DOI: 10.7860/JCDR/2025/80292.21401

Original Article

Ear, Nose and Throat Section

Chemical Cauterisation versus Fat Plug Myringoplasty for Closure of Small Central Tympanic Membrane Perforation: A Prospective Interventional Study

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ABSTRACT

Introduction: Perforation of the tympanic membrane is a commonly encountered problem in otolaryngology and often leads to conductive hearing loss as well as recurrent middle ear infections. For smaller, central perforations, treatment has gradually shifted toward less invasive methods. Two such techniques chemical cauterisation and fat plug myringoplasty are widely practiced but rarely compared in a single study. This research was undertaken to explore and contrast these procedures in terms of healing success, auditory recovery, complication rates, and patient-reported outcomes.

Aim: To compare the tympanic membrane closure rate with fat plug myringoplasty vs chemical cauterisation for treatment of small central perforations of pars tensa.

Materials and Methods: The present prospective interventional study involved 60 patients presenting with small central tympanic membrane perforations. Conducted at a tertiary care hospital, participants were randomly assigned to one of two intervention arms. Group I received chemical cauterisation, while Group II underwent fat plug myringoplasty, with 30 individuals in each cohort. Hearing was evaluated using Pure Tone Audiometry (PTA) at baseline and repeated at three months postprocedure to assess postoperative improvement. Additional data on patient satisfaction and postoperative complications were also collected and analysed. Statistical analysis was performed using the Chi-square test for categorical variables and the independent samples t-test for comparing mean hearing improvement between groups. A p-value of <0.05 was considered statistically significant.

Results: Among those treated with chemical cauterisation, 26 (86.7%) achieved complete closure of the perforation, compared to 28 (93.3%) in the fat plug group. Both interventions led to a meaningful improvement in hearing, with mean postoperative PTA was 16.21±1.26 dB in Group I and 17.62±1.67 dB in Group II. Minor postoperative issues were noted in both groups. Interestingly, satisfaction levels were higher in the fat plug group, with a mean score of 9.17±0.39 versus 8.50±0.50 in the cauterisation group.

Conclusion: The findings suggest that while both techniques are effective and minimally invasive, fat plug myringoplasty may offer a slight advantage in terms of closure rates and patient satisfaction. These results support its consideration as a first-line option for the management of small central tympanic membrane perforations.

Keywords: Ear diseases, Fat tissue, Otologic surgical procedures, Patient satisfaction, Postoperative complications, Pure tone audiometry, Tympanic membrane perforation

INTRODUCTION

In clinical otology, one of the persistent challenges involves managing tympanic membrane perforations. These are often the aftermath of chronic infections, trauma, or even procedures involving the middle ear [1,2]. Though some patients remain asymptomatic, many present with troublesome symptoms such as hearing loss, episodic discharge, or a sense of ear fullness [3]. Even a small central perforation seemingly minor on examination can affect quality of life more than expected [4]. While tympanoplasty remains the standard for larger or non-healing perforations, small central ones do not always warrant full surgical repair. Over the years, simpler alternatives have gained traction. Two such minimally invasive options include chemical cauterisation and fat plug myringoplasty both of which are relatively straightforward to perform and cost-effective for patients [5,6].

Fat plug myringoplasty, on the other hand, makes use of the patient's own tissue usually a small graft of fat from the earlobe. This graft is gently inserted into the perforation to provide structural support for healing. It offers a biological scaffold for epithelial cells to grow across and seal the defect, which has shown good results, especially in dry central perforations [7,8]. Chemical cauterisation, in particular, uses Trichloroacetic Acid (TCA) to irritate the edge of the perforation. This triggers a healing response by stimulating fibroblasts around the margin, eventually helping the membrane to regenerate [9]. It is a technique often done in outpatient clinics and does not require anaesthesia in most cases.

Although both chemical cauterisation and fat plug myringoplasty are widely practiced as minimally invasive treatments for small central tympanic membrane perforations, there is a lack of robust, direct comparative studies evaluating their relative efficacy under standardised clinical conditions. Therefore, this study addresses this gap by prospectively comparing these two methods in a randomised design, assessing closure rates, hearing improvement, patient satisfaction, and complications. The findings aim to provide practical evidence to help otologists select the most effective and patient-preferred option for managing small perforations.

MATERIALS AND METHODS

This was a prospective, randomised interventional study conducted in the Department of Otorhinolaryngology at Dr. D. Y. Patil Medical College, Hospital and Research Centre, Pimpri, Pune, Maharashtra, India between June 1, 2023, and December 31, 2024. The present study was initiated after obtaining approval from the Institutional Ethics Committee (IEC approval number: IESC/PGS/2023/123).

Written informed consent was obtained from all participants prior to enrolment.

Inclusion and Exclusion criteria: Patients aged 16 years and above with dry, central tympanic membrane perforations measuring ≤5 mm in diameter and persisting for at least two months were considered eligible for inclusion. Individuals with active ear discharge, prior otologic surgery, attico-antral disease, nasopharyngeal pathology, Eustachian tube dysfunction, mixed hearing loss, or active rhinosinusitis were excluded from the study.

Sample size calculation: Sample size estimation was based on expected closure rates of 97.2% for fat plug myringoplasty and 73.75% for chemical cauterisation [1,10]. Using a two-sided significance level of 5% and a power of 80%, the sample size was calculated using the formula for comparing two proportions:

$$n=((Z_{\alpha/2}+Z\beta)^2\times[p1(1-p1)+p2(1-p2)])/(p1-p2)^2$$

Substituting the values ($Z\alpha/2=1.96$, $Z\beta=0.84$, $p_1=0.97$, $p_2=0.73$), the minimum required sample size per group was 30. Thus, 30 patients were included in each group, yielding a total sample of 60 participants.

Study Procedure

Randomisation was carried out using computer generated random numbers, and allocation was concealed in sealed opaque envelopes opened at the time of intervention. Patients were assigned to either group I (chemical cauterisation) or group II (fat plug myringoplasty). In group I, 10% TCA was applied to the perforation margins under microscopic guidance to stimulate healing. The procedure was repeated weekly for a maximum of three sessions if closure was not achieved. This method has been previously described in the literature by Upreti G in 2019 [11]. In group II, autologous fat harvested from the earlobe was placed into the perforation using standard sterile technique under local anaesthesia, as per the technique described by Ringenberg JC (1978) [12].

All participants underwent a baseline clinical evaluation including general examination, otoscopic inspection, and PTA to document pre-treatment hearing thresholds at 500 Hz, 1000 Hz, and 2000 Hz. Follow-up visits were scheduled at one week, one month, and three months after the procedure to monitor healing progress; however, final postoperative healing status and PTA were recorded at the 3-month visit for outcome analysis. At each visit, otoscopic examination was performed to assess perforation healing, and PTA was repeated at three months to evaluate hearing improvement.

The primary outcomes included the rate of tympanic membrane closure and improvement in hearing thresholds. Secondary outcomes included incidence of postoperative complications such as infection or graft rejection, and patient satisfaction. Satisfaction was assessed using a 10-point Likert scale, where 0 represented complete dissatisfaction and 10 represented complete satisfaction [1]. Additional data such as demographics, perforation characteristics, audiometric results, and number of return visits were recorded at baseline and during follow-up.

STATISTICAL ANALYSIS

Data analysis was conducted using IBM Statistical Package for Social Sciences (SPSS) Statistics for Windows, Version 27.0 (IBM Corp., Armonk, NY) and Microsoft Excel (Microsoft 365). Quantitative variables were expressed as mean±standard deviation, and qualitative variables as frequencies and percentages. Normality was tested using the Shapiro-Wilk test. Intergroup comparisons were performed using the independent t-test for normally distributed variables and the Mann-Whitney U test for non-normally distributed variables. Paired t-test and Wilcoxon signed-rank test were used for within-group comparisons. Categorical data were analysed using the chi-square test or Fisher's-exact test as appropriate. A two-tailed p-value <0.05 was considered statistically significant.

RESULTS

Values for quantitative variables are displayed as mean±SD; Test used: Mann-Whitney U test. Qualitative variables were represented using frequency (%); Chi-square test or Fisher's-exact test were the test used. A p-value <0.05 shows statistically Significant (indicated by *).

The study included 60 patients with a mean age of 34.22±13.06 years. Group I (Chemical Cauterisation) had a mean age of 34.10±12.64 years, while group II (Fat Plug Myringoplasty) had a mean age of 34.33±13.69 years. Gender distribution was nearly equal, with 31 (51.7%) males and 29 (48.3%) overall. Group I comprised 16 (53.3%) males and 14 (46.7%) females, whereas group II included 15 (50%) males and 15 (50%) females. The mean perforation size was comparable between groups, with group I having 3.2±0.6 mm and group II 3.3±0.5 mm. The mean duration of perforation was 4.5±1.2 months in group I and 4.4±1.0 months in group II, with no statistically significant differences [Table/Fig-1].

Parameters		(Group I) Chemical cauterisation (n=30)	(Group II) Fat plug myringoplasty (n=30)	Total (N=60)	p-value
Mean age (years)		34.10±12.64	34.33±13.69	34.22±13.06	0.994
Gender distribution	Male	16 (53.3%)	15 (50%)	31(51.7%)	1
	Female	14 (46.7%)	15 (50%)	29 (48.3%)	
Mean perforation size (mm)		3.2±0.6	3.3±0.5	3.25±0.55	0.745
Mean duration of perforation (months)		4.5±1.2	4.4±1.0	4.45±1.1	0.681

[Table/Fig-1]: Baseline demographic characteristics of study participants in both groups.
Values for quantitative variables are displayed as mean±SD; Test used: Mann-Whitney U test. Qualitative variables were represented using frequency (%); Test used: Chi-square test or Fisher's-exact test. p-value <0.05 shows statistically Significant (indicated by *)

Paired t-test was used to compare mean preoperative and postoperative hearing thresholds. Mann-Whitney U test was used for analysing the total preoperative and postoperative. The PTA was used preoperatively and at the 3-month follow-up to assess improvements in hearing thresholds. Both groups demonstrated significant auditory improvement post-intervention. The mean preoperative PTA was 28.21±2.43 dB in group I (chemical cauterisation) and 29.74±2.89 dB in group II (fat plug myringoplasty). The mean postoperative PTA was 16.21±1.26 dB in group I and 17.62±1.67 dB in group II. The mean PTA gain was 11.83±2.07 dB in group I and 11.97±1.69 dB in group II. The within-group Improvements were statistically significant (p<0.001). Although the mean PTA gain between the two groups was slightly higher in group II, this difference was not statistically significant (p=0.836). These results indicate that both techniques are effective in restoring hearing in patients with small central perforations [Table/Fig-2].

Group	Preop PTA	Postop PTA	PTA gain
Group I	28.21±2.43	16.21±1.26	11.83±2.07
Group II	29.74±2.89	17.62±1.67	11.97±1.69
Total	28.98±2.76	16.92±1.63	11.90±1.87
p-value	0.011*	0.005*	0.836

[Table/Fig-2]: Comparison of preoperative and postoperative Pure Tone Audiometry (PTA) Thresholds and PTA Gain (dB).
*Highly significant; Paired t-test was used to compare mean preoperative and postoperative hearing thresholds. Mann-Whitney U test was used for analysing the total preoperative and postoperative PTA

Qualitative variables were represented using frequency (%); Test used: Chi-square test or Fisher's-exact test. p-value <0.05 shows Statistically Significant (indicated by *). Successful closure of the tympanic membrane served as a primary marker of therapeutic success. In group I (chemical cauterisation), 26 (86.7%) of perforations achieved complete closure, while in group II (fat plug myringoplasty), the closure

rate was slightly higher at 28 (93.3%). Although the difference was not statistically significant (p=0.671), it indicates a possible clinical benefit with fat plug myringoplasty. The lower residual perforation rate observed in group II (6.7%) compared to group I (13.3%) may reflect the enhanced structural support and epithelial bridging offered by the autologous fat graft. In contrast, variability in healing response or compliance with postoperative care might have contributed to the higher residual rate in the cauterisation group [Table/Fig-3].

Group	Number of closed perforations	Success rate (%)	Number of residual perforations	Residual rate (%)	p-value
Chemical cauterisation	26	86.7	4	13.3	0.671
Fat plug myringoplasty	28	93.3	2	6.7	

[Table/Fig-3]: Closure success rate and residual perforation rate.
Qualitative variables were represented using frequency (%); Test used: Chi-square test or Fisher's-exact test. p-value <0.05 shows Statistically Significant (indicated by*)

Values for quantitative variables are displayed as mean±SD; Test used: Chi-square test or Fisher's-exact test. p-value <0.05 shows statistically Significant (indicated by *).

Complications were relatively few and comparable between the two groups. In group I (chemical cauterisation), four cases of postoperative infection were noted, whereas group II (fat plug myringoplasty) reported one infection and one graft failure. Overall, five infections and one graft failure occurred across all participants. The mean patient satisfaction score was higher in the fat plug myringoplasty group (9.17±0.39) compared to the chemical cauterisation group (8.50±0.50), and this difference was statistically significant (p<0.001). Additionally, the mean number of follow-up visits per patient was significantly higher in group I (2.8±0.4) than in group II (2.1±0.3) (p=0.01), indicating fewer visits were needed for patients treated with fat plug myringoplasty [Table/Fig-4].

Parameters	Chemical cauterisation	Fat plug myringoplasty	Total	p-value
Infections	4	1	5	0.353
Graft failure	0	1	1	—
Mean satisfaction Score±SD	8.50±0.50	9.17±0.39	8.84±0.56	<0.001*
Mean follow-up visits per patient±SD	2.8±0.4	2.1±0.3	2.45±0.5	0.01

[Table/Fig-4]: Complications and patient satisfaction.
Values for quantitative variables are displayed as mean±SD; Test used: Chi-square test or Fisher's-exact test. p-value <0.05 shows statistically Significant (indicated by*)

DISCUSSION

Perforations of the tympanic membrane, particularly those located centrally, are frequently seen in patients with chronic ear infections or following traumatic events. While often considered minor, these defects can result in noticeable symptoms such as hearing loss and intermittent discharge, which may affect daily routines and overall well-being. In managing such conditions, the primary aim is to close the perforation, restore hearing, and prevent the recurrence of symptoms. To address this, the current study focused on evaluating two commonly used, less invasive procedures chemical cauterisation and fat plug myringoplasty to understand how effective they are in achieving these therapeutic outcomes. Sixty patients were included in this study, with participants randomly assigned to one of the two treatment arms. Group I underwent chemical cauterisation, while group II received fat plug myringoplasty. The average age in both groups was nearly identical 34.10±12.64 years in group I and 34.33±13.69 years in group II. Male and female representation was also comparable across both sets. This balance in baseline characteristics helped ensure that the outcomes could be attributed to the treatments themselves rather than differences in patient demographics.

PTA was utilised pre- and postoperatively to assess improvements in hearing. Both treatment groups demonstrated significant auditory gains following the intervention. The mean improvement in PTA was 11.83±2.07 dB in group I (chemical cauterisation) and 11.97±1.69 dB in group II (fat plug myringoplasty). These results indicate that both techniques are effective in enhancing auditory thresholds in patients with small central perforations, consistent with previous reports that have shown similar postoperative hearing improvements for these minimally invasive methods [13,14]. The difference in PTA gain between the two groups was not statistically significant, corroborating with Huang J et al., that has reported comparable auditory outcomes for these minimally invasive procedures [8].

Successful closure of the tympanic membrane is a primary indicator of therapeutic efficacy. In this study, group I (chemical cauterisation) achieved a closure rate of 86.7%, while group II (fat plug myringoplasty) demonstrated a slightly higher success rate of 93.3%. These results fall within the ranges reported by earlier studies, which have documented closure rates between 80 and 95% for chemical cauterisation and 85 to 98% for fat plug myringoplasty [13,15,16]. Although the difference was not statistically significant, it suggests a potential clinical advantage with fat plug myringoplasty [17]. The lower rate of residual perforation in group II (6.7 compared to 13.3% in group I) may be attributed to the structural support provided by the autologous fat graft, which enhances epithelial migration and promotes more effective healing [18]. Conversely, the presence of residual perforations in the chemical cauterisation group may be due to variable fibroblastic responses or inconsistent adherence to postoperative care protocols [10].

Throughout the follow-up period, both treatment groups showed encouraging results in terms of safety, with very few complications observed overall. In the chemical cauterisation group, four patients developed minor infections, which were managed conservatively without long-term consequences. Similarly, Santhi T and Rajan KV also reported low infection rates with chemical cauterisation, supporting its safety profile [10]. In the fat plug myringoplasty group, one patient developed a mild postoperative infection and another experienced graft failure. This aligns with findings by Kim HC et al., (2024) and Han JS et al., (2021), who noted occasional graft failures but overall low complication rates with fat grafting techniques [1,3]. Importantly, no serious or irreversible adverse events occurred in either group in the present study. These consistently low complication rates, comparable to previous reports, suggest that when performed with proper aseptic precautions, both chemical cauterisation and fat plug myringoplasty are safe and well tolerated for the treatment of small tympanic membrane perforations.

Patient satisfaction serves as a valuable indicator when evaluating the success of outpatient interventions, especially those intended to be minimally invasive and convenient. In the present study, individuals who underwent fat plug myringoplasty reported a higher level of satisfaction, with a mean score of 9.17±0.39, compared to 8.50±0.50 among patients treated with chemical cauterisation. Several factors may have contributed to this difference. The fat plug procedure is typically completed in a single session, involves fewer follow-up visits, and uses the patient's own tissue, which may be perceived as more natural and reassuring. These elements likely influenced patient preference and adherence, positioning fat plug myringoplasty as a favourable option for those seeking a more definitive and streamlined treatment experience.

The results of this study are consistent with previous findings regarding closure rates, hearing improvement, and safety, supporting the role of these techniques as effective minimally invasive options. Fat plug myringoplasty appears to be a more suitable option for patients desiring a single-stage intervention, offering marginally higher closure rates and greater patient satisfaction. However, chemical cauterisation remains an effective and minimally invasive

alternative, particularly advantageous for individuals who prefer to avoid surgical procedures or have contraindications to anaesthesia. Careful patient selection is crucial, especially in cases where perforation size approaches the upper limit of 5 mm, as these may benefit more from the mechanical support provided by the fat graft. Regardless of the intervention chosen, meticulous postoperative care and strict adherence to medical instructions are imperative to enhance healing, ensure tympanic membrane integrity, and minimise the risk of complications.

Limitation(s)

This study had certain limitations that may impact the broader applicability of its results. Long-term outcomes such as recurrence of tympanic membrane perforation and the emergence of delayed complications were not evaluated, thereby limiting insights into the sustained efficacy of the interventions. As the study was conducted at a single tertiary care centre, the findings may not account for potential variations in surgical techniques, practitioner experience, and patient characteristics that could occur in different clinical settings. Future research involving larger, multicentric cohorts with extended follow-up durations is necessary to corroborate these results and strengthen their relevance to clinical practice.

CONCLUSION(S)

This study demonstrates that both fat plug myringoplasty and chemical cauterisation are safe, effective, and minimally invasive techniques for managing small central tympanic membrane perforations. Each method resulted in significant postoperative hearing improvement and high rates of perforation closure. However, fat plug myringoplasty exhibited a modest advantage in closure success and patient-reported satisfaction. Given their simplicity, low complication rates, and effectiveness, these procedures can be considered viable first-line options before resorting to more extensive tympanoplasty. Future studies with larger cohorts and extended follow-up periods are warranted to further validate these findings and inform clinical decision-making.

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PLAGIARISM CHECKING METHODS: [Jain H et al.]
- Plagiarism X-checker: May 01, 2025
- Manual Googling: Jun 18, 2025
- iThenticate Software: Jul 12, 2025 (5%)

ETYMOLOGY: Author Origin

EMENDATIONS: 7

AUTHOR DECLARATION:
- Financial or Other Competing Interests: None
- Was Ethics Committee Approval obtained for this study? Yes
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

Date of Submission: **Apr 29, 2025**
Date of Peer Review: **May 28, 2025**
Date of Acceptance: **Jul 14, 2025**
Date of Publishing: **Aug 01, 2025**