



A STUDY TO ASSESS THE GRAFT UPTAKE AND AUDIOLOGICAL GAIN IN SURGICAL TREATMENT OF MIDDLE EAR DISEASE IN RELATION TO MIDDLE EAR RISK INDEX SCORE

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ABSTRACT

Background:

Chronic otitis media (COM) continues to be a major cause of preventable hearing loss in developing countries. The Middle Ear Risk Index (MERI) has been proposed as an objective method for stratifying disease severity and predicting surgical outcomes. However, regional data correlating MERI with surgical success remain limited.

Aims:

To assess graft uptake and audiological gain in relation to MERI scores in patients of COM undergoing ear surgery.

Materials and Methods:

A prospective longitudinal study was conducted in the Department of Otorhinolaryngology, Regional Institute of Medical Sciences, Imphal, from April 2023 to October 2024. A total of 108 patients aged 12–65 years with COM and conductive hearing loss underwent tympanoplasty (with or without mastoidectomy). Patients were categorized as mild (MERI 1–3), moderate (MERI 4–6), and severe (MERI 7–12). Postoperative graft uptake and hearing gain were evaluated by otoscopy and pure tone audiometry at 1 and 3 months. Data were analysed using SPSS v23 with p value < 0.05 considered significant.

Results:

Graft uptake rates were 95.3% in mild, 82.8% in moderate, and 46.7% in severe MERI groups ($p < 0.001$). Mean postoperative air–bone gap (ABG) improved across all groups, with percentage closure of 54.7%, 41.9%, and 28.3% respectively with respect to preoperative hearing thresholds. A significant negative correlation was observed between MERI score and both percentage audiological gain ($r = -0.407$, $p < 0.001$) and ABG closure ($r = -0.543$, $p < 0.001$).

Conclusion:

MERI scoring effectively predicts anatomical and functional outcomes following ear surgery for COM. Higher MERI scores are associated with lower graft success and poorer hearing improvement. MERI should be incorporated into preoperative evaluation for better prognostication and surgical planning.

Keywords: Chronic Otitis Media, Middle Ear Risk Index, Tympanoplasty, Graft Uptake, Audiological Gain, Hearing Outcome.

I. INTRODUCTION

Chronic otitis media (COM) implies a permanent abnormality of the pars tensa or flaccida, mostly likely a result of earlier acute otitis media, negative middle ear pressure or otitis externa with effusion¹. It affects approximately 65–330 million individuals worldwide, with up to 200 million suffering from hearing impairment².

COM is more prevalent in developing nations and low socioeconomic populations due to poor hygiene, recurrent upper respiratory infections, and limited access to healthcare services³.

Complications can range from 5% to 12.5% and include mastoiditis, subperiosteal abscess, facial paralysis, and labyrinthitis. Meningitis, lateral sinus thrombosis (LST), cerebral abscess, otitic hydrocephalus, extradural abscess, and encephalitis⁴.

Tympanoplasty with or without ossiculoplasty remains the principal surgical intervention for eradicating disease and restoring hearing and is often done along with mastoidectomy⁵.

Prognostic models such as the Middle Ear Risk Index (MERI), developed by Kartush and later modified by Becvarovski and Kartush (2001), integrate multiple preoperative risk factors—otorrhea, perforation, cholesteatoma, ossicular discontinuity, middle ear granulation, previous surgery, and smoking—into a composite score that predicts surgical outcomes⁶.

This study evaluates the correlation between MERI score and postoperative outcomes, including graft uptake and audiological improvement, in patients undergoing tympanoplasty at a tertiary care centre.

II. OBJECTIVES

To evaluate the success of graft uptake and audiological gain in patients undergoing middle ear surgeries in RIMS, Imphal in relation to MERI scores.

III. MATERIAL AND METHODS

A prospective longitudinal study was conducted in the Department of Otorhinolaryngology, Regional Institute of Medical Sciences (RIMS), Imphal, from April 2023 to October 2024. Permission to conduct the study was obtained from the Institutional Ethics Committee.

A total of 108 patients aged over 12 years of age with clinically and audiotologically confirmed COM were enrolled. Patients with acute otitis media, otitis externa, congenital ear anomalies, or severe sensorineural hearing loss were excluded.

Detailed demographic data, clinical history, otoscopic findings, and MERI scores were documented. MERI Scores were categorized as mild (1–3), moderate (4–6), and severe (≥ 7) based on the modified MERI system by Becvarovski and Kartush (2001). Surgical procedures included Type I–IV tympanoplasty with or without canal wall up/down mastoidectomy. Graft uptake was assessed after 3 months via endoscopic examination. Pre- and postoperative pure tone audiometry (PTA) was conducted, and air-bone gap (ABG) closure was calculated. Statistical analysis was performed using SPSS v23, with $p < 0.05$ considered significant

IV. RESULTS

A total of 108 patients were included in the study, comprising 61 females (56%) and 47 males (44%), with a mean age of 35.7 ± 12.2 years. Most patients were from rural areas (60%) and belonged to socioeconomic Class III (31.48%) as per the updated B.G. Prasad scale (2024). Based on MERI scoring, 59.3% of patients were classified as mild risk, 26.9% as moderate risk, and 13.9% as severe risk.

Unilateral disease predominated, accounting for 84.2% ($n = 91$) of cases, with mucosal disease being more frequent (56.5%) than squamosal disease (27.8%). Bilateral cases comprised 15.8% ($n = 17$), predominantly mucosal type (12%) followed by squamosal type (3.7%). Surgical distribution between right and left ears was nearly equal (51.9% vs 48.1%) (Table 1)

Type of Disease	Frequency	Side of Surgery		Percentage (%)		Cumulative Percentage (%)
		Right	Left	Right	Left	
Bilateral Mucosal COM	13	6	7	5.6	6.5	12
Unilateral Mucosal COM	61	35	26	32.4	24.1	56.5
Bilateral Squamosal COM	4	1	3	0.9	2.8	3.7
Unilateral Squamosal COM	30	14	16	13	14.8	27.8
Total	108	56	52	51.9	48.1	100

Table 1: Distribution of patients on the basis of type of disease and side of operated ear
The most common perforation pattern was central type, comprising small (15.7%), medium (22.2%), large (19.4%), and subtotal (11.1%) perforations. Marginal perforations accounted for 24.1%, while attic perforations represented 7.4%.
Tympanoplasty Type I was the most frequently performed surgery (27.8%), followed by Type I + CWU (24.1%) and Type III + CWD (14.8%). Less frequent procedures included Type I + CWD (7.4%) and Type IV + CWD (1.9%) (Table: 2)

Type of surgery	Frequency	Percentage (%)
Tympanoplasty Type I	30	27.8
Tympanoplasty Type I + CWU*	26	24.1
Tympanoplasty Type I + CWD**	8	7.4
Tympanoplasty Type II + CWU*	15	13.9
Tympanoplasty Type II + CWD**	11	10.2
Tympanoplasty Type III + CWD**	16	14.8
Tympanoplasty Type IV + CWD**	2	1.9

*Canal wall up procedure **Canal wall down procedure

Table 2: Distribution of patients on the basis of type of surgery

Tragal perichondrium cartilage composite graft was the most commonly used graft material (66.6%), followed by temporalis fascia (21.3%) and tragal perichondrium alone (13%).
The overall graft uptake rate was 85.2%. Graft success rates showed a significant decline with increasing MERI severity — 95.3% in mild, 82.8% in moderate, and 46.7% in severe risk categories ($p < 0.001$) (Table 3).

MERI Category	Graft uptake		Percentage (%) with successful graft uptake	P value
	Yes (%)	No (%)		
Mild Risk	61	3	95.3	<0.001
Moderate Risk	24	5	82.8	
Severe Risk	7	8	46.7	
Total	92	16	85.2	

Table 3: Distribution of patients according to successful graft uptake and comparison of MERI risk category and graft uptake with Chi Square test.

As the MERI risk category increased from mild to severe, both the absolute audiological gain and the percentage improvement in hearing decreased progressively. Patients in the mild-risk group demonstrated the lowest preoperative hearing loss (36.1 ± 9.3 dB) and a significant postoperative improvement to 25.2 ± 7.5 dB. The moderate-risk group showed improvement from 48.5 ± 8.5 dB preoperatively to 36.4 ± 9.2 dB postoperatively. Patients in the severe-risk group, who had the highest

baseline hearing loss (61.1 ± 8.6 dB), showed a comparatively smaller improvement to 51.2 ± 11 dB. The differences between pre- and postoperative hearing levels across all groups were highly significant ($p < 0.001$). Although the mean absolute audiological gain was similar across categories (10.8 ± 4.9 , 12 ± 6.2 , 9.8 ± 6 in mild, moderate and severe categories respectively) and not statistically significant, the percentage improvement in hearing decreased with increasing MERI severity. The difference was not significant between mild and moderate groups, but significant between moderate-severe groups, and mild-severe groups (Table 4)

MERI Category	Mild Risk	Moderate Risk	Severe Risk	P value		
				Mild vs Moderate	Moderate vs Severe	Mild vs Severe
Mean Preoperative hearing loss	36.1 \pm 9.3	48.5 \pm 8.5	61.1 \pm 8.6	<0.001	<0.001	<0.001
Mean post operative hearing loss	25.2 \pm 7.5	36.4 \pm 9.2	51.2 \pm 11	<0.001	<0.001	<0.001
Mean audiological gain	10.8 \pm 4.9	12 \pm 6.2	9.8 \pm 6	0.583	0.401	0.787
Percentage (%) of audiological gain	29.8	25.2	16.5	0.194	0.050	<0.001

Table 4: Comparison of Preoperative and Post Operative hearing loss between mild, moderate and severe MERI categories. Post-Hoc pairwise analysis performed using Tukey's HSD test.

Patients with successful graft uptake ($n = 92$) showed significantly greater mean audiological gain (12.4 ± 4.2 dB) corresponding to a 30.5% improvement ($p = 0.005$) compared to those with failed grafts (2.9 ± 4.8 dB) showing a minimal non-significant improvement of 4.3% (Table 5)

Graft Uptake	Frequency (n)	Mean preoperative hearing loss	Mean post-operative hearing loss	Mean audiological gain	Percentage of audiological gain (%)	p-value
Yes	92	40.9 \pm 11.7	28.5 \pm 9.4	12.4 \pm 4.2	30.5	0.005
No	16	53.8 \pm 13	50.9 \pm 11.2	2.9 \pm 4.8	4.3	0.707

Table 5: Comparison of Preoperative vs Post Operative hearing loss with audiological gain on the basis of graft uptake

Higher MERI scores are associated with worse initial air bone gap and even post operatively have worse residual air bone gap. The mean absolute audiological gain is similar across all groups with no significant statistical difference. Percentage ABG closure was 54.7% in mild, 41.9% in moderate, and 28.3% in severe groups, showing statistical significance between mild-moderate and mild-severe groups. (Table 6)

MERI Category	Mild Risk	Moderate Risk	Severe Risk	P value		
				Mild vs Moderate	Moderate vs Severe	Mild vs Severe
Mean Preoperative ABG	19.9 \pm 6.1	29.3 \pm 7.6	36.5 \pm 7	<0.001	0.003	<0.001
Mean post operative ABG	8.8 \pm 4.2	17 \pm 6.9	26.2 \pm 7.8	<0.001	<0.001	<0.001
Mean air bone gain	10.9 \pm 5	12.3 \pm 6	10.3 \pm 6	0.458	0.487	0.939

ABG difference expressed as percentage	54.7	41.9	28.3	0.029	0.081	<0.001
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Table 6: Comparison of pre-operative vs post operative air bone gap (ABG) on the basis of MERI score: Post-Hoc pairwise analysis performed using Tukey's HSD test.

Correlation analysis (Table 7) showed no significant association between MERI score and absolute audiological or Air-Bone gain. However, MERI had a strong negative correlation with percentage audiological gain ($r = -0.407$, $p < 0.001$) and ABG improvement ($r = -0.543$, $p < 0.001$), indicating poorer relative hearing outcomes with increasing MERI severity.

Correlation	Spearman's rho	p value
MERI score and Audiological gain	0.019	0.842
MERI score and Percentage (%) of audiological gain	-0.407	<0.001
MERI score and Air-Bone Gain	0.046	0.63
MERI score and ABG difference expressed as percentage	-0.543	<0.001

Table 7: Correlation between MERI score and Hearing improvement

V. DISCUSSION

This prospective study evaluated the relationship between Middle Ear Risk Index (MERI) and surgical outcomes of graft uptake and audiological improvement in 108 patients undergoing middle ear surgery for chronic otitis media (COM). The findings demonstrate a clear inverse correlation between MERI severity and both graft success and hearing gain, validating MERI as a reliable prognostic tool.

MERI Score Distribution and Graft Uptake

In this study, 59.3% of patients had mild, 26.9% moderate, and 13.9% severe MERI scores. Rates of graft uptake were 95.3%, 82.8%, and 46.7% in mild, moderate and severe MERI scores which are similar to findings were reported by Verma et al.⁷ (85.03%, 77.55%, 54.16%) and Nallapaneni et al.⁸ (96.5%, 70.5% and 55.17%). Graft uptake rates reported by Singh et al.⁹ were 83.9%, 82.2% and 50% in mild, moderate and severe MERI risk categories, showing no significant differences in graft uptake between mild and moderate categories but a sharp decline in severe category. However, Zhu et al.¹⁰ observed no significant graft difference among categories, possibly due to their retrospective design and case selection bias.

Audiological Outcomes and Air-Bone Gap (ABG) Improvement

Audiological improvement showed a downward trend with increasing MERI severity. The mean preoperative hearing thresholds improved from 36.1 ± 9.3 dB, 48.5 ± 8.5 dB, and 61.1 ± 8.6 dB to 25.2 ± 7.5 dB, 36.4 ± 9.2 dB, and 51.2 ± 11 dB postoperatively in the mild, moderate, and severe MERI risk categories, respectively.

Although the absolute mean ABG closure was almost similar across all categories (10.9 ± 5 dB, 12.3 ± 6 dB, and 10.3 ± 6 dB in the mild, moderate, and severe risk categories), the study showed a clear decline in ABG closure expressed as percentage relative to preoperative hearing thresholds with increasing MERI severity (54.7% in mild risk, 41.9% in moderate risk, and 28.3% in severe risk).

Torre et al.¹¹ and Horvath et al.¹² reported a comparable gain of 12.88 ± 6.95 dB and 9.8 dB reduction in ABG respectively in successful surgeries across all MERI categories but did not stratify the results by risk categories. Nallapaneni et al.⁸ reported similar post operative PTA values of 20.45 ± 4.17 dB, 33.35 ± 1.80 dB and 49.03 ± 6.78 dB in mild, moderate and severe risk category patients at the end of 3 months which is in line with the 3 months post operative PTA values in our study.

Significant improvements in hearing thresholds for patients with mild MERI scores compared to moderate and severe scores were also observed by Kalsotra et al.¹³, supporting our finding of differential improvement by risk category. However, none of the studies reported ABG closure as a percentage of preoperative hearing threshold, limiting direct numerical comparison. Although Zhu et al.¹⁰ did not find any significant difference in graft uptake success rates among MERI risk categories, but reported MERI as an independent predictor of hearing outcomes.

Correlation Analysis

MERI score showed no significant correlation with absolute audiological gain, but a moderate to strong negative correlation with percentage improvements in both audiological gain ($r = -0.407$) and ABG closure ($r = -0.543$), indicating diminished relative benefit in high-risk patients. The nuanced finding that relative improvement rather than absolute improvement correlates with MERI scores has not been consistently analysed or reported in previous studies. Most research has focussed on either absolute improvement or success/ failure rates, potentially missing this important distinction.

VI. CONCLUSION

Chronic otitis media (COM) significantly affects hearing and quality of life, and tympanoplasty remains the mainstay of treatment. The Middle Ear Risk Index (MERI), which incorporates key preoperative factors, effectively stratifies patients by surgical risk. In this study, graft uptake and hearing improvement showed a declining trend with increasing MERI severity, confirming its value as a prognostic tool. Incorporating MERI into routine practice can aid in patient counselling, surgical planning, and tailored perioperative care, particularly for high-risk cases.

VII. REFERENCES

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