the fascia is often not transparent[12].

In this study, tragal cartilage was used as a graft material in all cases. An insicion was made through the skin and cartilage on the medial side. Preparation of the perichondrium cartilage island graft is very easy and prolongs the operation time only to eight to ten minutes. Since 2 mm cartilage strip was left intact in the tragal dome, we have not observed any cosmetic problems related to tragal cartilage harvesting. The long process of the malleus was cleaned from epithelial remnants. Of the 36 procedures, after ICW mastoidectomy and 30° oto-endoscopic control (rarely 70°) of the sinus tympany, two different type 3 tympanoplasty were performed; placing cartilage island graft over the malleus and under the annulus (over-underlay technique) with TORP in 14 cases and with PORP in 22 cases.

Reevaluation of the patients should be performed with otoscopy and determination of a four-frequency PTA-ABG at least 12 months after surgery[1]. Dornhoffer reported the perforation closure rate for cartilage tympanoplasty as 95.8% in 215 high risk patients after four years of follow-up[6]. This rate was reported as 66.7% for type 3 tympanoplasty with cartilage reinforcement technique by Uslu et al [3]. Milewski (5 year follow up) and Evitar (one year follow up) achieved a 96.5% and 91.2% success closure rate in type 3 tympanoplasty respectively[11,20].

Sheehy and Glasscock reported the cholesteatoma recurrence rates as 5% and 14% respectively[2,18,21]. This rate was reported as 3.6% by Dornhoffer[6]. Cavaliere reported a 2.29% recurrence rate for cholesteatoma cases[12]. Bernal – Sprekelsen reported 2.2% recurrence cholesteatoma, and 2.5% retraction pockets[13].

The mean follow up period was 24.8 months (range, 12-48 months) in our study. Graft-take was achieved in 32 patients (88.9%). In remaining 4 patiets, there were two attic perforation with residual / recurrent cholesteatoma and two simple anterior perforations on follow-up otoscopic examination. Among the cholesteatoma cases, rate of the residual / recurrent disease were 6.9% (2/29). These results are consistent with the literature. As reported by Milewski[11], blunting or lateralization did not occur in our cases.

Cavaliere et al. repoted the overall mean pre- and postoperative (1 year after surgery) PTA-ABG as 43±7.07 dB and 10.43±5.25 respectively for cartilage type 3 tympanoplasty. In TORP (n=36) subgroup, pre- and postoperative PTA-ABG were reported as 53.89±3.19 dB and 14.25±7.27 dB. Whereas in PORP (n=40) subgroup, pre- and postoperative PTA-ABG were reported as 45.0±5.06 dB and 11.06±3.97 dB respectively[12]. Bernal – Sprekelsen reported the overall pre- and postoperative (54 months after surgery) four frequency PTA-ABG as 34.4 dB and 18.1 dB respectively. In the TORP group, pre- and postoperative PTA-ABG were reported as 40.5 dB and 19.4 dB respectively. In the PORP group, pre- and postoperative PTA-ABG were reported as 28.3 dB and 16.8 dB respectively[13].

In our study, the overall (n=32) pre-operative four frequency PTA-ABG was 28.91± 8.73 dB, whereas the postoperative (least 12 months after surgery) PTA-ABG was 10.42±6.10 ($p<0.0001$) (Wilcoxon Signed Ranks Test). In the TORP subgroup (n=13), pre- and postoperative PTA-ABG were 32.40±8.12 dB and 14.02±4.16 dB ($p<0.0001$) (Wilcoxon Signed Ranks Test). In the PORP subgroup (n=19), pre- and postoperative PTA-ABG were 26.51±8.51 dB and

7.96±6.07 dB respectively ($p<0.0001$) (Wilcoxon Signed Ranks Test). These results are consistent with the literature.

Although, advanced middle ear disease without stapes superstructure impairs the audiologic results, the influence of prosthesis type on audiologic outcomes continues to be controversial in the literature. Zenner et al reported that in their series better results were obtained in PORP group[22]. Contrary to this report, Neumann et al. reported better results in the TORP group[1]. Dornhoffer and Bernal – Sprekelsen reported no difference in the outcome between TORP and PORP[2,13]. In our study, comparision of the two groups, PORP subgroups had a statistically signifcant better psotoperative hearing result at 0.5 kHz, 4.0 kHz and average ($p<0.05$) (Mann Whitney U Test). Further studies with larger numbers of tympanoplasties are neccessary to investigate the influence of prosthesis type (TORP or PORP) on hearing results.

The results of this study represent relatively short-term follow-up and these preliminary anatomic and audiologic outcomes may change with time.

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References

1. Neumann A, Schultz-Coulon HJ, Jahnke K. Type III tympanoplasty applying the palisade cartilage technique: a study of 61 case. Otol Neurotol. 2003; 24:33-37.

2. Dornhoffer J. Cartilage tympanoplasty: Indications, techiques, and outcomes in a 1000 patients series. Laryngoscope 2003; 113:1844-1856.

3. Uslu C, Tek A, Tatlıpınar A, Kılıçaslan Y, Durmus R, Öğrendik EA, Karaman M, Oysu Ç. Cartilage reinforcement Tympanoplasty: otological and audiological results. Acta Oto-Laryngologica 2009; 26:1-9.

4. Liu Y, Sun JJ, Lin YS, Zhao DH, Zhao J, Lei F. Otoendoscopic treatment of hidden lesions in otomastoiditis. Chin Med J (Engl). 2010; 123:291-295.

5. Roger G, Denoyelle F, Chauvin P, Schlegel-Stuhl N, Garabedian EN. Predictive risk factors of residual cholesteatoma in children: a study of 256 cases. Am J Otol 1997; 18:550-558.

6. Dornhoffer J. Cartilage tympanoplasty: Indications, techniques, and outcomes in a 1000 - patient series. Laryngoscope 2003; 113:1844-1856.

7. Presutti L, Marchioni D, Mattioli F, Villari D, Alicandri-Ciufelli M. Endoscopic management of acquired cholesteatoma: our experience. J Otolaryngol Head Neck Surg. 2008; 37:481-487.

8. Good GM, Isaacson G. Otoendoscopy for improved pediatric cholesteatoma removal. Ann Otol Rhinol Laryngol. 1999;108:893-896.

9. Tarabichi M. Endoscopic management of cholesteatoma (Review) The Mediterranean Journal of Otology 2006; 3:143-155.

10. Ayache S, Tramier B, Strunski V. Otoendoscopy in cholesteatoma surgery of the middle ear: what benefits can be expected? Otol Neurotol. 2008; 29:1085-1090.

11. Milewski C.Composite graft tympanoplasty in the treatment of ears with advanced middle ear pathology.Laryngoscope. 1993; 103:1352-1356.

12. Cavaliere M, Mottola G, Rondinelli M, Iemma M. Tragal cartilage in tympanoplasty: anatomic and functional results in 306 cases. Acta Otorhinolaryngol Ital. 2009; 29:27-32.

13. 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.

14. Kalcioglu MT, Firat Y, Selimoglu E. Cartilage tympanoplasty with island technique; A comparison with the temporalis muscle fascia technique. Int. Adv. Otol. 2009; 5:45-50.

15. Mürbe D, Zahnert T, Bornitz M, Hüttenbrink KB. Acoustic properties of different cartilage reconstruction techniques of the tympanic membrane. Laryngoscope 2002; 112:1769-1776.

16. Kirazli T, Bilgen C, Midilli R, Ogut F. Hearing results after primary cartilage tympanoplasty with island technique. Otolaryngol Head Neck Surg 2005; 132:933-937.

17. Kartush JM, Michaelides EM, Becvarovski Z, LaRouere MJ. Over-under tympanoplasty Laryngoscope 2002; 112:802-807.

18. Glasscock ME 3rd, Jackson CG, Nissen AJ, Schwaber MK. Postauricular undersurface tympanic membrane grafting: a follow up report. Laryngoscope 1982; 92:718-722.

19. Adkins WY. Composite autograft for Tympanoplasty and tympanomastoid surgery. Laryngoscope 1990; 100:244-247.

20. Evitar A. Tragal perichondrium and cartilage in reconstructive ear surgery. Laryngoscope 1978; 88:1-23.

21. Sheehy JL. Personal experiences with TORPs and PORPs. A report on 455 operations. Am J Otol. 1985 Jan; 6(1):80-83.

22. Zenner HP, Stegmaier A, Lehner R, Baumann I, Zimmermann R. Open Tübingen titanium prostheses for ossiculoplasty: a prospective clinical trail. Otol Neurotol 2001; 22:582-589.