

# Endoscopic Transcanal Type I Cartilage Tympanoplasty for Anterior Perforation of Tympanic Membrane: A Cross-sectional Study

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## ABSTRACT:

**Introduction:** Repair of anterior perforation of tympanic membrane is difficult mainly due to inadequate exposure, minimal tympanic membrane remnant, impaired vascular supply, and delayed healing. **Methods:** This analytical cross-sectional study was done in a tertiary center over a period of 12 months from 25 April 2021 to 24 April 2022. There were 47 patients who underwent endoscopic transcanal type I cartilage tympanoplasty for anterior perforation. All operations were performed using an underlay technique and by transcanal approach. In all the cases, perichondrium with tragal cartilage was used as graft for the reconstruction of tympanic membrane. Evaluation was done after three months post-operatively in terms of graft uptake and post-operative hearing status. **Results:** The overall graft uptake success rate after three months post-operatively was 89.4%. The pre-operative mean pure-tone average was  $34.72 \pm 6.45$  dB, (range 17 dB to 43 dB). The mean postoperative pure-tone average was  $22.09 \pm 9.30$  (range 10 to 41 dB). The mean difference between preoperative pure tone average and postoperative pure tone average was  $12.63 \pm 8.96$  ( $p < 0.05$ ). The mean preoperative air-bone gap average was  $23.38 \pm 7.98$  (range 6 to 40 dB) and mean postoperative air-bone gap of  $13.45 \pm 6.89$  (range 5 to 32 dB). This resulted in improvement in the air-bone gap by 9.93 dB ( $p < 0.05$ ). **Conclusion:** Endoscopic transcanal tympanoplasty is a minimally invasive procedure, which provides complete exposure of anterior tympanic membrane perforation thus avoiding external incisions and canalplasty.

**Keywords:** Cartilage, Endoscopy, Graft, Tympanic membrane perforation, Tympanoplasty

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## INTRODUCTION:

Tympanoplasty for closing anterior perforation of the tympanic membrane is considered a difficult reconstructive challenge due to its poor visualization, inadequate anterior margin, graft stabilization and decreased graft viability.[1] There are different surgical techniques to repair anterior

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perforations including sandwich graft tympanoplasty, over-under tympanoplasty, mediolateral graft tympanoplasty, anterior hitch technique, window shade technique and Hammock tympanoplasty.[2]

The various techniques used for the repair of perforations have different success rate, however in many studies perforations with involvement of the anterior quadrant of the tympanic membrane have shown poor surgical outcome in terms of graft uptake and hearing outcome.[3] The limited visualization of anterior quadrants perforation may require more invasive procedures. In such situation, transcanal endoscopic surgery provides a wide surgical view, which provides minimally invasive and safe surgical approach avoiding unnecessary postauricular incision and canalplasty.[4]

The present study aimed to evaluate the graft success rate and hearing outcomes for endoscopic transcanal type I tympanoplasty in repairing anterior perforations of the tympanic membrane using perichondrium with tragal cartilage graft.

#### **METHODS:**

This was an analytical cross-sectional study conducted in the Department of Otorhinolaryngology of Lumbini Medical College and Teaching Hospital, Palpa, Nepal over a period of 12 months from 25 April 2021 to 24 April 2022. Ethical approval was obtained from the Institutional Review Committee of the institution prior to study (IRC-LMC 09-A/021). Informed consents were taken from the study participants. A detailed history, clinical examination, otoscopic examination and audiological evaluation were done in all cases pre-operatively. All the surgeries were done by the main author to reduce bias and patients were called for follow-up after one week to

remove ear canal pack and then three months after surgery. Pure-tone audiometry (PTA) were performed pre-operatively and three months post-operatively after the surgery. Air conduction (AC) threshold was measured at frequencies of 250, 500, 1000, 2000, 4000, and 6000 Hz, and bone conduction (BC) threshold was measured at frequencies of 500, 1000, 2000, and 4000 Hz. Pure-tone averages (PTAs) were then determined based on the threshold values at 500, 1000, 2000 and air bone gap (ABG) PTA values were calculated.

The sample size was calculated using the following formula:

$$n \geq \frac{z_{1-\frac{\alpha}{2}}^2 \times p(1-p)}{d^2}$$

Where,

Z= standard normal value for 95% confidence interval (1.96)

Alpha ( $\alpha$ ) =type 1 error rate

P= Proportion of patients with successful graft uptake is 96%[5]

d= Marginal error rate=7%

The minimum required sample size was 31. However, sample size of 47 was taken for the study.

#### **Inclusion criteria**

- Chronic otitis media (COM), mucosal inactive type
- Central perforations involving anterior quadrant, which may range from small to subtotal in size.
- Normal external auditory canal
- No sensorineural hearing loss

#### **Exclusion criteria**

- Active ear discharge( $\leq$  six weeks)
- Perforations involving only posterior quadrant

- Any focus of infection in the nose, paranasal sinuses and throat
- Patients unwilling to participate in the study

### **Procedure:**

#### **Instruments:**

All the procedures were performed by transcanal approach using a zero degree, 4-mm rigid endoscope (Tekno) of 18 cm length.

#### **Surgical Techniques:**

Surgeries were done under local anesthesia. General anesthesia was reserved for uncooperative patients. Ear was prepared and draped under sterile conditions without hair shaving. The preauricular area and postauricular area were infiltrated with 2% lidocaine hydrochloride and 1: 200000 epinephrine. Transcanal injections of 0.5 ml were administered in all four quadrants using a 1ml syringe under direct endoscopic visualization and blanching of the canal skin was observed.

Firstly, the anterior perforation margin and tympanic annulus were visualized through endoscope. The perforation margin was circumferentially freshened with a curved pick. An incision was made along the anterior ear canal (at approximately 2 o'clock in the right ear or 10 o'clock in the left ear) and brought circumferentially. A tympanomeatal flap was elevated 6 mm lateral to annulus and the middle ear space was entered inferiorly. The tympanic annulus was identified and then elevated anteriorly all the way to the 2 or 10 o'clock incision originally made. Posteriorly the tympanic annulus was elevated with the Rosen needle to dissect the annulus away from the chorda tympani nerve. Cotton soaked with epinephrine was applied to reduce bleeding from the edges of the flap. After the middle ear cavity was exposed, the integrity and mobility of the ossicular chains were examined.

After finishing the middle ear work, graft was harvested. Tragal cartilage with perichondrium was used as graft material in all cases. A 1.5 cm long incision with the help of a No. 15 blade was made 2 mm medially from tragal tip. The skin was undermined and tragus with perichondrium was harvested. Perichondrium was separated from both sides. At first, the perichondrium graft was placed using the underlay technique under the tympanic annulus and pushed anteriorly. The perichondrium layer was then lifted again and then barred cartilage was kept under the perichondrium. If the middle ear space was compromised due to a medialized handle of malleus, the cartilage was notched vertically to fit the handle of malleus. Previously lifted perichondrium was also placed back over the barred cartilage. No gelfoam was kept in middle ear. The tympanomeatal flap was placed back in the posterior canal wall and external auditory canal was packed with absorbable gelatin sponge. No mastoid dressing was required. The patients were discharged on the first postoperative day. The packing and stitches were removed one week post-operatively. Follow up was done in the outpatient department after three months and PTA was done in all cases.

Data was entered and analyzed with Statistical Package for Social Sciences (SPSS™) software version 20. Descriptive statistics was presented as frequencies, percentage, mean and standard deviation (SD). Comparison of the quantitative variables was made with paired-sample t test and Fisher exact test was applied for qualitative data. A p-value less than 0.05 was considered statistically significant.

### **RESULTS:**

A total of 47 patients involving anterior quadrant perforation of tympanic membrane were included in the study. There were 25 (53.2%) male and 22 (46.8%) female with male to female ratio of 1.13:1. Among the

total number of patients, minimum age in this study was nine years and maximum age was 57 years with mean age of 25.30±12.67 years with maximum number of patients between the age group of 21 to 40 years. The perforation was right-sided in 30 patients

(63.9%) and left-sided in 17 patients (36.1%) as shown in Table 1. The success rate of graft uptake at three months post-operative is shown in table 2. The graft uptake was compared between genders as shown in table 3.

Table 1: Demographic and clinical parameters of the study population (N = 47).

Age group (years)	No. of cases (%)	Male	Female	Perforation side	
				Right	Left
≤20	17 (36.2%)	9 (19.2%)	8 (17.0%)	10 (21.3%)	7 (14.9%)
21-40	22 (46.8%)	12 (25.5%)	10 (21.3%)	17 (36.2%)	5 (10.6%)
≥41	8 (17.0%)	4 (8.5%)	4 (8.5%)	3 (6.4%)	5 (10.6%)

Table 2: Surgical success rate (N=47)

Graft uptake	No of patients	Percentage
Perforation closure	42	89.4
Residual perforations	5	10.6

Table 3: Analysis of gender-wise graft uptake.

Gender	Graft uptake		<i>p</i> =0.654*
	Yes	No	
Male	23 (48.9%)	2 (4.3%)	
Female	19 (40.4)	3 (6.4%)	

\*Fisher exact test

The maximum number of patients have more than 20 dB air bone gap and these patients have better outcome in postoperative period as shown in table 4.

Table 4: Preoperative and postoperative air bone gaps in the study participants (N=47).

Air Bone Gap (dB)	Preoperative n (%)	Postoperative n (%)
≤10	2 (4.3%)	19 (40.4%)
11-20	15 (31.9%)	19 (40.4%)
≥20	30 (63.8%)	9 (19.2%)

The mean preoperative pure-tone average was 34.72 ± 6.45 dB, (range: 17 dB to 43 dB). The mean postoperative pure-tone average was 22.09 ± 9.30 dB (range: 10 to 41 dB). The mean difference between preoperative pure tone average and postoperative pure tone average was 12.63 ± 8.96 dB which was statistically significant (t=9.66, df=46,

p<0.05). Similarly, the mean preoperative air-bone gap average was 23.38 dB ±7.98 (range 6 to 40 dB) and mean postoperative air-bone gap of 13.45 ± 6.89 (range: 5 to 32 dB). This resulted in improvement in the air-bone gap by 9.93 dB (t=6.94, df=46, p<0.05) as shown in Table 5.

Table 5: Analysis of pre- and post-operative hearing outcome (N=47)

Parameters	Mean (dB)	Standard deviation	p value*
Pre-operative pure tone average	34.72	6.45	t=9.66,df=46, p<0.05
Post-operative pure tone average	22.09	9.30	
Pre-operative air bone gap	23.38	7.98	t=6.94, df=46, p<0.05
Post-operative air bone gap	13.45	6.89	

\*Paired-sample t test

**DISCUSSION:**

Transcanal endoscopic repair of tympanic membrane perforations for COM is gaining popularity among otorhinolaryngologists. The most common surgical technique used is

underlay with transcanal or post-auricular approach and it is preferred over overlay because it gives better access to middle ear and the ossicles.[6] The success rate of tympanoplasty is affected by various factors

such as visualization of the perforation area and support for the graft anteriorly. Anterior perforations are more difficult to repair using the underlay technique.[7] There are few studies that have described endoscopic transcanal tympanoplasty for repair of anterior perforation of the tympanic membrane.

The concept of grafting tragal cartilage and perichondrium was introduced by Goodhill.[8] The cartilage perichondrium composite grafts is frequently used nowadays during endoscopic ear surgery. Cartilage is easier to fit on the eardrum perforation site, thicker and less prone to resorption and retraction.[9] So doubts have been raised about its conduction properties due to thickness of cartilage. However, Atef et al. concluded thinning the cartilage to half of its thickness adds more to the technical difficulties without an actual hearing gain.[10]

In a study done by Kalcioğlu et al. there was no significant difference in either graft uptake or post-operative hearing in the patients undergoing type I tympanoplasty by temporalis fascia and cartilage perichondrium grafts.[11] Gamra et al. evaluated the anatomical and audiological results of type I cartilage tympanoplasty in the reconstruction of tympanic membrane perforations and they achieved functional results similar to the temporal fascia.[12]

In our study, we used tragal perichondrium with cartilage as a graft material with the help of endoscope and the overall success rate for graft take up was 89.4% after three months of post-operative period. Seidman et al. performed transcanal tympanoplasty in 45 patients in anterior perforations and reported 88% graft uptake with temporalis fascia graft.[13] Tseng et al. did endoscopic transcanal myringoplasty for anterior perforations in 59 patients and had graft

uptake of 93% with follow up of six months but they used temporalis fascia or tragal perichondrium as graft material.[2]

Similarly, Özdemir et al. performed endoscopic transcanal type I cartilage tympanoplasty using tragal cartilage perichondrium as graft materials in 104 patients, of which 35.6% had anterior quadrant involvement.[14] They had overall graft uptake of 93.2% (n=97) with significant improvement in hearing results, regardless of the perforation location and size.

Peng et al. performed Hammock tympanoplasty technique for anterior perforation in 25 patients. The graft uptake rate was 96%, with a follow-up period of  $3.5 \pm 1.7$  years.[5] The procedure of this study was similar to our study but it was done via a postaural approach using a microscope. They used temporalis fascia and cartilage as graft material but we used tragal cartilage and perichondrium as graft materials. Our procedure was minimally invasive with a single incision for tragal cartilage and all the procedures were completed by the per-meatal approach without mastoid bandage. Mohanty et al. did comparative study between cartilage and fascia graft and reported graft uptake rate of 91.95% using composite cartilage perichondrium island graft in transcanal endoscopic cartilage myringoplasty for anterior perforation in 87 patients with a minimum follow-up of one year.[15]

The pre-operative mean air conduction in our study was  $34.72 \pm 6.45$  dB and post-operatively it was  $22.09 \text{ dB} \pm 9.30$  with mean gain of  $12.63 \pm 8.96$  dB. Those patients who had more hearing loss pre-operatively benefited more than those with a minimal pre-operative hearing loss and improvement was significant where pre-operative air bone gap was more than 20 dB. Most of the studies mentioned above have hearing improvement

post-operatively with varying results in graft uptake.[16,17] In our study, most of the patients were in the age group of 21 to 40 years. Male were predominant over female however, there was no significant association between gender and graft success uptake rate, which was similar to another study.[17] Emir et al. showed that being a male gender was good prognostic factor.[18]

The basic requirement for successful closure is contact between graft and tympanic membrane remnant. The zero degree rigid endoscope provides complete exposure of tympanic perforation anteriorly which helps in elevating the anterior tympanic annulus. The perichondrium graft is kept underneath the anterior annulus with support of cartilage under an excellent endoscopic exposure, avoiding medialization of the graft in the middle ear. So in our surgical procedure perichondrium graft had reduced gap between tragal cartilage and tympanic membrane remnant. Using a perichondrium-supported graft as the graft material makes an important contribution to epithelialization in the tympanic membrane in the postoperative period.

This study has some limitations which include a limited sample size. The hearing assessment was done after three months postoperatively only. A study involving a larger sample size with longer follow up is recommended.

#### **CONCLUSION:**

Endoscopic transcanal tympanoplasty is a minimally invasive procedure that provides complete exposure of anterior tympanic membrane perforation thus avoiding external incisions. This technique has the advantages of wider field of view and superior visualization. Furthermore, the perichondrium with cartilage is a good grafting material for anterior quadrant perforation, which gives a good graft uptake success rate and hearing outcome.

**Conflict of Interest:** The authors declare that no competing interests exist

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