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Endoscopic versus microscopic approach to type 1 tympanoplasty in children

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ABSTRACT

Objectives: We investigated the outcomes of the endoscopic versus microscopic approach to type 1 tympanoplasty in pediatric patients.
Methods: In this retrospective study, the outcomes of 61 ears of 60 pediatric patients (33 male and 27 female) who underwent type 1 tympanoplasty were evaluated. One patient underwent a bilateral operation. The age range of the patients was 7–16 years. Group 1 underwent tympanoplasty with an endoscopic technique ($n = 32$), and Group 2 underwent tympanoplasty with the conventional microscopic technique ($n = 29$). A boomerang-shaped chondroperichondrial graft was used in both groups. The outcomes were analyzed in terms of the hearing gain, duration of surgery, and graft success rate.
Results: In both groups, the postoperative air–bone gap (ABG) was significantly lower than the preoperative ABG. There were no significant differences between the preoperative and postoperative ABG values (in dB) in either group. The mean operative duration in Group 1 was significantly lower than that in Group 2 (51.37 vs. 67.03 min, respectively). In the preoperative evaluation, 65.6% of patients in Group 1 had larger perforations and 34.4% had smaller perforations. In Group 2, 58.6% and 41.3% of patients had larger and smaller perforations, respectively. Perforations were detected in two (6.25%), four (12.50%), and four (12.50%) of the patients in Group 1 at postoperative months 1, 6, and 12, respectively. Perforations were detected in two (5.71%) patients in Group 2 at postoperative months 1, 6, and 12. At 12 months postoperatively, there were smaller perforations in four (12.5%) of the children in Group 1 and in two (5.71%) of the children in Group 2. The difference between the perforation conditions (larger vs. smaller) was not significant in either group. The preoperative and postoperative increases in the ABG were associated. The operative duration was shorter in Group 1 than in Group 2.
Conclusion: In pediatric patients undergoing type 1 tympanoplasty, especially if the external ear canal is narrow and the anterior canal wall is prominent, the endoscopic and microscopic approaches appear to give equal results in terms of easy visualization of the entire tympanic membrane and no requirement for extra intervention to evaluate the ossicular system. A shorter operative duration is an advantage of the endoscopic tympanoplasty technique.

1. Introduction

Chronic otitis media (COM) is a common disease that can have serious complications related to incorrect and inadequate treatment [1]. Tympanoplasty is a surgical procedure performed for eradication of infection and rehabilitation of hearing in patients with COM. The main purpose of tympanoplasty is to repair the perforated tympanic membrane (TM) and rehabilitate the patient's

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hearing [2]. This procedure has been performed frequently in pediatric patients in recent years. In the pediatric age group, the success rate is significantly affected by the particular instruments and techniques used because the relatively smaller and narrower ear canals of these patients often cause difficulties and insufficient visualization during surgery compared with adults [3,4].

In this study, we compared the results of the endoscopic and more classic microscopic approach to type 1 tympanoplasty in pediatric patients with respect to hearing gain, duration of surgery, and graft success rate. We tried to evaluate whether the transcanal endoscopic approach is an alternative tympanoplasty technique for the treatment of childhood COM.

2. Materials and methods

This retrospective study was conducted at the Mardin State Hospital and Kızıltepe State Hospital ENT Clinics and was performed in compliance with the Declaration of Helsinki [5]. No pharmaceutical companies funded the study or contributed to the study design or outcome evaluation, or writing of this paper.

2.1. Subjects

We retrospectively analyzed 75 pediatric patients aged 7–16 years with COM who were admitted to the ENT Clinics from 2011 to 2014. All patients had central or marginal perforation of the tympanic membrane (TM) and normal middle ear mucosa. Cholesteatomas were endoscopically detected in five patients, and the follow-up period was insufficient in nine patients. Therefore, these 14 patients were excluded from the study. Patients who had undergone revision type 1 tympanoplasty and who had experienced ear discharge for more than 3 months were also excluded. One patient underwent a bilateral operation. Sixty-one ears of 60 patients (33 male and 27 female) with a follow-up period of at least 10 months were included in the study.

The patients were divided into two groups based on the surgical procedure performed. Group 1 underwent endoscopic tympanoplasty (ET) (n = 32), and Group 2 underwent conventional microscopic tympanoplasty (MT) (n = 29).

2.2. Methods

The patients' demographic data, preoperative and postoperative audiometric test results, surgical technique (ET or MT), and operative duration were analyzed retrospectively. Follow-up evaluations were performed at 1, 6, and 12 months postoperatively. During these visits, pure-tone audiometric tests were performed and the status of the graft was evaluated otomicroscopically (Fig. 1). In all patients, the air–bone gaps (ABGs) were evaluated preoperatively and at 1, 6, and 12 months postoperatively [6]. Hearing thresholds were measured at 0.5, 1.0, 2.0, and 4.0 kHz, and the average hearing values were calculated.

2.3. Surgical technique

All patients underwent general anesthesia, and all type 1 tympanoplasty procedures were performed by R.D. at Kızıltepe State Hospital. In Group 2, a microscope (Opmi Vario S88; Carl Zeiss) was used and an endaural approach was preferred. After creation of the endaural incisions, a tympanomeatal flap was elevated, the middle ear cavity was revealed, and the necessary surgical procedures were performed to repair the TM by grafting. The procedure involved the use of a boomerang-shaped chondroperichondrial graft taken from the tragus and assisted by cartilage anteriorly and inferiorly (Fig. 1) [7].

In Group 1, operations were performed using an endoscopic system (Karl Storz, Tuttlingen, Germany) and rigid endoscopes (2.7 mm [6.0 cm] and 4.0 mm [16.0 cm]; Karl Storz, Tuttlingen, Germany) (Fig. 2). In this technique, an incision was performed laterally (about 6–8 mm from the TM) in the posterior part of the external auditory canal. A second incision was performed superior to the first, perpendicular to the TM and parallel to the external auditory canal. A tympanomeatal flap was elevated to protect the inferior connection. The middle ear cavity was visualized, and the

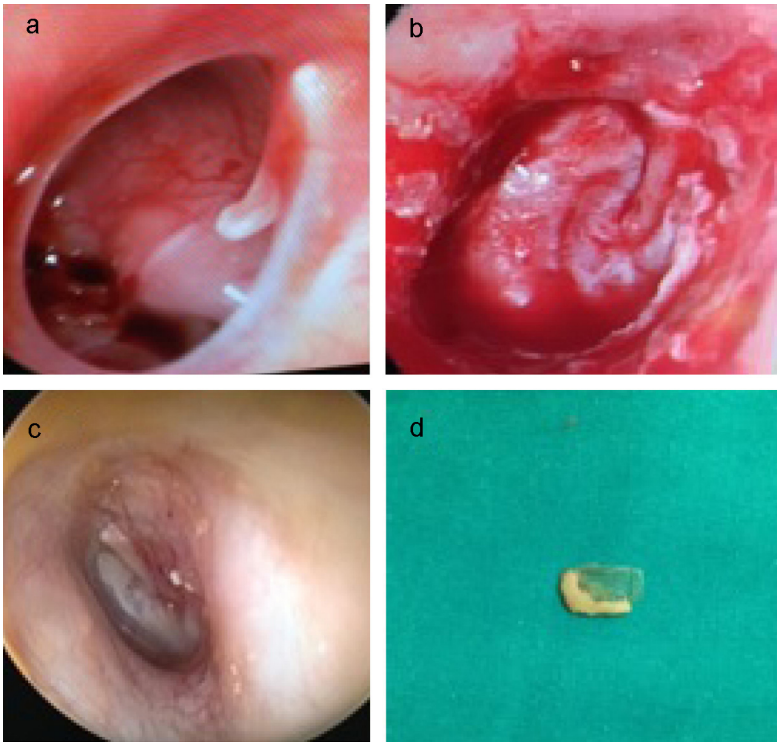

Fig. 1. Endoscopic tympanoplasty. (a) Preoperative view. (b) Perioperative view. (c) Postoperative view. (d) Chondroperichondrial graft.

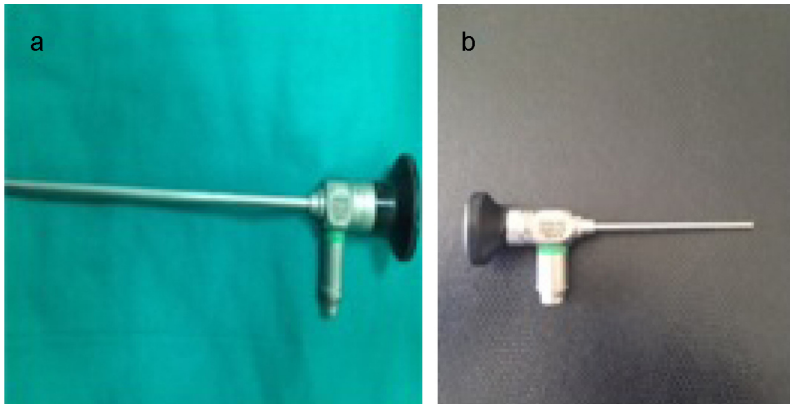

Fig. 2. Endoscopes. (a) 4-mm (16-cm) endoscope. (b) 2.7-mm (6.0-cm) endoscope* *Karl Storz, Tuttlingen, Germany.

TM was repaired by grafting. The graft used in this procedure had the same features as that used in the microscopic procedure [7]. The graft was placed medial to the malleus and arranged as an "underlay" graft (Fig. 1).

All patients underwent otomicroscopy and endoscopy examinations at 1, 6, and 12 months postoperatively. The patients were evaluated with respect to audiometric parameters, perforations, and ABGs.

3. Results

The demographic characteristics and clinical findings of Groups 1 and 2 are shown in Table 1. The mean age of the patients was 12.40 ± 2.36 years (range, 7–16 years) in Group 1 and 11.89 ± 2.07 years (range, 7–16 years) in Group 2. There were no significant differences in the ages of the patients between Groups 1 and 2 according to an independent-samples *t*-test ($p < 0.05$) (Table 1).

Group 1 comprised 14 (45.2%) male and 17 (54.8%) female patients. One female patient in Group 1 underwent bilateral operations. Group 2 comprised 19 (65.5%) male and 10 (34.5%) female patients. The difference in the sexes between the two groups was analyzed by chi-square test, and no significant difference was detected ($p = 0.113$, $\chi^2 = 2.509$).

4. ABG

In Group 1, the preoperative and postoperative ABGs were 20.40 ± 4.33 and 8.12 ± 3.27 dB, respectively. In Group 2, the preoperative and postoperative ABGs were 21.34 ± 3.90 and 8.13 ± 2.43 dB, respectively (Table 1, Fig. 3). The difference between the preoperative and postoperative ABGs was analyzed separately in Groups 1 and 2 by paired *t*-test, and in both groups, the postoperative ABG was significantly lower than the preoperative ABG ($p < 0.05$) (Table 1). The preoperative and postoperative ABGs were evaluated separately, and their differences between Groups 1 and 2 were analyzed by independent-samples *t*-test; no significant differences were detected ($p > 0.05$) (Table 1).

4.1. Operative duration

The average operative duration in Group 1 was 51.37 ± 5.91 min (range, 40–58 min), and that in Group 2 was 67.03 ± 3.76 min (range, 60–77 min) (Table 1). The operative duration in Group 1 was significantly lower than that in Group 2 according to an independent-samples *t*-test ($p < 0.05$) (Table 1).

The postoperative follow-up period ranged from 10 to 28 months. The average follow-up period in Groups 1 and 2 was 11.6 and 16.4 months, respectively.

4.2. Perforation conditions

4.2.1. Preoperative period

Group 1: In Group 1, 21 (65.6%) patients had larger perforations (>50% of the TM area), while 11 (34.4%) had smaller perforations (<50% of the TM area). Among the 21 patients with larger perforations, 15 (46.9%) had kidney-type perforations containing the anteroinferior, posteroinferior, and central parts of the TM, while 6 (18.8%) had central perforations. Among the 11 patients with smaller perforations, 9 (28.1%) had anteroinferior quadrant perforations and 2 (6.2%) had central perforations.

Table 1
Demographic characteristics and clinical findings of Groups 1 and 2.

	Endoscopic tympanoplasty (Group 1) ($n = 32$)			Microscopic tympanoplasty (Group 2) ($n = 29$)			*t*	*p**
	Mean ± SD	Min	Max	Mean ± SD	Min	Max		
Age (years)	12.40 ± 2.36	7.00	16.00	11.89 ± 2.07	7.00	16.00	0.890	0.377
Air–bone gap (dB)								
Preop	20.40 ± 4.33	10.00	30.00	21.34 ± 3.90	15.00	30.00	−0.885	0.380
Postop	8.12 ± 3.27	5.00	15.00	8.13 ± 2.43	5;00	15.00	−0.017	0.986
*p***	$p = 0.000$, $t = 18.473$			$p = 0.000$, $t = 14.775$				
Operation duration (min)	51.37 ± 5.91	40.00	58.00	67.03 ± 3.76	60.00	77.00	−12.193	0.000
Graft condition	*n*		%	*n*		%		*p****
Graft								
Perforated	4		12.5	2		6.9		$p = 0.467$
Healthy (nonperforated)	28		87.5	27		93.1		$X^2 = 0.530$

* *p* value by independent-samples *t*-test.
** *p* value by paired *t*-test.
*** *p* value by chi-squared test.

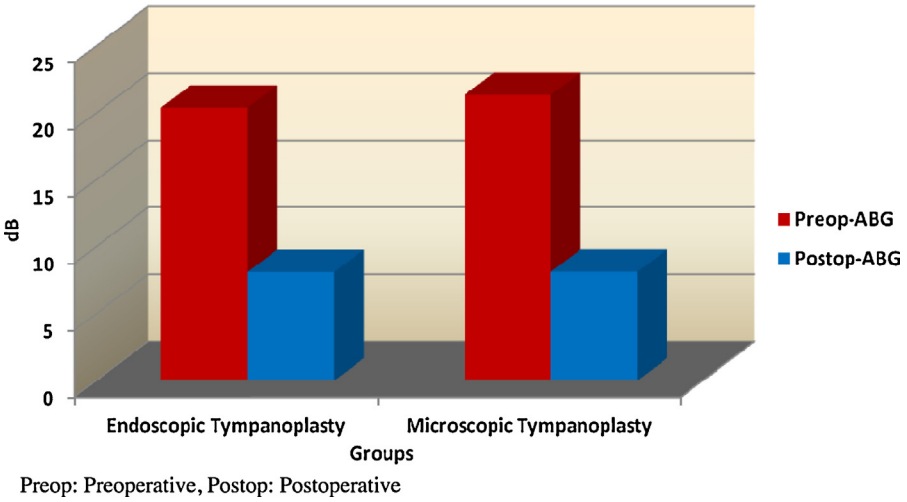

Fig. 3. Air–bone gaps (ABGs) in both groups Preop: preoperative, Postop: postoperative.

Group 2: In Group 2, 17 (58.6%) patients had larger perforations (>50% of the TM area) and 12 (41.3%) had smaller perforations (<50% of the TM area). Among the 17 patients with larger perforations, 9 (31.0%) had kidney-type perforations containing the anteroinferior, posteroinferior, and central parts of the TM, and 8 (27.5%) had central perforations. Among the 12 patients with smaller perforations, 10 (34.0%) had anteroinferior quadrant perforations, 1 (3.5%) had a posterosuperior quadrant perforation, and 1 (3.5%) had a central perforation.

4.2.2. Postoperative period

Group 1: In Group 1, perforations were detected in two (6.25%), four (12.5%), and four (12.5%) patients at the 1-, 6-, and 12-month follow-ups, respectively. At the 12-month follow-up, three (75.0%) patients had central perforations and one (25.0%) had a posterosuperior quadrant perforation. All post-operative perforations were small (<50% of the TM area).

Group 2: In Group 2, perforations were detected in two (5.71%) patients at the 1-, 6-, and 12-month follow-ups. At the 12-month follow-up, two (100.0%) patients had posterosuperior quadrant perforations, both of which were small (<50% of the TM area).

At 12 months postoperatively, the difference in the perforation conditions between Groups 1 and 2 was analyzed by chi-square test; no significant difference was found ($p > 0.05$).

4.2.3. Relationships among various patient and surgical factors

The relationships among sex, age, surgical approach, preoperative ABG, postoperative ABG, operative duration, and graft condition were analyzed by Pearson's correlation test or Spearman's correlation rho efficient test, as appropriate (Table 2). As the preoperative ABG increased, the postoperative ABG also increased ($p < 0.05$). The operative duration was shorter in Group 1 than in Group 2 ($p < 0.05$).

The factors affecting the postoperative ABG were subjected to backward linear regression analysis. The covariates were age, surgical approach, preoperative ABG, operative duration, and graft condition. As preoperative ABG increased, the postoperative ABG also increased ($p = 0.021$, beta = 0.295).

Table 2
Correlation test results.

	Sex**	Age*	Group*	Air–bone gap		Operation duration*	Graft condition**
				Preop*	Postop*		
Sex**							
r		0.118	−0.218	0.028	0.191	−0.177	−0.027
p		0.363	0.091	0.833	0.140	0.172	0.835
Age*							
r	0.118		−0.115	−0.017	0.186	−0.030	−0.122
p	0.363		0.377	0.895	0.151	0.819	0.348
Group*							
r	−0.218	−0.115		0.114	0.002	0.846	0.094
p	0.091	0.377		0.380	0.986	0.000	0.471
Air–bone gap							
Preop*							
r	0.028	−0.017	0.114		0.295	0.192	0.181
p	0.833	0.895	0.380		0.021	0.138	0.163
Postop*							
r	0.191	0.186	0.002	0.295		0.017	0.006
p	0.140	0.151	0.986	0.021		0.896	0.960
Operation duration*							
r	−0.177	−0.030	0.846	0.192	0.017		0.080
p	0.172	0.819	0.000	0.138	0.896		0.540
Graft condition**							
r	−0.027	−0.122	0.094	0.181	0.006	0.080	
p	0.835	0.348	0.471	0.163	0.960	0.540	

* *p* value by Pearson's correlation test.
** *p* value by Spearman's correlation rho efficient test.

The factors affecting the operative duration were subjected to backward linear regression analysis. The covariates were age, surgical approach, preoperative ABG, postoperative ABG, and graft condition. The operative duration was shorter in Group 1 than in Group 2 ($p = 0.000$, beta = 0.846).

5. Discussion

The main objective in the treatment of COM is to achieve symptomatic relief, relieve drainage, rehabilitate hearing, and minimize complications. Meeting these goals is particularly important in children with COM because patients in this age group may develop hearing loss due to COM, especially patients in whom both ears are affected in early childhood. Effective treatment of COM has great importance for learning correct speech and language, avoiding difficulties in the education process, enhancing communication, and improving the patient's overall quality of life [8,9].

Various medical and surgical treatments are available for pediatric COM. Many factors play a role in the outcome of surgical treatment, including the disease state, age of the patient, surgeon's experience, institution in which the procedure is carried out, and type of operation. The approach to COM in childhood is trending toward the application of minimally invasive surgical procedures under appropriate conditions [10].

Various materials are used to repair the TM during tympanoplasty [11]. In recent years, the use of cartilage grafts has been widespread and is frequently applied in pediatric patients with COM [12]. In the present study, we applied boomerang chondroperichondrial grafts, which we described previously [7].

Many ENT surgeons perform tympanoplasty under an operating microscope. However, despite providing direct exposure, microscopy may be insufficient in the viewing of certain areas during surgery. Although there are no exposure problems in the posterior and inferior areas, there may be exposure problems caused by the anterior wall prominence. Hidden areas that cannot be seen under a microscope can be better observed via thin and rigid endoscopes with different angles. In the endoscopic tympanoplasty procedure, a thin, rigid endoscope allows for functional reconstruction during surgery and the performance of minimally invasive procedures and conservative surgeries with protection of the anatomy [13].

The main advantage of endoscopic procedures during middle ear surgery is a decrease in the operation duration. The endoscopic approach gives results equal to those of the microscopic approach in terms of the cosmetic appearance, pain level, and dressing requirement. However, this procedure has several disadvantages, including a lack of sufficient microscopic magnification and focus, the need to perform one-handed operations because the surgeon must use one hand to hold the endoscope, frequent contamination of the surgical site secondary to bleeding, and instrument crowding within the surgical area [14].

Karhuketo et al. [15] emphasized that the use of endoscopic methods in ear surgery fulfills the requirements of minimally invasive surgery, and the least trauma to the normal tissues can be achieved in this way. Lade et al. [16] compared 60 patients undergoing myringoplasty (type 1 tympanoplasty) using either a microscopic or endoscopic procedure. Among the 30 patients who underwent the microscopic method, canaloplasty was performed to evaluate the ossicular system in 5 and external auditory canal curettage was performed in 4 patients. However, none of the 30 patients who underwent the endoscopic procedure required such interventions, and the ossicular system could be assessed easily. They concluded that the results of endoscopic tympanoplasty are similar to those of microscopic tympanoplasty and that endoscopic tympanoplasty is more tolerable in terms of the cosmetic appearance. Thus, this technique was considered a potential alternative to microscopic tympanoplasty. In the present study, we obtained results similar to those of Lade et al. [16].

In our microscopic procedure, curettage of the chordal crest was performed to assess the ossicular system, and in one patient, canaloplasty was performed due to the prominence of the anterior wall. However, patients who underwent the endoscopic transcanal procedure required no extra interventions involving the external auditory canal.

Ayache [17] reported a graft success rate of 96% in patients undergoing transcanal endoscopic cartilage tympanoplasty, and this procedure was reportedly a minimally invasive, safe, and effective treatment method. The graft success rate in the endoscopic tympanoplasty procedure of the present study was 87.5%.

Gasline et al. [18] performed the classical microscopic approach for cartilage grafting in 42 patients 3–16 years of age and reported a graft success rate of 83.3%. In a study by Albirmawy [12], the cartilage graft success rate was 95% in 82 children. Nevoux et al. [19] reported that their cartilage tympanoplasty success rate was 87.3% in 268 patients. In our study, the graft success rate was 87.5% in 32 patients who underwent the endoscopic procedure and 94.3% in those who underwent the microscopic procedure.

Postoperative hearing gain is an important indicator of treatment success in patients who have undergone tympanoplasty. Especially in pediatric patients, hearing gain is important in terms of the future quality of life. Many studies have reported successful results regarding postoperative hearing gain in such patients. Friedman et al. [20] performed type 1 tympanoplasty in 119 pediatric patients. Using cartilage grafts, the preoperative and postoperative ABGs were calculated to be 20.7 and 8.5, dB respectively. In a study by Yılmaz et al. [21], the ABGs were 30.6 dB preoperatively and 17.8 dB postoperatively in 45 pediatric patients who underwent type 1 cartilage tympanoplasty. In our study, the preoperative and postoperative ABGs were 20.40 and 8.12 dB, respectively, in the endoscopic tympanoplasty group and 21.34 and 8.13 dB, respectively, in the microscopic tympanoplasty group.

The duration of the operation is an important parameter in terms of the duration of anesthesia, the surgeon's concentration, and the increased risk of iatrogenic complications. In a study by Ghaffar et al. [22], the mean operation duration was 62.85 min among 34 patients who underwent endoscopic tympanoplasty. In 24 of these patients, the operation duration was less than 60 min.

In our study, the operation duration among the 26 patients who underwent endoscopic transcanal tympanoplasty was less than 60 min, and the mean duration among the 32 who underwent endoscopic tympanoplasty was 51.37 min. The mean operation duration was 69.03 min for the preferred approach using microscopes. The reason for these differences may be related to the fact that neither suturing nor extra time to view hidden areas is needed during endoscopic procedures.

6. Conclusion

In pediatric patients undergoing type 1 tympanoplasty, especially if the external ear canal is narrow and the anterior canal wall is prominent, the endoscopic approach appears to give results equal to those of the microscopic approach in terms of visualization of the entire TM and the lack of extra interventions required to evaluate the ossicular system.

Conflict of interest

The authors declare that there is no conflict of interest.

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