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EFFICACY OF OFFICE-BASED 50% TRICHLOROACETIC ACID CHEMICAL CAUTERISATION FOR SMALL TYMPANIC MEMBRANE PERFORATIONS: A PROSPECTIVE INTERVENTIONAL STUDY

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ABSTRACT

Introduction: *Small tympanic membrane perforations may be managed by office-based non-surgical techniques. Chemical cauterisation with trichloroacetic acid (TCA) stimulates healing of perforation margins and may provide an alternative to surgical repair in selected patients. This study evaluated the outcomes and closure rates of office-based 50% TCA chemical cauterisation in small tympanic membrane perforations.*

Materials and Methods: *This prospective interventional study was conducted from April 2020 to March 2023, at the Department of ENT, National Medical College and Teaching Hospital, Birgunj, Nepal. Fifty-four patients with 58 small, dry central pars tensa perforations were evaluated. To avoid unit-of-analysis clustering bias, statistical associations were adjusted to the patient level (n=54). Perforation margins were chemically cauterised using 50% TCA via video-endoscopic assistance at weekly intervals for a maximum of 12 sessions without patching. Short-term successful closure was assessed two weeks post-treatment.*

Results: *Among the cohort, complete anatomical closure was achieved in 39 patients, giving an overall success rate of 72.2% (95% CI: 59.8 % – 83.1%). The mean number of weekly treatment sessions required for successful closure was 4.9 ± 1.8 weeks (Range: 2–10). While traumatic perforations (n=4) all achieved closure, the sample was too small for definitive causal inference. Patients with single-quadrant perforations demonstrated a significantly higher closure rate (80.4 %) compared to those with multi-quadrant involvement (25.0 %); Fisher's Exact Test, p=0.019. No major sensorineural or vestibular complications were encountered.*

Conclusion: *Office-based chemical cauterization with 50% trichloroacetic acid is a safe, simple, and low-cost alternative for managing small, single-quadrant tympanic membrane perforations in resource-limited settings.*

Keywords: *Chronic Otitis Media, Chemical Cauterization, Office Myringoplasty, Trichloroacetic acid, Tympanic Membrane Healing, Tympanic Membrane Perforation*

INTRODUCTION

Tympanic membrane perforation is a common otological condition resulting from chronic suppurative otitis media, acute infections, trauma, or previous ear surgery. Persistent perforations may cause recurrent otorrhoea, conductive hearing loss, and repeated middle ear infections. While larger perforations are usually managed with myringoplasty or tympanoplasty, small dry perforations can often be treated successfully using minimally invasive office-based techniques.[1]

Chemical cauterisation is one of the oldest non-surgical methods for tympanic membrane repair. It promotes healing by removing the inactive epithelialized edge of the perforation, reducing localized matrix metalloproteinase activity, and stimulating a fresh inflammatory response.[2] Trichloroacetic acid (TCA) is among the most commonly used agents for this purpose.[3] Several studies have reported favorable closure rates with chemical cauterisation, particularly for small, dry, central perforations.[4–7]Makwana et al. demonstrated that office-based chemical cauterisation can achieve reliable anatomical closure in carefully selected patients, making it a practical alternative to surgery.[4,8]

Compared with conventional surgical repair, office-based chemical cauterisation is inexpensive, minimally invasive, avoids hospital admission, and can be performed in an outpatient setting without infiltrative anaesthesia.[3,9]

These advantages are particularly relevant in resource-limited settings. A systematic review and meta-analysis reported a pooled tympanic membrane closure rate of 88% for in-office procedures, highlighting their effectiveness while reducing healthcare costs and logistical burden.[10]

Careful patient selection remains essential, as the technique is most suitable for small, dry perforations without active middle ear infection, cholesteatoma, or significant ossicular pathology. Larger perforations and those involving the anterior margin have been associated with higher failure rates.[11] Although many protocols combine chemical cauterisation with adjuncts such as cigarette paper patches or fat grafts, the independent regenerative potential of chemical stimulation remains clinically relevant. A systematic review of transcanal office-based myringoplasty techniques without tympanomeatal flap elevation reported closure rates of 82.3%–86.8%, with favourable hearing outcomes and low morbidity.[12]

The present study aimed to evaluate the efficacy, safety, and predictors of successful closure following office-based 50% TCA chemical cauterisation of small tympanic membrane perforations without supplemental paper patching or external canal packing.

MATERIALS AND METHODS

Study Design and Setting

This prospective interventional study was conducted from April 2020 to March 2023 in the Department of ENT at National Medical College and Teaching Hospital, Birgunj, Nepal. Ethical approval was obtained from the Institutional Review Committee prior to commencement of the study (Reference No: F-NMC/421/075/076). Written informed consent was obtained from all participants or their legal guardians.

Study Population and Sample Selection

Patients older than 15 years presenting with small, dry, central tympanic membrane perforations were systematically evaluated for eligibility. Because this study relied on a convenience sample of all eligible patients presenting within our fixed three-year study window, a formal priori power calculation was not executed. Recruitment targeted a minimum footprint of 50 patients to ensure sufficient baseline data.

Inclusion Criteria

- Persistent dry central perforation for at least three weeks (selected to confirm that the perforation had passed its acute spontaneous closure window while balancing real-world outpatient presentation intervals).
- Perforation involving less than or equal to 25% of the total pars tensa area.
- Perforation boundaries confined to a single quadrant or small adjacent quadrants.

Exclusion Criteria

- Active chronic suppurative otitis media (mucosal or squamosal type).
- Marginal or attic perforations.
- Presence of a retraction pocket, cholesteatoma, or ossicular discontinuity.
- Active rhinosinusitis, overt allergy, or nasopharyngeal pathology.
- Obvious clinical eustachian tube dysfunction.
- Patients lost to follow-up or those opting for elective surgical tympanoplasty during the treatment course.

Pre-procedure Evaluation

All patients underwent a detailed otological examination including otoscopy, otomicroscopy, and video-endoscopic otoscopy using a 0-degree, 4-mm rigid endoscope. Perforation size, location, and margin characteristics were recorded. Perforation size estimation was standardized using a four-quadrant geometric mapping method; a perforation was quantified as ≤ 25 % if its boundaries were completely contained within a single quadrant or did not cross more than one quadrant boundary line. To maximize inter-examiner reliability, visual assessments were cross-verified by two independent senior otolaryngologists at each participating site. Baseline medical histories, including smoking status and estimated duration of the disease, were documented.

Procedure

The external auditory canal was carefully cleared of earwax and debris under direct endoscopic visualization. Topical local anesthesia was achieved by applying two sprays of 15% lignocaine directly toward the tympanic membrane. Under strict video-endoscopic guidance, a micro-cotton-tipped Jobson-Horne probe was dipped in freshly prepared 50% trichloroacetic acid. Excess acid was carefully blotted to prevent accidental liquid pooling.

The probe was applied circumferentially to the epithelial margins of the perforation until a uniform white blanching ring was observed, confirming chemical debridement of the edges. Extreme care was taken to avoid any chemical spillage into the middle ear mucosa. No paper patch, fat plug, or external auditory canal packing was applied. The procedure was repeated at weekly intervals for a

maximum of 12 sessions, or stopped early if complete anatomical closure occurred. All procedures were cross-monitored by the senior authors to control for inter-operator variability.

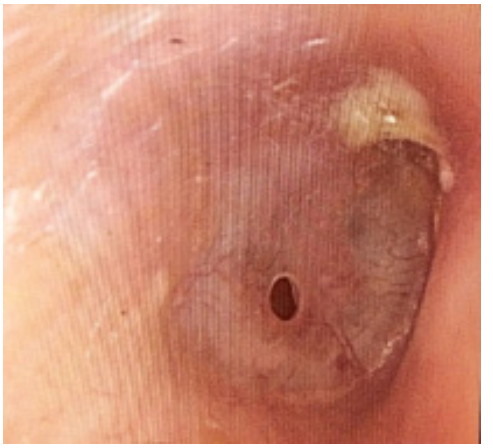

Figure 1: Small TM perforation before TCA application

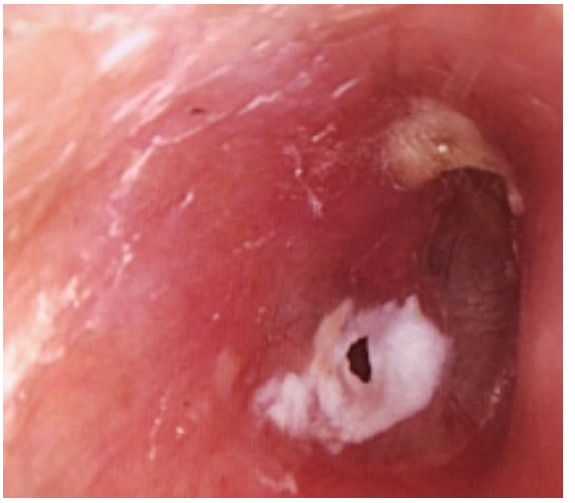

Figure 2: Perforation margin after TCA application

Outcome Measures and Safety Monitoring

Successful short-term treatment was defined as complete anatomical closure of the perforation visible on endo-otoscopy within the 12-week intervention window, and persistence of that complete closure at a scheduled two-week follow-up examination. Treatment failure was defined as:

1. Failure to achieve complete closure after 12 consecutive weekly sessions.
2. Reappearance or breakdown of the membrane during the follow-up window.
3. Discontinuation of treatment or conversion to surgery.

Safety outcomes were systematically tracked at every visit by asking patients about post-procedure pain severity, temporary vertigo, otalgia, localized burning sensations, and transient hearing changes.

Statistical Analysis

Data were entered and analysed using SPSS version 26. Categorical variables were expressed as frequency and percentage. Continuous variables were expressed as mean ± standard deviation (SD). To prevent unit-of-analysis clustering bias, statistical analyses were adjusted and reported strictly at the patient level (n=54). For the four patients who had bilateral perforations, the worse-performing ear was selected for independent categorical tracking to preserve the statistical assumption of independent observations.

Due to low sample frequencies within individual anatomical quadrants, data were aggregated into dichotomous groups (Single-Quadrant vs. Multi-Quadrant) for inferential analysis. Statistical associations were computed using Fisher's Exact Test where expected cell counts dropped below 5. A p-value of less than 0.05 was considered statistically significant. Given our sample size and limited failure events, multivariate logistic regression was avoided to prevent model over-fitting.

RESULTS

A total of 54 patients presenting with 58 tympanic membrane perforations were originally included. Fifty patients had unilateral disease, while four patients presented with bilateral perforations. Adjusting the final analysis strictly to the patient level (n=54) to maintain observation independence, complete short-term anatomical closure was achieved in 39 of 54 patients. This resulted in an overall success rate of 72.2% (95% Confidence Interval [CI]: 59.8 % – 83.1 %). The mean number of weekly chemical applications required to achieve complete successful closure was 4.9 ± 1.8 sessions, ranging from 2 to 10 sessions. The mean duration of the perforations prior to presentation was 5.4 ± 2.1 months.

Etiological Distribution and Outcomes

Inflammatory pathology secondary to inactive chronic otitis media was the most common cause of perforation within our cohort. Traumatic perforations demonstrated a high closure pattern, though the small number of cases limits definitive causal conclusions (Table 1).

Table 1. Patient-level treatment outcomes stratified by etiology (n=54)

Etiology	Total Patients (n)	Successful Closure n (%)	Failed Closure n (%)	95% Confidence Interval for Success
Inflammatory	39	27 (69.2)	12 (30.8)	52.4%–83.0%
Post-myringoplasty residual	11	8 (72.7)	3 (27.3)	39.0%–94.0%
Traumatic	4	4 (100.0)	0 (0.0)	39.8%–100.0%
Total	54	39 (72.2)	15 (27.8)	59.8%–83.1%

Quadrant-wise Outcomes and Extent of Perforation

Perforations strictly limited to a single anatomical quadrant demonstrated significantly better closure rates compared to multi-quadrant defects. When evaluating single-quadrant cases, anterior-inferior (AIQ) and posterior-inferior (PIQ) locations yielded reliable healing, whereas isolated posterior-superior quadrant (PSQ) cases responded poorly (Table 2).

Table 2. Treatment outcomes stratified by single-quadrant vs. multi-quadrant anatomical involvement (n=54) patients

Perforation Extent	Total Patients n	Successful Closure n (%)	Failed Closure n (%)	Statistical Parameter
Single-Quadrant	46	37 (80.4)	9 (19.6)	Fisher's Exact Test Test Statistic = 6.012 p = 0.019 (Statistically Significant) (95 % CI of Diff: 14.2 % - 72.8 %)
• Anterior Inferior (AIQ)	21	17 (81.0)	4 (19.0)	
• Posterior Inferior (PIQ)	22	18 (81.8)	4 (18.2)	
• Superior Quadrants (ASQ/PSQ)	3	2 (66.7)	1 (33.3)	
Multi-Quadrant	8	2 (25.0)	6 (75.0)	

A Fisher's exact test confirmed that the association between single-quadrant confinement and treatment success was statistically significant (p=0.019, Table 2).

Complications and Safety Profile

No major long-term complications such as sensorineural hearing loss, persistent secondary suppurative otorrhoea, or permanent vestibular vertigo were observed during the treatment or follow-up periods. However, minor transient adverse effects were common. A mild to moderate localized burning sensation lasting less than 5 minutes was reported by 48 patients (88.8 %) during chemical application. Mild, self-limiting post-procedural otalgia lasting less than 24 hours occurred in 8 patients (14.8 %). None of these minor adverse events required opioid analgesics or led to suspension of the treatment protocol.

DISCUSSION

The present study demonstrates that office-based chemical cauterisation with 50% trichloroacetic acid is an effective, simple intervention for carefully selected small tympanic membrane perforations, yielding an adjusted overall closure rate of 72.2%. This success rate aligns closely with historical studies by Derlacki and other authors, who reported outpatient chemical myringoplasty closure rates ranging from 70% to 90%.[7,9,13,14] Variations across the literature are often driven by differences in baseline perforation sizes, the duration of dry windows, varied patient demographics, and whether an adjunctive paper or fat patch was used.

The primary mechanism of action of trichloroacetic acid relies on its ability to chemically denude the outer keratinized squamous epithelium that frequently grows over the edge of chronic perforations, creating a mechanical barrier to healing. Applying 50% TCA safely destroys this inverted margin, inducing acute localized inflammation, vascular congestion, and look-through bleeding.[2] This cascade triggers fibrovascular migration and raw granulation tissue formation, allowing the collagenous layer of the tympanic membrane to bridge the open defect.

Our findings reveal a distinct advantage for perforations restricted to a single quadrant compared to multi-quadrant defects (80.4 % vs. 25.0 %; p=0.019). This difference can be explained by the physical distance the migrating epithelial and fibrous fronts must travel; larger or multi-quadrant gaps face a higher risk of structural tissue drying out or premature marginal stabilization before complete closure can be achieved. Interestingly, within our single-quadrant cohorts, the posterior-superior quadrant (PSQ) had poor outcomes (0 % closure, n=2). This poor performance is likely due to the unique mechanical stresses near the incudostapedial joint and different mucosal patterns in the postero-superior region, though our small sample size in this subgroup requires caution when drawing broad conclusions. Conversely, traumatic perforations demonstrated a 100% healing pattern (n=4), which reflects the excellent vascular supply

and natural healing potential of fresh margins.

A unique aspect of our protocol was omitting paper patching or canal packing, relying entirely on chemical margin stimulation. While this strategy simplifies the clinical protocol and prevents deep middle ear foreign-body migrations or patch infections, it does have trade-offs. The lack of a physical structural scaffold may explain why our overall closure rate (72.2 %) sits slightly lower than protocols combining chemical cauterization with paper patches, which report success rates near 85 %–90 %.[3]risk of anesthesia, psychological trauma, along with long waiting periods for patients, especially in a tertiary care centre like ours. The purpose of this study was to evaluate outcomes of chemical cauterization and patching of perforation, performed as an office procedure in select cases.</p><p class=\"abstract\">Methods: The study was conducted in a tertiary hospital from January 2016 to December 2017. The patients were selected based on the inclusion criteria, after thorough clinical assessment, examination under microscope and pure tone audiogram. All cases underwent cauterization of margins of perforation using 10% trichloroacetic acid (TCA

Strengths of the Study

This study provides highly practical clinical data regarding office myringoplasty in developing regions. It uses a prospective design tracking an office-based technique without the need for paper patches or complex packing. We demonstrate that chemical cauterization alone can achieve a 72.2% success rate, offering a safe, low-cost, and accessible alternative for patients in resource-limited settings who may lack access to conventional operating theaters.

Limitations

The clinical findings of this study must be interpreted within the context of several clear methodological limitations. First, our study did not utilize a parallel untreated control group or a paper-patch comparison arm; thus, despite our exclusion criteria, the potential for spontaneous biological healing cannot be entirely ruled out. Second, sample size was dictated by a pragmatic convenience cohort over a fixed timeline rather than an a priori power calculation, which limits statistical resolution for rare subgroup variations (such as isolated posterior-superior perforations).

Third, formal pre- and post-procedural pure-tone audiometry (PTA) tracking was not implemented; because these small perforations (≤ 25 %) caused minimal baseline air-bone gaps, our primary therapeutic target was achieving a dry, infection-resistant ear barrier rather than hearing correction. Fourth, perforation sizes were documented via standardized clinical visual mapping rather than computer-assisted digital software planimetry, introducing potential estimation variability. Finally, our follow-up period was limited to 2 weeks post-treatment, meaning our data captures short-term anatomical closure rather than long-term membrane stability or late re-perforation rates over 6 to 12 months.

CONCLUSIONS

Chemical cauterisation using 50% trichloroacetic acid is a safe, simple, and cost-effective office-based procedure for the short-term closure of selected small tympanic membrane perforations. Significantly better outcomes are achieved in perforations limited to a single quadrant, particularly within the anterior-inferior and posterior-inferior quadrants. Given its excellent safety profile, low material cost, and independence from operating room logistics, this technique can be considered an initial conservative treatment option for small, stable perforations before committing patients to conventional surgical myringoplasty.

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CONFLICT OF INTEREST

The authors declare that they have no competing financial or personal conflicts of interest regarding this manuscript.

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