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Evaluation of the Middle Ear Risk Index (MERI) as a prognostic tool in cases of tympanoplasty with mastoidectomy

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Abstract

Background Chronic suppurative otitis media (CSOM) is a long-standing inflammation of the middle ear mucosa characterized by tympanic membrane perforation and persistent or intermittent otorrhea (discharge lasting a minimum of 2–6 weeks). Our study aimed to assess the middle ear risk index as a prognostic tool in tympanoplasty with mastoidectomy cases.

Methods This single-center prospective observational study was performed at a tertiary care center from May 2024 to May 2025 comprising 60 patients with non-complicated safe CSOM candidate for post-auricular canal wall-up (CWU) tympanomastoidectomy through a post-auricular approach. Patients were assigned according to Austin-Kartush classification. All patients underwent multislice CT scan and pure tone audiometry (PTA).

Results Hearing improvement was achieved in 39 (65%) patients, and successful graft uptake occurred in 45 (75%). Higher MERI scores were associated with poorer postoperative hearing outcomes. Spearman correlation demonstrated a significant negative association between MERI score and hearing improvement ($r = -0.385$, $p = 0.002$). On multivariate logistic regression analysis, MERI score emerged as the only independent predictor of hearing improvement (OR = 0.600, 95% CI: 0.370–0.990, $p = 0.048$).

Conclusions Elevated MERI scores were significantly associated with unfavorable anatomical and functional outcomes, whereas lower scores correlated with successful graft uptake and greater hearing improvement.

Keywords Chronic suppurative otitis media, Middle ear risk index, Tympanoplasty, Mastoidectomy, Austin's classification, Pure tone audiometry

Introduction

Chronic suppurative otitis media (CSOM) is a persistent inflammatory disease of the middle ear characterized by tympanic membrane perforation and recurrent or persistent otorrhea lasting more than 2–6 weeks [1]. Clinically, CSOM is broadly classified into attico-antral (unsafe) and tubo-tympanic (safe) disease based on the site of perforation, extent of pathology, and associated complications [2]. Despite advances in surgical technique, variability in anatomical disease severity continues to influence outcomes following middle ear surgery [3].

Tympanoplasty, a surgical technique aimed at reconstructing both the middle ear cavity and the tympano-ossicular system, is critical for sound conduction [6]. The main objectives of tympanoplasty include eradicating disease within the ear, improving or preserving hearing function, ensuring adequate ventilation within the middle

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ear cleft, and maintaining a dry ear cavity [4]. Common methods for performing tympanoplasty include the endomeatal, endaural, and postauricular approaches [5].

However, restoration of normal middle ear anatomy and hearing remains a significant surgical challenge. The ability to predict surgical outcomes would facilitate better patient counseling and intraoperative decision-making. For such dilemmas, many methods have been used, out of which one is the Middle Ear Risk Index (MERI) score [6].

The Middle Ear Risk Index (MERI), originally developed by Kartush and later refined by Becvarovski and Kartush, is a composite scoring system that quantifies the severity of middle ear pathology using established preoperative and intraoperative risk factors such as otorrhea, ossicular status, middle ear granulation, and prior surgery [7]. MERI has been validated in multiple studies as a prognostic tool for tympanoplasty outcomes [4, 8, 9]. However, most existing validations focus on tympanoplasty performed in isolation, with limited emphasis on cases requiring concomitant mastoidectomy. Re-evaluating MERI in combined tympanoplasty–mastoidectomy cases, therefore, provides clinically relevant insight into whether this index retains its utility when applied to more extensive disease requiring surgical clearance of the mastoid air cell system.

We hypothesized that higher MERI scores would be independently associated with poorer anatomical outcomes (graft uptake) and reduced functional improvement (hearing gain) following tympanoplasty with mastoidectomy. This study aimed to evaluate the prognostic value of MERI and to identify independent predictors of postoperative hearing improvement and graft success.

Patients and methods

This prospective observational trial was performed at the department of Otorhinolaryngology at a tertiary care center from May 2024 to May 2025 comprising 60 patients with non-complicated safe chronic suppurative otitis media, operationally defined as tubotympanic disease with a central tympanic membrane perforation, absence of cholesteatoma, no evidence of extracranial or intracranial complications, and no facial nerve involvement. Patients were candidates for post-auricular canal wall-up (CWU) tympanomastoidectomy via a post-auricular approach, and aged between 18 and 45 years old of both genders. Ethical approval was obtained from an institutional research ethics committee, and written informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki (1975) and its subsequent amendments.

Exclusion criteria involved cases younger than 18 years or older than 45 years; those with a history of ototoxic drug use; individuals with otomycosis or acute infection; patients with cranial, extracranial, or intracranial complications of CSOM; those with autoimmune diseases or in an immunosuppressive state; and patients who declined to participate in the study.

All cases were submitted to detailed history taking, general, ear, nose, and facial nerve examination, imaging (multislice CT scan (bone and soft tissue windows) axial and coronal reconstruction of petrous bone), and preoperative audiological assessment pure tone audiometry (PTA).

Ossicles assessment

Austin-Kartush classification (1971) included four groups regarding the presence or absence of the malleus and stapes. Group A: malleus and stapes present, incus eroded; Group B: only malleus present, stapes absent; Group C: only stapes present, malleus absent; and Group D: both malleus and stapes superstructure absent. Kartush later (1994) expanded the classification to include two more categories to address ossicular fixation: Group E: ossicular head fixation with intact ossicles; and Group F: stapes fixation with presence of all ossicles.

Surgical technique

Post auricular CWU tympanomastoidectomy through post-auricular approach under general anesthesia, local anesthesia was administered in the postauricular region, followed by the postauricular incision, dissection, and harvesting of the temporalis fascia graft. The tympanomeatal flap was then elevated, and the middle ear was explored. Depending on the pathology, mastoidectomy, tympanoplasty, and ossicular chain management were performed, after which the wound was closed. Following surgery, each patient's MERI was calculated according to the scoring system of Agarwal et al. [10] (Table 1), incorporating parameters like otorrhea, perforation, severity, ossicular status, cholesteatoma, presence of granulations

Table 1 Middle Ear Risk Index (MERI) scoring system according to Agarwal et al [10]

Parameter	Score
Otorrhea (dry/intermittent/persistent)	0/1/2/3
Tympanic membrane perforation	0/1
Ossicular status (Austin–Kartush classification)	A/B/C/D/E/F
Granulation tissue/middle ear effusion	0/2
Cholesteatoma	0/2
Previous ear surgery	0/1/2
Smoking	0/2
Total MERI score	0–12

or effusion, history of previous surgery, and smoking status. The resulting MERI score provided an overall assessment of postoperative risk. All patients were monitored for 6 months, with weekly follow-up during the first month, monthly visits for the next 3 months, and a final evaluation at 6 months. Follow-up included assessment of wound healing, graft uptake, and any complications, while hearing was reassessed after 3 months for all patients (Fig. 1).

Hearing gain was defined as an improvement in pure-tone average air-conduction thresholds of ≥ 5 dB at 0.5, 1, 2, and 4 kHz measured 3 months postoperatively.

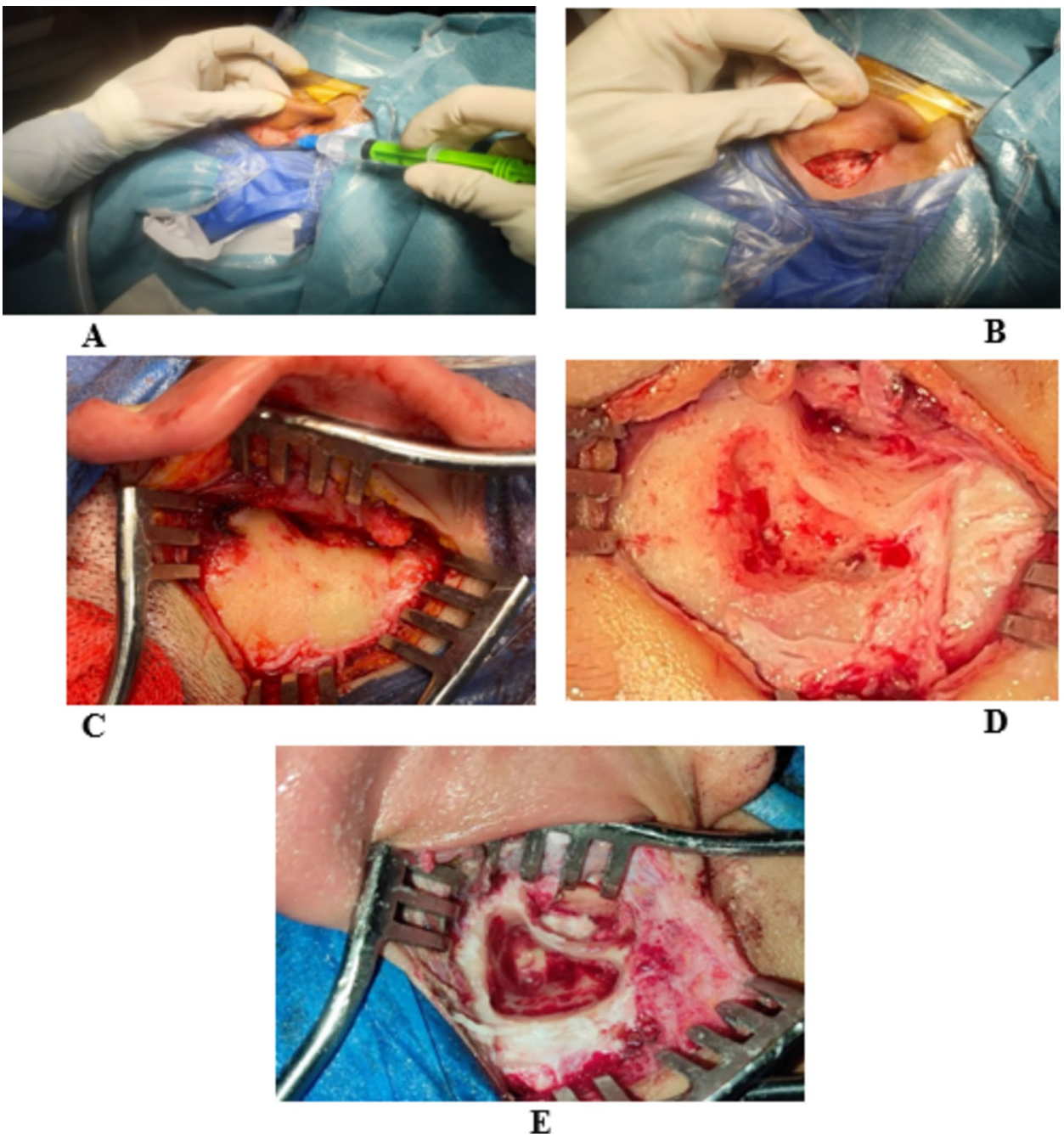

Fig. 1 **A** Injection of local anesthesia post auricular of right ear, **B** post auricular incision of right ear, **C** right ear after elevation of the periosteal flap and placement of mastoid retractor, **D** right ear after removal of outer mastoid cortex till reaching mastoid antrum, **E** right ear after completion of canal wall up (CWU) procedure and graft placement

Sample size calculation

A sample size of 60 patients was considered feasible and comparable to previous MERI validation studies. Post-hoc power analysis demonstrated that this sample provided more than 80% power to detect a moderate effect of MERI score on hearing improvement at a significance level of 0.05.

Statistical analysis

Because several variables were ordinal or non-normally distributed, non-parametric statistical tests were used. Associations were assessed using Spearman rank correlation. Independent predictors of hearing improvement were evaluated using multivariate binary logistic regression. Results are presented as odds ratios (OR) with 95% confidence intervals (CI). A two-tailed p-value of less than 0.05 was considered statistically significant.

Results

Table 2 shows patients' demographic and clinical characteristics. Regarding the postoperative outcomes, 45 (75%) grafts were taken and hearing was improved in 39 (65%) patients by (5–20 dB).

Spearman correlation analysis demonstrated a significant negative correlation between MERI score and postoperative hearing improvement ($r = -0.385$, $p = 0.002$).

On univariate analysis, several factors including age, otorrhea, ossicular status, and MERI score showed associations with hearing outcomes; however, on multivariate binary logistic regression analysis, MERI score emerged as the only independent predictor of hearing improvement (OR = 0.600, 95% CI: 0.370–0.990, $p = 0.048$) while age, otorrhea, ossicular status, and previous surgery were not independently associated with hearing outcomes (Table 3).

Table 2 Demographic, clinical characteristics, and postoperative outcomes of the study population

	Total ($n = 60$)
Age (years), mean ± SD	28.2 ± 11.26
Gender (male/female)	21 (35%)/39 (65%)
Smoking	9 (15%)
Previous ear surgery	15 (25%)
Otorrhea (intermittent/persistent)	21 (35%)/39 (65%)
Ossicular status (Austin–Kartush)	A: 60%, B: 10%, D: 10%, E: 20%
MERI score, mean ± SD	5.95 ± 3.38
MERI severity (mild/moderate/severe)	30%/35%/35%
Graft uptake	45 (75%)
Hearing improvement	39 (65%)

Data are presented as mean ± SD or frequency (%), MERI score: Middle ear risk index.

Discussion

Chronic otitis media (COM) continues to pose a significant public health challenge in developing nations, including Egypt, where its prevalence is maintained by recurrent upper respiratory tract infections, limited healthcare access, and substandard socioeconomic conditions [11]. It indicates a persistent inflammation of the middle ear and mastoid cavity that often leads to perforation of the tympanic membrane [12].

In the present study, the mean age of the participants was 28.2 ± 11.26 years, indicating a relatively young cohort, with a predominance of females (65%). This aligned with ElNaem et al. [13] who reported that there were 46 (60.5%) females and 30 (39.5%) males of patients who underwent type 1 tympanoplasty. Likewise, Bhat et al. [14] demonstrated that among patients diagnosed with COM who underwent surgical intervention, the age of participants ranged from 13 to 76 years, with a mean age of 36.4 ± 17.2 years. The majority were male ($n = 45$, 86.5%), and only 13.5% were female ($n = 7$).

In our study, a minority of patients were smokers (15%), while one-quarter (25%) had a history of previous ear surgery, suggesting a notable proportion of revision cases. There was no significant difference observed in postoperative hearing outcomes [7]. While Bhat et al. [14] showed that a significant proportion of the patients were smokers ($n = 45$, 86.5%). Revision surgery was performed in 7.7% of cases ($n = 4$), while 92.3% ($n = 48$) were undergoing primary surgery. The differences in findings could be attributed to the variations in geographical settings, environments, and population characteristics.

In the current study, otorrhea was common, with persistent discharge observed in 65% of patients, reflecting a substantial burden of active middle ear disease at presentation. Supporting our study, Parupalli et al. [15] reported that the majority of patients had reduced hearing (92%) and otorrhea (87%) as their main manifestations. Similarly, Bhat et al. [14] showed that regarding otorrhea,

Table 3 Multivariate logistic regression analysis of predictors of postoperative hearing improvement

	Odds ratio (OR)	**95% CI**	***P* value**
MERI score	0.600	0.370–0.990	**0.048***
Age	1.010	0.900–1.120	0.920
Previous surgery	0.460	0.120–1.840	0.270
Ossicular status	0.950	0.440–2.270	0.910
Otorrhea	0.970	0.340–2.990	0.950

MERI score Middle Ear Risk Index, *OR* odds ratio, *CI* confidence interval

*Statistically significant *P* value ≤ 0.05

51.9% had occasional discharge, 23.1% had persistent discharge, and 25% had dry ears.

In this study, assessment of ossicular integrity using the Austin–Kartush classification revealed that the majority of patients (60%) had type A ossicular status, whereas types B and D were each observed in 10% of cases, and type E in 20%, indicating varying degrees of ossicular involvement. In line with our findings, Bangera et al. [16] reported that the malleus was intact in 80 patients, eroded in 17 patients, and absent in 3 cases. The incus was identified as the most frequently eroded ossicle, being intact in 65 cases, eroded in 29 cases, and absent in 6 cases.

Also, Bhat et al. [14] revealed that the ossicular chain status was assessed intraoperatively in all 52 patients. The most commonly observed status was an intact ossicular chain (M + I + S +), present in 32 patients (61.5%). Partial ossicular discontinuity was observed in 7 patients (13.5%) with the malleus, incus erosion but stapes present (M−S +), and in 5 patients (9.6%) with the malleus present but stapes erosion (M + S−). Complete ossicular chain erosion (M−S−) was found in another 5 patients (9.6%). A configuration with both the malleus and stapes present, but with incus eroded (M + S +), was noted in 3 patients (5.8%).

According to our findings, the mean MERI score was 5.95 ± 3.38, with the severity distribution showing an almost equal proportion of moderate and severe disease (35% each), and 30% classified as mild, highlighting the heterogeneous risk profile of the study population. This was consistent with Kamath and Gulla [17] who noted that among 82 patients undergoing tympanoplasty with/without mastoidectomy, 43 (52.4%) had mild MERI, 29 (35.4%) had moderate MERI, and 10 (12.2%) had severe MERI. The average MERI score for the patients was 4.26 ± 2.49. Our findings contrast with those of Kumar et al. [18], in whose study approximately 72% of patients were categorized as having mild disease, possibly reflecting earlier presentation in their cohort (MERI scores in the mild category, with better eustachian-tube function). In their series, they reported a graft-uptake (anatomical) success rate of about 80% and found that the ears with mild MERI disease and normal Eustachian-tube function achieved the best functional outcomes—in contrast, patients with higher MERI scores or poor ET function had a significantly higher failure rate.

In the present study, postoperatively, graft uptake was achieved in 75% of patients, and hearing improvement was documented in 65%, demonstrating generally favorable surgical outcomes despite the presence of moderate-to-severe disease in a significant proportion of cases. Consistent with the 75–98% success rates reported in prior series by Bayram et al. [19]. The 25% graft failure rate observed may be attributable to persistent infection, Eustachian tube dysfunction, or higher MERI scores, underscoring the role of surgical precision and preoperative optimization in achieving favorable anatomical outcomes. Furthermore, the report by Lesinskas and Stankeviciute [20], found significantly higher graft and hearing success in primary tympanoplasty (81.1%) compared with revision cases (69.5%, $p < 0.01$).

Comparable gains have been reported by Mahesh Babu et al., who reported an average gain of 24.7 dB following type III tympanoplasty with ossiculoplasty [21, 22].

This study demonstrated a significant negative correlation between MERI score and postoperative hearing improvement ($r = -0.385$, $p = 0.002$). These findings are congruent with those of Kamath and Gulla [17] and Lal [23], who reported that ossicular discontinuity, active otorrhea, and higher MERI scores negatively influence postoperative hearing recovery. Also, prior investigation by Aggarwal and Dev [24] demonstrated that higher MERI grades correlate with greater disease burden, reduced graft uptake, and diminished hearing improvement.

On univariate analysis, several factors including age, otorrhea, ossicular status, and MERI score showed associations with hearing outcomes; however, on multivariate binary logistic regression analysis, MERI score emerged as the only independent predictor of hearing improvement. In accordance with these observations, Dash et al. [25] reported that accumulated MERI is hence a good prognostic factor for the hearing outcome of surgery. Similarly, ElNaem et al. [13] found that younger age, female gender, no comorbidities, and higher surgeon experience were associated with better outcomes. In addition, patients with a mild MERI score showed a higher rate of success for tympanoplasty than patients with moderate and severe MERI scores. Additionally, Bhat et al. [14] highlighted that patients with low MERI scores demonstrated the most favorable surgical and audiological outcomes. On the other hand, Kamath and Gulla [17] concluded that MERI may not accurately predict the hearing outcome in patients undergoing tympanoplasty with/without mastoidectomy. This discrepancy in results could be explained by variations in study areas and patients' characteristics.

Limitations

The small sample size and single-center design of the study, which may restrict the generalizability of the findings. Additionally, potential inter-observer variability in intraoperative assessment of ossicular status and MERI scoring may have influenced data consistency. The relatively short follow-up duration of 6 months represents an important limitation of this study, as it restricts

assessment of long-term graft durability, delayed reperforation, and sustained hearing outcomes.

Conclusions

Higher MERI scores were significantly associated with poorer anatomical and functional outcomes following tympanoplasty with mastoidectomy. MERI was the only independent predictor of hearing improvement. Lower MERI scores were associated with higher graft uptake rates and greater postoperative hearing improvement.

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s43163-026-01025-3.

Supplementary Material 1.

Authors' contributions

A.E.F.G. contributed to study conceptualization. A.E.F.S. contributed to methodology and original draft preparation. E.F.A.S. contributed to formal analysis and investigation. All authors reviewed and approved the final manuscript.

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Data availability

No datasets were generated or analyzed during the current study.

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the institutional research ethics committee of the Faculty of Medicine, Benha University, on 23 August 2025, Code Number: MS 40-3-2024, and written informed consent was obtained from all participants. The study was conducted in accordance with the Declaration of Helsinki (1975) and its subsequent amendments.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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