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Original Research Article

Comparative Study between Anterior Pull through and Conventional Flap Method of Tympanoplasty with Respect to Hearing Outcome and Graft Uptake in Anterior Eardrum Perforation

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Conflict of interest: Nil

Abstract:

Introduction: Anterior tympanic membrane perforations pose unique surgical challenges due to poor graft support and limited visualization. Various surgical techniques, including the anterior pull-through method and conventional flap method, have been proposed to improve graft uptake and functional hearing outcomes.

Aims: The study aims to compare the anterior pull-through and conventional flap methods of tympanic membrane grafting with respect to complete graft uptake and postoperative hearing improvement. Specifically, it evaluates differences in graft success and hearing outcomes between the two techniques.

Materials & Methods: This prospective, comparative hospital-based study was conducted in the Department of Otorhinolaryngology, KPC Medical College & Hospital, Jadavpur, Kolkata, over a period of 18 months (1st January 2023 to 30th June 2024). A minimum of 94 patients undergoing tympanoplasty for anterior tympanic membrane perforations were enrolled and allocated into two groups by simple random sampling after appropriate counseling and informed consent.

Result: A total of 94 patients were equally divided into two groups: anterior pull-through (n=47) and conventional flap (n=47). The mean age was comparable between the groups (38.38 ± 7.25 vs. 36.00 ± 8.02 years; p=0.1341), with similar age distribution across 21–30, 31–40, and 41–50 years (p=0.5284). Both groups also had identical sex distribution with 14 females (29.8%) and 33 males (70.2%) each (p=1.000). Graft uptake at 2 weeks was 93.6% in the anterior pull-through group and 89.4% in the conventional group (p=0.4597), while at 1 and 3 months, uptake rates remained similar (93.6% vs. 91.5%, p=0.6944). Preoperative mean PTA was 26.83 ± 2.99 dB in the anterior pull-through group and 27.49 ± 3.12 dB in the conventional flap group (p=0.2977). At 1 month, PTA improved to 17.51 ± 3.69 dB vs. 18.28 ± 4.15 dB (p=0.3476), and at 3 months, further improved to 9.90 ± 3.93 dB vs. 10.73 ± 5.58 dB (p=0.4056). Overall, both techniques demonstrated high graft uptake rates and significant hearing improvement, with no statistically significant differences between them.

Conclusion: The study indicate that both the anterior pull-through and conventional flap techniques of tympanoplasty are highly effective in managing anterior tympanic membrane perforations, achieving excellent graft uptake and significant hearing improvement. Graft success rates remained consistently above 89% in both groups at all follow-up intervals, while postoperative air-bone gap closure was substantial and comparable. No statistically significant differences were observed between the two methods in terms of graft uptake or hearing outcomes, suggesting that either technique can be reliably employed, with the choice depending on surgeon preference and intraoperative considerations.

Keywords: Tympanoplasty, Anterior perforation, Graft uptake, Hearing outcome, Anterior pull-through technique, Conventional flap.

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Introduction

Tympanoplasty is commonly performed for patients with chronic otitis media associated with tympanic membrane (TM) perforation. The primary goals of tympanoplasty are the eradication of disease and the restoration of hearing function. Functional restoration requires a healthy tympanic membrane, an air-filled middle ear lined with mucosa, and a secure connection between the TM and the inner ear fluids [1].

Two traditional surgical techniques for TM repair are the underlay (medial) and overlay (lateral) approaches. The underlay technique is easier to perform and less time-consuming [2,3], making it the preferred method among many otologists [4]. In this technique, the graft is placed medial to the TM remnant and the handle of the malleus, making it particularly suitable for posterior perforations [4]. However, challenges with the underlay approach include a reduced mesotympanic space and lower success rates when addressing anterior perforations [5]. The overlay technique, often used for anterior perforations, involves precise elevation of the epithelial layer, with the graft positioned lateral to the fibrous layer of the TM remnant and the annulus [1]. While this method has a higher success rate in anterior perforations, it is technically more demanding and carries potential complications such as graft lateralization, anterior blunting, delayed healing, external auditory canal stenosis, epithelial pearls, and iatrogenic cholesteatoma [2,6].

Repairing anterior TM perforations remains a challenge, particularly with the underlay technique. Factors contributing to failure in these cases include inadequate blood supply [7], insufficient residual TM to provide epithelial cells, lack of anterior graft support, and poor surgical exposure. To overcome these limitations, recent studies have explored modifications of the underlay technique [8,9].

One such modification involves creating a tunnel anterior to the annulus and using a temporalis fascia graft with a “pull-through” technique, which has been shown to improve the success rate in challenging anterior perforations [12]. The study aims to compare the anterior pull-through and conventional flap methods of tympanic membrane grafting with respect to complete graft uptake and postoperative hearing improvement. Specifically, it evaluates differences in graft success and hearing outcomes between the two techniques.

Methodology

Study Design: A prospective, comparative hospital-based study with patients divided into two groups using simple random sampling.

Place of Study: Department of Otorhinolaryngology, KPC Medical College & Hospital, Jadavpur, Kolkata.

Study Period: 1st January 2023 to 30th June 2024 (18 months).

Sample Size: At least 94 patients undergoing tympanoplasty will be selected and allocated into two groups through simple random sampling after proper counseling and informed consent.

Inclusion Criteria

- Mucosal type of chronic otitis media with anterior tympanic membrane perforation.
- No ear discharge for at least 6 weeks prior to surgery.
- Age between 12 and 50 years.
- Patients providing written informed consent.

Exclusion Criteria

- Unwilling or unfit for tympanoplasty.
- Age <12 or >50 years.
- Traumatic or recurrent tympanic membrane perforations.
- Chronic otitis media with cholesteatoma.
- Ossicular dysfunction or necrosis.
- External ear pathology.
- Diabetes mellitus or autoimmune disorders.
- Nasal/nasopharyngeal pathology or cleft palate.
- Sensorineural hearing loss.
- Pinhole or posterior tympanic membrane perforations.

Study Variables

- Success of surgery measured by complete graft uptake in anterior pull-through and conventional flap methods.
- Hearing improvement before and after surgery in both anterior pull-through and conventional flap methods.

Statistical Analysis Plan: All preoperative and postoperative data recorded in the proforma will be analyzed using standard statistical methods.

Data Analysis: Data will be entered into Microsoft Excel, and relevant charts, diagrams, and tables will be prepared according to the study objectives. Descriptive statistics such as percentages, rates, ratios, odds ratios, and confidence intervals will be calculated as needed. Inferential statistical tests, including Chi-square test, Z-test, t-test, and ANOVA, will be applied wherever appropriate to assess the significance of differences between groups.

Result

Table 1: Association between demographic parameter: Group

Variable	Category	Anterior Pull-Through (n=47)	Conventional (n=47)	Total (n=94)	Chi-square / p-value	Remarks
Age Group (years)	21–30	7 (14.9%)	10 (21.3%)	17 (18.1%)	χ^2=1.276, p=0.5284	Not significant
	31–40	18 (38.3%)	20 (42.6%)	38 (40.4%)		
	41–50	22 (46.8%)	17 (36.2%)	39 (41.5%)		
Sex	Female	14 (29.8%)	14 (29.8%)	28 (29.8%)	χ^2=0.000, p=1.000	Not significant
	Male	33 (70.2%)	33 (70.2%)	66 (70.2%)		

Table 2: Association between Graft Uptake at different time interval: Group

Time Point	Graft Uptake	Anterior Pull-Through (n=47)	Conventional Flap (n=47)	Total (n=94)	Chi-square / p-value	Interpretation
2nd Week	Taken up	44 (93.6%)	42 (89.4%)	86 (91.5%)	χ^2=0.547, p=0.4597	Not significant
	Not taken up	3 (6.4%)	5 (10.6%)	8 (8.5%)		
1 Month	Taken up	44 (93.6%)	43 (91.5%)	87 (92.6%)	χ^2=0.154, p=0.6944	Not significant
	Not taken up	3 (6.4%)	4 (8.5%)	7 (7.4%)		
3 Months	Taken up	44 (93.6%)	43 (91.5%)	87 (92.6%)	χ^2=0.154, p=0.6944	Not significant
	Not taken up	3 (6.4%)	4 (8.5%)	7 (7.4%)		

Table 3: Distribution of mean PTA at different time interval (A-B Gap): Group

Time Point	Group	N	Mean PTA (dB)	SD	p-value
Pre-op (A-B Gap)	Anterior Pull-Through	47	26.83	2.99	0.2977
	Conventional Flap	47	27.49	3.12	
1st Month (A-B Gap)	Anterior Pull-Through	47	17.51	3.69	0.3476
	Conventional Flap	47	18.28	4.15	
3rd Month (A-B Gap)	Anterior Pull-Through	47	9.9	3.93	0.4056
	Conventional Flap	47	10.73	5.58	

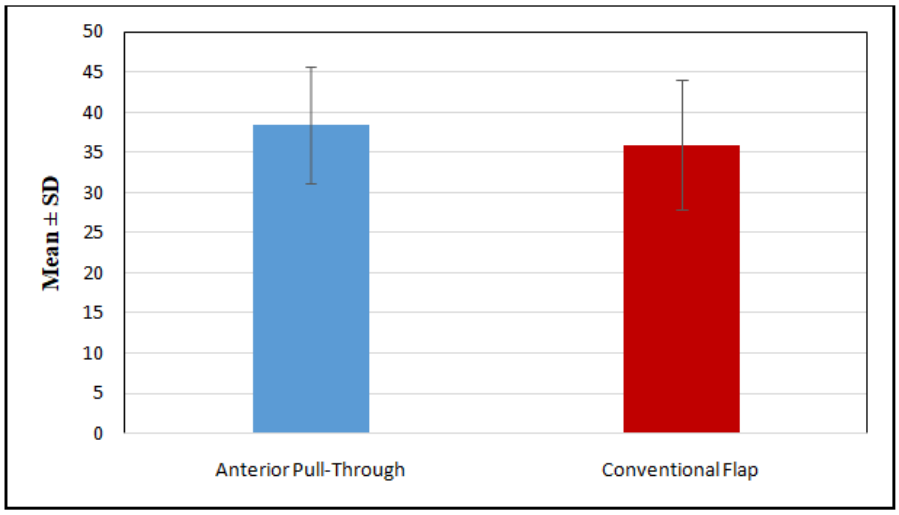

Figure 1: Distribution of mean Age : Group

A total of 94 patients were included in the study, equally divided into two groups: anterior pull-through (n=47) and conventional flap (n=47).

Demographic Characteristics: The mean age in the anterior pull-through group was 38.38 ± 7.25 years, and in the conventional flap group was 36.00 ± 8.02 years, with no statistically significant difference (t=1.5113, p=0.1341). Age distribution across the groups (21–30, 31–40, 41–50 years) was also comparable (χ^2=1.276, p=0.5284, not significant). Both groups had an identical sex distribution with 14 females (29.8%) and 33 males (70.2%) in each group (χ^2=0.000, p=1.000, not significant).

Graft Uptake: At the 2nd week, graft uptake was observed in 44 patients (93.6%) in the anterior pull-through group and 42 patients (89.4%) in the conventional group (χ^2=0.547, p=0.4597, not significant). At 1 month, uptake rates were 93.6% vs. 91.5% (χ^2=0.154, p=0.6944, not significant), and at 3 months, 93.6% vs. 91.5% (χ^2=0.154, p=0.6944, not significant). No statistically

significant differences were observed between the groups at any time point.

Hearing Outcomes (PTA – Air-Bone Gap): The mean preoperative PTA was 26.83 ± 2.99 dB in the anterior pull-through group and 27.49 ± 3.12 dB in the conventional flap group (t=1.0473, p=0.2977, not significant). At 1 month postoperatively, mean PTA improved to 17.51 ± 3.69 dB vs. 18.28 ± 4.15 dB (t=0.9442, p=0.3476, not significant), and at 3 months, further improved to 9.90 ± 3.93 dB vs. 10.73 ± 5.58 dB (t=0.8354, p=0.4056, not significant). There was no statistically significant difference in hearing improvement between the groups at any follow-up.

Discussion

The present study was a prospective, comparative hospital-based study conducted from 1st January 2023 to 30th June 2024 (18 months) in the Otorhinolaryngology department of KPC Medical College & Hospital, Jadavpur, Kolkata. A total of 94 patients with anterior tympanic membrane perforations were included, divided equally into anterior pull-through and conventional flap groups.

Demographic Characteristics: In our study, most patients were in the 41–50 years age group [39 (41.5%)], though the difference between groups was not statistically significant (p=0.5284). Kumar Gupta M et al. [13] (2021) reported the majority of patients were between 21 and 40 years of age. Male patients predominated in our study [66 (70.2%)] with a male-to-female ratio of 2.3:1, which was not statistically significant (p=1.0000). Indorewala S et al. [14] (2015) similarly reported a nearly equal male-to-female ratio in tympanoplasty cases. Duval M et al. [15] (2015) observed that anatomical success of tympanoplasty was not significantly different between age groups in children, and hearing improvement was similar across groups. This aligns with our findings where age did not significantly influence graft uptake or hearing improvement. Naderpour M et al.[16] (2016) also found no significant association between age, sex, or perforation characteristics and tympanoplasty outcomes, with a graft success rate of 93.3% and hearing improvement in 93% of cases.

Graft Uptake: In our study, graft uptake at the 2nd week was 93.6% in the anterior pull-through group and 89.4% in the conventional flap group (p=0.4597). At 1 month, uptake was 93.6% vs. 91.5% (p=0.6944), and at 3 months, 93.6% vs. 91.5% (p=0.6944). None of these differences were statistically significant. These findings are consistent with Gamra OB et al.[17] (2016), who reported comparable graft uptake between wet and dry ears, and with previous studies on anterior pull-through and loop underlay techniques that demonstrated high graft success rates (84.6–99.3%) without significant differences compared to conventional underlay techniques.

Hearing Outcomes (PTA – Air-Bone Gap): The mean preoperative PTA was slightly higher in the conventional flap group [27.49 ± 3.12 dB] compared to the anterior pull-through group [26.83 ± 2.99 dB], but the difference was not statistically significant (p=0.2977). At 1 month postoperatively, the mean PTA improved to 17.51 ± 3.69 dB vs. 18.28 ± 4.15 dB (p=0.3476), and at 3 months, to 9.90 ± 3.93 dB vs. 10.73 ± 5.58 dB (p=0.4056), again with no significant difference. Similar findings were reported by Dhanapala N et al. [18] (2018) and Fatih Mutlu et al.,[19] who found significant postoperative hearing gains in both techniques but no statistically significant difference between groups.

Comparison with Literature: Jeffrey P. Harris et al. [20] reported 84.6% graft closure using anterior pull-through in patients with anterior perforations, with audiometric improvement similar to our findings. Sharp et al. [9] reported a 95.7% success rate using the anterior hitch technique. D'Eredita and Lens [21] observed 93.2% closure with anterior tab flap vs. 84.6% with standard underlay, without significant difference. Loop underlay techniques described by Rana Barake et al.[22] showed closure rates of 99.3% and ABG improvement to <10 dB in 99.5% of cases. Raga PS et al. [23] also demonstrated >91% closure rates using modifications of underlay techniques.

Conclusion

In our study of 94 patients with anterior tympanic membrane perforations, demographic characteristics including age and sex distribution were comparable between groups and not statistically significant. Both anterior pull-through and conventional flap techniques demonstrated high graft uptake rates at 2 weeks, 1 month, and 3 months, with no significant differences between the groups. Similarly, hearing outcomes measured by mean PTA (air-bone gap) improved postoperatively in both groups, with slightly better results in the anterior pull-through group, though differences were not statistically significant. Overall, both techniques are effective for repairing anterior eardrum perforations, providing good anatomical and functional outcomes, with the choice of method guided by surgeon experience and patient-specific factors.

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