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Original Research Article

Comparison of Outcome Between Microscopic and Endoscopic Tympanoplasty Type 1

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Abstract

Objective: This study aimed to compare the outcome of endoscopic and microscopic tympanoplasty and to analyze the outcomes in terms of the hearing gain, duration of surgery, and graft success rate.

Methods: In this retrospective study, the outcomes of 120 patients (63 male and 57 female) who underwent type 1 tympanoplasty were evaluated. The age range of the patients was 20–60 years. Group 1 underwent tympanoplasty with an endoscopic technique ($n = 60$), and Group 2 underwent tympanoplasty with the conventional microscopic technique ($n = 60$). 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. The mean operative duration in Group 1 was significantly lower than that in Group 2 . 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: With endoscopic system, minimal invasive tympanoplasty can be possible with similar graft success rate ,less pain and shorter operative time.

Keywords: Endoscopy, Tympanoplasty, Minimally Invasive Surgical Procedures, Pain

Introduction

Tympanoplasty was conventionally performed using a microscope for decades. However, since the endoscope began to be used in middle ear surgery in the 1970s, endoscopic tympanoplasty has gained increasing attention. The main objective of this study was to compare endoscopic and microscopic tympanoplasty with and without

ossiculoplasty, demonstrating the potential advantages, disadvantages, and outcomes of each. [1-4]

Since the introduction of tympanoplasty, a variety of graft materials and surgical techniques have been developed and used to close perforations in the tympanic membrane (TM). Temporalis fascia and perichondrium remain the most widely used materials, and successful closure can be achieved in 80% to 90% in patients who undergo primary tympanoplasty with a microscopic approach . Conventional microscopic tympanoplasty with a postauricular incision remains the most effective procedure for patients with chronic otitis media, especially in cases of anterior or large TM perforation as well as anterior bony overhang. This conventional procedure results in surgical scar and significant pain to the patient. [5-8]

There has been lack of reliable data regarding the efficacy and functional outcome of endoscopic tympanoplasty as compared with conventional microscopic tympanoplasty. In this study, we evaluate and compare the results of hearing outcome, postoperative pain assessment, operation time, graft success rate, and surgical complications in patients who underwent endoscopic and conventional microscopic tympanoplasty. The aim is to clarify the clinical benefit of endoscopic tympanoplasty compared to conventional microscopic surgery by an endaural or postauricular approach. [6-9]

Materials and Methods

The study enrolled 120 patients aged 20 to 60 years (mean, 38.0±8.2 years) who underwent tympanoplasty type I for chronic otitis media. All patients had endoscopic examination, pure tone audiometry, and temporal bone computed tomography as preoperative work-up and had postoperative follow-up with endoscopic examination and pure tone audiometry at 3 months after surgery. Mean follow-up was 6.4 months (range, 3 to 11 months). Patients were classified into two groups according to type of surgery: endoscopic tympanoplasty (ET) and microscopic tympanoplasty (MT). Type of surgery was decided by each surgeon's preference and patient counselling. Either microscopic or endoscopic tympanoplasty were performed by experienced otologists.

All subjects had pain control with acetaminophen 650 mg administered orally three times a day postoperatively for 1 week. Pure tone audiotory tests were performed at preoperatively and 3 months postoperatively. Hearing thresholds including air conduction and bone conduction were measured at 0.5, 1.0, 2.0, and 4.0 kHz, and the puretone averages were calculated. TM perforation size was expressed as a percentage of the entire TM. Detailed operative data were collected including type of operation (ET, MT), operation time, whether external auditory canal (EAC) widening was performed for a better surgical view or not. Width of the narrowest portion of the EAC on the axial image of computed tomography was measured. During the postoperative follow-up, pain scale score was collected immediately after surgery, at 3 hours, and 1 day postoperatively. The graft success rate was also determined. Pain scale was scored using an 11-item, patient-reported numeric rating scale of pain intensity (NRS-11, range 0 to 10). Graft success as well as healing status of the EAC was evaluated at 3 months postoperatively by endoscopic examination. A dry, clean ear canal without TM perforation represented graft success.

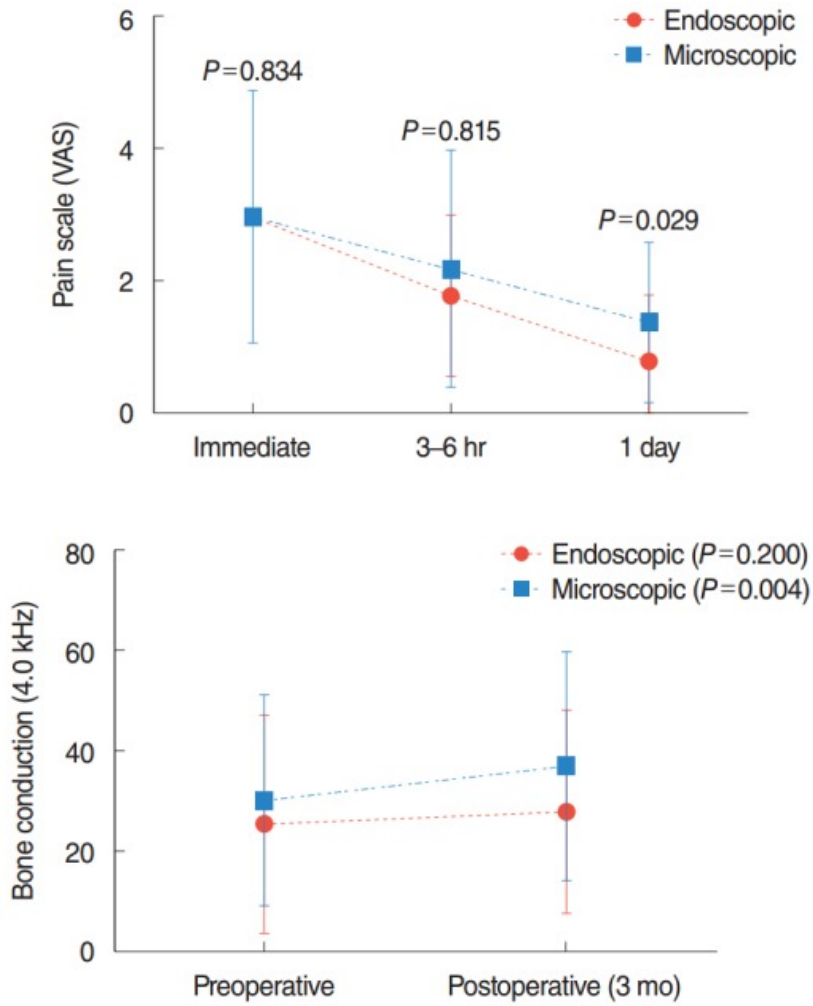
Surgical technique Tympanoplasty type I procedures were performed in all patients. The EAC was widened during the surgery when visualization of the middle ear cavity was difficult due to anterior bony overhang. In the MT group, surgery was performed with an endaural incision, based on the Lempert method . The first incision was made along the posterior half of the ear canal. The second vertical incision was made in the incisura to connect the first incision with the area

between the tragus and the root of the helix . A postauricular incision was used in cases where the perforation margin was poorly visualized due to narrow external ear canal, anterior bony overhang, or large TM perforation .

In the ET group, an endoscopic system and 0- or 30-degree rigid endoscopes were used. In this technique, incisions were performed 5 to 6 mm lateral to tympanic annulus in the posterior part of the EAC perpendicular to the TM tympanic from the superior and inferior end of the first incision. A tympanomeatal flap was elevated for middle ear cavity visualization, and pathologic processes of the middle ear were removed . The middle ear was packed with a Gelfoam and the autologous graft, which was most often harvested from tragal perichondrium and rarely temporalis fascia, was underlaid medial to the TM remnant and the manubrium of the malleus. Finally, the tympanomeatal flap was returned to its original position and the medial aspect of the ear canal was packed with Gelfoam .

Observation chart

Variable	**Overall (n=120)**	**ET (n=60)**	**MT (n=60)**	***P*-value**
Age (yr)	52.0±12.2	54.4±11.7	53.7±12.6	0.810
Sex (male:female)	63:57	34:26	29:31	0.140
TM perforation (%)	21.9±12.0	25.3±11.7	20.1±11.9	0.074
Operation time (min)	81.8±28.1	68.2±22.1	88.9±28.5	0.002*
EAC width (mm)	4.2±0.6	3.9±0.7	4.3±0.6	0.011*
EAC widening	16 (21.9)	0	16 (33.3)	0.001*
Graft success rate	71 (97.3)	25 (100)	46 (95.8)	0.304
PTA-preoperative				
Bone	26.6±16.2	23.9±16.9	28.0±15.8	0.174
Air	45.2±18.1	42.7±19.7	46.5±17.3	0.276
Air-bone gap	18.7±7.3	18.9±7.8	18.6±7.1	0.995
Air-bone gap (dB)				
Preoperative	18.7±7.2	18.9±1.6	18.6±1.0	0.877
Postoperative	11.3±8.6	9.2±1.4	12.5±1.3	0.120
P-value	<0.001*	<0.001*	<0.001*	
Bone conduction (dB)				
Preoperative	26.6±16.2	23.9±16.9	28.0±15.8	0.174
Postoperative	27.8±18.1	29.9±19.6	29.8±18.5	0.105
P-value	0.098	0.221	0.342	



Results

The demographic data and clinical findings of each group (ET, n=60; MT, n=60) are presented in . Mean ages were 48.4±1.7 years (ET) and 48.7±2.6 (MT). The ages did not differ significantly. Preoperative audiometric tests including bone and air conduction, and air-bone gap were not significantly different between the two groups (*P*=0.174, 0.277, and 0.995, respectively).

The TM perforation size was larger in ET group (25.3%±11.7%) than MT group (20.1%±11.9%), without statistical significance (*P*=0.074). Mean operation time of the MT group (88.9±28.5 minutes) was significantly longer than the ET group (68.2±22.1 minutes) (*P*=0.002). EAC width was shorter in the ET group (3.9±0.7 mm) than in the MT group (4.3±0.6 mm). However, EAC widening was not necessary in the ET group and was performed in 33.3% of patients in the MT group. Graft success rate in the ET and MT group was 100% and 95.8%, respectively, which was not statistically significantly different (*P*=0.304).

Pain scale scores were compared between the three groups immediately after surgery, 3 to 6 hours later, and 1 day postoperatively . Immediately and 3 to 6 hours after surgery, pain scales were not significantly different (*P*=0.834 and 0.815, respectively). Pain scale score of 1 day after surgery was significantly lower in ET group (*P*=0.029). The ET group

displayed 0.8±1.0 of pain score, and MT group was 1.5±1.3 at 1 day after surgery. Preoperative audiometric parameters including bone conduction, air conduction, and air-bone gap were not significantly different between ET and MT group (P=0.174, P=0.276, and P=0.995, respectively).

Pre- and postoperative air-bone gap was analyzed with paired *t*-test separately in each group. In the ET group, the pre- and postoperative air-bone gap was 18.9±1.6 dB and 9.2±1.4 dB, respectively, which was a significant improvement (P<0.001). The respective values in the MT group (18.6±1.0 dB and 12.5±1.3 dB) also represented a significant (P<0.001).Bone conduction preoperatively and 3 months postoperatively were compared using the paired *t*-test in each group to evaluate inner ear damage. All groups had no significant difference between pre- and postoperative bone conduction (ET, 23.9±16.9 vs. 29.9±19.6 dB, P=0.221; MT, 28.0±15.8 vs. 29.8±18.5 dB, P=0.342).

In addition, 4.0 kHz bone conduction hearing levels were compared for sensitive evaluation of inner ear damage in each group . In the ET group, bone conduction hearing level was 25.8±21.9 dB preoperatively and 28.2±20.3 dB at 3 months postoperatively. There was no significant changes in the ET group (P=0.200). Otherwise, there was significant aggravation of bone conduction in the MT group (P=0.004). Preoperative bone conduction of the MT group was 30.5±21.0 dB and postoperative bone conduction was 37.4±22.8 dB.

Statistical analysis:

The collected data was summarized by using frequency, percentage, mean & S.D. To compare the qualitative outcome measures Chi-square test or Fisher's exact test was used. To compare the quantitative outcome measures Independent t test was used. If data was not following normal distribution, Mann Whitney U test was used. SPSS version 22 software was used to analyse the collected data. p value of <0.05 was considered to be statistically significant.

Discussion

Surgical technique Tympanoplasty type I procedures were performed in all patients. The value of endoscopes combined with the conventional microscopic eradication of cholesteatoma has been established. Besides surgeries for cholesteatoma removal, an exclusively endoscopic approach during tympanoplasty has been applied to facilitate minimally invasive surgery .However, endoscopic surgery has several disadvantages. Only one-hand surgery is feasible with the endoscopic technique, which is less efficient; in a situation of massive bleeding, the endoscopic view could be stained by blood and continuing the procedure could be difficult. Furthermore, endoscopic instrument could make direct injury and thermal damage by light source .

Dündar R et al investigated the outcomes of the endoscopic versus microscopic approach to type 1 tympanoplasty in pediatric patients.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.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.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.Huang TY et al also did a similar comparative study of endoscopic and microscopic approach type 1

tympanoplasty for simple chronic otitis media. [10,11]

Choi N et al aimed to compare the outcome of endoscopic and microscopic tympanoplasty.This was a retrospective comparative study of 73 patients . The subjects were classified into two groups; endoscopic tympanoplasty (ET, n=25), microscopic tympanoplasty (MT, n=48). Demographic data, perforation size of tympanic membrane at preoperative state, pure tone audiometric results preoperatively and 3 months postoperatively, operation time, sequential postoperative pain scale (NRS-11), and graft success rate were evaluated. In all groups, the postoperative air-bone gap was significantly improved compared to the preoperative air-bone gap. Immediate postoperative pain was similar between the groups. However, pain of 1 day after surgery was significantly less in the ET group.It was concluded that with endoscopic system, minimal invasive tympanoplasty can be possible with similar graft success rate and less pain. [12]

Kuo CH et al also did comparison of endoscopic and microscopic tympanoplasty. This retrospective study included 126 patients with chronic otitis media .The overall endoscopic tympanoplasty graft uptake rate was 97.7% (128/131). The operation time was significantly shorter in the endoscopic group statistically. A paired *t* test was used to compare pre- and postoperative audiometry results and showed significant differences between the endoscopic and microscopic groups. Our study demonstrated that endoscopic tympanoplasty can be feasibly applied in middle ear surgery. The success rate, audiometry improvement, and complication rate are comparable between endoscopic tympanoplasty and conventional microscopic tympanoplasty. Moreover, the endoscopic group had smaller operation wounds and lower medical expenditures. [13]

Akyigit A et al postulated that as in other surgical fields, there is also a trend towards minimally invasive intervention in the field of otorhinolaryngology.
Smaller incisions performed under the guidance of endoscopes are preferred over conventional large incisions. Using this approach, improved outcomes can be achieved and postoperative morbidities can be reduced. In addition, the outcomes of grafts performed using the endoscopic approach are similar to that achieved by the microscopic approach. Therefore, endoscopic ear surgery implementations are becoming increasingly popular. [14]

Jyothi AC et al did study with aim was to compare the results of endoscopic permeatal myringoplasty with that of conventional myringoplasty by post aural approach using operating microscope. Temporalis fascia was used as a graft material. The patients were kept in follow-up for 1 year. The pre-operative and post-operative audiograms, post-operative pain, graft uptake and time taken for surgery were compared in both the groups.. In our study success rate was equal between endoscopic and microscopic technique. In terms of morbidity and postoperative recovery endoscope produced better results. Endoscopic tympanoplasty can be a good alternative of microscopic tympanoplasty. [15]

Gülşen S et al did endoscopic transcanal versus conventional microscopic tympanoplasty in treatment of anterior tympanic membrane perforations.They retrospectively analyzed the graft success rate, hearing outcomes, operative time, hospitalization period and complications in patients who underwent ETT and CMT .In addition, the authors investigated whether anterior canal wall protrusion (ACWP) affects the graft success rate and operative time.Regarding operative time, there was no statistically significant difference between patients with and without ACWP (38.3 versus 36.3 min, respectively ($p = 0.124$)) in the ETT

group. However, the mean operative time of patients with ACWP in the CMT group was significantly longer than patients without ACWP [62.3 versus 48.8 min, respectively ($p < 0.001$)].ETT offering fewer complication rates and shorter duration of surgery may serve as a reasonable alternative to CMT in repairing ATMPs, with comparable graft success rates. [16]

Lee S et al evaluated the results of transcanal endoscopic tympanoplasty for pediatric patients with chronic otitis media (COM) and compared them to that of the previously standard microscopic assisted tympanoplasty technique. They analyzed the outcomes in terms of the hearing gain according to the surgical method and COM type, operation time, hospital stay after surgery, and graft success rate. The intact graft success rate was 91.6% in group 1 and 93% in group 2; the values were not significantly different (**P**>0.05). There was neither intra- nor postoperative complications.Transcanal endoscopic ear surgery technique is more conservative than microscopic approach and can be performed in pediatric patients under 15 years of age with COM. Moreover, it offers similar surgical results compared to traditional microscopic technique, and a shorter operative time and hospital stay after surgery are the advantages of this technique.Various other similar studies with similar results like ours supports the study and inferences derived by us. [17-20]

Advantages of endoscopic ear surgery compared to the conventional microscopic surgery include avoiding endaural vertical and postauricular incisions, and mastoidectomies in securing the surgical view . Endoscopically, the typical transcanal approach is possible by elevating a tympanomeatal flap. This avoids other unnecessary incisions and soft tissue dissections. The endoscopic approach also provides better visualization of hidden areas in the middle ear cavity including the anterior and posterior epitympanic spaces, sinus tympani, facial recess, and hypotympanum. Endoscopy-mediated procedures can decrease residual cholesteatomas and recurrences during surgeries for cholesteatoma removal. [21,22,23]

Conclusion

Endoscopic ear surgery avoids other unnecessary incisions and soft tissue dissections. The endoscopic approach also provides better visualization of hidden areas in the middle ear cavity. Endoscopy-mediated procedures can decrease surgical time ,residual cholesteatomas and recurrences during surgeries

Declarations:

Funding: None **Conflicts of interest/ Competing interests**: None **Availability of data and material**: Mahaveer Medical College & Research Center Bhopal **Code availability**: Not applicable **Consent to participate**: Consent taken **Ethical Consideration**: There are no ethical conflicts related to this study. **Consent for publication**: Consent taken

What this study add to existing knowledge
Minimally invasive otologic surgery has recently been developed along with endoscopic techniques. Advantages of endoscopic ear surgery compared to the conventional microscopic surgery include avoiding endaural vertical and postauricular incisions, and mastoidectomies in securing the surgical view . Endoscopically, the typical transcanal approach is possible by elevating a tympanomeatal flap. This avoids other unnecessary incisions and soft tissue dissections. The endoscopic approach also provides better visualization of hidden areas in the middle ear cavity including the anterior and posterior epitympanic spaces, sinus tympani, facial recess, and hypotympanum. Endoscopy-mediated procedures can decrease residual cholesteatomas and recurrences during surgeries for cholesteatoma removal .

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