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Comparison of Endoscopic and Microscopic Type 1 Tympanoplasty on Surgical Outcomes and Quality of Life*

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ABSTRACT

Objective: The purpose of this study was to compare the surgical and functional outcomes, as well as the quality of life, of patients who underwent endoscopic and microscopic type 1 tympanoplasty.

Material and Methods: In two groups of patients undergoing endoscopic and microscopic tympanoplasty, pre- and postoperative audiological outcomes, Middle Ear Risk Index, and Chronic Otitis Media Benefit Inventory, a newly designed questionnaire specific for chronic otitis media surgery, were prospectively evaluated.

Results: The endoscopic tympanoplasty group had 30 patients, while the microscopic tympanoplasty group had 22 participants. There were no statistically significant differences in demographic parameters, Middle Ear Risk Index, or graft material chosen between the groups, although the time of hospitalization was considerably shorter in the endoscopic tympanoplasty group ($p<0.001$). In terms of air conduction thresholds and air-bone gap, the difference between pre and postoperative time points was statistically significant in both groups ($p<0.001$), but not between groups. There was no statistically significant difference between the groups in terms of hearing gain and Chronic Otitis Media Benefit Inventory scores.

Conclusion: Although the endoscopic tympanoplasty group is known to decrease early postoperative complaints and shorten hospitalization periods, the equivalent late functional outcomes (audiological and quality of life results) reveal that the two surgical procedures are not superior to each other in the long term.

Keywords: Endoscopic tympanoplasty, microscopic tympanoplasty, quality of life, middle ear

INTRODUCTION

Chronic otitis media (COM) is a condition that causes irreversible changes in the eardrum, middle ear components, and mastoid cells, resulting in ear discharge, hearing loss, tinnitus, and balance problems (1). Different surgical methods have been described for both the removal of the existing disease and the improvement of hearing (2). Tympanoplasty is a surgical treatment used to restore the tympanic membrane (TM) and/or ossicles. Type 1 tympanoplasty was described by Berthold in 1878 and popularized by Wullstein and Zollner after 1950 and involves repair of TM perforation only in the absence of pathology in the middle ear and mastoid cells (3). Traditionally, since their origin, all ear operations have been performed microscopically. Despite microscopes being highly comfortable due to their binocular and high three-dimensional vision and the surgeon's freedom to use both hands, the conical working field may require extra soft tissue and bone excision to provide adequate vision and light. These unnecessary resections in microscopic tympanoplasty (MT) open the way for a variety of complications and have a negative impact on patient comfort due to prolonged recovery time and increased pain (4). Since the 1990s, endoscopes have been introduced in ear surgeries and are now used in practically all ear surgeries such as tympanoplasty, otosclerosis surgery and even cochlear implantation. Endoscopes allow access to the TM and middle ear without creating a large skin incision, minimizing pain and enhancing cosmetic outcomes. Endoscopes also provide a wider field of view, especially angled endoscopes can provide direct visualization of hidden areas that are difficult to view

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under a microscope, such as epitympanum, sinus tympani and facial recesses. Despite these advantages, endoscopic tympanoplasty (ET) has disadvantages, such as being a single-handed technique, having a long learning curve, and not being three-dimensional (5). Patient-reported outcome measures (PROMs) enable clinicians to assess the outcome of different treatment modalities from the patients' perspective. Until recently, ear surgery success was measured by graft success and hearing outcomes, as well as disease eradication. The analysis of health-related quality of life (HRQoL) is a current area of research in the field of otology, therefore it has become popular in recent years to assess the outcome of ear procedures with PROMs (6). Phillips et al. developed the Chronic Otitis Media Benefit Inventory (COMBI) in 2017, and Kara et al. conducted a Turkish validity-reliability study in 2020 (7, 8). The COMBI is a PROM that compares the postoperative and preoperative periods in a single questionnaire and focuses on the change in patients' complaints related to COM in the postoperative period (7).

Although there have been many studies investigating the surgical and audiological outcomes of endoscopic and microscopic tympanoplasty, there are limited studies comparing these two techniques with the PROM.

The objective of this study was to evaluate the surgical and audiological outcomes of patients who underwent endoscopic and microscopic type 1 tympanoplasty, as well as the results of HRQoL using a recently introduced ear specific questionnaire (COMBI).

MATERIAL AND METHODS

This prospective observational study was conducted at Ondokuz Mayis University Department of Otorhinolaryngology between September 2020 and February 2022. Following obtaining approval from the Ondokuzmayıs University Clinical Research Ethics Committee (Date: 12.05.2020, No: OMU KAEK 2020/331), the study was performed in accordance with the Helsinki Declaration. Written informed consent was obtained.

Patients

The study included 52 patients with conductive hearing loss between the ages of 18 and 65 who had endoscopic and microscopic Type 1 tympanoplasty for isolated tympanic membrane perforation. All patients were followed up on for at least 6 months after the surgery. Thirty (30) patients were included in the endoscopic tympanoplasty group (ETG) and 22 patients were included in the microscopic tympanoplasty group (MTG). Patients with other known otologic diseases (otosclerosis, vestibular pathology, history of temporal bone trauma and neoplasia, mixed or sensorineural hearing loss in the preoperative and postoperative periods), prior ear surgery, examination findings other than perforation (retraction, atelectasis, cholesteatoma, wet ear), posterior quadrant perforation, and patients who did not continue regular follow-up were excluded.

Prospectively collected data included demographic characteristics, surgical techniques and findings, duration of hospitalization, preoperative audiological findings, postoperative audiological findings at the sixth month, and graft status at the sixth month were recorded.

Audiological evaluation

Hearing improvement was assessed with the guidelines of the American Academy of Otolaryngology—Head and Neck Surgery (9). Air Conduction (AC) thresholds, Bone Conduction (BC) thresholds and Air-Bone Gap (ABG) values were calculated by measuring the average of 500, 1000, 2000 and 3000 Hz frequencies with Pure Tone Audiometry in the preoperative period and the sixth month postoperatively. We interpolated a 3000-Hz threshold by averaging the thresholds at 2000 Hz and 4000 Hz when 3000-Hz thresholds were not available, according to the guidelines.(10) Hearing Gain (HG) was calculated as the difference between preoperative and postoperative ABG values.

Surgical procedure

All surgeries were performed by clinicians with at least 8 years of otologic surgery expertise. For ETG, a 0-degree, 3 mm, 14 cm endoscope (Karl Storz, Tuttlingen, Germany), and for MTG, an Opmi Vario 700 microscope (Carl Zeiss, Oberkochen, Germany) were used. An endomeatal incision was performed in ETG, whereas a postauricular incision was performed in MTG. The tympanomeatal flap was lifted 10 mm lateral to the fibrous annulus. Before grafting, the perforation margins are circularly extracted and renewed. The fibrous annulus was detached from the tympanic sulcus whilst preserving the chorda tympani, providing access to the middle ear. The integrity and mobility of the ossicular chain were examined. Cartilage graft with perichondrium from the tragus was used in both ETG and MTG. Absorbable sponges were placed in the middle ear to support the graft. The graft material was placed beneath the manibrium mallei and the fibrous annulus. Absorbable sponges were placed in the EAC. Compressed ear dressing was applied to the patients in the MTG group for 2 days postoperatively. In the second week, absorbable sponges were aspirated from the EAC.

Middle ear risk index (MERI)

The Middle Ear Risk Index (MERI) is the most well-known grading system for classifying the severity of middle ear disease (11). The MERI score is calculated by assigning a specific value to each risk factor and summing these values. Risk factors include Belluci criteria for assessing the degree of ear discharge, Austin/Kartush criteria for ossicular status, presence of perforation, cholesteatoma middle ear granulation/effusions, history of previous surgery and smoking. Risk categories are as follows: 0 = normal; 1-3 = mild disease; 4-6 = moderate disease; 7-12 = severe disease (11).

Quality of life assessment

COMBI is a questionnaire that asks how the patient's ear disease complaints and quality of life altered after surgery versus before surgery. At the six month after surgery, patients were asked to rate each question on the 12-question questionnaire from 5 to 1 as "much better," "slightly better," "no change," "slightly worse," and "very bad," in that order. Low scores indicate symptom worsening, whereas high scores indicate symptom improvement (7, 8). The first seven questions (Q1-7) addressed the intensity of ear problems, questions 8-11 (Q8-11) concerned the impact of surgery on lifestyle, employment and health, and question 12 (Q12) examined overall well-being, and we analyzed these sub-scores separately.

Statistical analysis

Statistical analyses were performed with SPSS version 23.0 (IBM Corp., Armonk, NY, USA). Shapiro-Wilk, Kolmogorov-Smirnov tests and skewness-kurtosis statistics were used to assess normal distribution. Categorical variables were analyzed using the Pearson Chi-Square test. An independent sample t-test was used for normally distributed data and Mann Whitney U test was used for non-normally distributed data. Analysis of covariances (ANCOVA) was performed to answer the question of whether the surgical technique or the patient's existing hearing reserve was more effective on postoperative audiological measurements. Partial eta squared (η2) values were calculated. η2 values calculate the strength of the effect of the independent variable on the dependent variable (postoperative hearing outcomes) while controlling for the main and joint effects of other independent variables (time). The level of significance was set at $p<0.05$.

RESULTS

The ETG included 30 patients (18 female/12 male;mean age=36.23±13.35). The MTG had 22 patients (16 female/6 male; mean age=39.54±12.42). There was no statistically significant difference between the two groups in terms of age and gender ($p=0.368$ and $p=0.341$ respectively). Also, there was no difference between the groups in terms of right ear/left ear ratio (ETG=14/16; MTG=12/10) ($p=0.575$). While one patient in ETG and three patients in MTG had moderate disease, all other patients were in the mild disease category, and there was no statistical difference in the MERI category between the groups. The duration of hospitalization was significantly shorter in the ET group ($p<0.001$). Table 1 summarizes the demographic and surgical characteristics of the groups.

The effect of surgical method on AC, BC and ABG postop results was analyzed by the ANCOVA test. When the preop values were added to the model as a covariate variable, it was determined that the postop results did not differ according to the groups ($p=0.137$, $p=0.960$ and $p=0.139$ respectively). The effect of preop values on postop values was found to be significant ($p<0.001$). When partial eta square values were analyzed, the effect of groups on postop measurements for AC, BC and ABG variables were 0.045, 0.960 and 0.139, respectively, while the effect of preop values were calculated as 0.704, 0.889 and 0.443, respectively. In other words, the effect of preop values on postop values is more independent of the groups. In other words, the variable that has an effect on postoperative audiological measurements is preoperative measurements and not the method of surgery (Table 2).

The mean hearing gain was 11.8±5.01 in the endoscopic tympanoplasty group and 9.36±6.98 in the microscopic tympanoplasty group with no statistically significant difference between the two groups ($p=0.149$) (Figure 1).

Postoperative surgical results and quality of life assessment questionnaire results of the groups are demonstrated in Table 3. The graft failed in 2 patients in ETG and 3 patients in MTG. There were no statistically significant differences between groups in terms of severity of ear symptoms (Q1-7), impact of surgery on lifestyle, work and health (Q8-11), general well-being (Q12) and total COMBI score ($p>0.05$) (Table 3).

DISCUSSION

Chronic otitis media surgery includes repair of the tympanic membrane, removal of pathological tissues such as cholesteatoma, sclerosis, or granulation tissue, and interventions on the ossicular chain for hearing reconstruction. For this purpose, numerous surgical procedures, hearing reconstruction techniques, graft materials, and grafting techniques have been used (4, 11, 12). While the microscopic approach was the only accepted surgical approach for ear surgeries for many years, the endoscopic approach has been used with increasing frequency since the 1990s (4). Endoscopic type 1 tympanoplasty has become increasingly popular recently (13). In addition to the significant differences in surgical comfort, learning curve, and field of view between microscopic and endoscopic techniques, many studies analyzing the surgical results of the two surgical approaches have been published in recent years (13).

The Middle Ear Risk Index (MERI) is the most well-known grading system for classifying the severity of middle ear disease (11). Based on MERI scores, in this study, one patient in ETG and three patients in MTG had moderate disease, while all other patients had mild disease, and there was no statistical difference between the groups. This was essential baseline data for assessing the severity of the disease. In a retrospective study, Ismi et al. reported that graft failure rates were more common in patients with high MERI scores, and they recommended double-layer tympanoplasty instead of single-layer grafting for patients with medium-high MERI scores (14). We preferred single-layer cartilage grafting, as none of the patients' MERI scores was high. According to Tseng et al., graft success rates were similar, as 85.1% and 86.4% for endoscopic and microscopic tympanoplasty, respectively (15). Graft success rates ranged between 83.3%-100% for endoscopic and 82.4%-100% for microscopic approaches in various studies that compare the endoscopic and microscopic tympanoplasty (16-18). In our study, these rates were 93.3% for ETG and 95.5% for MTG, which is similar with the literature.

Table 1: Demographic and clinic features of groups

	ETG (n:30)	MTG (n:22)	p
Age (Mean±SD)	36.23±13.35	39.54±12.42	0.368[a]
Gender (F/M)	18/12	16/6	0.341[b]
Ear Side (Right/Left)	14/16	12/10	0.575[b]
MERI score (mild/moderate)	29/1	19/3	0.168[b]
Hospitalization (day) (Median (min-max))	1 (1-2)	3 (2-4)	**<0.001**[c]

a : Independent sample t test, b: Chi-Square test, c: Mann Whitney U test, ETG: Endoscopic tympanoplasty group, MTG: Microscopic tympanoplasty group, SD: standard deviation, F: female, M: male, MERI: Middle Ear Risk Index. Bold prints in 'p' column, indicate a significant difference between groups

Table 2: Preoperative and postoperative audiological results of the groups

		Descriptive Statistics		ANCOVA Results			
		Group		Group		Pre	
		ETG (n=30)	MTG (n=22)	p	PES	p	PES
AC (Mean±SD)	Pre	37.47±11.48	39.59±10.02	0.137	0.045	**<0.001**	0.704
	Post	25.67±11.78	30.23±11.01				
BC (Mean±SD)	Pre	11.87±8.04	14.91±5.49	0.960	0.000	**<0.001**	0.889
	Post	12.03±7.9	14.91±5.57				
ABG (Mean±SD)	Pre	25.6±7.43	24.68±7.34	0.139	0.044	**<0.001**	0.443
	Post	13.63±7.01	15.32±7.33				

ETG: Endoscopic tympanoplasty group, MTG: Microscopic tympanoplasty group, SD: standard deviation, AC: Air conduction threshold, BC: Bone conduction threshold, ABG: Air-bone gap, pre: preoperative results, post: postoperative results, PES: Partial Eta Squared
Bold prints in 'p' column, indicate a significant difference between groups

Table 3: Graft success and postoperative quality of life results of the groups

	ETG	MTG	p
Graft success (success/unsuccess)	28/2	18/1	0.746[a]
COMBI total (Mean±SD)	49.63±6.04	47.86±4.83	0.263[b]
Q1-7 (Mean±SD)	29.43±3.73	27.73±3.49	0.101[b]
Q8-11 (Mean±SD)	16.13±2.7	15.77±2.07	0.603[b]
Q12 (Mean±SD)	4.07±0.91	4.32±0.57	0.258[b]

a: Chi-Square test, b: independent sample t test, ETG: Endoscopic tympanoplasty group, MTG: Microscopic tympanoplasty group, SD: Standard deviation, COMBI: Chronic Otitis Media Benefit Inventory, Q1-7, First 7 question of COMBI, severity of ear symptoms, Q8-11, 8-11th questions of COMBI, lifestyle, work and health service impact, Q12, 12th question of COMBI, general wellness. Bold prints in 'p' column, indicate a significant difference between groups

Similar studies comparing the results of microscopic and endoscopic type 1 tympanoplasty by Kim et al., Gulsen et al., and Ohki et al. found that preoperative AC and ABG values decreased significantly in the postoperative period within the group, but there was no difference in preoperative and postoperative values between the groups (19-21). As in our work, there was no difference in HG across groups in the studies of Gulsen et al. and Ohki et al. (20, 21).

Endoscopic Type 1 tympanoplasty, according to Yonglan Zhang et al. 2021, has a smaller incision, less postoperative pain, and no postoperative scarring or periauricular paresthesia compared to microscopic Type 1 tympanoplasty (2). Several meta-analyses and review studies on endoscopic ear surgery confirm the approach's safety with minimal morbidity (13). Although early discomfort and scar formation were not addressed in our research, the length of hospitalization was significantly shorter in ETG (p<0.001). Although brief hospitalization is a preferred and satisfactory condition for all patients in the early period, it is not sufficient to measure the success or benefit of a surgery.

As with many procedures targeting functional outcomes, there are conceptual differences in how patients and surgeons perceive treatment success in ear surgery. According to otologists, healing of the perforation, a non-draining ear,

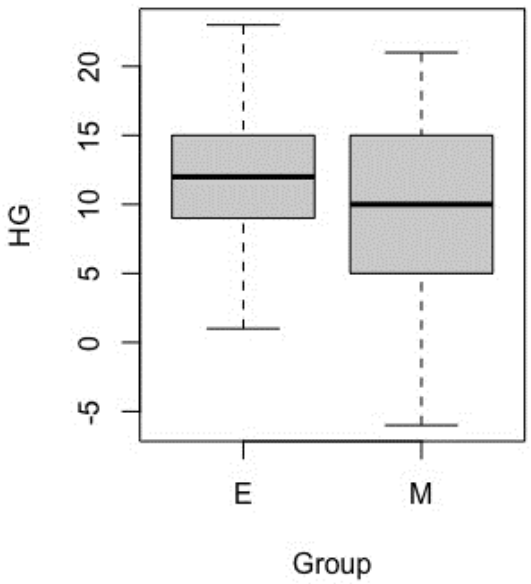

Figure 1: Comparison of HG in endoscopic and microscopic tympanoplasty groups. Boxes indicate the first and third quartiles, and median observations are denoted by a line in each box.
HG: Hearing gain, E: Endoscopic tympanoplasty, M: Microscopic tympanoplasty

improvement in hearing values on audiological evaluation, and the lack of residual disease on postoperative imaging are all signs of successful surgery. However, these measurements are inadequate to assess patients' quality of life. In recent years, there has been a lot of interest in determining a disease's physical and mental impacts from the patients' point of view. Combining clinical data and patient feedback is believed to provide more accurate information for evaluating surgical outcomes (22). While objective evaluation tools should be applied to highlight the benefits of procedures, self-assessment tools such as quality-of-life surveys should be preferred to accurately predict changes in patients' quality of life (8). Although many studies investigate the surgical and audiological results of endoscopic and microscopic tympanoplasty, a limited number of studies compare them with PROM. Kallyadan et al. compared the two techniques regarding patient satisfaction, and they reported that patients who underwent surgery with the endoscopic method reported significantly less pain, shorter hospital stays, and better cosmetic results (23). Metwaly et al. evaluated the satisfaction of their patients to whom they performed endoscopic and microscopic tympanoplasty using the Chronic Ear Survey (CES), and they reported that the subscale and total scores of those who had surgery using the endoscopic method were significantly better (11). We compared ear surgery-related quality of life using COMBI. The severity of ear symptoms (Q1-7), impact of surgery on lifestyle, work, and health (Q8-11), general well-being (Q12), and total COMBI score were similar in the two groups in our study. The most crucial aspect distinguishing COMBI from other ear-related surveys is comparing the postoperative and preoperative conditions with a single survey. Our study did not ask the patients any questions about early-term satisfaction. However, through the COMBI, which we performed in the 6th postoperative month, we saw that the two surgical methods were not superior to each other in terms of long-term satisfaction. However, due to the limited number of participants in our study, larger patient groups are needed to reach a definitive conclusion.

This prospective study was limited by several factors. First, since the number of microscopic tympanoplasties has decreased considerably in recent years, the sample size was limited to avoid intergroup differences. Additionally, this study was only conducted in one hospital. A more thorough case survey, relatively long-term follow-up data, or a multicenter investigation would be more informative.

CONCLUSION

We determined that endoscopic and microscopic tympanoplasty have equivalent success rates in terms of perforation repair and hearing improvement. The endoscopic approach, however, has less postoperative morbidity, a shorter operation time, better intraoperative visualization of the middle ear, and better cosmetic results. However, there are disadvantages to the endoscopic technique, such as the difficulty of one-handed operation, the need for frequent cleaning and vaporization of the optics, and the lack of three dimensional vision and depth perception. In this study, we evaluated these two techniques together with their effects on patient-reported COMBI and quality of life. Although there have been numerous studies examining the surgical and audiological outcomes of these two approaches, there have been few studies comparing these two methods with the PROM. More extensive studies are needed in this area.

Ethics Committee Approval: This study was approved by the Ethics Committee of Ondokuz Mayis University (Date: 12.05.2020, No: OMU KAEK 2020/331).

Informed Consent: Written informed consent was obtained.

Peer Review: Externally peer-reviewed.

Author Contributions: Conception/Design of Study- E.K.U., E.T., Ö.K., M.A.; Data Acquisition- E.K.U., E.T., Ö.K., M.A.; Data Analysis/Interpretation- E.K.U., E.T., M.A.; Drafting Manuscript- E.K.U., E.T., M.A.; Critical Revision of Manuscript- E.K.U., E.T., M.A.; Final Approval and Accountability- E.K.U., E.T., Ö.K., M.A.

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