

The wheel-shaped composite cartilage graft for type 1 tympanoplasty: Comparison with palisade and island cartilage graft.

Ejder Çiğer¹, Akif İşlek², and Mustafa Yazır³

¹Izmir Katip Celebi University

²Nusaybin State Hospital

³Izmir Katip Celebi Universitesi

March 30, 2022

Abstract

Objectives: This study aims to compare the graft success and hearing results of the palisade and island cartilage graft, with a new wheel-shaped composite cartilage graft for type 1 tympanoplasty. **Design:** The study was designed retrospectively. **Setting:** The study was conducted at Katip Celebi University, Ataturk Training and Research Hospital, Otolaryngology-Head & Neck Surgery Clinic. **Participants:** Only patients with conductive hearing loss and simple pars tensa perforation of the tympanic membrane were included in the study. **Main outcome measures:** Pure tone average (PTA), air-bone gap gain (ABG), word recognition score (WRS), ABG closure and grafts success were compared between the graft groups. **Results:** Records of 111 patients were analyzed. The graft success rate was 89.7% for palisade cartilage graft (PCG, n= 39), 86.1% for island cartilage graft (ICG, n=36), and 97.2% for wheel-shaped composite cartilage graft (WsCCG, n= 36) (p=0.244). Average postoperative PTA and ABG values were significantly affected by the cartilage graft type, but WRS was not affected. (p = 0.005, 0.019, 0.306, respectively, One Way-Anova test). Post-Hoc LSD test showed a statistically significant decrease in PTA and ABG averages for WsCCG group compared to the ICG group (p= 0.004; CI%95= 15.1-2.2 dB and p= 0.023; CI%95= 8.2-0.4 dB, respectively). Postoperative PTA and ABG averages for WsCCG and PCG groups were similar (p= 0.069 and p=0.053, respectively). In addition, while there were 2 (5.1%) retractions in the PCG group and 1 (2.7%) in the ICG group, there was no retraction in the WsCCG group. **Conclusion:** The WsCCG provided comparable results with classical reliable graft techniques (PCG and ICG) and may recommend as a more suitable graft due to hearing results and resistance against retraction.

The wheel-shaped composite cartilage graft for type 1 tympanoplasty: Comparison with palisade and island cartilage graft.

Abstract

Objectives: This study aims to compare the graft success and hearing results of the palisade and island cartilage graft, with a new wheel-shaped composite cartilage graft for type 1 tympanoplasty.

Design: The study was designed retrospectively.

Setting: The study was conducted at Katip Celebi University, Ataturk Training and Research Hospital, Otolaryngology-Head & Neck Surgery Clinic.

Participants: Only patients with conductive hearing loss and simple pars tensa perforation of the tympanic membrane were included in the study.

Main outcome measures: Pure tone average (PTA), air-bone gap gain (ABG), word recognition score (WRS), ABG closure and grafts success were compared between the graft groups.

Results: Records of 111 patients were analyzed. The graft success rate was 89.7% for palisade cartilage graft (PCG, n= 39), 86.1% for island cartilage graft (ICG, n=36), and 97.2% for wheel-shaped composite cartilage graft (WsCCG, n= 36) (p=0.244). Average postoperative PTA and ABG values were significantly affected by the cartilage graft type, but WRS was not affected. (p = 0.005, 0.019, 0.306, respectively, One Way-Anova test). Post-Hoc LSD test showed a statistically significant decrease in PTA and ABG averages for WsCCG group compared to the ICG group (p= 0.004; CI%95= 15.1-2.2 dB and p= 0.023; CI%95= 8.2-0.4 dB, respectively). Postoperative PTA and ABG averages for WsCCG and PCG groups were similar (p= 0.069 and p=0.053, respectively). In addition, while there were 2 (5.1%) retractions in the PCG group and 1 (2.7%) in the ICG group, there was no retraction in the WsCCG group.

Conclusion: The WsCCG provided comparable results with classical reliable graft techniques (PCG and ICG) and may recommend as a more suitable graft due to hearing results and resistance against retraction.

Key Words: Chronic otitis media; Cartilage graft; Tympanoplasty; Wheel-shaped composite cartilage graft; Palisade cartilage; Island cartilage.

Objectives

The primary aim and an important step in chronic otitis media (COM) surgery are to repair the tympanic membrane (TM) [1]. The two most widely used graft materials in tympanoplasty are temporal fascia (TF) and cartilage graft (CG), and it is now recognized that graft performance and hearing outcomes are comparable, but CG is superior in ears with poor prognostic features [1, 2]. Tos reviewed 23 different cartilage tympanoplasty methods according to the indications in 2008 [3]. New cartilage graft designs with successful results continue to report in the literature due to the easy harvesting and application of cartilage grafts [4, 5]. Cartilage graft techniques, different designs, and indications were discussed in two comprehensive systematic review by Tos and Yung [3, 6]. Studies involving new cartilage graft techniques in the literature are mostly in the form of case-control studies or technical reports, and multiple comparative analyzes are very rare. WsCCG technique is a new modification and designed to adapt to tympanic membrane structure and avoiding retraction pockets. Successful results of the WsCCG according to the TF graft technique have been reported previously [5]. Therefore, this research aims to compare the graft success and audiological results of the most experienced and valid techniques (palisade cartilage graft: PCG and island cartilage graft: ICG) with the wheel-shaped composite cartilage graft (WsCCG) method.

Design

The study was designed retrospectively. This study was reported according to STROBE guideline recommendations.

Setting

The study was conducted at Katip Celebi University, Atatürk Training and Research Hospital, Otolaryngology-Head & Neck Surgery Clinic.

Participants

Patients who underwent type-1 tympanoplasty due to COM between January 2013 - December 2018 enrolled in the study. Only patients with conductive hearing loss and simple pars tensa perforation of the tympanic membrane were included in the study. Patients with PCG, ICG, and WsCCG grafts, patients older than 18 years of age, patients with air conduction threshold less than 50 dB, and patients with bone conduction threshold less than 20 dB were included in the research. Also, the patients aged < 18 years old, patients with cholesteatoma, tympanosclerosis, an ossicular chain defect, bilateral chronic otitis media, adhesive otitis or retraction pockets, pars flaccida perforations, total or subtotal perforations were eliminated.

Main outcome measures

The type of cartilage graft used for type 1 tympanoplasty, the preoperative and postoperative audiometry results (pure-tone average: PTA, air-bone gap: ABG, word recognition score: WRS, air-bone gap closure), the graft's success, the demographic characteristics of the patients, and the follow-up period were recorded. PTA, ABG, WRS, ABG closure and grafts success were compared between the graft groups.

Grafts

Grafts were harvested from conchal or tragal cartilage during operation. PCG: It consists of the full fold and 2 mm wide sliced cartilages and its length can be adjusted according to perforation. Perichondrium was preserved only lateral side. ICG: It contains layers of cartilage islands on the perichondrium. WsCCG; A wheel-shaped graft material including four island cartilage units and an asymmetric groove for manubrium mallei (Figure 1, Image 1).

Statistical Analysis

The findings analyzed by the SPSS 22.0 (SPSS Inc., Armonk, NY) software system Normality assumption was measured by the Kolmogorov Smirnov test. Categorical variables were compared with chi-square test, and scale variables were compared with One Way Anova test. Finally, a multivariate analysis was performed to research the effect of cartilage groups on postoperative average of PTA, ABG, and ABG closure.

Results

Records of 165 type-1 tympanoplasty cases operated with PCG, ICG, and WsCCG were obtained and 111 patients included final analysis according to inclusion criteria. 58 (52.3%) of the patients were female and 53 (47.7%) were male. The mean age was 33.3 ± 14.9 years for all patients. 39 patients (35.1%) with PCG, 36 (32.4%) patients with WsCCG and 36 (32.4%) patients with ICG were included in the study groups. The graft success rate was 91.0% in all patients at the end of 30.6 ± 10.1 (min: 26 max: 44) months of follow-up. PTA was 33.0 ± 7.2 dB, ABG was 22.7 ± 6.6 dB and the word recognition score (WRS) was $94.5 \pm 6.6\%$ in all patients preoperatively. The Kolmogorov Smirnov test showed that preoperative variables were normally distributed in all three cartilage graft groups ($p > 0.05$). According to the OneWay Anova test, there was no statistically significant difference between age, preoperative PTA, ABG, WRS and follow-up times (Table 1).

There was no significant relationship between graft success and graft type ($p = 0.224$, χ^2 test). (Table 2). A statistically significant decrease for PTA and ABG means and a significant increase for WRS means were detected after the surgery ($p = 0.000$, 0.004 , 0.049 , respectively, t-test). Average of postoperative PTA and ABG closure were significantly affected by the cartilage graft type, but WRS values was not affected by the cartilage graft type ($p = 0.005$, 0.019 , 0.306 , respectively, OneWay-Anova test) (Table 3). Post-Hoc tests showed a statistically significant decrease in PTA and ABG closure for WsCCG group compared to the ICG group ($p = 0.004$; CI = 15.1 - 2.2 dB and $p = 0.023$; CI = 8.2 - 0.4 , respectively). Postoperative PTA and ABG averages for WsCCG and PCG groups were similar ($p = 0.069$ and $p = 0.053$, respectively). Multiple comparisons of the graft groups for postoperative PTA, ABG closure were given in Table 4. However, according to the multivariate analysis, the postoperative PTA, ABG closure, WRS, and the graft success are not affected by the type of cartilage graft ($p = 0.647$, 0.799 , 0.232 , 0.377 respectively).

Two of four failure cases were retractions development between cartilage slices in the PCG group. One of the graft failures was due to retraction, and four were marginal perforations in the ICG group. One graft failure in WsCCG group was perforation at the anterior margin of TM.

4. Discussion

The two most widely used graft materials in tympanoplasty are temporal fascia (TF) and auricular cartilage and the popularity of the cartilage graft has been increasing in recently [1, 2]. PCG and ICG are popular graft types that have long been used for TM repair in cartilage tympanoplasty. Dornhoffer [7] reported an analysis including 1000 cases of tympanoplasty using ICG and PCG (conchal and tragal cartilage) in 2003 and calculated the perforation rate as 4.2% ($n = 9$) during an average of 12 months follow-up with 215 patients

who were operated for pure TM perforation. This study included revision cases, children, and adults. The average preoperative ABG was found to be 21.7 ± 13.5 dB, and 11.9 ± 9.3 dB at the end of the follow-up ($p < 0.05$). In this study, atelectasis occurred as a complication in during follow up [7]. The technique of PCG (conchal cartilage) and the indications have been identified for the first time in the literature by Heerman et al. [8]. The PCG is divided into groups according to their thickness as a slice or strip and also combined with fascia [3]. Khan and Parab [9] observed graft failure in 5 (2.3%) cases after 4 years of follow-up in 223 cases of primary tympanoplasty with PCG (conchal cartilage). In the same study, perforation was not detected in patients with small perforations (perforation $< 50\%$ of TM), while all 5 graft failures were detected in 154 (3.2%) patients with large perforations (perforation $> 50\%$ of TM). The mean of preoperative ABG was 30.6 ± 4.7 dB and 7.1 ± 3.0 dB after four years of follow-up. In this study, the perichondrium of the cartilage slices was preserved and no retraction was detected postoperatively [9]. Velepik et al. [10] identified graft defects in 14 (25%) of 51 patients (9 children and 42 adults) who underwent tympanoplasty with PCG (conchal cartilage) and also detected perforation in 2 patients (3.5%) in 11 years of follow-up. In this study, the indication was reported as total tympanic membrane (TM) perforation in 38 patients (68%), and retraction and cholesteatoma were reported in other patients. The mean preoperative ABG was found to be 27.2 ± 10.2 and 10.7 ± 7.8 dB after 11 years. PCG has applied with perichondrium on both sides of the palisades and cartilage resorption was detected in 14 (25.0%) patients in this study [10]. Kazikdas et al. [11]. reported a high success rate as 95.7% for PCG. In this study, the preoperative PTA was 31.4 ± 10.7 , and 22.4 ± 12.0 dB at the end of 18.7 months of follow-up, and the mean decrease in ABG was recorded as 8.3 dB. Perichondrium was preserved only on the lateral side of the cartilage in this study and retraction was not reported [11]. A similar study reported the graft success rates as 97% ($n=34$) and 78% ($n=19$) in ICG (conchal cartilage) and PCG (tragal cartilage) graft groups respectively [12]. According to audiological results, the average ABG decreased to 11.9 dB and 15.2 dB, respectively. Similarly, PCG was prepared with one-side perichondrium, and retraction was not mentioned [12]. Vashishth et al. [13] compared PCG with the temporal fascia graft for TM perforation and reported 90% graft success for PCG after one-year follow-up. The mean of PTA was determined as 29 ± 6.21 dB preoperatively and 7.33 ± 3.88 dB after surgery. An average ABG decrease of 21.6 ± 6.7 dB was recorded and retraction was not detected [13]. Jeffery et al. [14] calculated the weighted average graft take rate for PCG in type-1 tympanoplasty as 96% and the average postoperative ABG closure as 20.9 dB in a systematic meta-analysis. It was also discussed in this review that while postoperative complications are usually listed the only perforation but subgroups are not detailed, and follow up periods approximately 12 months [14]. In this study, the mean of postoperative PTA was 24.5 ± 9.7 dB and ABG closure was 7.5 ± 7.0 dB in the PCG group and results were similar to the literature. Also, we found that retraction developed between cartilage slices in two of the four failure case in the PCG group.

Island cartilage graft (ICG) was used for similar indications and has been described as a composite graft on the perichondrium containing different numbers of independent cartilage islands in different shapes [3, 6]. Dornhoffer [15] presented the results of 22 type-1 tympanoplasty cases with ICG for atelectatic TM and recurrent perforation and graft failure was detected in 3 patients (13.6%) at the end of an average of 11 months of follow-up. The mean ABG was defined before the operation as 21.1 ± 8.4 dB and 6.8 ± 6.1 dB after the operation. Also, it was reported that the cartilage graft was intact, even though otitis media with effusion occurred in 3 patients during follow-up [15]. Kirazlı et al. [16] presented an average of 17 months of follow-up outcomes of 15 type-1 tympanoplasty cases performed with ICG (tragal cartilage). The indications for tympanoplasty in this study are similar to the presented study but graft take rates has not mentioned. In the audiological examination, the mean ABG before surgery was 28.1 ± 8.8 dB and 16.2 ± 6.2 dB at the end of follow-up [16]. Önal et al. [17] detected the success of graft as 93.2% in 44 type-1 tympanoplasty cases with ICG and ABG gain as 12.7 dB after 21.8 months follow-up. In this study, while emphasizing the resistance of ICG to retraction, it was argued that it could adversely affect hearing results due to the thickness and rigidity of cartilage. Consistent with the initial study, Önal et al. [18] reported the success of the graft as 93.2% in 39 patients using ICG grafts after an average of 20.9 months. Also, graft failure is not detailed in this study. De Seta et al. [19] reported any recurrent perforation with ICG after a one-year follow-up period. ABG was 15 dB and below in 61% of patients in this study after one year of follow-up. However, in this study, retraction was observed in 2 patients (5.5%) at the end of one year. The number of studies

with ICG that offer a detailed audiological examination preoperatively and postoperatively, detailed graft success definition, adequate follow-up period, and homogeneous study groups were limited in the literature. In presented study, the success of tympanoplasty with ICG was 86.1%. Preoperative PTA was 33.5 ± 8.4 dB, and postoperative PTA was 28.8 ± 3.0 dB ($p < 0.036$). One of the graft failures was due to retraction, and four were marginal perforation due to possible surgical technique. In addition, unfavorable audiological results were found in the ICG group compared to PCG and WsCCG groups.

WsCCG tympanoplasty was defined by in 2005 Shin et al. [20] as for the prevention of retraction pockets and the prevention of partial ossicular replacement prosthesis extrusion. At the end of an average follow-up duration of 50 months, graft failure was observed in six of 47 patients (12.7%) and retraction was detected in three (6.4%) patients. Mean 6 dB ABG gain was observed at the end of the follow-up. This study emphasized the unsuitable consequences of a thick cartilage plate due to thickness, stiffness, and mass that could compromise the acoustic results. WsCCG re-designed to provide flexibility and avoid stiffness on the perichondrium instead of a single plate-shaped graft or palisade to achieve better audiological results by the authors. [5, 20]. WsCCG (conchal cartilage) was modified and used for type-1 tympanoplasty and the graft success was detected as 97.7% (43/44). After a mean of 15 months of follow-up, ABG improvement was found 6.6 ± 11.0 dB. WsCCG was used in this study for the repair of total or subtotal perforations, and anterior-inferior recurrent perforation was detected in only one patient, no retraction was observed [5]. In the presented study, graft success of WsCCG was 97.2% and ABG closure was detected as a mean of 9.1 ± 6.0 dB after an average of 32.8 months follow up period. ABG closure was detected higher in the WsCCG group than the PCG and ICG groups. Also, only one graft failure detected at the anterior margin of the annulus, and retraction was not observed after a long follow up period compared to the literature.

The results are consistent with the referential study, and the success of the graft is similar to the other study in the literature. However, the fact that this technique has not been experienced by different surgeons and this increases the risk of bias. Also, in this study, a set of homogeneous study groups was aimed and the adhesive COM or retraction pockets were excluded at the beginning of the study. But a total of three retractions were relapsed. This was another limitation of the study.

Conclusion

In this study, graft success and audiological improvement were observed similar to literature. As this study aims to reveal, it has been demonstrated by multivariate analysis that cartilage graft selection has no effect on outcome in cartilage tympanoplasty cases. Additionally, the success of WsCCG graft was detected higher and audiological results was better than PCG and ICG groups. The WsCCG provided comparable results with classical reliable graft techniques (PCG and ICG) and may recommend as a more suitable graft due to hearing results and resistance against retraction. But WsCCG graft technique needs to be supported by different surgeons in larger samples.

Acknowledgments: None.

Funding: This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

Declaration of interest statement : The Authors declare that there is no conflict of interest.

Data Availability Statement: Data of the study will share if requests.

References

- [1]. Yang T, Wu X, Peng X, Zhang Y, Xie S, Sun H. Comparison of cartilage graft and fascia in type 1 tympanoplasty: systematic review and meta-analysis. *Acta Otolaryngol.* 2016;136(11):1085–90.
- [2]. Lyons SA, Su T, Vissers LET, Peters JPM, Smit AL, Grolman W. Fascia compared to one-piece composite cartilage-perichondrium grafting for tympanoplasty. *Laryngoscope.* 2016;126(7):1662–70.

- [3]. Tos M. Cartilage tympanoplasty methods: Proposal of a classification. *Otolaryngol - Head Neck Surg.* 2008;139(6):747–58. Doi: 10.1016/j.otohns.2008.09.021
- [4]. Dündar R, Soy FK, Kulduk E, Muluk NB, Cingi C. A new grafting technique for tympanoplasty : tympanoplasty with a boomerang-shaped chondroperichondrial graft (TwBSCPG). *Eur Arch Otorhinolaryngol.* 2014 Oct;271(10):2687-94. Doi: 10.1007/s00405-013-2764-x.
- [5]. Ciğer E, Balcı MK, İşlek A, Önal K. The wheel-shaped composite cartilage graft (WsCCG) and temporalis fascia for type 1 tympanoplasty : a prospective , randomized study. *Eur Arch Otorhinolaryngol.* 2018 ;275(12):2975-2981. Doi: 10.1007/s00405-018-5171-5
- [6]. Yung M. Cartilage tympanoplasty: Literature review. *J Laryngol Otol.* 2008;122(7):663–72.
- [7]. Dornhoffer J. Cartilage Tympanoplasty : Indications , Techniques , And Outcomes In A 1,000- Patient Series. *Laryngoscope.* 2003 Nov;113(11):1844-56.
- [8]. Heermann JJ, Heermann H, Kopstein E. Fascia and cartilage palisade tympanoplasty. Nine years' experience. *Arch Otolaryngol.* 1970;91:228–41.
- [9]. Khan MM, Parab SR. Comparative study of sliced tragal cartilage and temporalis fascia in type I tympanoplasty. *J Laryngol Otol.* 2015;129:16–22.
- [10]. Velepici M, Starcevic R, Ticac R, Kujundzic M, Velepici M. Cartilage palisade tympanoplasty in children and adults: Long term results. *Int J Pediatr Otorhinolaryngol.* 2012;76(5):663–6. Doi: 10.1016/j.ijporl.2012.01.036
- [11]. 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(9):985–9.
- [12]. 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. (Doi: 10.1007/s00405-010-1473-y)
- [13]. 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(5):422–7. Doi:10.1016/j.anl.2014.05.015
- [14]. Jeffery CC, Shillington C, Andrews C, Ho A. The palisade cartilage tympanoplasty technique: A systematic review and meta-analysis. *J Otolaryngol - Head Neck Surg.* 2017;46(1):1–6.
- [15]. Dornhoffer JL. Hearing Results With Cartilage Tympanoplasty. *Laryngoscope.* 1997 Aug;107(8):1094-9
- [16]. Kirazli T, Bilgen C, Midilli R, Ogut F. Hearing results after primary cartilage tympanoplasty with island technique. *Otolaryngol - Head Neck Surg.* 2005;132(6):933–7.
- [17]. Onal K, Arslanoglu S, Oncel S, Songu M, Kopar A, Demiray U. Perichondrium/cartilage island flap and temporalis muscle fascia in type I tympanoplasty. *J Otolaryngol - Head Neck Surg.* 2011 Aug;40(4):295–9.
- [18]. Onal K, Arslanoglu S, Songu M, Demiray U, Demirpehlivan IA. Functional results of temporalis fascia versus cartilage tympanoplasty in patients with bilateral chronic otitis media. *J Laryngol Otol.* 2012;126(1):22–5.
- [19]. De Seta E, De Seta D, Covelli E, Viccaro M, Filipo R. Type I tympanoplasty with island chondroperichondrial tragal graft: The preferred technique? *J Laryngol Otol.* 2013;127(4):354–8.
- [20]. Shin S, Lee W, Kim H, Lee H. Wheel-shaped cartilage-perichondrium composite graft for the prevention of retraction pocket development. *Acta Oto-Laryngologica.* 2007;127: 25-28.

Figure 1 Illustrations for wheel-shaped composite cartilage graft (WsCCG).

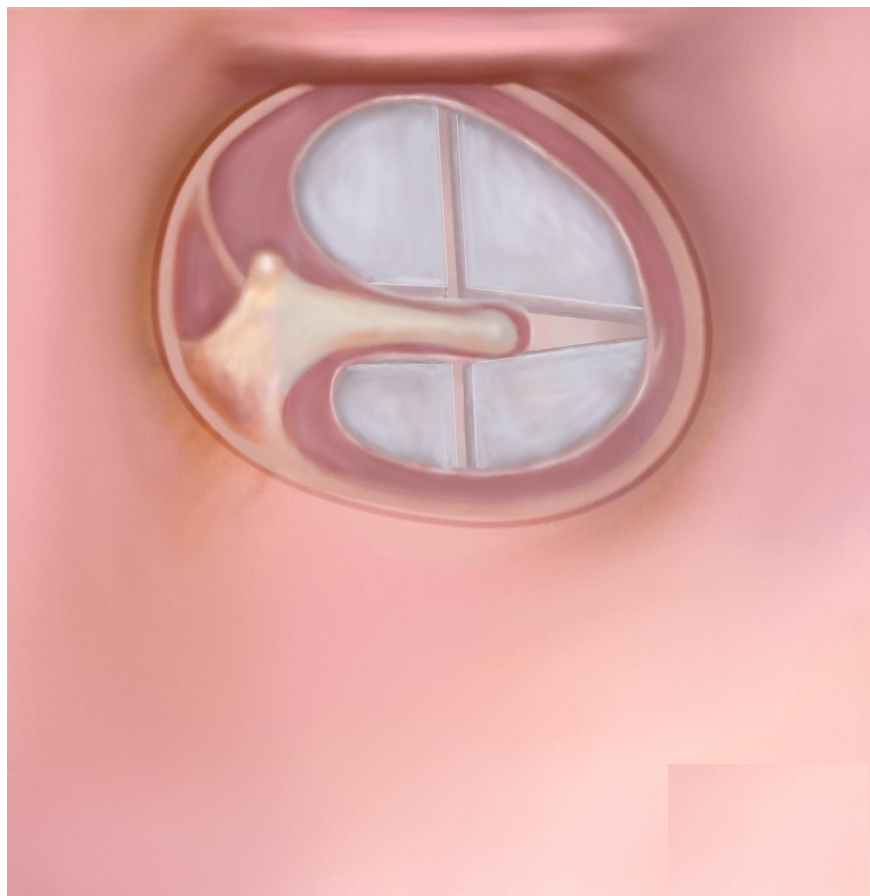
Image 1 Prepared wheel-shaped composite cartilage graft and postoperative view.

Table 1 The mean and standard deviation of age, preoperative audiometric tests and follow-up period in cartilage groups.

Table 2 Graft take rates and Chi-Square test statistic according to cartilage groups.

Table 3 The mean and standard deviation of postoperative audiometric tests according to cartilage groups.

Table 4 Multiple comparisons of the graft groups for postoperative PTA, ABG closure





Hosted file

Tables.docx available at <https://authorea.com/users/469826/articles/562406-the-wheel-shaped-composite-cartilage-graft-for-type-1-tympanoplasty-comparison-with-palisade-and-island-cartilage-graft>