

Analysis of Endoscopic Transcanal Tympanoplasty: Benefits and Outcomes

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Abstract:

Aim: To assess the outcome of Endoscopic Transcanal Tympanoplasty in terms of air bone gap, hearing gain & graft success.

Methodology: 90 patients who underwent endoscopic transcanal tympanoplasty without elevating tympanomeatal flap from January 2020 - March 2021 at M.G.M Medical College and M.Y. Hospital, Indore were included in the study based on inclusion and exclusion criteria. Patients were followed after 3 months and the outcome was analyzed.

Result: The patients in the study are of age group of 20-70 years out of which 36 were males and 54 were females. Cause of the perforation was CSOM safe type in 84(93.34%) patients while only in 6(6.67%) patients have etiology was trauma. Out of 90, 39(43.3%) patients were having SCP, 30 patients (33.3%) were having MCP and 21 patients (23.3%) were having LCP on the oto-endoscopic findings. 10 patients shows graft rejection while hearing loss improved significantly with reduction in air bone gap.

Conclusion: Transcanal endoscopic tympanoplasty without raising tympanomeatal flap is highly successful, safe, and less traumatic with low operation and hospitalization time as well.

Keywords: Endoscopic Transcanal Tympanoplasty (ETT), Chronic Suppurative Otitis Media (CSOM), Pure Tone Audiometry (PTA), Small, Medium and large Central Perforation (SCP, MCP & LCP respectively).

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Introduction

Tympanic membrane (TM) is a delicate tissue which can be damaged by trauma or infection in the middle ear (acute or chronic otitis media) resulting in perforation of the membrane. This damage reduces the amount of sound energy captured by the ear thereby causing hearing loss [1]. Chronic otitis media is very common in developing countries, and can be managed both conservatively and surgically.

The perforated TM is repaired by tympanoplasty. This surgery aims at protecting the middle ear from infections and improve the hearing in cases of chronic otitis media (COM) without cholesteatoma [2]. Endoscopic ear surgery was first tried in the 1990s. It has become popular in otology with the advancement of optical and medical engineering. Advantages of Transcanal Endoscopic Tympanoplasty as compared to conventional microscopic

surgery are better surgical view and lack of requirement of endaural or post-auricular incisions or of canaloplasty [3].

Transcanal approach is usually advanced by raising the tympanomeatal flap endoscopically. This also avoids other unnecessary incisions and soft tissue dissections. In our study, we attempt to analyse the outcomes of endoscopic tympanoplasty without raising tympanomeatal flap. Endoscopes offer a wide field of view with magnification [4]. Close-up and wide-angle views can also be obtained. Angled endoscopes provide an all-round vision. This enables the surgeon to observe hidden areas closely like the anterior margin of the perforation; the anterior canal wall, attic, hypotympanum, sinus tympani and facial recess. It also reduces the interference by the curvature of the external auditory canal. Also, Endoscopes allows close observation of the

ossicles, as well as various tympanic recesses in the middle ear [5].

Since endoscopic surgery is based on 2D images making the depth perception difficult. Thus, the surgeon has to carefully ascertain whether the graft has been sufficiently lifted to make contact with the edge of the perforation [6]. However, drawbacks of 2D images have been minimized greatly by advances in full HD camera systems that provide much clearer and contrasted endoscopic views.

In this paper we studied the practical advantages of endoscopic ear surgery in terms of benefit to the patient, ease of the procedure to the surgeon and learning opportunities for students.

Aims and Objectives

To compare the pre-operative and post-operative state 3 months after transcanal endoscopic tympanoplasty in terms of

1. Degree of Deafness using Pure Tone Audiometry
2. Graft success Rate - Oto-endoscopic finding
3. Complications after transcanal endoscopic tympanoplasty

Our secondary aims were to find out the benefits of this surgery for

1. The patient in form of satisfaction with cosmetic result
2. The residents watching the procedure on screen

Patients and Methods:

This is a prospective observational study with sample size of 90 patients carried out from January 2020 to March 2021 at Department of ENT M.G.M Medical College & M.Y Hospital Indore with:

Inclusion Criteria

- Patients giving consent for the surgery
- Age group between 20 to 70 years
- Patients with history of ear discharge, hearing loss or trauma to the ear resulting in central tympanic membrane perforation leading to conductive hearing loss
- Dry ear for past 3 months.

Exclusion Criteria

- Patients not giving consent for the surgery
- The external auditory canal width less than 6 mm
- Patient with history of previous middle ear surgery.
- Acute exacerbation of chronic otitis media (COM) or purulent otorrhea, unsafe COM with or without Cholesteatoma, attic perforation, patients having sensorineural hearing loss and mixed deafness.

- Presence of any obstruction, exostosis in the external auditory canal or ossicular fixation

A detailed history of the patients was taken. Full E.N.T. examination and hearing evaluation was done including Tuning Fork Test, Otoscopic, Otoendoscopic examination & Pure tone audiometry (PTA). 90 patients of central perforation were identified and included. Figure 1 shows endoscopic findings in cases of small and medium central perforations. After written & informed consent, surgeries were performed in Local Anaesthesia (LA) & sedation with 3mm 0 degree endoscope with an endo-holder making it a two-handed surgery (Figure 2a). Tarabichi suture was used for widening of the ear canal (Figure 2b). Cartilage was taken from tragus and perichondrium graft was harvested by using cartilage slicer. Using 0 degree endoscopic vision, perforation margins were freshened. Absorbable gelfoam was placed in middle ear, over which the cartilage was placed. Then the perichondrium graft was placed over the cartilage medial to the tympanic membrane remnant, without raising tympano-meatal flap (Figure 3a,b).

Post-operative follow-up included assessment of graft, hearing and complications. Figure 3c shows a successful graft uptake status. After 3 months, tuning fork tests and pure tone audiometry was done to compare hearing with the pre-operative data. The data was entered into the excel sheet. The data was analysed using SPSS (Statistical Package for Social Sciences) 20.0 version. The data was analysed for probability distribution using Kolmogorov- Smirnov test, p value < .05 indicated that the data was not normally distributed, thus non-parametric test of significance was applied. The intra-group comparison of categorical variables was done using Chi-square test and comparison of continuous variable was done using Wilcoxon sign rank test. P value < .05 was considered statistically significant. Confidence interval was set at 95%.

Observation and Results

We followed 90 cases of endoscopic ear surgery. The mean age of the patients was 34.33 years (Range- 20-70 years) (Table 1). There were 46 males and 54 females in the study with male to female ratio being 4:5. The most common etiology of perforation was chronic suppurative otitis media (93.34%) while in rest of the patients (6.67%), the perforation was due to trauma (Table 2). Out of 90 patients, 39 (43.3%) were having SCP, 30 patients (33.3%) were having MCP and 21 patients (23.3%) were having LCP on the oto-endoscopic findings (Table 3). The hearing loss improved significantly after surgery, as assessed by tuning fork test and pure tone audiometry (PTA) as shown in tables 4 and 5 respectively. A statistically significant

reduction in mean air-bone gap was observed after the operative procedure from 25.97 to 17.07.

The overall successful graft uptake in our study was 88.8%. Graft displacement was seen in 5.5% while another 5.5% developed re-perforation. The median time required for performing the operative procedure was 52.5 (50.0-60.0) minutes.

We found that the cosmetic results were satisfactory for the patients. The understanding of the residents who watched the surgery onscreen was good. The new residents found the identification and orientation of anatomical structures easier in this procedure.

Table 1: Frequency distribution of study subjects based on age

		Number	Percentage
Age groups	20-30 years	42	46.67%
	31-40 years	18	20%
	41-50 years	21	23.34%
	51-60 years	6	6.67%
	61 years or more	3	3.34%
Total		90	100.0%

Table 2: Frequency distribution of study subjects based on Etiology of perforation

		Number	Percentage
Etiology of perforation	Chronic Suppurative Otitis Media	84	93.34%
	Traumatic	6	6.67%
Total		90	100%

Table 3: Frequency distribution of study subjects based on size of the central perforation

		Number	Percentage
Size of the perforation	SCP	39	43.3%
	MCP	30	33.3%
	LCP	21	23.3%
Total		90	100%

Table 4: Comparison of findings of tuning fork test before & after the operative procedure (Clinical Test)

Tuning fork frequency		Pre-operative	Post-operative	P value ^β
256 Hz	Positive	0 (0.0%)	36 (40%)	<.05*
	Negative	90 (100.0%)	54 (60%)	
512 Hz	Positive	36 (40%)	78 (86.6%)	<.05*
	Negative	54 (60%)	12 (13.3%)	
1024 Hz	Positive	75 (83.3%)	90 (100.0%)	>.05
	Negative	15 (16.6%)	0 (0.0%)	

^βMcNemar test. *p value<.05 was considered statistically significant

Table 5: Comparison of pre-operative and post-operative hearing loss by Pure Tone Audiometry

Preoperative hearing loss	Post-operative Hearing loss				Chi-square value	P value ^Ω
	Normal	Mild	Moderate	Severe		
Normal (n=0)	-	-	-	-	13.091	<.05*
Mild (n=46)	39 (84.8%)	7 (15.2%)	-	-		
Moderate (n=23)	6 (26.1%)	15 (65.2%)	2 (8.7%)	-		
Severe (n=21)	-	12 (57.1%)	9 (42.9%)	-		

^ΩChi-square test. *p value<.05 was considered statistically significant.

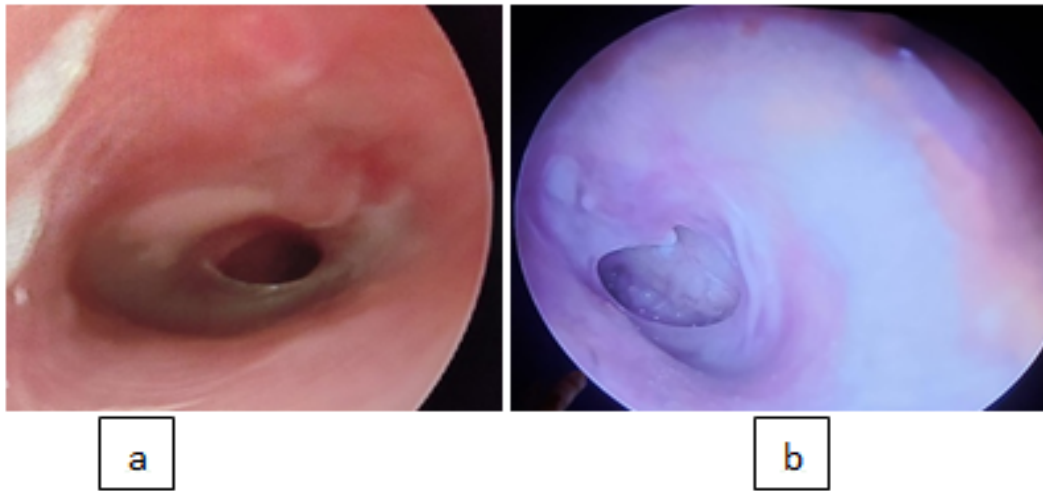


Figure 1: a) SCP endoscopic image, b) MCP endoscopic image

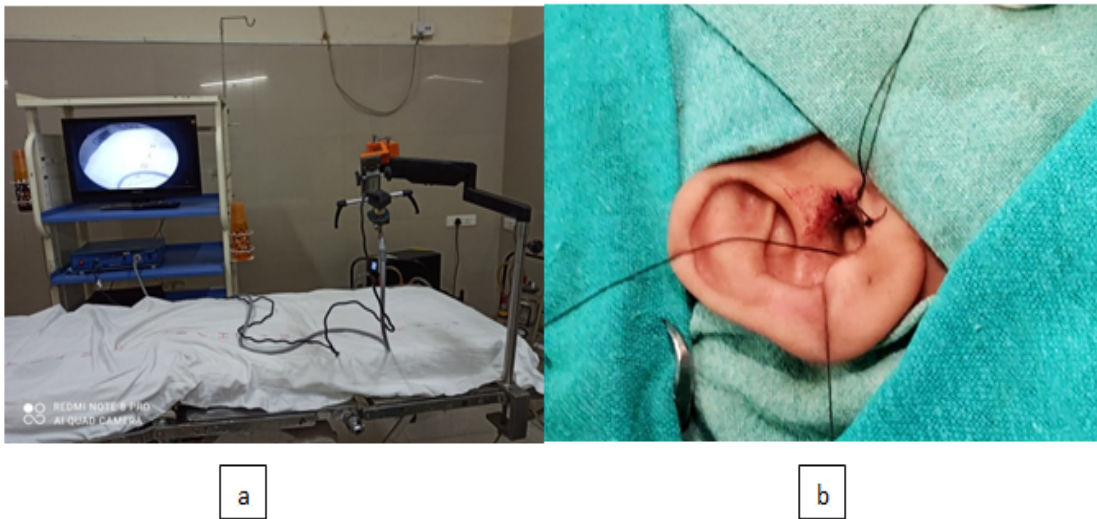


Figure 2: a) 3mm 0 degree endoscope with endholder, b) Tarabichi suture in ETT

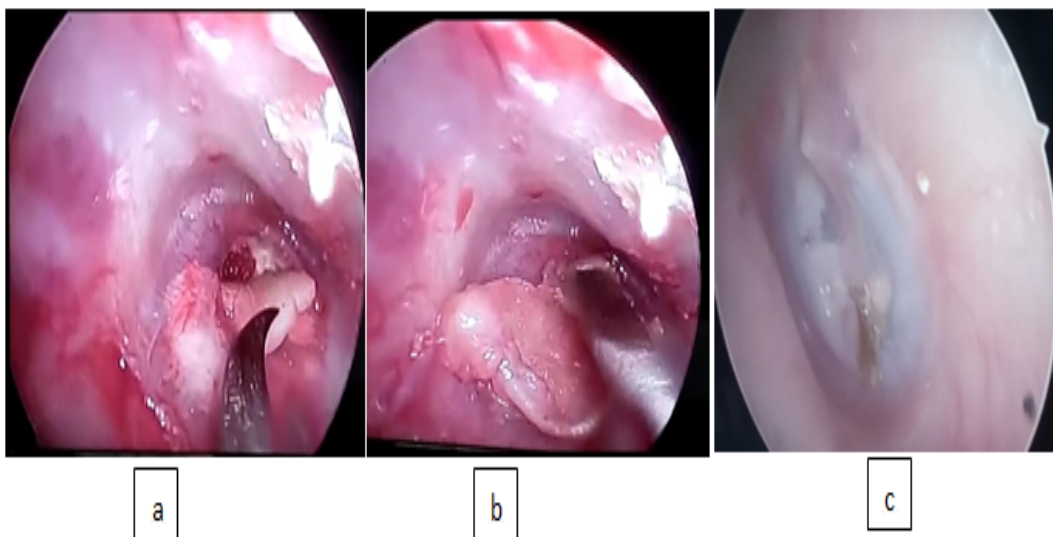


Figure 3: a) Tragal cartilage graft placement, b) pericondrium graft placement, c) post-operative graft uptake

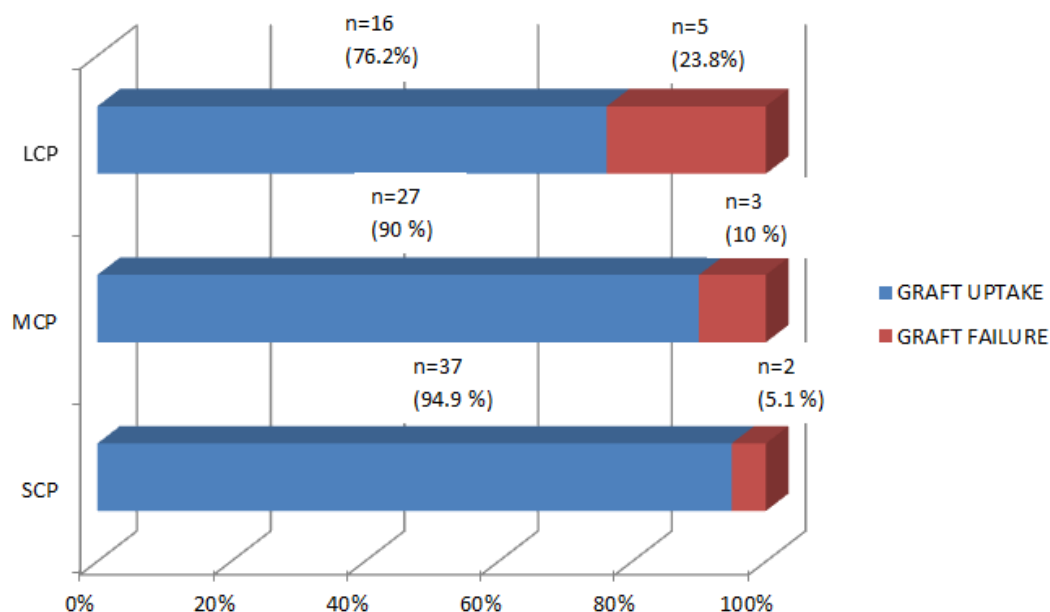


Figure 4: Graft uptake and failure rates in different central perforation sizes

Discussion

Tympanoplasty is a commonly performed surgery in otology. The endoscope is a new tool in the ear surgeon's basket. Revolutionary changes occurred in the field of otology by the use of nasal endoscope in tympanoplasty with satisfactory results [7]. Endoscope provides a magnified view of the surgical field. Visualization of structures, such as the tubal orifice, incudo-stapedial joint and oval/round window niche is improved by endoscopic approach. Advantages of the endoscopic approach include shorter operation time, reduced exposure to anesthetic agents and associated side effects, and improved surgeon concentration [8]. The endoscopic approach is less invasive, as it does not require incision or canaloplasty, is associated with less postoperative bleeding and pain, and it provides improved cosmetic outcomes [9].

In this study the major cause of the perforation was found to be CSOM safe type which was in 84 (93.34%) patients while only 6 (6.67%) patients had traumatic etiology.

Hearing assessment was done by tuning fork test for clinical purpose and pure tone audiometry. In tuning fork assessment, all 90 patients were negative to 256 Hz frequency preoperatively in which after the surgery 36 (40%) patients became positive for the same and 54 (60%) were still negative. Similarly, 54 (60%) patients were negative to 512 Hz before the surgery which reduced significantly to 12 (13.3%) patients after the surgery. In 1024 Hz frequency there were only 15 (16.6%) patients negative and none of the patients were negative postoperatively. (Table 4) Out of 90 patients according to pure tone

audiometry there were 46 patients with mild hearing loss at the start of the study, of which after surgery 39 (84.8%) patients improved to normal hearing, while 7 (15.2%) patients showed no improvement. There were 23 patients with moderate hearing loss at presentation, and after the surgery 15 (65.2%) patients improved to mild hearing loss, 6 (26.1%) achieved normal hearing and 2 patients (8.7%) remained in moderate hearing loss category. 21 patients had severe hearing loss, out of which, 12 patients (57.1%) improved to mild hearing loss category and 9 patients (42.9%) improved to moderate hearing loss category. (Table 5) The hearing improvement achieved is statistically significant. In a study by Shakya et al hearing improvement in endoscopic group was found to be significant [10]. The mean air-bone gap in our study improved significantly from 25.97 to 10.07. Study by Saini et al shows that the mean preoperative air bone gap (ABG) was 22.40 SD2.55dB. ABG improved in 40 patients, yielding a mean postoperative ABG of 9.1 SD1.71 dB implies that the difference is statistically significant ($p < .001$) [11]. Also in a study by Yueqi Wang, et al, the mean preoperative and postoperative air-bone gaps were 16.9 and 5.6 dB, respectively, revealing a significant improvement of 11.6 dB ($P < 0.001$, paired t test) in the air-bone gap (1).

In our study the overall successful graft uptake was seen in 80 (88.88%) patients while in 10 cases (11.11%), graft failure was observed due to displacement of the graft. This could be due to an insufficient gelfoam support, inadequate blood supply to the graft, shrinkage of graft or infection [12]. In SCP group, 34 patients (94.9%) showed successful graft uptake while 2 patients (5.1%) showed graft failure. In MCP group, 27 patients

(90%) showed successful graft uptake while 3 cases (10%) showed graft failure. LCP group showed the highest graft failure rate, having failure in 5 out of 21 patients (23.8%), while successful graft uptake was seen in 16 patients (76.2%) (Figure 4). Furukawa et al showed that the overall success rate for perforations was 84.0% while failure was seen in 16.0% [13]. The study by Chen et al compared 2 techniques of endoscopic tympanoplasty - with and without tympanomeatal flap elevation, and found that the overall success rates after 1-year of follow-up was 86.8%; and they observed the success rates for small and medium perforations to be good comparable in the 2 groups. However, they found that for large perforations, the success rate of Endoscopic Transcanal Tympanoplasty was significantly higher than that of Endoscopic Transcanal Transtympanic Tympanoplasty [14].

In the study by Ozgur et al, out of 24 patients, 1 patient had re-perforation while 1 had graft displacement, none of the patients had facial paresis and vertigo as complications [15]. In a study by Ayache et al, out of 30 patients only 1 had graft displacement while others had no complication [5].

In our study the mean overall time required for surgery was 52.5 minutes. The average time required for the endoscopic surgery can be further reduced with more experience.

The lack of an obvious scar, less pain, smaller dressing and lesser number of sutures were appreciated by the patients. The residents, especially the new ones, could better recognize the landmarks and the steps of the procedure. Their feedback included easier appreciation of middle ear anatomy in endoscopic approach as compared to the microscopic view.

Conclusion

Endoscopic Transcanal Tympanoplasty (ETT) is increasingly becoming the choice of ear surgeons due to the less invasive approach, short operative time, satisfactory audiological results and a short learning curve. Also endoscope serves as a great teaching tool for trainees to learn the middle ear anatomy and pathology. Postoperative care is easy as the technique is minimally invasive in surgical approach, causes minimal bleeding and pain, requires less sutures and leaves an almost negligible surgical scar. It was also associated with reduced postoperative morbidity.

In our study graft uptake rate was found to be excellent in small and medium central perforations, whereas it was relatively less in large central perforations. The author finds the technique of transcanal endoscopic tympanoplasty without flap elevation to be very effective and less invasive, and hence advocates the technique in cases of small and

medium central perforations, whereas in large central perforations, elevation of tympanomeatal flap is a must. Endoscopes also provide larger and better images of the middle ear, offers wide panoramic view, can be easily negotiated through the external auditory canal and offers complete examination of graft tucking. Endoscopes make the visualization of hidden areas of middle ear better, and give direct view of ossicular chain, chorda tympani nerve etc. On analyzing the pre and postoperative hearing results, it was found that there was a statistically significant improvement in hearing results following tympanoplasty. Furthermore, the cost of the endoscope is much less than the operating microscope, thus it is more cost-effective, especially in developing countries.

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