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Original Research Article

ASSOCIATION OF THE MIDDLE EAR RISK INDEX WITH ANATOMICAL AND FUNCTIONAL OUTCOMES FOLLOWING TYMPANOPLASTY IN PATIENTS WITH CHRONIC OTITIS MEDIA: A PROSPECTIVE OBSERVATIONAL STUDY

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ABSTRACT

Background: The outcome of tympanoplasty in patients with chronic otitis media (COM) is influenced by several patient- and disease-related factors. The Middle Ear Risk Index (MERI) is a validated prognostic scoring system that incorporates multiple clinical variables to predict surgical outcomes. However, evidence regarding its predictive value in the Indian population remains limited. To evaluate the role of the Middle Ear Risk Index in predicting anatomical and functional outcomes following tympanoplasty in patients with chronic otitis media.

Materials and Methods: This prospective observational study included 100 consecutive patients with chronic otitis media who underwent tympanoplasty with or without cortical mastoidectomy at a tertiary care teaching hospital between June 2025 and May 2026. Preoperative MERI scores were calculated for all patients and categorized as mild (1–3), moderate (4–6), or severe (≥7). Anatomical success was defined as an intact tympanic membrane at three months postoperatively. Functional outcome was assessed using postoperative pure-tone average (PTA) and air–bone gap (ABG).

Results: The mean MERI score was 2.76 ± 1.58. Mild, moderate, and severe MERI scores were observed in 72%, 27%, and 1% of patients, respectively. Overall graft uptake at three months was 78%. Anatomical success was achieved in 84.7% of patients with mild MERI scores compared with 63.0% of those with moderate MERI scores, while the patient with a severe MERI score experienced graft failure. More than 10 dB hearing improvement was observed in 61.1% of patients with mild MERI scores compared with 40.7% of patients with moderate MERI scores. Smokers demonstrated lower graft uptake than non-smokers (33.3% vs. 82.4%).

Conclusion: Lower MERI scores were associated with better graft uptake and greater postoperative hearing improvement following tympanoplasty. The MERI is a practical and reliable preoperative prognostic tool that can facilitate patient counselling, surgical planning, and outcome prediction in chronic otitis media.

Keywords: Chronic Otitis Media; Tympanoplasty; Hearing Loss; Prognosis; Risk Assessment; Treatment Outcome.

INTRODUCTION

Chronic otitis media (COM) is one of the most common chronic inflammatory diseases of the middle ear and remains a major public health problem, particularly in developing countries. It is characterized by persistent inflammation of the middle ear cleft with tympanic membrane perforation

and recurrent or persistent ear discharge, often resulting in varying degrees of conductive hearing loss. If left untreated, COM may lead to significant morbidity, including irreversible hearing impairment, ossicular erosion, cholesteatoma formation, facial nerve paralysis, labyrinthine complications, and intracranial infections, thereby adversely affecting communication, education, and quality of life. Despite advances in antimicrobial therapy and surgical techniques, COM continues to impose a considerable healthcare burden worldwide.[1-4]

Tympanoplasty is the standard surgical procedure performed to eradicate disease, reconstruct the tympanic membrane, restore the sound-conducting mechanism of the middle ear, and improve hearing. Over the past several decades, refinements in operative techniques, magnification, instrumentation, graft materials, and perioperative care have resulted in improved surgical outcomes. Nevertheless, graft uptake and postoperative hearing improvement remain variable, with reported success rates ranging from approximately 70% to 95%. This variability suggests that surgical outcome is influenced by several patient-related, disease-related, and intraoperative factors rather than by surgical technique alone.[5–8]

Numerous prognostic factors have been reported to influence the outcome of tympanoplasty. These include the status of middle ear mucosa, presence and duration of otorrhoea, size and location of tympanic membrane perforation, Eustachian tube function, ossicular chain integrity, smoking, revision surgery, cholesteatoma, granulation tissue, mastoid pathology, and surgeon experience. While each factor independently affects surgical success to varying degrees, their cumulative effect often determines the final anatomical and functional outcome. Therefore, assessment based on a single prognostic variable may not adequately predict the likelihood of surgical success.[6,8–10]

To address this limitation, Kartush introduced the Middle Ear Risk Index (MERI) as a comprehensive prognostic scoring system that combines multiple adverse clinical factors into a single numerical score. The original index was subsequently modified by Becvarovski and Kartush to include smoking as an additional prognostic variable. The revised MERI incorporates otorrhoea, tympanic membrane perforation, cholesteatoma, ossicular status, middle ear granulation or effusion, previous surgery, and smoking history. Based on the total score, patients are classified into mild-, moderate-, or severe-risk categories, thereby providing an objective estimate of disease severity before surgery.[11,12]

Several studies have demonstrated an association between increasing MERI scores and poorer anatomical as well as functional outcomes following tympanoplasty. Patients with lower MERI scores generally achieve higher graft uptake rates and better postoperative hearing improvement than those with higher scores. However, differences in study design, patient selection, surgical techniques, duration of follow-up, and geographical variations have resulted in considerable heterogeneity in published findings. Moreover, evidence from Indian tertiary care teaching hospitals remains relatively limited, highlighting the need for further prospective studies to validate the clinical utility of MERI in routine otologic practice.[13–18]

An objective preoperative prognostic tool is valuable not only for estimating the likelihood of surgical success but also for patient counselling, surgical planning, comparison of outcomes across institutions, and standardization of research. Identifying patients at increased risk of suboptimal outcomes enables surgeons to provide realistic expectations regarding hearing improvement and graft uptake while facilitating individualized postoperative follow-up strategies.

Therefore, the present prospective observational study was undertaken to evaluate the role of the Middle Ear Risk Index in predicting the anatomical and functional outcomes following tympanoplasty in patients with chronic otitis media. We hypothesized that lower MERI scores would be associated with higher graft uptake rates and superior postoperative hearing outcomes.

MATERIALS AND METHODS

Study Design and Setting: This prospective observational study was conducted in the Department of Otorhinolaryngology, Government Medical College Kathua, Jammu and Kashmir, India, over a period of one year from June 2025 to May 2026. The study was approved by the Institutional Ethics Committee of Government Medical College Kathua (IEC Approval No. IEC/GMCK/2025/201, Protocol No. IEC/GMCK/6 dated 28 May 2025) and was carried out in accordance with the ethical principles outlined in the Declaration of Helsinki. Written informed consent was obtained from all participants prior to enrolment.

Study Population: A total of 100 consecutive patients diagnosed with chronic otitis media (COM) and planned for tympanoplasty, with or without cortical mastoidectomy, were enrolled during the study period using a consecutive sampling technique. All eligible patients presenting during the study period who fulfilled the inclusion criteria and provided informed consent were included.

Inclusion Criteria

Patients fulfilling the following criteria were included in the study:

- Age ≥18 years.
- Diagnosis of chronic otitis media requiring tympanoplasty.
- Dry ear or intermittently discharging ear considered suitable for surgery.
- Willingness to participate in the study and comply with postoperative follow-up.

Exclusion Criteria

Patients with any of the following were excluded:

- Acute otitis media or acute exacerbation of chronic otitis media.
- Intracranial or extracranial complications of chronic otitis media.
- Congenital anomalies of the external or middle ear.
- Malignancy involving the temporal bone or middle ear.
- Patients medically unfit for surgery under general anaesthesia.
- Patients unwilling to participate or those lost to follow-up.

Preoperative Assessment

All patients underwent a detailed clinical evaluation, including history regarding duration of ear discharge, hearing loss, previous ear surgery, smoking status, and associated medical illnesses. A comprehensive otorhinolaryngological examination was performed, including otoscopic and microscopic examination of the affected ear.

Audiological assessment was carried out in a sound-treated room using calibrated pure-tone audiometry according to standard audiometric protocols. Air conduction thresholds, bone conduction thresholds, pure-tone average (PTA), and air–bone gap (ABG) were recorded preoperatively.

Routine laboratory investigations and anaesthetic fitness assessment were performed according to institutional protocol. High-resolution computed tomography (HRCT) of the temporal bone was performed in selected patients when clinically indicated.

Middle Ear Risk Index Assessment

The Middle Ear Risk Index (MERI) was calculated preoperatively for every patient using the modified scoring system proposed by Becvarovski and Kartush. The index incorporates seven prognostic variables:

- Otorrhoea
- Tympanic membrane perforation
- Presence of cholesteatoma
- Ossicular status
- Middle ear granulation tissue or effusion
- Previous ear surgery
- Smoking

The total MERI score was calculated for each patient and categorized as follows:

- Mild risk: MERI score 1–3
- Moderate risk: MERI score 4–6
- Severe risk: MERI score ≥7

Surgical Technique

All surgical procedures were performed under general anaesthesia by experienced otologic surgeons using a standardized surgical technique. A postauricular approach was employed in all patients. Temporalis fascia harvested through the same incision was used as the graft material and placed using the underlay technique.

The type of surgery performed depended upon intraoperative findings:

- Type I tympanoplasty (68 patients)
- Cortical mastoidectomy with Type I tympanoplasty (29 patients)
- Cortical mastoidectomy with Type II tympanoplasty (3 patients)

Intraoperative findings including the condition of the middle ear mucosa, presence of granulation tissue, ossicular chain status, and other pathological findings were documented.

Postoperative Follow-up

All patients received standard postoperative care and were followed up at 2 weeks, 1 month, and 3 months after surgery.

At each follow-up visit, otoscopic examination was performed to assess graft integrity, epithelialization, and evidence of residual perforation or infection. Pure-tone audiometry was repeated at the 3-month follow-up to evaluate postoperative hearing outcomes.

Outcome Measures

The primary outcome was anatomical success, defined as complete graft uptake with an intact tympanic membrane at 3 months after surgery.

The secondary outcomes included:

- Postoperative hearing improvement.
- Postoperative pure-tone average (PTA).
- Postoperative air–bone gap (ABG).
- Relationship between MERI score and anatomical outcome.
- Relationship between MERI score and functional hearing outcome.

Statistical Analysis: Data were entered into Microsoft Excel and analysed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, NY, USA).

Continuous variables were expressed as mean ± standard deviation (SD), whereas categorical variables were presented as frequencies and percentages.

The relationship between MERI categories and postoperative anatomical and functional outcomes was evaluated descriptively. Results were presented using appropriate tables and figures.

RESULTS

Table 1: Distribution of patients according to preoperative MERI scores

MERI measure	Number of patients	Percentage / Value
Mean MERI score (mean ± SD)	100 assessed	2.76 ± 1.58
Mild risk (MERI 1–3)	72	72%
Moderate risk (MERI 4–6)	27	27%
Severe risk (MERI ≥7)	1	1%
Total	100	100%

The majority of patients belonged to the mild MERI category (72%), followed by the moderate category (27%), while only 1% had a severe MERI score. The mean MERI score was 2.76 ± 1.58, indicating a predominance of patients with lower middle ear risk scores.

Table 2: Clinical, intraoperative and surgical characteristics

Characteristic	Number of patients	Percentage
Dry ear	36	36%
Intermittently discharging ear	44	44%
Persistently wet ear	20	20%
Granulation tissue observed	30	30%
Current smokers	9	9%
Previous ear surgery	4	4%
Staged surgical procedure	2	2%
Intact ossicular chain	97	97%
Incus erosion	3	3%
Type I tympanoplasty	68	68%
Cortical mastoidectomy + Type I tympanoplasty	29	29%
Cortical mastoidectomy + Type II tympanoplasty	3	3%

Intermittent ear discharge was the most common clinical presentation (44%), followed by dry ear (36%) and persistently wet ear (20%). Granulation tissue was observed in 30% of patients, while the ossicular chain was intact in the majority (97%). Type I tympanoplasty was the most commonly performed procedure (68%), followed by cortical mastoidectomy with Type I tympanoplasty (29%).

Table 3: Anatomical outcome at postoperative follow up

Follow-up time	Graft uptake	Graft failure
2 weeks	100/100 (100%)	0/100 (0%)
1 month	80/100 (80%)	20/100 (20%)
3 months	78/100 (78%)	22/100 (22%)

Complete graft uptake was observed in all patients at two weeks postoperatively. However, the graft uptake rate decreased to 80% at one month and 78% at three months, with an overall graft failure rate of 22% at the final follow-up.

Table 4: Postoperative audiological outcomes

Outcome measure	Right ear	Left ear / Overall
Mean postoperative PTA (dB HL), mean ± SD	19.83 ± 8.97	19.10 ± 7.94
Mean postoperative ABG (dB HL), mean ± SD	5.83 ± 3.31	6.01 ± 3.25
Normal hearing	—	12 (12%), overall
Minimal hearing loss	—	42 (42%), overall
Mild hearing loss	—	42 (42%), overall
Moderate hearing loss	—	4 (4%), overall

The mean postoperative PTA was 19.83 ± 8.97 dB HL in the right ear and 19.10 ± 7.94 dB HL in the left ear, while the corresponding mean ABG values were 5.83 ± 3.31 dB and 6.01 ± 3.25 dB, respectively. Most patients had minimal or mild hearing loss (84%) postoperatively, while 12% had normal hearing and 4% had moderate hearing loss.

Table 5: Anatomical and functional outcomes according to MERI category

MERI category	n	Graft uptake n (%)	Graft failure n (%)	Hearing gain >10 dB n (%)	Hearing gain ≤10 dB n (%)
Mild (1–3)	72	61 (84.7%)	11 (15.3%)	44 (61.1%)	28 (38.9%)
Moderate (4–6)	27	17 (63.0%)	10 (37.0%)	11 (40.7%)	16 (59.3%)
Severe (≥7)	1	0 (0%)	1 (100%)	0 (0%)	1 (100%)
Total	100	78 (78%)	22 (22%)	55 (55%)	45 (45%)

Graft uptake rates were higher in the mild MERI category (84.7%) compared with the moderate category (63.0%), while the single patient in the severe category experienced graft failure. Similarly, hearing improvement exceeding 10 dB was observed in 61.1% of patients with mild MERI scores compared with 40.7% of those with moderate scores. These findings showed a trend towards better anatomical and functional outcomes in patients with lower MERI scores.

Table 6: Association between smoking status and graft uptake

Smoking status	Graft uptake	Graft failure	Total
Smokers	3 (33.3%)	6 (66.7%)	9
Non-smokers	75 (82.4%)	16 (17.6%)	91
Total	78 (78%)	22 (22%)	100

Graft uptake was achieved in 82.4% of non-smokers compared with 33.3% of smokers. Conversely, graft failure was observed in 66.7% of smokers compared with 17.6% of non-smokers, indicating a lower observed anatomical success rate among smokers.

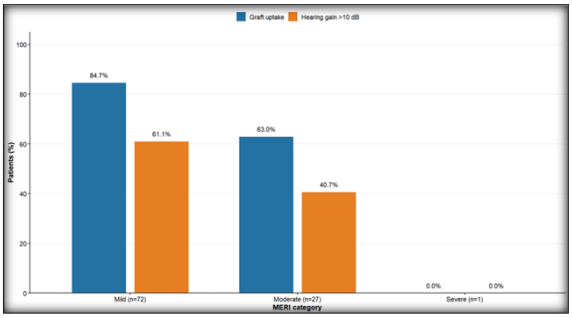


Figure 1: Anatomical and functional outcomes according to Middle Ear Risk Index (MERI) category

DISCUSSION

The present prospective observational study evaluated the role of the Middle Ear Risk Index (MERI) in predicting the anatomical and functional outcomes following tympanoplasty in patients with chronic otitis media. The findings demonstrated that lower MERI scores were associated with better graft uptake and greater postoperative hearing improvement, whereas increasing MERI scores were associated with comparatively less favourable surgical outcomes. These observations support the usefulness of MERI as a simple and objective preoperative prognostic tool for patient counselling, surgical planning, and outcome prediction.

The mean MERI score in the present study was 2.76 ± 1.58, with 72% of patients belonging to the mild-risk category, 27% to the moderate-risk category, and only 1% to the severe-risk category. This distribution indicates that most patients presented with relatively favourable middle ear conditions before surgery. Similar findings have been reported in previous studies, where the majority of patients were classified as having mild MERI scores, reflecting earlier diagnosis and timely surgical intervention before progression to advanced middle ear disease.[13–18] The predominance of low-risk patients in our study may also be attributed to careful patient selection and optimization before surgery.

The overall graft uptake rate at three months in the present study was 78%. Although complete graft uptake was observed in all patients during the second postoperative week, graft failures became apparent during subsequent follow-up, reducing the final anatomical success rate. This finding highlights the importance of assessing surgical outcomes after an adequate follow-up period rather than relying solely on early postoperative observations. Published graft uptake rates following tympanoplasty generally range from 70% to 95%, depending on disease severity, patient selection, surgical technique, graft material, duration of follow-up, and surgeon experience.[6–10,19] Therefore, direct comparison between different studies should be interpreted with caution.

A notable finding of the present study was the progressive decline in graft uptake with increasing MERI score. Anatomical success was achieved in 84.7% of patients with mild MERI scores compared with 63.0% of those with moderate MERI scores, while graft failure occurred in the single patient with a severe MERI score. These findings are consistent with those reported by Kumar et al., Nallapaneni et al., Gupta et al. and Hossain et al., all of whom observed that higher MERI scores were associated with poorer graft uptake following tympanoplasty.[7,20–22,27,28] The poorer outcomes observed in patients with higher MERI scores may be explained by the cumulative effect of persistent middle ear inflammation, unhealthy middle ear mucosa, ossicular pathology, previous surgery, smoking, and chronic infection, all of which adversely influence graft healing.

Hearing restoration is an equally important objective of tympanoplasty. In the present study, postoperative audiological assessment demonstrated satisfactory hearing improvement, with mean postoperative pure-tone averages of 19.83 ± 8.97 dB HL and 19.10 ± 7.94 dB HL for the right and left ears, respectively. Similarly, the mean postoperative air–bone gap was reduced to approximately 6 dB, indicating effective restoration of the sound-conducting mechanism of the middle ear. These findings are comparable with those reported in previous studies evaluating hearing outcomes following tympanoplasty.[7,9,20]

The relationship between MERI score and functional outcome was similar to that observed for graft uptake. Hearing improvement exceeding 10 dB was observed in 61.1% of patients with mild MERI scores compared with 40.7% of patients with moderate MERI scores, whereas no appreciable hearing gain was observed in the patient with a severe MERI score. Better hearing outcomes in patients with lower MERI scores are likely attributable to healthier middle ear mucosa, intact ossicular chain, reduced inflammatory burden, and more favourable Eustachian tube function. Previous studies have likewise reported superior postoperative hearing outcomes in patients with lower MERI scores, supporting the utility of MERI in predicting both anatomical and functional success.[20,23,27,28]

Smoking has been identified as an important adverse prognostic factor in middle ear surgery and is included in the modified MERI scoring system. In the present study, graft uptake was considerably lower among smokers (33.3%) than among non-smokers (82.4%). Although inferential statistical analysis was not performed, this observation is biologically plausible and consistent with previous reports demonstrating impaired wound healing and poorer surgical outcomes in smokers.[2,20] Smoking adversely affects mucociliary clearance, tissue oxygenation, fibroblast activity, and vascularity,

thereby delaying graft healing and increasing the likelihood of surgical failure.

The findings of the present study have important clinical implications. Preoperative calculation of the MERI score enables objective assessment of disease severity and facilitates realistic counselling regarding expected anatomical and functional outcomes. Patients with lower MERI scores can be informed about the higher likelihood of successful graft uptake and hearing improvement, whereas those with higher scores can be counselled regarding comparatively lower success rates and the need for closer postoperative follow-up. In addition, routine use of MERI provides a standardized method for reporting disease severity and comparing surgical outcomes across institutions.

The strengths of the present study include its prospective design, standardized preoperative assessment using the MERI scoring system, uniform surgical technique, and systematic evaluation of both anatomical and functional outcomes. The inclusion of consecutive patients reflects routine clinical practice and enhances the applicability of the findings. Furthermore, assessment of both graft uptake and hearing improvement provides a comprehensive evaluation of surgical success.

The study has certain limitations. It was conducted at a single tertiary care centre with a relatively modest sample size, and only one patient belonged to the severe MERI category, limiting subgroup analysis in high-risk patients. The follow-up period of three months was adequate for assessing early postoperative outcomes but may not fully reflect long-term graft integrity and hearing stability. In addition, multivariable statistical analysis was not performed; therefore, the independent contribution of individual prognostic variables could not be evaluated. Future multicentre studies with larger sample sizes, longer follow-up, and advanced statistical modelling are warranted to further validate the predictive value of MERI.

Overall, the findings of the present study support the use of the Middle Ear Risk Index as a practical and reliable prognostic tool in patients undergoing tympanoplasty for chronic otitis media. Lower MERI scores were associated with better anatomical healing and greater postoperative hearing improvement, highlighting the value of routine preoperative MERI assessment in optimizing patient counselling, surgical planning, and standardized outcome reporting.

CONCLUSION

The present study demonstrates that lower Middle Ear Risk Index (MERI) scores are associated with better anatomical and functional outcomes following tympanoplasty in patients with chronic otitis media. Patients with lower MERI scores achieved higher graft uptake rates and greater postoperative hearing improvement than those with higher MERI scores. Routine assessment using MERI may facilitate risk stratification, realistic patient counselling, appropriate surgical planning, and standardized reporting of surgical outcomes. However, the small number of patients in the severe-risk category and the short follow-up period limit definitive conclusions regarding its predictive value. Larger multicentric studies with longer follow-up and appropriate statistical analysis are recommended to further validate its prognostic utility across diverse patient populations.

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