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Endoscopic versus Microscopic Type 1 tympanoplasty – Comparison of surgical outcomes.

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ABSTRACT

Objective

This study aims to compare the surgical outcomes of type 1 tympanoplasty performed with endoscopic and microscopic techniques. It aims to compare the outcomes in terms of hearing restoration and graft success rates. It also assesses differences in postoperative pain and operative time.

Methods

A prospective study conducted over 8 months included 84 patients, divided into two groups: 42 undergoing microscopic tympanoplasty (postaural approach) and 42 undergoing endoscopic tympanoplasty (endomeatal approach), using temporalis fascia graft. Preoperative and postoperative hearing were evaluated through pure tone audiometry. Post operative hearing improvement and graft success was assessed at 3 months. Postoperative pain was measured using a numerical rating scale at immediate and 1-week follow-ups.

Results

Both groups demonstrated similar graft success rates (microscopic 95.23%, endoscopic 92.86%) with no significant difference in hearing improvement or air-bone gap closure. However, the endoscopic group had significantly shorter operation times (mean 65.12 minutes) and less postoperative pain (immediate and at 1-week follow-up) compared to the microscopic group (mean operation time 82.17 minutes, higher pain scores).

Conclusion

Endoscopic tympanoplasty offers comparable graft success and hearing outcomes to the microscopic approach while providing the advantages of shorter operation time and reduced postoperative pain. These findings support the growing preference for endoscopic techniques in minimally invasive middle ear surgeries.

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INTRODUCTION

Chronic otitis media is a stage of ear disease in which there is an ongoing chronic infection of the middle ear without an intact tympanic membrane. The goal of type 1 tympanoplasty is to repair the tympanic membrane (TM) and enable hearing restoration in chronic otitis media.[1] It is typically performed microscopically worldwide.[2] The microscope offers not only binocular vision but also an excellent stereoscopic surgical view and leaves both the surgeon's hands free. However, it is limited by the straight-line vision which makes visualization of the middle ear through the ear canal relatively challenging. The microscopic surgery requires an upside-down conical "working space," resulting in much more soft tissue resection, with or without drilling of the bone to obtain adequate illumination.[3] With the advent of minimally invasive surgery, endoscopes have gained popularity for middle ear surgeries.[4] It has become widely accepted with the introduction of high-quality narrow-diameter endoscopes, ultra-high-definition cameras and screens, and cold light sources.[5] In contrast to the microscope, the endoscope has a cone-shaped source of illumination, which provides optimal visualization and allows a wider field of view of the surgical area.[6] Endoscopic ear surgery permits a direct visualization of hidden areas[7] such as the sinus tympani, hypotympanum, posterior part of the mesotympanum, and epitympanum.[8] In this study, we compared the results of type I tympanoplasty performed with endoscope versus microscope for treatment of chronic otitis media in terms of hearing outcome, postoperative pain assessment, operation time and graft success rate.

Aims and Objectives

Our study aimed to compare the surgical outcomes of type 1 tympanoplasty performed with endoscopic and microscopic techniques. It compares the outcomes in terms of hearing restoration and graft success rates. It also assesses differences in postoperative pain and operative time.

Materials and Methods

The study was approved by the Institutional Ethics Committee. This was a prospective study performed over a period of 8 months in the Ear, Nose and Throat (ENT) department of a tertiary care teaching hospital in western India. Patients presenting to our outpatient department, diagnosed as Chronic otitis media mucosal type with dry ear for a minimum of three weeks and planned for tympanoplasty, were included in the study. A total of 84 patients were selected. 42 patients underwent microscopic tympanoplasty. The remaining 42 patients underwent endoscopic tympanoplasty. Informed written consent was taken from patients, after explaining the study in their native language. We excluded patients less than 10 years of age, those with mixed hearing loss on pure tone audiometry (PTA), those with active ear discharge, those with a previous history of ear surgery, patients requiring ossicular chain reconstruction, and those not consenting to the study.

Endoscopic tympanoplasty was done by the endomeatal approach and the microscopic surgery was done by the postaural approach. A temporalis fascia graft was used in all cases. In the endoscopic group, tissue for the graft was harvested from a small horizontal incision above the pinna which was completely covered by the hairline. An endoscope with a 4 mm diameter, 18 cm length and 0-degree was used for the endoscopic surgery. Pure tone audiometry was done to assess the hearing preoperatively. Duration of surgery in minutes was noted down for all the patients. A pain assessment was done using a numerical rating scale (scores 0–10) in the immediate post operative period and at 1 week follow-up. Patients were followed up for 3 months. Graft uptake was confirmed by otoscopic findings and PTA was done to assess hearing outcome at three months follow-up.

Data was collected and analysed, regarding age, gender, size of perforation, preoperatively PTA, the technique of tympanoplasty, operative time, postoperative pain, graft uptake and changes in PTA.

Results

In our study, data was collected on a number of parameters. These included the preoperative state of patients, and pure tone audiometric results both preoperatively and 3 months postoperatively. Data was also collected on

operation time, sequential postoperative pain, and graft success rate. All collected data was analysed and assessed. Statistical analysis was performed using SPSS. SPSS was chosen for its ease of use and robust analytical capabilities. The main limitation is its restricted availability due to licensing requirements. A total of 84 patients were included in the study. Their mean age was 33.43years (SD ± 14.308) with a range of 10 to 68 years (Table1). The overall mean preoperative hearing loss was 28.88 (±6.99) dB and mean postoperative hearing loss at 3 month follow up was 9.29 (±3.21) dB. (Table1).

Table 1 Demography and operative parameters

	Age	Pre op AB gap (dB)	AB gap post op dB HL (3 months f/u)
Mean	33.43	28.88	9.29
Median	32.50	28.00	8.00
Mode	35	26	8
Std. Deviation	14.308	6.990	3.210

10 (11.9%) belong to <18 years age group,26(31%) to 18-30years,24(28.6%) to 31-40years age group,11(13.1%) to 41-50 years age group,8(9.5%) to 51-60 years age group and 5(6%) to >60 years age group(Table 2). 46 (54.8%) patients were female compared to 38 (45.2%) males. Characteristic features of perforation are given in Table 2. We classified TM perforations based on the percentage of area of the TM involved-small (<25%), moderate (25-50%), large (50-75%), and subtotal (75-99%). There were 22 (26.2%) participants with large perforations, 36(45.2%) with perforations-classified as moderate, and 20(23.8%) with a small perforation and 6 (7.1%) were subtotal in size. (Table2).

Table 2 Demographics, perforation characteristics and graft success

	Frequency	Percentages
age group		
<18yrs	10	11.9
18-30yrs	26	31.0
31-40yrs	24	28.6
41-50yrs	11	13.1
51-60yrs	8	9.5
>60yrs	5	6.0
Gender		
Female	46	54.8
Male	38	45.2
Perforation size		
Large	22	26.2
Moderate	36	42.9
Small	20	23.8
Subtotal	6	7.1
Graft success		
Failure	5	6.0
Intact	79	94.0

Out of 84 patients, an overall successful graft uptake was seen in 79 (94%) patients. (Table2). No statistically significant correlation was found between perforation size and graft take rate (P-value 0.426). (Table3)

Table 3 Comparison of demographics, perforation characteristics and graft success

Age group	Endoscopic	Microscopic	Chi square	P value
<18yrs	7	3	6.106	0.313
18-30yrs	15	11		
31-40yrs	9	15		
41-50yrs	5	6		
51-60yrs	5	3		
>60yrs	1	4	0.192	0.827
Gender				
Female	24	22		
Male	18	20		
Perforation size				
Large	13	9	8.194	0.039
Moderate	12	24		
Small	12	8		
Subtotal	5	1		
Postoperative graft uptake/Graft success				
Failure	3	2	0.213	1.00
Intact	39	40		

The microscope group was compared with the endoscope group. The groups were compared in terms of participant age, gender, perforation size and rates of postoperative graft uptake/graft success.. However, there was no significant difference found between the ages and genders of the two groups (p value 0.313 and 0.827) (Table 4) Microscopic and endoscopic tympanoplasties had similar graft success rates; 95.23% and 92.86%, respectively. Successful graft uptake was not significantly associated with the technique of surgery, with a p value of 1.00(Table 4)

Table 4 Comparison of age, hearing loss (preoperative, postoperative and gap closure), pain at follow up between groups

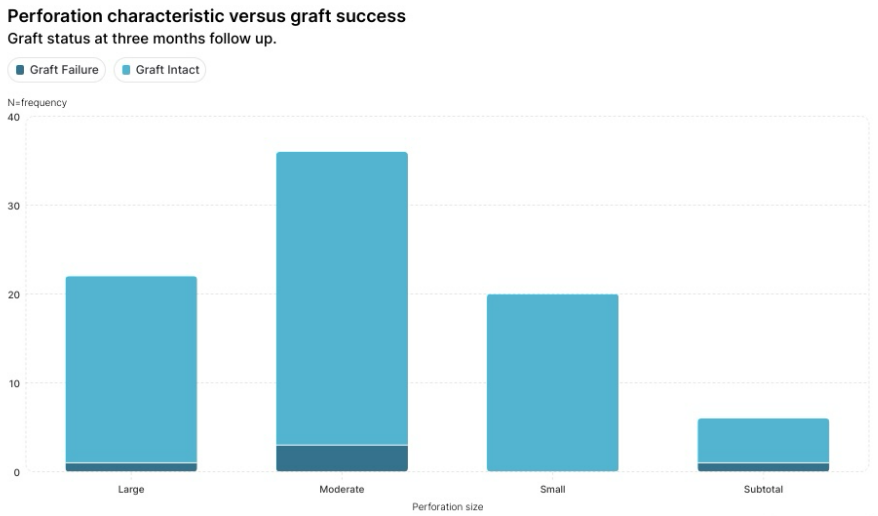
Variables	Groups	Mean	Standard deviation	P value
Age	Endoscopic	31.12	14.273	0.140
	Microscopic	35.74	14.134	0.140
Comparison of hearing loss				
Pre op AB gap (dB)	Endoscopic	29.74	7.474	0.264
	Microscopic	28.02	6.445	0.264
Operative time (mins)	Endoscopic	65.12	6.110	<0.001
	Microscopic	82.17	9.763	<0.001
AB gap post op dB HL (3 months f/u)	Endoscopic	9.26	3.422	0.946

	Microscopic	9.31	3.024	0.946
	Endoscopic	5.45	1.435	<0.001
Pain NRS (immediate post op)	Microscopic	7.79	0.951	<0.001
	Endoscopic	1.88	0.889	<0.001
Pain at follow up (1week)	Microscopic	5.00	1.230	<0.001
	Endoscopic	20.48	7.769	0.264
AB gap closure	Microscopic	18.71	6.545	0.264

Abbreviations
AB gap- Air Bone Gap
MS- Microscopic Tympanoplasty
PTA – Pure Tone Audiogram
TES- Endoscopic Tympanoplasty
TM- Tympanic Membrane

When we compared the patients undergoing Type I tympanoplasty by endoscope(TES), the preoperative hearing loss was 29.74 (7.474) dB, and the mean postoperative hearing loss was 9.26 (±3.422) dB. In the microscope(MS) group, the mean preoperative hearing loss was 28.02 (± 6.445) dB, and mean postoperative hearing loss was 9.31 (± 3.024) dB. There was no significant difference found between the two groups for preoperative and postoperative air-bone gap/hearing loss (p value 0.264 and p value 0.946) The mean operative time in the TES group (65.12 ± 6.11mins) was significantly lower than that of the MS group (82.17 ± 9.763 mins). The difference between the groups with regard to this was statistically significant (P-value <0.001). (Table 5). Overall, the TESprocedure was shorter. The mean air-bone gap closure was 20.48 (± 7.769) dB for the endoscope group and ai18.71 (±6.545) dB for the microscope group. There was no statistically significant difference in air-bone gap closure between the two groups (P-value 0.264)(Table 5). This implies that TES shows similar results to MS for the restoration of hearing after surgery. The immediate postoperative pain reported by participants was 5.45+/- 1.435 in the endoscopic group and 7.79+/- 0.951 in the microscopicgroup. Thus, pain immediately after surgery was significantly less in the ET group. Similarly, thepostoperative pain reported by participants at 1 week was 1.88+/- 0.889 in the endoscopic group and 5+/- 1.23 in the microscopic group. Thus, though pain decreased in both groups 1 week after surgery it was significantly less in the ET group (Table 5)Also, in both groups, the postoperative air-bone gap was significantly improved compared to the preoperative air-bone gap. Pre- and postoperative audiometric results including bone conduction thresholds and air-bone gap were not significantly different between the groups.

Figure 1



Discussion

Tympanoplasty goals include reconstruction of a healthy middle ear cavity, closure of perforation, and optimal restoration of hearing. 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.[9] Endoscopic type 1 Tympanoplasty has gained popularity in recent times. Since the endoscopic technique was introduced for middle ear surgery, the concept of minimally invasive surgery has developed. This could avoid mastoidectomies, external incisions, and soft tissue dissection in selected cases as compared with the conventional microscopic approach.[10] [11] [12]There are still many advantages of microscopic ear surgery. Its main advantage is the ability to provide binocular vision to the surgeon along with an excellent magnified surgical view. It also gives the benefit of two-handed surgery, which is extremely useful to keep the operation field clear. However, visualization of deep and hidden spaces involving sinus tympani, epitympanum, facial recess, and the attic area are limited with a microscope.[10] [11] Therefore, microscopic techniques frequently need further soft tissue dissection/retraction and bony drilling to obtain a better surgical view.[13] An endoscopic system allows a clear and high-definition surgical view, reducing the need for incision and drilling, as the powerful light source is located at the tip of the endoscope, and angled lenses facilitate visualization of hidden recesses.[13]In addition, endoscopes are an important educational tool. However, using an endoscope for ear surgery has several drawbacks as compared with microscopes. The endoscope can cause direct injury, and the close proximity of the powerful light source can lead to thermal damage to the external canal and middle ear.[14] [15] Furthermore, the endoscopic technique allows for only one-handed surgery. Thus, in a situation of massive bleeding, the endoscopic view could be obscured by blood and continuing the procedure could be difficult. However, the limitations of one-handed surgery would likely be overcome by experience. Due to heat generation from the light source of the endoscope, Kozin et al.[15] recommended using submaximal light intensity, and frequent repositioning of the endoscope. In our study, we could infer that there was no thermal damage to the inner ear, as bone conduction was not impacted, nor did the patients experience dizziness or nystagmus.In our study, the graft success rate in microscopic and endoscopic tympanoplasties were similar, with graft success rates of 95.23% and 92.86%, respectively. The successful graft uptake was not significantly associated with the technique of surgery i.e endoscopic vs. microscopic. Tseng et al. conducted a meta-analysis and said that graft success rates were 86.4% and 85.1%, with no significant difference between tympanoplasty with a microscope and an endoscope.[16] [17]Our study

showed results similar to the study by A. C. Jyothi et al. They reported a 91.67% graft uptake rate in the endoscopic group and 93.3% in the microscopic group.[18] This suggested that both techniques were equal in terms of inducing a successful graft uptake. Another study done by Ying-Chieh Hsu et al. concluded that rates of complete healing of the tympanic membrane were not statistically significant ($p < 0.05$) between endoscopic and microscopic tympanoplasty groups.[19]Similarly, a study by Qimei Yang et al showed that perforation closure rates were similar in the endoscopic and microscopic group with a post-operative follow-up of at least 6 months.[20]The graft success rate and post-op air-bone gap (ABG) closure was not influenced by the perforation size. Graft success rates are influenced by middle ear status and post operative care and is not significantly associated with perforation size. Tsing et al. and Ayache et al. reported, in their studies, that the perforation size does not affect graft success or hearing restoration.[21] [22] Our study found that the air-bone gap reduced significantly in both groups after surgery. Similarly, we found no statistically significant difference between the endoscope and microscope groups in terms of postoperative hearing improvement. The result of our study is comparable to previous studies by Dunder et al., Huang et al., Sinha et al., who also found that postoperative ABG improvement is statistically significant after tympanoplasty regardless of which technique was used.[23] [24] [25] In addition, there was no significant difference in air-bone gap closure between patients undergoing surgery using the microscopic technique and the endoscopic technique.Similarly, in our work, there was no difference in ABG improvement across endoscopic and microscopic groups in the studies of Gulsen et al. and Ohki et al.[26] [27]In this study, we observed that the mean operative time was significantly longer in the microscopic group than in the endoscopic group ($P < 0.001$). In a study by Huang et al.[24], the mean operative time was 50.4 min among 50 patients who underwent endoscopic tympanoplasty, compared with 75.5 min for the microscopic approach ($P < 0.0001$). Hsu et al.[19] also reported that the mean duration of surgery and the operative time were shorter in the endoscopic group than in the microscopic group. These results are comparable to findings from the study by Choi et al. who reported that the endoscopic group had significantly shorter operation time than the microscopic tympanoplasty group.[10]

In our study, we evaluated post operative pain by the numerical response scale (NRS) and found that immediate post operative pain was reduced in the endoscopic group. The increased pain in the microscopic technique can be attributed to the postauricular incision and the elevation of the musculoperiosteal flap. In contrast, the endoscopic approach avoids the need for a conventional postauricular incision and flap elevation, reducing tissue trauma. This results in less immediate postoperative pain.

Furthermore, though pain decreased in both groups 1 week after surgery it was reduced more significantly in the endoscopic group. In a study done by Rakesh Kumar Maran et al., Wong–Baker FACES pain rating scale was used for the purpose of recording post-operative pain till the discharge date. Patients were asked about post-operative pain one day after surgery; in endoscopic patients there was mild to no pain while in the microscopic patients, there was significant and irritating pain due to the postaural route.[28] This is comparable to other findings across the literature. For instance, reports by Yonglan Zhang et al. 2021 found that endoscopic tympanoplasty involves a smaller incision, less postoperative pain, and no postoperative scarring or periauricular paresthesia compared to microscopic Type 1 tympanoplasty.[29] Several meta-analyses and review studies on endoscopic ear surgery confirm the approach's safety with minimal morbidity.[30]

Only one study reported that endoscopic tympanoplasty gave an equal result to microscopic tympanoplasty regarding pain level.[23] In this study, the endoscopic group reported significantly lower levels of pain than the microscopic groups 1 day after surgery.

Limitations

The limitation of our study was that the technique of surgery (endoscopic or microscopic) was decided by each surgeon's preference and patient counselling which could cause bias. However, all surgeries were performed by fully qualified otology surgeons.

Additionally, clinical data such as age, sex, hearing and size of TM perforation were compared, and they were not significantly different between two groups. Another limitation was the small sample size. A larger sample would give the study more statistical strength and make the results more reliable. In the future, randomized controlled trials should be done to avoid bias. Studies with more patients and longer follow-up periods would help check how well the grafts and hearing improvements last over time. It would also be useful to compare different graft materials.Research should look into how quickly surgeons can learn the endoscopic technique and how training can be improved, especially in places with fewer resources. Looking at patient satisfaction, cosmetic outcomes, and overall quality of life would give a better picture of success. Lastly, using new tools like 3D endoscopy might make help in improving outcomes

Conclusion

To summarise, our results conclude that the endoscopic technique has a shorter operation time and reduced pain level when compared with microscopic tympanoplasty. Endoscopic tympanoplasty is a minimally invasive surgery with graft and hearing outcomes comparable to microscopic surgery.

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