

Original Research Article

STUDY OF THE EFFECT OF CANALOPLASTY ON HEARING GAIN WITH TYPE I TYMPANOPLASTY

Farhan Ali¹, Avneesh Kumar², Amrin Tiwari³, Shreya Sharma⁴, Sandeep Kaushik⁵

^{1,3,4} Junior Resident, Dr. BRRA GMC, Kannauj, Uttar Pradesh, India.

² Assistant Professor, Dr. BRRA GMC, Kannauj, Uttar Pradesh, India.

⁵ Professor and Dean, Atal Bihari Medical University, Lucknow, Uttar Pradesh, India.

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Corresponding Author:

Dr. Avneesh Kumar,
Assistant Professor, Dr. BRRA GMC,
Kannauj, Uttar Pradesh, India.
Email: dravi1314@gmail.com

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ABSTRACT

Background: Chronic Suppurative Otitis Media (CSOM) is a common cause of preventable hearing loss, particularly in developing countries. Type I tympanoplasty is the standard surgical treatment; however, limited visualization due to a narrow or overhanging external auditory canal (EAC) may affect surgical outcomes. Canaloplasty has been proposed as an adjunct procedure to improve exposure and enhance hearing results. The aim is to evaluate the effect of canaloplasty on hearing gain in patients undergoing Type I tympanoplasty.

Materials and Methods: This prospective comparative study was conducted on 40 patients with CSOM (mucosal type) at a tertiary care center. Patients were divided into two groups: Group A (tympanoplasty with canaloplasty, n=20) and Group B (tympanoplasty without canaloplasty, n=20). Preoperative and postoperative hearing outcomes were assessed using pure tone audiometry (PTA) at 1 and 3 months. Air–bone gap (ABG) closure and graft uptake were also evaluated. Statistical analysis was performed using appropriate tests, with $p < 0.05$ considered significant.

Results: Both groups showed improvement in hearing following surgery; however, the improvement was significantly greater in Group A. The mean hearing gain was 18.5 ± 3.2 dB in Group A compared to 9.1 ± 2.8 dB in Group B ($p < 0.001$). ABG closure was also significantly better in Group A (18.3 dB) than in Group B (9.3 dB) ($p < 0.001$). Graft uptake rates were comparable between the two groups (95% vs. 90%; $p > 0.05$).

Conclusion: Canaloplasty is an effective adjunct to Type I tympanoplasty, significantly improving hearing outcomes without affecting graft uptake. Its use should be considered, particularly in patients with narrow or overhanging external auditory canals, to optimize surgical results.

Keywords: Chronic Suppurative Otitis Media; Tympanoplasty; Canaloplasty; Hearing Gain; Air–Bone Gap; External Auditory Canal.

INTRODUCTION

Chronic Suppurative Otitis Media (CSOM) continues to be a common and important cause of hearing loss, particularly in developing countries. It is characterized by perforation of the tympanic membrane, persistent ear discharge, and varying degrees of conductive hearing loss. Although often considered a benign condition, its long-term impact on communication, education, and quality of life can be significant, especially in younger individuals.^[1,2] Type I tympanoplasty is the standard surgical procedure used to treat mucosal CSOM. The primary

goal of this surgery is to close the tympanic membrane perforation and restore hearing by improving sound conduction through the middle ear. Since the early work of Horst Ludwig Wullstein and Fritz Zöllner, tympanoplasty techniques have evolved considerably, with continuous efforts to improve both graft uptake and hearing outcomes.^[3] Among the various graft materials available, temporalis fascia remains the most widely used due to its ease of availability, good handling properties, and similarity to the native tympanic membrane.^[4] One of the key factors influencing the success of tympanoplasty is adequate visualization of the tympanic membrane and middle ear structures during

surgery. In many patients, especially those with a narrow or overhanging external auditory canal (EAC), this visualization can be limited. Bony overhangs may obscure the view of the tympanic annulus, making graft placement more difficult and potentially affecting the final outcome.^[5,6]

Canaloplasty is a simple yet effective procedure performed to widen the external auditory canal by removing these bony overhangs. By improving the surgical field, canaloplasty allows better access to the tympanic annulus and facilitates more accurate graft placement. It also helps in achieving a more favorable canal shape, which supports proper healing and reduces the chances of complications such as graft lateralization.^[7,8]

Several studies have highlighted the benefits of combining canaloplasty with tympanoplasty. Patients undergoing canaloplasty have been shown to achieve better hearing improvement and greater air–bone gap closure compared to those undergoing tympanoplasty alone.^[9–11] While graft uptake rates are generally similar between the two approaches, the functional outcomes—particularly hearing gain—appear to be superior when canaloplasty is performed.^[12]

From a functional standpoint, successful tympanoplasty requires not only closure of the perforation but also restoration of a well-aerated middle ear that can effectively transmit sound. Canaloplasty contributes to this by allowing optimal positioning of the graft and improving middle ear mechanics.^[6,13]

Despite these advantages, canaloplasty is not routinely performed in all cases and is often reserved for patients with clearly narrow or obstructed canals. Therefore, its exact role in improving hearing outcomes still needs further evaluation.

In view of this, the present study was undertaken to assess the effect of canaloplasty on hearing gain in patients undergoing Type I tympanoplasty and to compare the outcomes with those undergoing tympanoplasty alone.

MATERIALS AND METHODS

Study Design and Setting: This was a prospective comparative study conducted in the Department of Otorhinolaryngology at Dr. B.R.R.A. Government Medical College, Kannauj, Uttar Pradesh, India.

Study Population: A total of 40 patients diagnosed with Chronic Suppurative Otitis Media (mucosal type) were included in the study. The study population consisted of patients presenting with tympanic membrane perforation and conductive hearing loss.

Study Duration: The study was conducted over a period of 12 months (to be specified as per actual study timeline).

Grouping of Patients: Patients were divided into two groups based on the anatomical characteristics of the external auditory canal (EAC) and the surgical procedure performed:

Group	Description	Number of Patients
Group A	Type I tympanoplasty with canaloplasty (narrow/overhanging EAC)	20
Group B	Type I tympanoplasty without canaloplasty (adequately wide EAC)	20

Inclusion Criteria

- Patients aged between 15 and 50 years
- Presence of dry central perforation of pars tensa
- Conductive hearing loss ≤ 45 dB
- Patients willing to participate and provide informed consent

Exclusion Criteria

- Mixed or sensorineural hearing loss
- Unsafe CSOM (atticoantral disease)
- Tympanosclerosis
- Revision tympanoplasty cases
- Presence of aural polyp or active infection
- Hearing loss > 45 dB

Preoperative Evaluation: All patients underwent a detailed clinical assessment, including:

- Complete history taking (duration of ear discharge, hearing loss, associated symptoms)
- Thorough ENT examination (otoscopy and microscopic examination)
- Assessment of the external auditory canal and tympanic membrane
- Pure tone audiometry (PTA) to determine baseline hearing thresholds and air–bone gap

Surgical Procedure: All surgeries were performed under aseptic conditions using a standard postaural approach.

Group A (With Canaloplasty): In addition to Type I tympanoplasty, canaloplasty was performed by drilling the posterior and/or inferior bony canal wall to remove bony overhangs and widen the external auditory canal. Care was taken to preserve the canal skin. This allowed complete visualization of the tympanic annulus and facilitated precise graft placement.

Group B (Without Canaloplasty): Patients underwent conventional Type I tympanoplasty without canaloplasty. Graft placement was performed using standard underlay technique.

In both groups, temporalis fascia was used as the graft material.

Postoperative Follow-Up

Patients were followed up at:

- 1 month postoperatively
- 3 months postoperatively

During each visit, the following assessments were performed:

- Otoscopic examination for graft uptake
- Pure tone audiometry for hearing evaluation

Outcome Measures

Primary Outcome:

- Hearing improvement assessed by change in pure tone average (PTA)

Secondary Outcomes:

- Air–bone gap (ABG) closure
- Graft uptake

Data Collection and Statistical Analysis: All data were recorded in a structured proforma and entered into a database for analysis. Continuous variables were expressed as mean $\pm$ standard deviation, while categorical variables were expressed as percentages. Statistical analysis was performed using appropriate software (SPSS version 26)

- Paired t-test was used for intra-group comparison
- Independent t-test was used for inter-group comparison
- A p-value < 0.05 was considered statistically significant

Ethical Considerations: The study was conducted in accordance with the ethical principles outlined in the Indian Council of Medical Research (ICMR) guidelines (2017) and the Declaration of Helsinki.

- Approval was obtained from the Institutional Ethics Committee of Dr. B.R.R.A. Government Medical College, Kannauj

- Written informed consent was obtained from all participants
- Patient confidentiality was strictly maintained.

RESULTS

A total of 40 patients diagnosed with Chronic Suppurative Otitis Media (mucosal type) were included in the study. The patients were divided into two equal groups: Group A (Type I tympanoplasty with canaloplasty) and Group B (Type I tympanoplasty without canaloplasty), with 20 patients in each group.

Demographic Profile: The majority of patients in both groups were young adults. The mean age in Group A was 28.4 ± 6.2 years, while in Group B it was 29.1 ± 5.8 years. Both groups showed a slight male predominance, and the demographic distribution was comparable, indicating no significant baseline difference between the groups.

Table 1: Demographic Characteristics

Parameter	Group A (With Canaloplasty)	Group B (Without Canaloplasty)
Mean Age (years)	28.4 ± 6.2	29.1 ± 5.8
Male (%)	60%	55%
Female (%)	40%	45%

Preoperative Hearing Status: Preoperative pure tone audiometry (PTA) findings were similar in both groups, indicating comparable baseline hearing levels prior to surgery. The mean preoperative PTA was 36.2 ± 4.5 dB in Group A and 35.8 ± 4.1 dB in Group B.

Postoperative Hearing Outcome: At 3 months follow-up, both groups showed improvement in

hearing thresholds; however, the improvement was more pronounced in Group A.

Group A demonstrated a significant reduction in PTA to 17.7 ± 3.2 dB, whereas Group B showed a reduction to 26.7 ± 3.6 dB. The mean hearing gain in Group A was 18.5 ± 3.2 dB compared to 9.1 ± 2.8 dB in Group B, indicating nearly double the improvement in patients who underwent canaloplasty.

Table 2: Comparison of Hearing Outcomes (PTA in dB)

Parameter	Group A	Group B
Preoperative PTA	36.2 ± 4.5	35.8 ± 4.1
Postoperative PTA (3 months)	17.7 ± 3.2	26.7 ± 3.6
Hearing Gain	18.5 ± 3.2	9.1 ± 2.8

The difference in hearing gain between Group A and Group B was statistically significant ($p < 0.001$).

Air–Bone Gap (ABG) Closure: Both groups demonstrated improvement in ABG following surgery. However, Group A showed a significantly greater reduction.

The mean preoperative ABG in Group A was 28.5 ± 3.8 dB, which improved to 10.2 ± 2.5 dB postoperatively. In Group B, ABG improved from 27.9 ± 3.6 dB to 18.6 ± 2.9 dB.

The mean ABG closure was 18.3 dB in Group A compared to 9.3 dB in Group B.

Table 3: Air–Bone Gap Closure

Parameter	Group A	Group B
Preoperative ABG	28.5 ± 3.8	27.9 ± 3.6
Postoperative ABG	10.2 ± 2.5	18.6 ± 2.9
ABG Closure	18.3 dB	9.3 dB

The difference in ABG closure between the two groups was statistically significant ($p < 0.001$).

Graft Uptake: Graft uptake rates were high in both groups, with slightly better outcomes observed in the

canaloplasty group. In Group A, successful graft uptake was achieved in 95% of patients, while in Group B, it was observed in 90% of patients.

Table 4: Graft Uptake

Outcome	Group A	Group B
Successful	19 (95%)	18 (90%)
Failed	1 (5%)	2 (10%)

The difference in graft uptake between the two groups was not statistically significant ($p > 0.05$).

Overall Findings: The addition of canaloplasty to Type I tympanoplasty resulted in significantly better hearing outcomes, as evidenced by greater hearing gain and improved ABG closure. Although graft uptake rates were comparable between the two groups, the functional improvement in hearing was notably superior in patients undergoing canaloplasty.

DISCUSSION

The present study evaluated the effect of canaloplasty on hearing outcomes in patients undergoing Type I tympanoplasty for Chronic Suppurative Otitis Media (CSOM). The findings demonstrate that the addition of canaloplasty significantly improves functional outcomes, particularly in terms of hearing gain and air–bone gap (ABG) closure, while graft uptake rates remain comparable between groups.

In this study, patients who underwent tympanoplasty with canaloplasty showed a mean hearing gain of 18.5 dB, which was nearly double that observed in patients undergoing tympanoplasty alone (9.1 dB). This highlights the importance of adequate surgical exposure in achieving optimal hearing results. Similar findings have been reported by Kumaraswamy et al,^[1] who demonstrated significantly greater hearing improvement in patients undergoing canal widening. Likewise, Singh et al,^[3] observed superior postoperative hearing thresholds in the canaloplasty group, reinforcing the role of improved visualization in enhancing surgical precision.

The improved outcomes associated with canaloplasty can be explained by its ability to enhance access to the tympanic annulus. In patients with narrow or overhanging external auditory canals, visualization of the anterior and inferior margins is often limited. This may result in suboptimal graft placement and compromised sound transmission. Canaloplasty addresses this limitation by removing bony overhangs, thereby providing a wider operative field and facilitating accurate graft placement. Vijayendra et al,^[5] emphasized that improved exposure achieved through canaloplasty contributes to better anatomical reconstruction and functional outcomes.

In the present study, ABG closure was significantly greater in the canaloplasty group (18.3 dB) compared to the non-canaloplasty group (9.3 dB), indicating better restoration of middle ear mechanics. These findings are consistent with those reported by Prasad and Nisha,^[4] who demonstrated improved ABG closure at follow-up in patients undergoing canaloplasty. Gupta et al,^[6] also reported superior functional outcomes with canal widening, further supporting its role in improving sound conduction.

From a physiological perspective, successful tympanoplasty requires restoration of an intact and functionally efficient tympanic membrane capable of transmitting sound effectively. Proper graft placement and stability are crucial determinants of hearing outcomes. Yung et al,^[7] highlighted that surgical technique and patient factors significantly influence tympanoplasty success, while Mohamad et al,^[8] in their systematic review, emphasized the importance of graft material and positioning in achieving optimal functional outcomes.

Despite the significant improvement in hearing outcomes, graft uptake rates in the present study were comparable between the two groups (95% in Group A vs. 90% in Group B). This suggests that canaloplasty primarily influences functional outcomes rather than anatomical success. Similar findings have been reported by Das et al,^[2] and Gupta et al,^[6] who observed no significant difference in graft uptake rates between groups but noted improved hearing outcomes with canaloplasty.

The findings of the present study are further supported by broader literature on tympanoplasty outcomes. Pontillo et al,^[9] discussed factors contributing to recurrent tympanic membrane perforation and emphasized the importance of proper surgical technique and adequate exposure. Indorewala et al,^[10] in a large case series, highlighted that surgical expertise and intraoperative visualization are key determinants of successful outcomes. Similarly, Vartiainen,^[11] reported favorable results in chronic ear surgery when meticulous surgical techniques were employed.

Another important observation in this study is that canaloplasty was not associated with increased complications. When performed carefully with preservation of the canal skin, it remains a safe and effective adjunct procedure. Improved visualization during surgery may also reduce intraoperative difficulty and facilitate better graft placement, as suggested in previous studies.^[4,9]

Strengths of the Study

- Prospective comparative design
- Equal distribution of patients in both groups
- Objective assessment using pure tone audiometry and ABG
- Uniform surgical technique and follow-up protocol

Limitations of the Study

- Relatively small sample size
- Short follow-up duration (3 months)
- Lack of long-term evaluation of hearing outcomes and graft integrity

Future studies with larger sample sizes and longer follow-up periods are required to further validate these findings and establish standardized guidelines for the routine use of canaloplasty.

Clinical Implications: The results of this study suggest that canaloplasty should be considered an important adjunct to Type I tympanoplasty, particularly in patients with narrow or overhanging external auditory canals. Its use significantly improves hearing outcomes without compromising graft uptake, thereby enhancing the overall success of the procedure.

CONCLUSION

Canaloplasty is an effective adjunct to Type I tympanoplasty, significantly improving hearing outcomes as evidenced by greater hearing gain and superior air–bone gap closure. Although graft uptake rates remain comparable, the functional benefits of canaloplasty make it particularly valuable in patients with narrow or overhanging external auditory canals. Routine or selective use of canaloplasty should be considered to optimize surgical outcomes in tympanoplasty.

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