The Journal of International Advanced Otology

Int Adv Otol 2014; 10(1): 64–7 • DOI:10.5152/iao.2014.014

Original Article

Factors Affecting Success and Results of Cartilage–Perichondrium Island Graft in Revision Tympanoplasty

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OBJECTIVE: The chance of complete postoperative healing of the tympanic membrane is relatively low due to poor blood supply of the graft in patients who undergo revision tympanoplasty. The aim of this study is to assess postoperative healing and the factors affecting closure of the tympanic membrane and hearing gain after revision tympanoplasty with cartilage-perichondrium island graft.

MATERIALS and METHODS: This study was conducted as a retrospective review of charts of patients who underwent revision tympanoplasty with composite cartilage-perichondrium island graft at our clinic. Patients who underwent radical or modified radical mastoidectomy for the treatment of cholesteatoma and who had stapes fixation were excluded. All grafts were placed using over-under technique. Ossiculoplasty and mastoidectomy were performed as needed. Closure of the tympanic membrane and hearing thresholds were evaluated at the end of postoperative year 1.

RESULTS: Thirty-three cases, 14 females and 19 males with mean age 37.5±12.7, were included in the study. Ossiculoplasty was performed in 8 cases, and mastoidectomy was added to tympanoplasty in 12 cases. Tympanic membrane was intact in 29 cases (87.4%) in the 12th postoperative month. Large perforation, adhesive tympanic membrane, and especially hypertrophic middle ear mucosa were found to have negative impact on success of graft ($p<0.01$). The success of graft in patients with mastoidectomy was lower than without mastoidectomy ($p<0.001$). Age ($p=0.491$), gender ($p=0.567$), surgical approach ($p=0.378$), and the number of operations ($p=0.283$) did not contribute to the success of the graft. Average improvement of postoperative air conduction hearing threshold was 13.2±5.5 dB, and average decrease in air bone gap was 11.7±5.5 dB.

CONCLUSION: Postoperative closure rate of the tympanic membrane was high and audiologic improvement was satisfactory with cartilage-perichondrium island graft in revision tympanoplasty. Cartilage-perichondrium island graft may be preferred for reconstruction of the tympanic membrane because of its resistance to inflammation and poor feeding in revision tympanoplasty.

KEY WORDS: Cartilage, graft survival, tympanoplasty

INTRODUCTION

Treatment of recurrent tympanic membrane perforation or adhesion is more difficult than primary surgery. Temporal muscle fascia graft is usually preferred for primary surgical care in tympanoplasty. The success rate of tympanoplasty with temporal fascia graft is higher than 80% [1-3]. Failure in tympanoplasty may be due to a variety of reasons, such as properties of the graft used, operation technique, or patient-related reasons [4, 5]. It is reported that factors, like ear atelectasis, Eustachian tube dysfunction, tympanosclerosis, active suppuration, condition of middle ear mucosa, wide perforation, and revision myringoplasty, are the reasons for low success rates in the use of temporal fascia [3, 6, 7].Temporal muscle fascia graft is of poor stability, because it contains connective fibrous tissue with irregular elastic fibers [7]. Otherwise, cartilage or composite cartilage grafts are more resistant to infections, middle ear pressure, and lack of capillary feed. Therefore, it can be preferred in revision tympanoplasty in which the risk of perforation or retraction is higher [4, 5, 6, 8, 9].

Despite the many surgical techniques described for tympanoplasty, overlay and underlay techniques are widely used [10-12]. Overlay technique is used less frequently due to the need of experience, longer operation duration, risk of blunting, and higher risk of cholesteatoma. Regardless of the technique used, in the postoperative period of graft membrane in revision tympanoplasty, the closure is harder due to tissue malnutrition. The aim of this study is to assess the postoperative healing and the factors contributing to success for closure of the tympanic membrane and hearing gain after revision tympanoplasty with cartilage-perichondrium island graft.

MATERIALS and METHODS

The research protocol was submitted and approved by the Mugla Sıtkı Kocman University Ethics Committee (2013-170). Informed consent was provided by all patients and/or parents of patients. Patients that had undergone revision tympanoplasty with cartilage-

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Submitted: 12.10.2013 **Revision Received:** 15.01.2014 **Accepted:** 19.02.2014

perichondrium island graft in our clinic between January 2009 and August 2012 were included to the study. Required information was obtained with retrospective review of patients' charts. Patients with radical or modified radical mastoidectomy due to cholesteatoma and with stapes fixation were excluded from the study. Endaural or postauricular approaches were preferred, according to the external ear canal anatomy or location of perforation. In the postauricular approach, conchal cartilage-perichondrium graft was used, and in the endaural approach, tragal cartilage-perichondrium graft was preferred. The morphology of the preoperative tympanic membrane (perforation or adhesive) and the size of perforation (if smaller than 50% of the tympanic membrane central, small; if larger than 50% subtotal, large) were classified. The middle ear mucosa was classified as hypertrophic, normal, and sclerotic. Basic mastoidectomy was added to the procedure in cases with purulating discharge from the tympanum and hypertrophic tympanic mucosa on the preoperative otoscopic exam and in cases with soft tissue density of the antrum or mastoid cells on the temporal bone CT. In patients with eroded incudostapedial joint, interposition of the incus and ossiculoplasty were performed. Postoperative follow-up was performed on the 1st, 3rd, and 6th months and at the end of the 1st year. According to the otoscopic exam at the end of the 1st year, the membrane was classified as intact, retracted, or perforated. Closure of the membrane at the end of the 1st year was accepted as morphological success. Audiological tests were performed with 0.5-4 KHz on the 3rd and 6th months and at the end of the 1st year.

Statistical Analysis

Data at the end of 1st year were used for statistical study. SPSSv15 was used to analyze the data. Statistical analysis included mean value, percent, and chi-square test. Significance was determined by a 'p' value less than 0.05.

RESULTS

All previous surgical procedures were performed with postauricular approach using a temporal fascia graft. Of the 33 patients included in the study, 14 (42.4%) were female and 19 (57.6%) were male with mean age 37.5±12.7 (15-52). Six (18.2%) of the patients had their third surgery, 27 (81.8%) patients had their second surgery; postauricular approach was used on 22 (66.7%) ears, and endaural approach was used on 11 (33/3%) patients. In 8 (24.2%) of the patients, the incudostapedial joint was eroded and ossiculoplasty was performed. In the preoperative evaluation, the tympanic membrane of 19 (57.6%) patients was subtotally (large) perforated, centrally (small) perforated in 8 (24.2%) patients, and adhesive in 6 (18.2%) patients. The middle ear mucosa was found to be normal in 16 (48.5%) patients, sclerotic in 9 (27.3%) patients, and hypertrophic in 8 (24.2%) patients (Table 1). Mastoidectomy was performed in 12 (36.4%) patients.

The postoperative evaluation of 6 patients with preoperative adhesive tympanic membrane showed intact tympanic membrane; however, 5 were retracted. On the postoperative evaluation of 19 patients with subtotal perforation (large perforation), 15 were intact and 4 were perforated. On the postoperative evaluation of 8 membranes with preoperative central perforation, the membranes were intact. The preoperative and postoperative tympanic membrane conditions were found to be statistically significant and related ($p<0.001$; Table 2). In patients with preoperative central membrane perforation, the success rate of closure was 100% and 78.9% in patients with subtotal perforation, and in those with adhesive membrane, the success rate was 100%. Overall closure of tympanic membrane success rate was 87.9%.

On the evaluation of preoperative morphologic condition of the middle ear mucosa with postoperative state of the tympanic membrane, of 8 patients with hypertrophic mucosa, 1 had intact tympanic membrane, 4 had retracted, and 3 had perforated; of 16 patients with normal mucosa 15 had intact tympanic membrane, 1 had perforated; and of 9 patients with mucosal sclerosis, 8 were intact and 1 retracted. The preoperative middle ear mucosa and postoperative tympanic membrane conditions were found to be statistically significant and related ($p<0.001$; Table 3). The success rate for postoperative membrane closure was 62.5% in hypertrophy, 93.8% in normal membrane, and 100% in sclerosis.

On the evaluation of patients who underwent mastoidectomy, postoperative conditions of tympanic membranes were retracted in 5, intact in 4, and perforated in 3. Postoperative tympanic membrane conditions that underwent mastoidectomy or not were found to be statistically significant ($p<0.001$). The success rate of postoperative membrane closure was 75% in mastoidectomy and 95.2% without mastoidectomy.

No statistically significant were age ($p=0.491$), gender ($p=0.567$), surgical approach ($p=0.378$) and number of operations ($p=0.283$) with postoperative tympanic membrane conditions.

No patient had disturbance of hearing on the postoperative audiologic evaluation. However, 2 patients had no improvement. Overall evaluation of preoperative mean airway threshold decreased from

Table 1. Findings of tympanic membrane and mucosa in the preoperative evaluation

Condition of tympanic membrane		Condition of middle ear mucosa	
Subtotal perforation	19 (57.6%)	Normal	16 (48.5%)
Central perforation	8 (24.2%)	Hypertrofic	8 (24.2%)
Adhesive	6 (18.2%)	Sclerotic	9 (27.3%)

Table 2. Preoperative and postoperative morphologic condition of tympanic membrane

		Condition of tympanic membrane in Postoperative Period			
		Intact	Perforated	Retracted	Total
Condition of tympanic	Adhesive	1	0	5	6 (18.2%)
membrane in	Subtotal perforation	15	4	0	19 (57.6%)
Preoperative Period	Central Perforation	8	0	0	8 (24.2%)
Total	24 (72.2%)	4 (12.1%)	5 (15.2%)	33 (100%)	

Table 3. Comparison of the middle ear mucosa with postoperative morphologic condition of tympanic membrane

		Condition of tympanic membrane in Postoperative Period			
		Intact	Perforated	Retracted	Total
Condition of Middle Ear	Hypertrofic	1	3	4	8 (24.2%)
Mucosa in Preoperative	Normal	15	1	0	16 (48.5%)
Period	Sclerotic	8	0	1	9 (27.3%)
Total		24 (72.2%)	4 (12.1%)	5 (15.2%)	33 (100%)

34.4±9.9 dBs to 21.2±7.8 dBs (13.2±5.5 dBs mean improvement), and air-bone gap decreased from 24.5±7.2 dBs to 12.8±5.6 dBs (11.7±5.5 mean ABG closure). Pre- and postoperative air-bone gap changes were found to be statistically significant ($p<0.001$), and hearing data are summarized on Table 4.

Table 4. Pre and postoperative hearing evaluation

	Mean Hearing Threshold (dB HL)±Standard Deviation
Preoperative Air Conduction Threshold	34.4±9.9
Postoperative Air Conduction Threshold	21.2±7.8
Preoperative Air-bone Gap	24.5±7.2
Postoperative Air-bone Gap	12.8±5.6

DISCUSSION

The main purpose of tympanoplasty is to close the tympanic membrane, thus protecting the middle ear from infections and improving the hearing. In different literatures, the rate ranges between 75-98% [1-3, 6]. Factors affecting the success rate of surgery are age, localization and size of perforation, the condition of middle ear mucosa, the function of the Eustachian tube, the type of graft used, and surgical experience [2, 6, 13]. All of the patients in our study were operated by the same surgeon, and the same graft kind and surgical technique were used in order to standardize these variables as much as possible.

The success rates of revision and primary tympanoplasty are similar according to many studies [4, 5, 8, 14]. The safety and functionality of the tympanic membrane depend on the free airflow in the middle ear and mastoid cells. The airflow from the temporal bone to the antrum in humans occurs between the tendon of the tensor tympani muscle and the stapes or the short arm of the incus and the tendon of stapes [11]. Even if suppuration is not present in the middle ear, granulation, edema, or inflammation obstructs these aeration pathways, leading to pathological changes in the antral or mastoid mucosa or the bone. Da Costa and Paparella found out that of 116 tympanic perforation cases, ossicle changes developed in 96% of granulation tissue and 36% had tympanosclerotic changes of the temporal bone [15]. These structural changes can be more commonly found in cases with tympanoplasty. Lesinkas [16]. reported that tympanosclerosis and ossicle pathologies (fixation, adhesion, erosion) are found in 29.5% on the first surgery and in 63.4% on revision. Hypertrophic or wet look of the middle ear mucosa should raise suspicion of active inflammation, secretory middle ear, or Eustachian tube dysfunction [17, 18]. These findings may decrease the success rates of revision tympanoplasty. In our case series, 6 (18.2%) patients had their third operation and all others had a second ear operation, in which 8 (24.2%) had ossicle pathologies and 9 (27.3%) had tympanoslcerotic changes. The number of operations did not affect the closure of the tympanic membrane ($p=0.283$). The tympanic membrane of 29 (87.4%) patients was closed on the postoperative period. However, in 8 (24.2%) of the cases with hypertrophic middle ear mucosa, 3 had a perforated graft and 4 had retracted, and of 6 (18.2%) cases with preoperative adhesive tympanic membrane, the graft was retracted in 5. These conditions may be interpreted as progress of the middle ear disease or that the middle ear mucosa mainly determines the success of the graft. Success of graft in tympanosclerosis or adhesive otitis media (atelectatic ear) is known to be low [3, 4, 16, 19]. In our all failure cases, the perforation was small and due to malposition of cartilage. Graft failure in 1 of the 15 patients with normal middle ear mucosa might have resulted from subtotal perforation or graft malposition. However, it can not say that graft success rate in ears with sclerosis is high, because this study contains a limited number of cases. Even if cartilage is used for tympanoplasty in the adhesive ear, retraction may develop at different rates [4]. To prevent the development of retraction, tube insertion could be performed intraoperatively or postoperatively. Dornhoffer reported that the rate of tube insertion in cartilage tympanoplasty was higher in adhesive ears (10.4% of all cases, 19.1% of adhesive ears) [4].

In some studies, it is reported that the dimension of perforation does not affect the success of closure [13, 16, 17]. According to some studies, the localization of perforation affects the graft success more [2, 19]. Especially, anterior perforations affect the graft negatively because of difficulty in surgical manipulation and weak capillary feed. Bhat [19] reported the success rate of closure as 90% in posterior and inferior perforations and 67% in anterior perforations. Westerberg [2] has also emphasized the surgical exposure, reporting the postauricular approach as more successful in membrane closure rates (97% in postauricular approach, 77% in endaural or transcanal approach). In our study, surgical approach ($p=0.378$) did not affect closure of the tympanic membrane; however, it is remarkable that the middle ear mucosa was hypertrophic in 3 of 4 patients with unsuccessful graft. It may be considered that these differences arise from ear mucosa disease and not from the perforation dimensions.

It is known that age and sex differences do not affect the closure of tympanic membrane [3, 5, 13, 17]. In elderly patients, the mental state and metabolic (diabetes mellitus) and cardiovascular diseases are more important than the age, whereas in children (especially in those younger than 6 years of age), the risk of perforation or retraction is related to underdeveloped immunity, serous otitis media, and recurring middle ear infections [9, 20]. Furthermore, the small middle ear structure and narrow external ear canal lower the success of tympanoplasty [20]. Our patients were between 15 and 52 years of age. In the literature research, only in Lin's [13] study was the success rate of graft in males 78% and 95% in females. This difference was related

to higher tobacco use by males. In the same study, the success rate of graft in tobacco users was reported as 63% and 93% in non-users.

The contribution of mastoidectomy to the success rate of tympanoplasty is still arguable. Some studies advocate that especially in revision tympanoplasty, the success rate of the graft can be increased by adding mastoidectomy [21]. However, there are studies advocating that in tympanoplasty in which cartilage graft is used, adding mastoidectomy does not affect the success rate of the graft and gain in hearing [3, 5, 16, 22]. In our case series, antrum and mastoid aeration disorders were detected on the temporal CT of 12 (36.4%) patients, and mastoidectomy was added to the surgery. The postoperative healing of the tympanic membrane was found to be worse in patients with mastoidectomy. This finding was statistically significant. Even if mastoidectomy is undergone, this difference can be interpreted as due to the continuation of the middle ear mucosal disease and mastoid aeration disorder.

In conclusion, the use of cartilage in tympanoplasty has been known for many years; however, because of the doubt of the negative effect on sound conduction, it is not used [3, 4, 6]. Yet, many studies have shown that there is no difference in the use of cartilage or fascia in morphological or hearing aspects [3, 5, 6, 23]. Even studies reporting better hearing results in tympanoplasty with cartilage are present [22]. In our study, no patient had postoperative deterioration of hearing. However, in 2 of our patients, the hearing did not improve. Overall, postoperative audiologic evaluations of hearing improvement were satisfactory.

In conclusion, the postoperative closure rate of tympanic membrane was high and audiologic improvement was satisfactory with cartilage-perichondrium island graft in revision tympanoplasty. Perichondrium-cartilage grafts can be preferred in reconstruction of tympanic membranes because of their resistance to poor feeding, recurring infections, and retractions.

Ethics Committe Approval: Ethics committee approval was received for this study from the ethics committee of Muğla Sıtkı Koçman University / 2013-170.

Informed Consent: Written informed consent was obtained from patients and parents of the patients who participated in this study.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept - M.Ş., S.D.; Design - M.Ş., S.D.; Supervision - M.Ş.; Materials - M.Ş., Ö.S.; Data Collection and/or Processing - S.D., N.Ç., L.Ş.; Analysis and/or Interpretation - M.Ş., S.D., Ö.S.; Literature Review - M.Ş., L.Ş., Ö.S.; Writing - M.Ş., M.D., S.D.; Critical Review - M.Ş., M.D.

Acknowledgements: The authors thank to Dr. Ömer Faruk Tekbaş for statistical analysis of this study.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study has received no financial support.

REFERENCES

1. Sheehy JL, Anderson RG. Myringoplasty. A review of 472 cases. Ann Otol Rhinol Laryngol 1980; 89: 331-4.
2. Westerberg J, Harder H, Magnuson B, Westerberg L, Hydén D. Ten-year myringoplasty series: does the cause of perforation affect the success rate? J Laryngol Otol 2011; 125: 126-32. [CrossRef]
3. Callioglu EE, Tijen Ceylan B, Kuran G, Demirci S, Tulaci KG, Caylan R. Cartilage graft or fascia in tympanoplasty in patients with low middle ear risk index (anatomical and audological results). Eur Arch Otorhinolaryngol. 2013; 270: 2833-7. [CrossRef]
4. Dornhoffer JL Cartilage tympanoplasty: indications, techniques, andoutcomes in a 1,000 patient series. Laryngoscope 2003; 113: 1844-56.
5. Boone RT, Gardner EK, Dornhoffer JL. Success of cartilage grafting in revision tympanoplasty without mastoidectomy. Otol Neurotol 2004; 25: 678-81. [CrossRef]
6. Mohamad SH, Khan I, Hussain SS. Is cartilage tympanoplasty more effective than fascia tympanoplasty? A systematic review. Otol Neurotol 2012; 33: 699-705. [CrossRef]
7. Indorewala S. Dimensional stability of free fascia grafts: a humanstudy. Laryngoscope 2004; 114: 543-7. [CrossRef]
8. Altuna X, Navarro JJ, Algaba J. Island cartilage tympanoplasty in revision cases: anatomic and functional results. Eur Arch Otorhinolaryngol 2012; 269: 2169-72. [CrossRef]
9. Ozbek C, Ciftçi O, Tuna EE, Yazkan O, Ozdem C. A comparison of cartilage palisades and fascia in Type 1 tympanoplasty in children: anatomic and functional results. Otol Neurotol 2008; 29: 679-83. [CrossRef]
10. Tos M. Cartilage tympanoplasty methods: proposal of a classification. Otolaryngol. Head Neck Surg 2008; 139: 747-58. [CrossRef]
11. Charles William Cummings, Bruce H. Haughey, M.D., J. Regan Thomas, Lee A. Harker. Cummings Otolaryngology: Head and neck surgery, 4th editon, Philadelphia: Elsevier Mosby; 2005.p.3058-73.
12. Anand TS, Kathuria G, Kumar S, Wadhwa V, Pradhan T. Butterfly inlay tympanoplasty: A study in Indian scenario. Indian J Otolaryngol Head Neck Surg 2002; 54: 11-3.
13. Lin YC, Wang WH, Weng HH, Lin YC. Predictors of surgical and hearing long-term results for inlay cartilage tympanoplasty. Arch Otolaryngol Head Neck Surg 2011; 137: 215-9. [CrossRef]
14. Yung M, Vivekanandan S, Smith P. Randomized study comparing fascia and cartilage grafts in myringoplasty. Ann Otol Rhinol Laryngol 2011; 120: 535-41.
15. Da Costa SS, Paparella MM, Schachern PA, Yoon TH, Kimberley BP. Temporal bone histopathology in chronically infected ears with intactand perforated tympanic membranes. Laryngoscope 1992; 102: 1229-36. [CrossRef]
16. Lesinskas E, Stankeviciute V.Results of revision tympanoplasty for chronic non-cholesteatomatous otitis media. Auris Nasus Larynx 2011; 38: 196-202. [CrossRef]
17. Noh H, Lee DH. Vascularisation of myringo-/tympanoplastic grafts in active and inactive chronic mucosal otitis media: a prospective cohort study. Clin Otolaryngol 2012; 37: 355-61. [CrossRef]
18. Webb BD, Chang CY Efficacy of tympanoplasty without mastoidectomy for chronic suppurative otitis media. Arch Otolaryngol Head Neck Surg 2008; 134: 1155-8. [CrossRef]
19. Bhat NA, De R. Retrospective analysis of surgical outcome, symptom changes, and hearing improvement following myringoplasty. J Otolaryngol 2000; 29: 229-32.
20. Boronat-Echeverría NE, Reyes-García E, Sevilla-Delgado Y, Aguirre-Mariscal H, Mejía-Aranguré JM. Prognostic factors of successful tympanoplasty in pediatric patients: a cohort study. BMC Pediatr 2012; 12; 12: 67.
21. Ruhl CM, Pensak ML. Role of aerating mastoidectomy in noncholesteatomatous chronic otitis media. Laryngoscope 1999; 109: 1924-7. [CrossRef]
22. Yetiser S, Hidir Y. Temporalis fascia and cartilage-perichondrium composite shield grafts for reconstruction of the tympanic membrane. Ann Otol Rhinol Laryngol 2009; 118: 570-4.
23. Demirpehlivan IA, Onal K, Arslanoglu S, Songu M, Ciger E, Can N. Comparison of different tympanic membrane reconstruction techniques in Type I tympanoplasty. Eur Arch Otorhinolaryngol 2011; 268: 471-4. [CrossRef]