

Original Research Article

An outcome evaluation of 360-degree subannular tympanoplasty for subtotal and anterior tympanic membrane perforations: a prospective observational study from Eastern India

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ABSTRACT

Background: Subtotal and anterior tympanic membrane (TM) perforations remain a surgical challenge as the anterior tympanomeatal angle is prone to blunting, graft lateralization and residual perforation with conventional underlay tympanoplasty. This study evaluated the anatomical and functional outcomes of 360° subannular tympanoplasty in such perforations at a tertiary care centre in Eastern India.

Methods: This prospective observational study enrolled 52 patients aged 12-70 years with subtotal or anterior TM perforation, dry middle ear, normal middle ear mucosa, intact ossicular chain and no cholesteatoma, at our institution, a tertiary care centre in Eastern India, between June 2023 and May 2025. Patients with prior ear surgery or head-neck radiotherapy were excluded. All patients underwent 360° subannular tympanoplasty by a postaural, microscopic approach using a temporalis fascia graft, with anatomical and audiometric follow-up at 6 and 12 months. Data were analysed using the paired t test.

Results: The mean age was 45.9 ± 10.4 years; 25 patients (48.1%) were male and 27 (51.9%) were female. Anatomical success was 92.0% at 6 months and 98.1% (51/52 ears) at 12 months. Mean air-bone gap (ABG) improved from 44.2 ± 10.4 dB preoperatively to 14.3 ± 8.3 dB postoperatively ($p < 0.001$). ABG closure to ≤ 20 dB was achieved in 43/52 ears (82.6%). Granulations occurred in 4 ears (7.6%) and residual perforation in 1 ear (1.9%, 95% CI=0.3-10.1%); no graft medialization, lateralization or anterior blunting occurred.

Conclusions: The 360° subannular tympanoplasty is a reliable technique for subtotal and anterior TM perforations, providing a high graft uptake rate, significant hearing improvement and a low complication rate.

Keywords: Microscopic tympanoplasty, Circumferential subannular graft technique, Air-bone gap closure, Graft uptake, Chronic otitis media

INTRODUCTION

Chronic otitis media with a TM perforation is among the commonest conditions encountered in otolaryngological practice, and tympanoplasty remains its definitive surgical treatment. While small-to-medium central perforations are reliably closed by conventional underlay myringoplasty, subtotal and anterior perforations continue to pose a distinct surgical challenge. The

absence of a stable anterior remnant and the acute angle of the anterior tympanomeatal recess predispose conventional underlay grafts to anterior blunting, graft lateralization, and residual anterior perforation.

Several modifications have therefore been described to improve graft stability in this subset of perforations, including anterior tucking, the “window-shade” technique, butterfly cartilage inlay grafting, and endoscopic approaches.¹⁻⁶ Among these, the

circumferential or “360-degree” subannular technique-in which the tympanomeatal flap is elevated through its entire circumference and the fascia graft is placed directly below the bony and fibrous annulus rather than being tucked beneath the residual drum remnant-has gained increasing acceptance because it provides uniform, tension-free graft support across the entire perforation margin, including the difficult anterior segment.^{1,7}

Existing series report graft uptake rates of 95–100% and closure of the ABG from a preoperative mean of 42–44 dB to 14–30 dB postoperatively, with a low incidence of complications such as lateralization, blunting and retraction.^{1–9} However, prospective data on this technique from Eastern India remain limited. This study was therefore undertaken to evaluate the anatomical and functional outcomes of 360° subannular tympanoplasty in a cohort of patients with subtotal or anterior TM perforations managed at a tertiary care railway hospital in this region.

METHODS

This was a prospective observational study conducted at our institution, a tertiary care centre in Eastern India, over a period of two years (June 2023 to May 2025). Fifty-two patients with subtotal or anterior TM perforation attending the outpatient department were enrolled consecutively after fulfilling the eligibility criteria; no formal a priori sample-size calculation was performed. The study is reported in accordance with the STROBE (Strengthening the Reporting of Observational Studies in Epidemiology) guideline for observational studies; a completed STROBE checklist is provided as supplementary material.

Inclusion criteria

Patients with subtotal or anterior TM perforation with a dry middle ear cavity (no otorrhoea for more than 4 weeks prior to surgery) and normal middle ear mucosa, age between 12 and 70 years, intact ossicular chain and absence of cholesteatoma or other middle ear complications were included in study.

Exclusion criteria

Patients with previous ear surgery, history of radiotherapy to the head and neck region and retraction pockets were excluded from the study.

Eligible patients underwent detailed clinical history-taking and otological examination, otoendoscopic assessment of the perforation, and baseline pure-tone audiometry (PTA). All patients underwent 360° subannular tympanoplasty performed under local anaesthesia via a postaural approach under the operating microscope, using a temporalis fascia graft. All procedures were performed by a single consultant otologist (the operating surgeon). In this technique, the

tympanomeatal flap was elevated circumferentially through 360 degrees and the fascia graft was placed below the annulus along its entire circumference, ensuring firm support beneath the anterior perforation margin. Patients were followed up at 6 months with repeat otoendoscopy and PTA, and a final assessment was performed at 12 months. Intra- and postoperative complications were documented at each visit. All 52 enrolled ears (consecutively accrued over the two-year study period) completed both scheduled follow-up assessments, with no losses to follow-up.

Anatomical success was defined as an intact, well-healed grafted TM without lateralization, blunting, or medialization at the 6- and 12-month follow-up visits. Graft status at each follow-up visit was independently assessed by a second consultant otologist who was not involved in the surgery, in order to reduce assessment bias; both the operating surgeon and the assessor were consultant-grade otologists. Functional outcome was assessed by comparing the pre- and postoperative ABG on PTA.

Continuous variables were expressed as mean±standard deviation (SD) and compared using the paired t test. A $p < 0.05$ was considered statistically significant.

RESULTS

A total of 52 patients (52 ears) with subtotal or anterior TM perforation who underwent 360° subannular tympanoplasty were analysed. Of these, 25 (48.1%) were male and 27 (51.9%) were female, giving a near-equal gender distribution (Figure 1, Table 1). The mean age was 45.9 ± 10.4 years (range 12–70 years), and the mean duration of disease was 8 ± 2 years. The right ear was affected in 31 patients (59.6%) and the left ear in 21 patients (40.4%). Of the 52 ears, 38 had a subtotal perforation (73.1%) and 14 had an isolated anterior perforation (26.9%) (Table 1).



Figure 1: Gender distribution of the study population, (n=52).

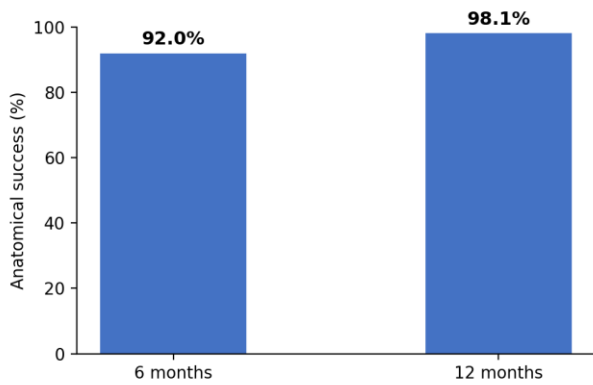


Figure 2: Anatomical success rate at the 6-month and 12-month follow-up visits.

Table 1: Demographic profile of study population (n=52).

Parameters	N	Percentage
Male	25	48.1
Female	27	51.9
Mean age±SD (in years)	45.9±10.4	-
Age range (in years)	12-70	-
Right ear	31	59.6
Left ear	21	40.4
Mean duration of disease	8±2	-
Subtotal perforation	38	73.1
Anterior perforation	14	26.9

Graft uptake improved progressively over the follow-up period. Anatomical success—an intact, well-healed graft without lateralization, blunting, or medialization—was recorded in approximately 92% of ears at the 6-month assessment and reached 98.1% (51 of 52 ears) by the 12-month assessment (Figure 2), reflecting late closure of perforations in a majority of ears that showed granulations at the earlier visit. One ear (1.9%) had a persistent residual perforation at final follow-up, which was managed with a revision myringoplasty.

Representative pre- and postoperative otoendoscopic appearances of a repaired anterior perforation are shown in Figure 3.

Table 2: Complications observed following 360° subannular tympanoplasty (n=52).

Complications	N	Percentage
Graft medialization/lateralization	0	0
Granulations	4	7.6
Anterior blunting	0	0
Residual perforation	1	1.9

No instance of graft medialization, lateralization, or anterior blunting was observed in this series. Granulations were noted in 4 ears (7.6%), all of which resolved with local measures and did not affect final graft integrity in the remainder (Table 2).

The mean preoperative ABG was 44.2±10.4 dB, which improved to a mean postoperative ABG of 14.3±8.3 dB, a mean closure of approximately 29.9 dB ($p<0.001$, paired t test). On categorising the degree of postoperative ABG, closure to 10 dB or less was achieved in 2 ears (3.8%), closure to 10-20 dB in 41 ears (78.8%), and a residual gap of 20 dB or more in 9 ears (17.3%); no patient showed a failure of hearing improvement (Table 3).

Table 3: Distribution of the postoperative ABG (n=52).

Postoperative ABG	Number of ears	Percentage
≤10 dB	2	3.8
10-20 dB	41	78.8
≥20 dB	9	17.3
No improvement	0	0
Total	52	100

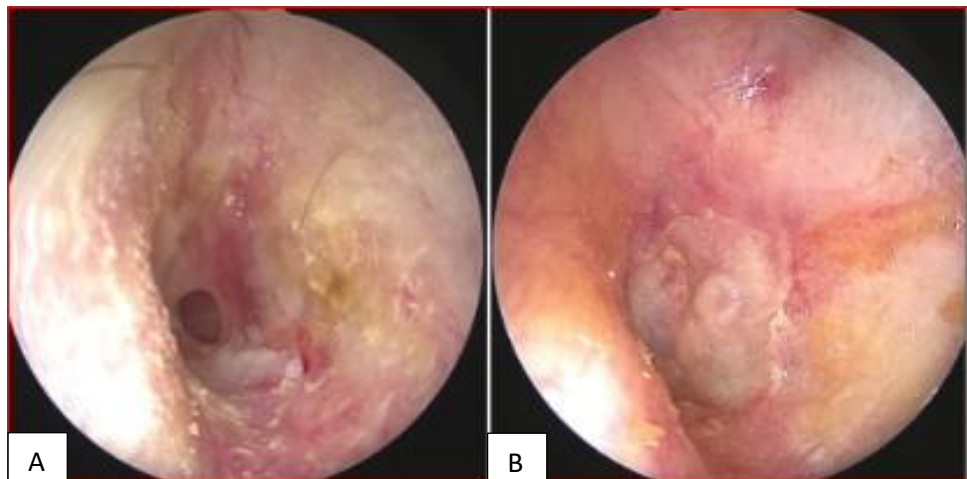


Figure 3 (A and B): Pre-operative and postoperative otoendoscopic picture of a TM with anterior perforation.

Table 4: Comparison of outcomes with existing literature on circumferential/subannular and conventional tympanoplasty techniques.

Techniques	Graft uptake	ABG improvement	Complication rate
Present study	98.1% at 12 months	29.9 dB mean closure	Low
360° subannular tympanoplasty^{1,2}	95-100%	12-30 dB	Minimal
Conventional (underlay) tympanoplasty^{7,9}	83-94%	10-20 dB	Higher in large perforations
Other modified techniques⁴⁻⁶	93-98%	9-20 dB	Low

DISCUSSION

Subtotal and anterior TM perforations are recognised as one of the more technically demanding indications for tympanoplasty, largely because conventional underlay grafting provides poor mechanical support to the anterior drum remnant, predisposing to blunting of the tympanomeatal angle and anterior residual perforation.³⁻⁵ The 360° subannular technique addresses this limitation directly: by elevating the tympanomeatal flap circumferentially and seating the graft below the annulus along its entire perimeter, the anterior segment of the graft receives the same bony support as the posterior segment, which is not achievable with a partial or three-quarter flap elevation.^{1,7}

In the present series, anatomical success improved from approximately 92% at 6 months to 98.1% (51 of 52 ears) at 12 months, with a single ear (1.9%) showing a persistent residual perforation. This falls well within the previously reported anatomical success range of 95-100% at 12 months for the 360° subannular technique.^{1,2} Arora et al, in a large series of 224 ears, reported comparable graft uptake with this circumferential approach, reinforcing the reproducibility of the technique across different patient populations.¹ The interval improvement between the 6- and 12-month assessments in the present study is explained by the resolution of transient granulations in most ears rather than true graft failure, a pattern also described in other subannular series; the single residual perforation is consistent with the small proportion of failures reported even with meticulous circumferential technique.^{1,7}

A statistically significant reduction in the ABG was observed, from a mean preoperative value of 44.2±10.4 dB to 14.3±8.3 dB postoperatively ($p<0.001$), with more than 80% of ears achieving closure to within 20 dB. These findings align closely with published data, in which mean preoperative ABG values of 42–44 dB have been shown to improve to 14-30 dB following 360° subannular or related circumferential techniques.¹⁻⁵ The magnitude of hearing gain in the present cohort is comparable to that reported after endoscopic type I tympanoplasty and “window-shade” grafting for anterior perforations, both of which similarly emphasise circumferential or extended graft support to prevent anterior slippage.^{4,5}

The complication profile in this study was favourable overall, with granulations as the predominant adverse finding (7.6%) and no instance of graft lateralization or anterior blunting. A single ear (1.9%) developed a residual perforation, a recognised, if infrequent, outcome even with meticulous circumferential flap elevation and adequate graft support. This compares well with rates of complication reported for circumferential subannular techniques in both primary and revision settings, where lateralization and blunting are distinctly uncommon compared with conventional underlay tympanoplasty, particularly for larger perforations.⁶⁻⁹ Singh et al similarly reported a high success rate with minimal complications when applying the circumferential subannular principle to revision tympanoplasty, underscoring the versatility of the technique even in previously operated ears—a subgroup that was specifically excluded from the present cohort.⁸

When benchmarked against published series of conventional (partial-flap) underlay tympanoplasty and other modified techniques such as butterfly cartilage inlay and endoscopic approaches, the outcomes of the present series compare favourably across all three domains—anatomical success, hearing improvement, and complication rate (Table 4). As this was a single-arm observational study without a concurrent internal comparator, these comparisons are indirect (drawn from the published literature rather than a randomised or matched control group within the present study) and should be interpreted with corresponding caution. Conventional tympanoplasty series report graft uptake in the range of 83-94%, with higher complication rates in larger perforations, whereas circumferential subannular and other modified techniques consistently report graft uptake above 93%.^{2,6,7,9} This is consistent with circumferential flap elevation being an important technical step in the management of subtotal and anterior perforations, though confirmation would require a direct, adequately powered comparative trial.

More recent literature continues to support circumferential and margin-preserving strategies for anterior and subtotal perforations. In a systematic review and meta-analysis, Jungbauer et al reported pooled graft success rates exceeding 90% for type I tympanoplasty across a large number of studies, reinforcing the reliability of formal tympanomeatal flap elevation over simple myringoplasty for larger or anteriorly located

perforations.¹⁰ In a randomised comparison of endoscopic techniques for large anterior perforations, Li et al found that a cartilage inlay technique with anterior margin preservation achieved a 96.4% graft success rate and a 0% residual perforation rate, compared with 88.9% success and an 11.1% residual perforation rate with a conventional underlay flap-raising technique, highlighting that meticulous handling of the anterior margin-the same principle underlying circumferential subannular grafting-is the key determinant of outcome in this anatomically difficult subsite.¹¹ Similarly, in a large retrospective series of 784 patients, Şahin et al demonstrated a 99% graft success rate and a mean ABG improvement from 24 dB to 6.6 dB using a modified asymmetric chondro-perichondrial island graft with a longer anterior limb, again underscoring that reinforcing anterior graft support translates into superior anatomical and functional outcomes irrespective of the specific grafting material used.¹² The results of the present study, with 98.1% anatomical success and a mean ABG closure of nearly 30 dB, are therefore concordant with this growing body of recent evidence favouring anterior-margin-focused surgical strategies for subtotal and anterior TM perforations.

Circumferential elevation of the tympanomeatal flap, while advantageous for anterior graft support, could theoretically alter middle ear aeration dynamics or predispose to retraction pocket formation over a longer time horizon than the 12-month follow-up reported here. None of the ears in this series developed a retraction pocket or evidence of early cholesteatoma formation within the study period, but the follow-up duration is insufficient to exclude such late complications, which have been described only rarely, if at all, in longer series of circumferential and subannular tympanoplasty.^{1,7,8} Extended follow-up beyond 12 months would help to confirm the long-term safety of circumferential flap elevation with respect to middle ear aeration.

Limitations

This study is limited by its single-centre, single-arm observational design without a comparator group undergoing conventional underlay tympanoplasty, the absence of a formal a priori sample-size calculation, a relatively modest sample size, and follow-up limited to 12 months. Multicentric, comparative (ideally randomised) studies with longer follow-up would help to further validate these findings and to establish the technique's role relative to endoscopic and cartilage-based alternatives.

CONCLUSION

In this single-centre observational series, the 360° subannular tympanoplasty was associated with a high graft uptake rate, reaching 98.1% anatomical success (51 of 52 ears) by 12 months, along with significant and sustained hearing improvement (mean ABG closure of

nearly 30 dB) and low complication rate. These findings suggest that 360° subannular technique is a valuable surgical option for subtotal and anterior TM perforations.

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