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Original Research Article

Underlay Tympanoplasty is Superior to Overlay: A Comparative Study

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Abstract:

Introduction: Tympanoplasty is a surgical procedure aimed at repairing tympanic membrane perforations and restoring hearing. The underlay and overlay techniques are commonly employed, but there is ongoing debate regarding which approach yields better functional and anatomical outcomes.

Aims: To compare the outcomes of underlay versus overlay tympanoplasty in patients with central and subtotal tympanic membrane perforations, in terms of graft success, postoperative hearing gain, and complications.

Materials and Methods: The present study was a prospective comparative study. This study was conducted over a period of 16 months (February 2020 to May 2021) at the Department of Otorhinolaryngology, KPC Medical College & Hospital, Kolkata, West Bengal, India, and Pin-700032. The study population consisted of 50 patients with central tympanic membrane perforations who attended the outpatient department and fulfilled the inclusion criteria.

Result: The underlay group demonstrated higher postoperative hearing gain, with 21 of 23 patients (91.3%) showing improvement, compared to 13 of 22 patients (59.1%) in the overlay group. Graft success was strongly correlated with Eustachian tube patency, achieving 95.6% in patent ET cases versus 25% in non-patent ET cases. Duration of preoperative dry ear also influenced graft uptake, with the highest success seen in patients with 1–6 months of dry ear (92.8%). Complications were fewer in the underlay group, with graft failure in 2 patients (8%) and pinhole perforation in 2 (8%), compared to 3 (12%) graft failures and higher rates of lateralization, healing problems, and myringitis in the overlay group.

Conclusion: Underlay tympanoplasty demonstrated superior functional and anatomical outcomes compared to overlay tympanoplasty, with higher hearing improvement, greater graft success, and fewer complications. The study supports the preferential use of the underlay technique for central and subtotal tympanic membrane perforations, particularly in patients with patent Eustachian tubes and adequately dry middle ears.

Keywords: Tympanoplasty, Underlay Technique, Overlay Technique, Hearing Gain, Graft Success, Eustachian Tube Patency.

Introduction

Tympanoplasty, the surgical repair of tympanic membrane perforations, is a cornerstone procedure in the management of chronic suppurative otitis media (CSOM), a condition long recognized as disabling, socially limiting, and occasionally life-threatening. Despite the advent of various antimicrobial agents and improved understanding of CSOM pathophysiology, persistent tympanic membrane perforations remain a challenge, manifesting as recurrent ear discharge, conductive hearing loss, and predisposition to recurrent infections across all age groups. Globally, the prevalence of CSOM varies widely, ranging from 2% in developed countries like the USA to as high as 50% in parts of Africa such as Zimbabwe, while Indian studies report a prevalence of around 11% among ENT outpatients (Sachdev [1]& Bhatia, 1965; Cullon, [2] 1947). The impact of tympanic membrane perforation extends beyond physical symptoms: hearing impairment in children can hinder speech, language, and cognitive development, while in adults it can restrict educational, occupational, and social opportunities, leading to psychological and financial consequences. The surgical repair of the tympanic membrane has evolved over centuries, from early experimental attempts using pig's bladder in 1640 to Berthold's skin graft in 1878, culminating in

modern techniques employing temporalis fascia and either underlay or overlay grafting. Despite being a well-established procedure, controversies remain regarding the optimal surgical approach, timing of intervention, graft material, and factors influencing success, such as perforation size and site, middle ear status, Eustachian tube function, and duration of preoperative dry ear. West Bengal, with a significant population of economically and medically underprivileged individuals, offers an ideal setting to evaluate these factors. The present study aims to compare the outcomes of underlay versus overlay tympanoplasty in patients with central tympanic membrane perforations, assessing graft uptake, hearing improvement, and the influence of preoperative dry ear duration, Eustachian tube function, functional results, and postoperative complications, thereby providing insights into the technique that offers superior functional and anatomical results in this population.

Materials and Methods

Type of Study: Prospective comparative study.

Place of Study: Department of Otorhinolaryngology, KPC Medical College and Hospital, Kolkata, West Bengal, India, Pin-700032.

Study Duration: February 2020 to May 2021 (16 months).

Sample Size: Fifty patients with central tympanic membrane perforations.

Study Population: The study included 50 patients attending the Out-patient Department of Otorhinolaryngology, KPC Medical College and Hospital, Kolkata, who underwent tympanoplasty by either overlay or underlay technique using temporalis fascia as a graft. Patients were assigned to surgical technique based on medical record numbering: odd-numbered patients received underlay tympanoplasty, and even-numbered patients received overlay tympanoplasty.

Inclusion Criteria

1. Patients aged 15–55 years with dry central perforations of the tympanic membrane and inactive mucosal-type chronic otitis media, with adequate cochlear reserve.
2. Patients with dry perforations that failed to heal after conservative management.
3. Patients with conductive hearing loss less than 40 dB.
4. In bilateral cases, the ear with poorer hearing was selected for surgery.

Exclusion Criteria

1. Patients with associated nasal allergy, smoking history, diabetes, hypertension, chronic obstructive pulmonary disease, cleft palate, or autoimmune disease.
2. Patients younger than 15 years or older than 55 years.
3. Noncompliance with follow-up, post-surgical ear trauma, or any ear pathology affecting outcomes
4. Patients with a single hearing ear.
5. Patients with sensorineural or mixed hearing loss.

Study Parameters: The study evaluated graft uptake, postoperative hearing improvement, and complications in relation to surgical technique, duration of preoperative dry ear, and Eustachian tube status.

Statistical Analysis: Data were entered into Excel and analyzed using SPSS and Graph Pad Prism. Numerical variables were summarized using means and standard deviations, while categorical variables were described with counts and percentages.

Two-sample t-tests were used to compare independent groups, while paired t-tests accounted for correlations in paired data. Chi-square tests (including Fisher's exact test for small sample sizes) were used for categorical data comparisons. P-values ≤ 0.05 were considered statistically significant.

Results

Table 1: Demographic and Baseline Characteristics (n = 50)

Characteristic	Category	Number of Cases	Percentage (%)
Age Group (years)	16–20	8	16
	21–25	26	52
	26–30	9	18
	31–35	4	8
	36–40	3	6
Sex	Male	32	64
	Female	18	36
Occupation	Student	10	20
	Labour	18	36
	Housewife	8	16
	Cultivator	6	12
	Driver	3	6

	Businessman	2	4
	Office Assistant	2	4
	Police Personnel	1	2
Residential Address	Rural	34	68
	Urban	16	32

Table 2: Clinical Presentation and History

Parameter	Category / Condition	Number of Cases	Percentage (%)
Presenting Symptoms	Impairment of Hearing	50	100
	Discharge per Ear/Ears	29	58
	Itching in the Ear	13	26
	Pain in the Ear	7	14
	Tinnitus	4	8
	Vertigo	3	6
	Headache	2	4
	Sneezing	16	32
	Nasal Block	9	18
	Fever	1	2
Duration of Ear Discharge	<1 month	5	10
	1 to 6 months	28	56
	6 months to 1 year	10	20
	1 year and above	7	14
Condition of the Ears (Dry / Discharging)	Discharging Ears at First Visit	29	58
	Dry Ears at First Visit	21	42
	Dry Ears after Conservative Therapy	29	58
Duration of Absence of Discharge	<3 months	21	42
	3–6 months	26	52
	>6 months	3	6
Dry Ears after Aural Toilet, Medical Therapy, and Management of Predisposing Factors	Aural Toilet + Medical Therapy	21	21
	Tonsillectomy + Medical Therapy	1	1
	SMR + Medical Therapy + APW	3	3
	Electrocauterization of HIT + APW + Medical Therapy	4	4

Table 3: General and ENT Examination Findings

Examination Parameter	Findings / Condition	Number of Cases	Percentage (%)
General Examination	Good Health	8	16
	Average Health	33	66
	Anaemia	5	10
	Poor Nutrition	4	8
Pinna Examination	External Deformity	0	0
	Unhealthy Skin	0	0
	Inflammatory Lesion	0	0
	Tenderness	0	0
External Auditory Canal	Deformity	0	0
	Discharge	29	58
	Ulceration	0	0
	Bony Swelling	0	0
Tympanic Membrane	Perforation (Large Central)	32	64
	Subtotal	18	36
Nose and Throat Examination	Nasal Discharge	6	12
	Deviation of Nasal Septum	3	6
	Hypertrophied	4	8

	Inferior Turbinate		
	Pharyngitis	2	4
	Purulent Discharge in Middle Meatus with Postnasal Dribbling	1	2
Pre-operative Audiogram (Conductive Hearing Loss)	Air Conduction 25–29 dB	6	12
	Air Conduction 30–34 dB	20	40
	Air Conduction 35–40 dB	24	48
	Bone Conduction 25–29 dB	0	0
	Bone Conduction 30–34 dB	0	0
	Bone Conduction 35–40 dB	0	0
Condition of Eustachian Tube	Patent	46	92
	Non-patent	4	8

Table 4: Operative Details

Operative Parameter	Category / Detail	Number of Cases	Percentage (%)
Technique of Tympanoplasty	Underlay	25	50
	Overlay	25	50
	Total	50	100
Type of Perforation	Central	32	64
	Subtotal	18	36
Technique of Operation Undertaken	Underlay (Central + Subtotal)	25	50
	Overlay (Central + Subtotal)	25	50
	Total	50	100

Table 5: Tympanoplasty Outcomes in Relation to Hearing Gain, Eustachian Tube Status, and Duration of Dry Ear

Parameter	Subcategory	Total Cases	Successful Cases	Percentage (%)
Postoperative Gain in Hearing (Successful Cases)	Underlay	23	21	91.3
	Overlay	22	13	59.1
Graft Success in Relation to Eustachian Tube Status	Patent	46	44	95.6
	Non-Patent	4	1	25
Graft Success in Relation to Duration of Dry Ear	<1 month	5	4	80
	1–6 months	28	26	92.8
	6 months–1 year	10	9	90
	1 year & above	7	6	85.7

Table 6: Postoperative Gain in Hearing (After 6 Weeks and 6 Months)

Gain in Hearing (dB)	Underlay Technique (N = 23)		Overlay Technique (N = 22)	
	6 Weeks	6 Months	6 Weeks	6 Months
Upto 10	11	11	5	5
11–15	4	4	3	3
16–20	3	3	2	2
21–25	1	1	2	2
26–30	2	2	1	1
Nil	2	2	9	9
Total	23	23	22	22

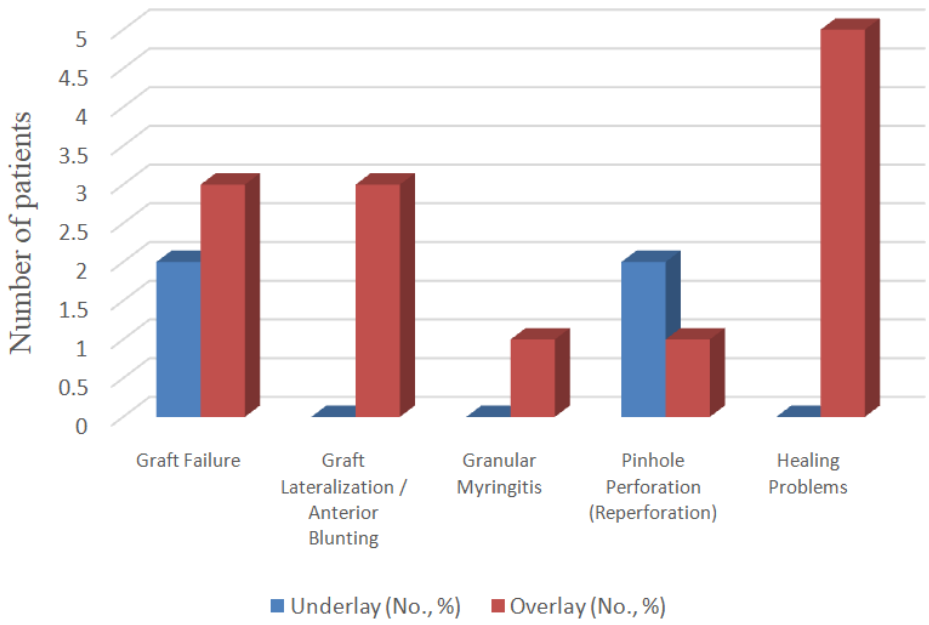

Figure 1: Complications after Underlay and Overlay Techniques of Tympanoplasty

Among the 50 participants, the majority were in the 21–25 years age group (26, 52%), followed by 26–30 years (9, 18%), 16–20 years (8, 16%), 31–35 years (4, 8%), and 36–40 years (3, 6%). Males predominated with 32 cases (64%) compared to 18 females (36%). Regarding occupation, most participants were labourers (18, 36%), followed by students (10, 20%), housewives (8, 16%), cultivators (6, 12%), drivers (3, 6%), businessmen (2, 4%), office assistants (2, 4%), and police personnel (1, 2%). A majority of participants resided in rural areas (34, 68%) while 16 (32%) were from urban areas. (Table 1)

All 50 patients (100%) presented with impairment of hearing, while other symptoms included ear discharge in 29 cases (58%), itching in 13 (26%), pain in 7 (14%), tinnitus in 4 (8%), vertigo in 3 (6%), headache in 2 (4%), sneezing in 16 (32%), nasal block in 9 (18%), and fever in 1 case (2%). The duration of ear discharge was less than 1 month in 5 cases (10%), 1–6 months in 28 cases (56%), 6 months to 1 year in 10 cases (20%), and more than 1 year in 7 cases (14%). At the first visit, 29 patients (58%) had discharging ears, while 21 (42%) had dry ears; after conservative therapy, 29 patients (58%) achieved dry ears. The duration of absence of discharge was less than 3 months in 21 cases (42%), 3–6 months in 26 (52%), and more than 6 months in 3 cases (6%). Dry ears were achieved through aural toilet and medical therapy in 21 cases (21%), tonsillectomy plus medical therapy in 1 case (1%), SMR with medical therapy and APW in 3 cases (3%), and electro cauterization of HIT with APW and medical therapy in 4 cases (4%). (Table 2). On general examination, 8 patients (16%) were in good health, 33 (66%) in average health, 5 (10%) had anaemia, and 4 (8%) showed poor nutrition. Pinna examination revealed no external deformity, unhealthy skin, inflammatory lesions, or tenderness in any patient. Examination of the external auditory canal showed discharge in 29 cases (58%), with no deformity, ulceration, or bony swelling. Tympanic membrane evaluation revealed large central perforation in 32 patients (64%) and subtotal perforation in 18 (36%). Nose and throat findings included nasal discharge in 6 cases (12%), deviation of nasal septum in 3 (6%), hypertrophied inferior turbinate in 4 (8%), pharyngitis in 2 (4%), and purulent discharge in the middle meatus with postnasal dribbling in 1 case (2%). Pre-operative audiogram demonstrated conductive hearing loss with air conduction of 25–29 dB in 6 patients (12%), 30–34 dB in 20 patients (40%), and 35–40 dB in 24 patients (48%); bone conduction thresholds were normal in all cases. The Eustachian tube was patent in 46 patients (92%) and non-patent in 4 (8%). (Table 3)

Among the 50 patients who underwent tympanoplasty, the surgical technique was equally divided between underlay and overlay, with 25 cases (50%) in each group. Regarding the type of tympanic membrane perforation, 32 patients (64%) had central perforations, while 18 (36%) had subtotal perforations. The operative techniques undertaken mirrored the perforation types, with underlay tympanoplasty performed in 25 cases (50%) and overlay tympanoplasty in 25 cases (50%). (Table 4). Postoperative hearing gain was achieved in 21 of 23 underlay tympanoplasty cases (91.3%) and 13 of 22 overlay cases (59.1%). Graft success in relation to Eustachian tube status was 95.6% in patients with a patent Eustachian tube (44 of 46) and 25% in those with a non-patient tube (1 of 4). When analyzed by duration of dry ear, graft success was

80% for less than 1 month (4 of 5), 92.8% for 1–6 months (26 of 28), 90% for 6 months to 1 year (9 of 10), and 85.7% for 1 year and above (6 of 7). (Table 5)

In the present study, assessment of hearing gain following tympanoplasty revealed that the majority of patients in the underlay technique group achieved measurable improvement. At both 6 weeks and 6 months, 11 patients (47.8%) demonstrated hearing gain up to 10 dB, while 4 patients (17.4%) had gain of 11–15 dB, 3 patients (13%) showed 16–20 dB gain, 1 patient (4.3%) had 21–25 dB improvement, and 2 patients (8.7%) achieved 26–30 dB gain. Only 2 patients (8.7%) in this group showed no hearing improvement. In contrast, in the overlay technique group, 5 patients (22.7%) had gain up to 10 dB, 3 patients (13.6%) showed improvement of 11–15 dB, 2 patients (9.1%) gained 16–20 dB, 2 patients (9.1%) had 21–25 dB gain, and 1 patient (4.5%) achieved 26–30 dB improvement. However, a significantly higher proportion, 9 patients (40.9%), showed no hearing gain. The results indicate that the underlay technique produced comparatively better postoperative hearing outcomes than the overlay technique, both at 6 weeks and at 6 months of follow-up.(Table 6)

Postoperative complications following tympanoplasty varied between the underlay and overlay techniques. In the underlay group, graft failure occurred in 2 patients (8%), pinhole perforation in 2 patients (8%), while no cases of graft lateralization, anterior blunting, granular myringitis, or healing problems were observed. In the overlay group, graft failure was noted in 3 patients (12%), graft lateralization or anterior blunting in 3 patients (12%), granular myringitis in 1 patient (8%), pinhole perforation in 1 patient (4%), and healing problems in 5 patients (20%). (Figure 1)

Discussion

The present study was a prospective comparative study. This study was conducted over a period of 16 months (February 2020 to May 2021) at the Department of Otorhinolaryngology, KPC Medical College & Hospital, Kolkata, West Bengal, India, Pin-700032. The study population consisted of 50 patients with central tympanic membrane perforations who attended the outpatient department and fulfilled the inclusion criteria.

In the present study of 50 patients undergoing tympanoplasty, the majority of participants were aged 21–25 years (26, 52%), followed by 26–30 years (9, 18%), 16–20 years (8, 16%), 31–35 years (4, 8%), and 36–40 years (3, 6%). There was a male predominance with 32 cases (64%) versus 18 females (36%), which is consistent with previous reports suggesting higher prevalence of chronic otitis media in males, possibly due to increased exposure to environmental risk factors (Sachdev HP et al [1]; Cullon WA [2]). Most participants were labourers (18, 36%) or students (10, 20%), and a majority resided in rural areas (34, 68%), reflecting the higher burden of ear disease in rural populations with limited access to healthcare (Sachdev HP et al [1]; Cullon WA [2]).

All patients (100%) presented with hearing impairment, and ear discharge was observed in 29 cases (58%), followed by itching in 13 (26%), pain in 7 (14%), tinnitus in 4 (8%), vertigo in 3 (6%), headache in 2 (4%), sneezing in 16 (32%), nasal block in 9 (18%), and fever in 1 case (2%). The duration of discharge was 1–6 months in most cases (28, 56%), while 5 patients (10%) had discharge for less than 1 month, and 7 patients (14%) had symptoms for over a year. These findings align with earlier reports indicating that persistent otorrhea is a common presenting feature in chronic suppurative otitis media (Marcus B [3]; Berthold C [4]). At presentation, 29 patients (58%) had discharging ears, and following conservative therapy, dry ears were achieved in 29 patients (58%), either through aural toilet and medical therapy (21, 21%) or additional interventions such as SMR with medical therapy and APW (3, 3%) and electrocauterization of HIT with APW and medical therapy (4, 4%) (Sheehy JL et al [5]).

On general examination, 33 patients (66%) were of average health, 8 (16%) were in good health, 5 (10%) had anaemia, and 4 (8%) had poor nutrition. No pinna abnormalities were observed, while the external auditory canal showed discharge in 29 patients (58%). Tympanic membrane perforations were predominantly central (32, 64%) with 18 subtotal perforations (36%) (Tos M [6]; Glasscock ME et al [7]). Nose and throat examination revealed nasal discharge in 6 cases (12%), hypertrophied inferior turbinate in 4 (8%), deviation of nasal septum in 3 (6%), pharyngitis in 2 (4%), and purulent discharge with postnasal dribbling in 1 case (2%). Preoperative audiometry indicated moderate conductive hearing loss, with air conduction thresholds of 30–34 dB in 20 patients (40%) and 35–40 dB in 24 patients (48%). The Eustachian tube was patent in 46 patients (92%), highlighting the importance of ET function in tympanoplasty outcomes (Wullstein H [8]; Paparella MM et al [9]).

Operative details showed an equal distribution between underlay and overlay techniques (25, 50% each). Central perforations were more common (32, 64%) than subtotal perforations (18, 36%), reflecting the typical distribution in chronic otitis media populations (Tos M [6]; Glasscock ME et al [7]). Postoperative hearing gain was significantly higher in the underlay group, with 21 of 23 patients (91.3%) achieving improvement compared to 13 of 22 (59.1%) in the overlay group, indicating superior functional outcomes with the underlay

technique (Chauhan A et al [10]; Rizer FM [11]; Khan AS et al [12]). Graft success correlated strongly with Eustachian tube patency: 44 of 46 patients (95.6%) with patent ET achieved successful graft uptake, whereas only 1 of 4 patients (25%) with non-patent ET had successful grafting. Duration of dry ear also influenced graft success, with success rates of 92.8% for 1–6 months (26 of 28), 90% for 6 months–1 year (9 of 10), 85.7% for over 1 year (6 of 7), and 80% for less than 1 month (4 of 5). These results underscore the critical role of middle ear dryness and ET function in tympanoplasty success (Wullstein H [8]; Paparella MM et al [9]; Chauhan A et al [10]).

Postoperative audiometric evaluation at 6 weeks and 6 months confirmed stable hearing gains. In the underlay group, most patients (11, 48%) gained up to 10 dB, while only 2 patients (8%) had no gain. In the overlay group, 9 patients (41%) had no gain, and only 5 (23%) achieved up to 10 dB improvement, indicating that overlay techniques may have slightly lower functional efficacy (Chauhan A et al [10]; Rizer FM [11]; Khan AS et al [12]).

Complications were minimal in the underlay group, with graft failure in 2 patients (8%) and pinhole perforation in 2 (8%), and none experienced graft lateralization or healing problems. In contrast, the overlay group had graft failure in 3 patients (12%), graft lateralization or anterior blunting in 3 (12%), granular myringitis in 1 (4%), pinhole perforation in 1 (4%), and healing problems in 5 (20%). This aligns with prior studies reporting higher rates of lateralization and healing issues with overlay tympanoplasty (Pandey R et al [13]).

In summary, underlay tympanoplasty demonstrated higher rates of graft success (91.3% hearing gain), fewer complications, and better functional outcomes compared to overlay techniques, particularly in patients with patent Eustachian tubes and adequately dry ears. These findings support the continued preference for underlay tympanoplasty in appropriately selected cases of chronic otitis media with central or subtotal perforations (Chauhan A et al [10]; Rizer FM [11]; Pandey R et al [13]).

Conclusion

In this comparative study of tympanoplasty, the underlay technique demonstrated superior efficacy and safety compared to the overlay technique. Patients undergoing underlay tympanoplasty achieved higher rates of postoperative hearing improvement (91.3% vs. 59.1%), greater graft uptake, and fewer complications such as graft lateralization, healing problems, or reperforation. Success was particularly notable in patients with a patent Eustachian tube and adequately dry ears, highlighting the importance of preoperative middle ear optimization for optimal outcomes. While overlay tympanoplasty remains a valuable option, especially in cases with large or anterior perforations, it was associated with slightly lower functional gains and higher complication rates. Overall, the study supports the preferential use of the underlay technique as the procedure of choice for central and subtotal tympanic membrane perforations, offering predictable hearing restoration and a lower risk of postoperative complications.

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