Main Article

A Study of Predictive Value of Middle Ear Risk Index on Hearing Improvement in Patients Undergoing Surgery for Chronic Suppurative Otitis Media

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ABSTRACT

Introduction

Middle ear risk index is one of the most reliable measuring tools to predict and evaluate the results of tympanoplasty. This study was done to analyse the predictive value of revised middle ear risk index on hearing improvement in patients undergoing surgery for chronic otitis media and to correlate the association between each index factor with hearing results.

Materials and Methods

This prospective observational study was done over 2 years in a tertiary care Army Hospital with 88 patients in the age group of 10-65 years. Preoperative hearing thresholds and air-bone gaps were recorded. Patients were assigned to mild, moderate and severe groups with risk index scores. Hearing thresholds were assessed at 3 and 6 months following surgery for chronic otitis media. Data was statistically analysed.

Results

92.04% and 77.27% showed hearing improvements, 4.54% and 1.13% had deterioration and 3.40% and 21.59% had no change when compared to preoperative results in AC and BC thresholds respectively. 57.95% had post-operative closure of air bone gap of ≤ 12. Compared to cases with AB gap closure ≤ 12, those with AB gap closure > 12 showed statistically significant gain in BC by 0.2dB. Each unit increase in risk index score was associated with statistically significant increase of 0.64 dB in BC. Out of the seven individual factors, only perforation and previous surgery showed statistical significance in terms of hearing improvement.

Conclusion

Middle ear risk index is not a good predictor of hearing improvement in ear surgery. Individually, risk index or air bone gap are not strong predictors but jointly, they show strong association with hearing improvement both in terms of AC and BC.

Keywords

Middle Ear Risk Index; Air Conduction; Bone Conduction; Air-Bone Gap; Hearing Improvement

Otitis media is a serious health problem worldwide, especially in developing countries, where significant percentage of population lack specialized medical care without high cost, suffer from malnutrition, live in poor hygienic condition and are hard pressed to earn a living. The prevalence of chronic otitis media (COM) in India is 7.8% according to a WHO study. 77% of these patients have hearing loss, out of which 94 % have moderate hearing loss and rest have severe loss.[1] Most cases of COM can be managed surgically, by Tympanoplasty with or without Mastoidectomy.

There are many factors that can affect the outcome of surgery such as eustachian tube function, middle ear conditions, ossicular status, type of surgical procedure etc. The middle ear risk index (MERI) is one of the most

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reliable measuring tools to predict and evaluate the results of tympanoplasty. MERI includes intrinsic and extrinsic factors that may influence the surgical intervention and outcome. The intrinsic factors include eustachian tube function, severity of disease, and status of ossicular chain. Extrinsic factors include surgical technique, staging of procedure, use of graft material and prosthesis. Kartush et al. initially suggested a scoring system termed MERI, and Becvarovski and Kartush revised the final system, including the smoking status.[2]

The present study was done with the aim to analyse the predictive value of revised MERI ('revised MERI' will henceforth be referred as MERI in this article) on hearing improvement in patients undergoing surgery for COM and also to correlate the association between each factor within MERI and hearing results.

Materials and Methods

This prospective observational study was done in a tertiary care hospital of Indian Armed Forces over a duration of two year. The patients of COM undergoing ear surgery, in the age group of 10-65 years, who were willing to be a part of study protocol, were included in the study. The patients with any known comorbidities like Diabetes Mellitus, Autoimmune diseases, HIV positive status, organ or bone marrow transplant cases, chronic kidney disease, which could contribute to delayed wound healing were excluded from this study. Out of 146 patients who underwent tympanomastoid surgery, 100 consented to be the part of study.

However, since 12 patients were lost to follow up during post-operative visits, hence the results and statistical analysis was done with the sample size of 88 patients. Approval for conducting the study was obtained from Institutional Ethical Committee and a written and informed consent was taken from each patient.

A thorough general and ENT examination was done for all the patients. Tympanic membrane (TM) status was recorded. Nose, paranasal sinuses, oral cavity and oropharynx were examined to rule out infection. Preoperative hearing evaluation was done by Pure Tone Audiometry (PTA) using modified Hughson-Westlake method. Pure Tone Average of 4 frequencies (500, 1000, 2000 and 4000Hz) was calculated for Air Conduction (AC) and Bone Conduction (BC) thresholds. Air Bone Gap (AB gap) was derived. Masking was done wherever necessary. MERI with its scoring was used as below (Table I). Patients were assigned to three groups, namely mild, moderate and severe with the score of 1 to 4, 5 to 8 and more than 8 respectively.

Table I: Middle ear risk index with their scores

RISK FACTORS		VALUE ASSIGNED
Ossicular status (Austin/ Kartush)	M+I+S+	0
	M+S+	1
	M+S-	2
	M-S+	3
	M-S-	4
	Ossicular head fixation	2
	Stapes fixation	3
TM Perforation	None	0
	Present	1
Cholesteatoma	None	0
	Present	1
Otorrhea (Belluci)	Dry ear	0
	Occasionally wet ear	1
	Persistently wet ear	2
	Wet ear with cleft palate	3
Middle ear granulation or effusion	No	0
	Yes	1
Previous surgery	None	0
	Staged	1
	Revision	2
Smoking	No	0
	Yes	1
	Total MERI Score	16

Patients were planned for ear surgeries based on the disease status after counselling them about the preoperative precautions, intraoperative steps and post-operative expectations.

Patients with central perforation of TM underwent Type I Tympanoplasty by a post aural route using temporalis fascia graft by underlay technique over gelfoam bed. Patients with diseased ossicles underwent reconstruction of ossicular chain using either refashioned autologous incus or synthetic prosthesis of hydroxyapatite or titanium. Patients with retraction pockets with or without cholesteatoma underwent tympanomastoid exploration, complete removal of disease and reconstruction of normal anatomy where feasible. Individual patients requiring a combination of techniques underwent the necessary surgery.

The result of tympanoplasty may also vary in different age groups of the patients, more so in pediatric and geriatric groups. However, since this study was based on intrinsic and extrinsic factors of MERI, and hence, age factor has not been considered as a variable. All the surgeries have been done by a single surgical team, operated by same surgeon and assisted by another, thus eliminating the possible variability of result due to different operating hands.

Post-operative ENT examination was done at 3 months and 6 months with special emphasis on graft uptake and hearing improvement. Pure tone average of AC and BC was calculated and AB gap was derived. Hearing improvement was assessed by comparing pre and post-operative pure tone average of AC, BC and AB gap. The data was statistically analysed with Overall Least Square (OLS) linear regression using STATA statistical package.

Results

Closure of TM perforation was achieved in 86 out of 88 patients (97.72%) and two patients had a residual perforation following surgery. All patients in the current study lied in the age group of 10-62 years, mean age being 32.6 with a standard deviation of 16.1. There were 35 male and 53 female patients. (Table II).

Table II: Distribution of patients as per age group, gender and laterality of ear

GENDER	LATERALITY	AGE GROUP (YEARS)					MEAN	STANDARD DEVIATION
		10-20	21-30	31-40	41-50	51-62	32.6	16.1
		Number of patients						
Male	Right ear	8	2	2	2	3	17	
	Left ear	5	2	3	5	3	18	
Female	Right ear	10	3	2	3	4	22	
	Left ear	6	8	3	7	7	31	
Total number		29	15	10	17	17	88	

Mean preoperative AC was 32.6 with the mean improvement in AC being 21.7dBHL. Mean preoperative BC was 45.9 with the mean improvement in BC being 14.5dBHL (Table III).

Table III: Mean audiometric frequency thresholds and hearing improvement

AUDIOMETRIC THRESHOLD (DB)	MEAN	STANDARD DEVIATION	MINIMUM	MAXIMUM
Preoperative AC	**32.6**	**16.1**	**10**	**62**
Preoperative BC	**45.9**	**18.4**	**18**	**94**
Hearing improvement in AC	**21.7**	**11.1**	**6**	**58**
Hearing improvement in BC	**14.5**	**12.6**	**-22**	**51**

The two dependent variables as the outcome in this study were hearing improvement in AC and in BC. These are derived from taking the difference between pre-op values and 6 months post-op values for air and bone conduction both. Out of 88 patients, 81(92.04%) showed hearing improvements in AC thresholds, 4 (4.54%) had deterioration and 3 (3.40%) had no change when compared to preoperative results. Mean hearing improvement in AC was 16.2 dB, range being 1 to 51dB. The mean deterioration in AC was 9.5 dB and a range of -22 to – 4dB (Table IV).

On the other hand, 68 patients (77.27%) showed hearing improvements in BC thresholds, 1 (1.13%) had deterioration and 19 (21.59%) had no change when compared to preoperative results. Mean hearing improvement in BC was 7.7dB, range being 1 to 30dB (Table IV).

Table IV: Change in hearing thresholds postoperatively

AUDIOMETRIC FINDINGS	CASES WITH IMPROVEMENT IN THRESHOLDS		CASES WITH DETERIORATION IN THRESHOLDS		CASES WITH NO CHANGE THRESHOLDS	
	AC	BC	AC	BC	AC	BC
Total number of patients	**81**	**68**	**4**	**1**	**3**	**19**
Mean threshold (dB) of improvement/deterioration	**16.2**	**7.7**	**-9.5**	**-1**		
Range of threshold (dB)	**1 to 51**	**1 to 30**	**-22 to -4**	**-1**		

The range of MERI score in our data was 0 to 10. Majority (48%) of our sample had a MERI score between 2 and 3 (Fig. 1).

Continuous MERI score (from 0 to 16) was grouped into 3 categories; mild - having score of 1 to 4, moderate - having score of 5 to 8 and severe - having score above 8 (Fig. 2).

AB gap closure up to 12 dB with an intact neotympanum was classified as successful surgery in this study. 51 patients (57.95%) had post-operative closure of air bone gap of ≤ 12 and 37 (42.05%) patients had AB gap of >12 (Fig. 3).

OLS regression analysis (bivariate and multivariate) was conducted with robust standard errors to account for heteroscedasticity. The association between MERI score and hearing improvement (air and bone conduction) was tested. Each unit increase in MERI score is associated with an increase of 0.13 dB in hearing improvement score in AC (p value 0.84) and each unit increase in MERI score is associated with an increase of 0.64 dB in hearing improvement score in BC (p value 0.058). This result is statistically significant at $\alpha = 0.1$.

In AC, compared to 'mild' category of MERI score, 'Moderate' category patients showed less hearing

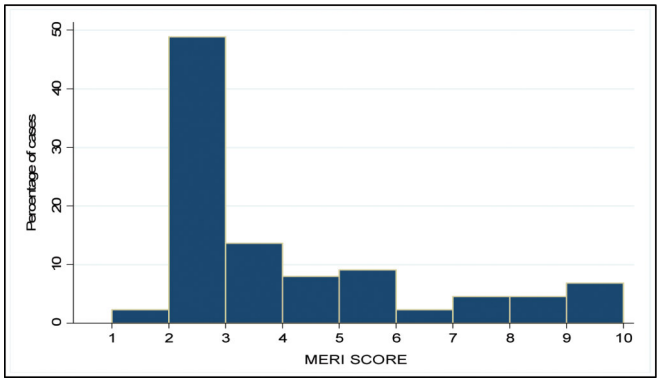

Fig. 1. Histogram depiction of MERI score distribution

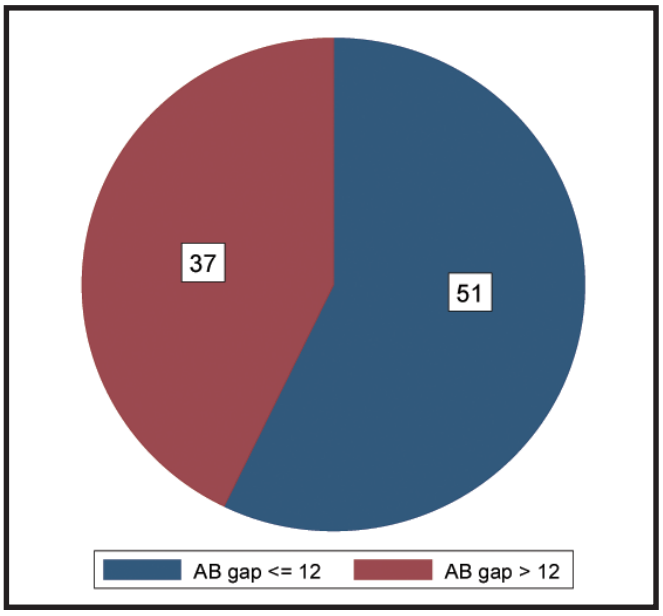

Fig. 3. Pie chart depicting number of patients achieving AB gap closure

improvement by 0.415 dB (p value 0.91) and 'Severe' category patients showed a gain in hearing improvement by 2.6 dB (p value 0.65). Whereas in BC, compared to 'mild' category of MERI score, 'Moderate' category patients showed a gain in hearing improvement by 2.3 dB (p value 0.13) and the 'Severe' category patients showed a gain in hearing improvement by 5.7 dB (p value 0.13) (Table V).

The association between individual clinical indicators of MERI and the hearing improvement (air and bone conduction) was studied using Overall Least Squares

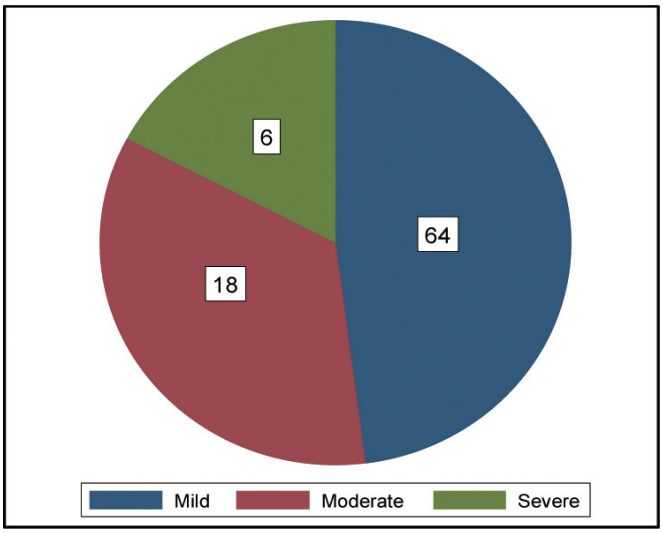

Fig. 2. Pie chart depicting MERI score categories

(OLS) linear regression (bivariate). Seven individual factors namely; ossicular status, perforation, cholesteatoma, otorrhea, middle ear granulation/effusion, previous surgery and smoking status were analysed. The findings were as below:

1. Ossicular status

The patients were allotted scores based on their ossicular status. Score 0 indicates intact ossicles. Score 1 indicates eroded incus with intact malleus and stapes. Score 2 indicates eroded incus and stapes but with intact malleus. Score 3 indicates malleus and incus eroded with intact stapes. Score 4 indicates erosion of all 3 ossicles. There were no case of ossicular head fixation and Stapes fixation in our sample.

The study of gain or deterioration in AC in ossicular defect groups in comparison to ossicular status score 0 showed that cases with score 1 showed a decline in hearing improvement by 2.8dB (p value 0.6), cases with score 2 showed a gain by 5.6dB (p value 0.6), cases with score 3 showed a decline by 5.6dB (p value 0.15) and cases with score 4 showed a gain by 3.2dB (p value 0.4) (Table VI).

The study of gain or deterioration in BC in ossicular defect groups in comparison to ossicular status score 0 showed that cases with score 1 showed a decline in

Table V : MERI category wise hearing thresholds and AB gap before and after surgery

PTA (dB) & AB GAP	PRE-OP		3 MONTHS POST-OP		6 MONTHS POST-OP		DIFFERENCE IN MEAN AB GAP AFTER 6 MONTHS	NUMBER OF CASES
	MEAN	*RANGE*	*MEAN*	*RANGE*	*MEAN*	*RANGE*		
MERI score category 1: score 1 – 4								
AC	42.3	18 to 94	29.4	15 to 77	27.25	15 to 77	10.1	64
BC	20.45	6 to 55	16.7	6 to 55	15.6	6 to 55		
AB gap	21.5	6 to 51	12.7	1 to 47	11.4	1 to 39		
MERI score category 2: score 5 – 8								
AC	55.7	25 to 79	46.9	20 to 80	42.7	17 to 80	7.5	18
BC	24.7	11 to 58	21.4	8 to 58	19.8	8 to 50		
AB gap	30.6	10 to 58	26.3	3 to 46	23.1	5 to 46		
MERI score category 3: score > 8								
AC	55.3	36 to 75	39.3	30 to 52	38.3	27 to 50	2.8	6
BC	25.6	12 to 43	15.2	9 to 25	14.8	9 to 20		
AB gap	26.3	20 to 37	24.2	14 to 36	23.5	7 to 36		

Table VI: Ossicular status scores and comparative analysis of hearing gain

OSSICULAR STATUS SCORE	NUMBER OF PATIENTS		GAIN OR DETERIORATION IN AC IN OSSICULAR DEFECT GROUPS IN COMPARISON TO OSSICULAR			GAIAN OR DETERIORATION IN BC IN OSSICULAR DEFECT GROUPS IN COMPARISON TO OSSICULAR		
			status score 0			status score 0		
	n	%	Gain	Decline	P value	Gain	Decline	P value
0	68	77.27						
1	9	10.23	-	2.8dB	0.6	-	0.35dB	0.9
2	3	3.41	5.6dB	-	0.6	6.8dB	-	0.12
3	5	5.68	-	5.6dB	0.5	0.03dB	-	0.99
4	3	3.41	3.2dB	-	0.4	5.3dB	-	0.3

Table VII: TM perforation status scores and comparative analysis of hearing gain

TM PERFORATION STATUS SCORE	NUMBER OF PATIENTS		GAIN OR DETERIORATION IN AC IN PATIENTS WITH SCORE 1 IN COMPARISON SCORE 0			GAIN OR DETERIORATION IN BC IN PATIENTS WITH SCORE 1 IN COMPARISON SCORE 0		
	n	%	Gain	Decline	P value	Gain	Decline	P value
0	17	19.32						
1	71	80.68	7.5dB	-	0.017	0.91dB	-	0.6

hearing improvement by 0.35dB (p value 0.9), cases with score 2 showed a gain by 6.8dB (p value 0.12), cases with score 3 showed a gain of 0.03dB (p value 0.99) and cases with score 4 showed a gain in hearing improvement by 5.3dB (p value 0.3) (Table VI).

2. TM perforation

There were 71 patients with TM perforations and 17 with intact TM. Absence of perforation was given a score of 0 and the presence 1. Compared to cases with a score of 0 for perforation, cases with score 1 showed a gain in AC by 7.5dB (p value 0.017 which was statistically significant at $\alpha = 0.05$). Compared to cases with a score of 0 for perforation, cases with score 1 showed a gain in BC by 0.91 dB (p value 0.6) (Table VII).

3. Cholesteatoma

There were 16 patients with cholesteatoma and 72 without it. Absence of cholesteatoma was given a score of 0 and the presence 2. Compared to cases with a score of 0 for cholesteatoma, cases with score 2 showed a decline in AC by 2.8dB (p value 0.5). Compared to cases with a score of 0 for cholesteatoma, cases with score 2 showed a gain in BC by 2.2dB (p value 0.3) (Table VIII).

Table VIII: Cholesteatoma status scores and comparative analysis of hearing gain

CHOLESTEATOMA STATUS SCORE	NUMBER OF PATIENTS		GAIN OR DETERIORATION IN AC IN PATIENTS WITH SCORE 1 IN COMPARISON SCORE 0			GAIN OR DETERIORATION IN BC IN PATIENTS WITH SCORE 1 IN COMPARISON SCORE 0		
	n	%	Gain	Decline	P value	Gain	Decline	P value
0	16	18.18						
2	72	81.82	-	2.8dB	0.5	2.2dB	-	0.3

Table IX: Otorrhea status scores and comparative analysis of hearing gain

OTORRHEA STATUS SCORE	NUMBER OF PATIENTS		GAIN OR DETERIORATION IN AC IN PATIENTS WITH SCORE 1 AND 2 IN COMPARISON SCORE 0			GAIN OR DETERIORATION IN BC IN PATIENTS WITH SCORE 1 AND 2 1 IN COMPARISON SCORE 0		
	n	%	Gain	Decline	P value	Gain	Decline	P value
0	4	4.55						
1	57	64.77	2.6dB	-	0.43	1.9dB	-	0.2
2	27	30.68	4.9dB	-	0.2	3.3dB	-	0.103

4. Otorrhea

Dry ear was given a score of 0 (4 patients), occasionally wet ear score of 1 (57 patients) and persistently wet ear score of 2 (27 patients). Compared to cases with a score of 0 for otorrhea, cases with score 1 showed a gain in AC by 2.6dB (p value 0.43) and cases with score 2 showed a gain in AC by 4.9dB (p value 0.2). Compared to cases with a score of 0 for otorrhea, cases with score 1 showed a gain in BC by 1.9dB (p value 0.2) and cases with score 2 showed a gain in BC by 3.3dB (p value 0.103) (Table IX).

5. Middle ear granulation/effusion

There were 18 patients with middle ear granulation/effusion and 70 without it. Absence of middle ear granulation/effusion was given a score of 0 and the presence 2. Compared to cases with a score of 0 for middle ear granulation/effusion, cases with score 2 showed a gain in AC by 0.13dB (p value 0.97). Compared to cases with a score of 0 for Middle ear granulation/effusion, cases with score 2 showed a gain in BC by 0.95dB (p value 0.6) (Table X).

Table X: Middle ear granulation/effusion scores and comparative analysis of hearing gain

MIDDLE EAR GRANULATION/ EFFUSION STATUS SCORE	NUMBER OF PATIENTS		GAIN OR DETERIORATION IN AC IN PATIENTS WITH SCORE 1 IN COMPARISON SCORE 0			GAIN OR DETERIORATION IN BC IN PATIENTS WITH SCORE 1 IN COMPARISON SCORE 0		
	n	%	Gain	Decline	P value	Gain	Decline	P value
0	18	20.45						
1	70	79.55	0.13dB	-	0.97	0.95dB	-	0.6

Table XI: Previous surgery status and comparative analysis of hearing gain

PREVIOUS SURGERY STATUS SCORE	NUMBER OF PATIENTS		GAIN OR DETERIORATION IN AC IN PATIENTS WITH SCORE 1 AND 2 IN COMPARISON SCORE 0			GAIN OR DETERIORATION IN BC IN PATIENTS WITH SCORE 1 AND 2 IN COMPARISON SCORE 0		
	n	%	Gain	Decline	P value	Gain	Decline	P value
0	79	89.77						
1	1	1.14	-	3.3dB	0.025	9.6dB	-	0.00
2	8	9.09	2.2dB	-	0.65	4.97B	-	0.03

6. Previous surgery

No history of previous surgery was given a score of 0 (79 patients), staged surgery score of 1 (1 patient) and revision surgery score of 2 (8 patients). Compared to cases with a score of 0 for previous surgery, cases with score 1 showed a decline in AC by 3.3dB (p value 0.025 which was statistically significant at $\alpha = 0.05$) and cases with score 2 showed a gain in AC by 2.2dB (p value 0.65). Compared to cases with a score of 0 for previous surgery, cases with score 1 showed a gain in BC by 9.6dB (p value 0.0) and cases with score 2 showed a gain in BC by 4.97dB (p value 0.03). This was statistically significant at $\alpha = 0.05$ (Table XI).

7. Status of smokers

There were 82 non-smokers and only 6 smokers in our study population. Non-smokers were given a score

Table XII: Smoking status scores and comparative analysis of hearing gain/deterioration

SMOKING STATUS SCORE	NUMBER OF PATIENTS		GAIN OR DETERIORATION IN AC IN PATIENTS WITH SCORE 1 IN COMPARISON SCORE 0			GAIN OR DETERIORATION IN BC IN PATIENTS WITH SCORE 1 IN COMPARISON SCORE 0		
	n	%	Gain	Decline	P value	Gain	Decline	P value
0	82	93.18						
2	6	6.82	-	3.2dB	0.64	-	6.82dB	0.94

of 0 and the smokers 2. Compared to cases with a score of 0, smoker cases with score 2 showed a decline in AC by 3.2dB (p value 0.64). Compared to cases with a score of 0, cases with score 2 showed a decline in BC by 6.82dB (p value 0.94) (Table XII).

The variations in PTA AC thresholds, BC thresholds and AB gap were statistically analysed comparing their preoperative values with their postoperative values at 3 months and 6 months (Fig. 4).

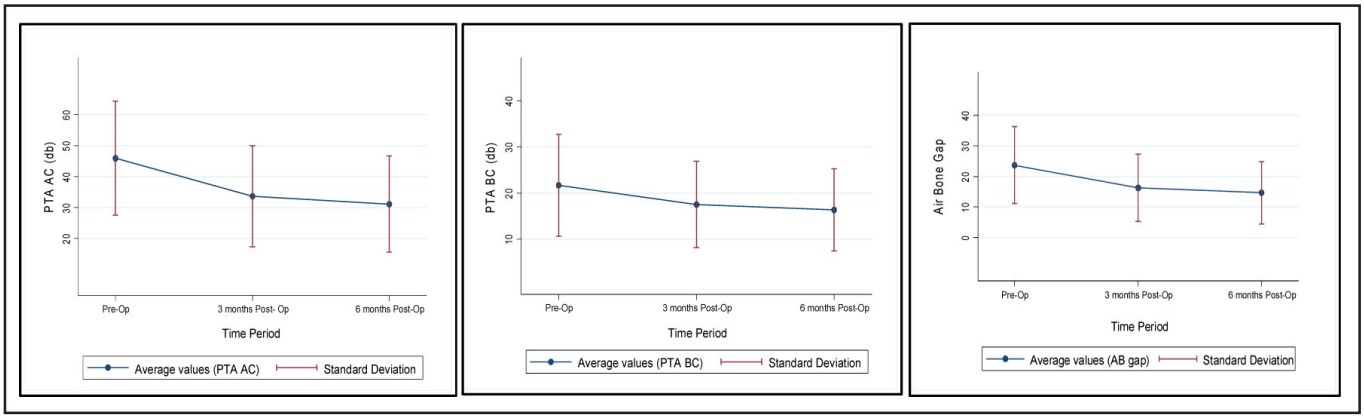

Fig. 4. Variations in AC, BC and AB gap with standard deviation over time

The variations were not found to be statistically significant. Further analysis revealed the following findings:

a. The association between hearing improvement and (binary) AB gap was analysed. It was found that compared to cases with AB gap ≤ 12, the cases with AB gap > 12 showed a decline in hearing improvement in AC by 3.6 dB (p value 0.19) whereas they showed a gain in BC by 0.2 dB (p value 0.88).

b. The association between MERI (continuous) and hearing improvement with (binary) AB gap as mediator was analysed. Controlling for (binary) AB gap, one-unit increase in MERI score is found to be associated with 0.74 dB gain in hearing improvement in AC (p value 0.31). Adjusting for MERI score, cases with AB gap > 12 showed a decline in hearing improvement in AC by 5.42 dB (p value 0.078) compared to those with AB gap ≤ 12.

For BC, controlling for (binary) AB gap, one-unit increase in MERI score is associated with 0.86 dB gain in hearing improvement (p value 0.03 which was statistically significant at $\alpha = 0.05$). Adjusting for MERI score, cases with AB gap > 12 showed a decline in hearing improvement in BC by 1.92 dB (p value 0.195) compared to those with AB gap ≤ 12.

c. Association between MERI (category wise-mild, moderate, severe) and hearing improvement with (binary) AB gap as mediator was studied. Controlling for (binary) AB gap, the 'moderate' MERI cases show a 2.5dB gain (p value 0.51) and 'severe' MERI category cases show 5.5dB gain (p value 0.34) in hearing improvement in AC compared to 'mild' MERI category. Adjusting for MERI categories, cases with AB gap > 12 show a decline in hearing improvement by 5.1dB (p value 0.08) compared to those with AB gap ≤ 12. This result is significant at $\alpha = 0.1$.

For BC, controlling for (binary) AB gap, the 'moderate' MERI cases show a 3.24dB gain (p value 0.055) and 'severe' MERI category cases show 6.7dB gain (p value 0.078) in hearing improvement compared to 'mild' MERI category. These results are significant at $\alpha = 0.1$.

Adjusting for MERI categories, cases with AB gap > 12 show a decline in hearing improvement by 1.7 dB (p value 0.215) compared to those with AB gap ≤ 12.

Discussion

This study has been done over 2 years period with a sample size of 88, 35 being male and 53 females, in the age group of 10 to 62 years. Khalid et al did their study over 10 years with a sample size of 65 patients in the age group of 4 to 18 years.[3] Chrobok et al did their study over 8 years with 155 patients.[4] Pinar et al did theirs over 6 years with 231 patients in the age group of 11 to 58 years.[5]

The statistical analysis in our study showed that 1 unit increase in MERI score is associated with an increase of 0.13 dB in hearing improvement in AC and 1 unit increase in MERI score is associated with an increase of 0.64 dB in hearing improvement in BC (statistically significant). Literature search has failed to yield any study done so far, which shows the effect of each unit MERI score increament on hearing improvement.

In this study, we have considered the postoperative AB gap values of ≤ 12 dB along with an intact neotympanum as successful surgical outcome. 51 patients (57.95%) had post-operative closure of AB gap of ≤ 12 and 37 patients (42.05%) had AB gap of >12. In a study by Naderpour et al[6] average AB gap improvement for all 60 tympanoplasty procedures was 18.8 dB±5.62 SD. Serviceable hearing (AB gap <20 dB) was achieved in 93.3% of the 60 tympanoplasties postoperatively. In a study by Khalid et al [3] the overall success rate (closure of the AB gap within 20 dB) was achieved in 17 cases (38.63%). Lin et al reported hearing gain in 79% cases and deterioration in 21% cases in his study involving 46 patients.[7] It suggests that there is wide variance in postoperative AB gap closure.

Ahmad and Sharma[8] in their study over 3 years with 81 patients in the age group of 7 to 46 years found incus necrosis in 51 patients, malleus necrosis in 36 patients and stapes necrosis in 18 patients. Preoperative thresholds were compared with postoperative thresholds at 3 months and 6 months and the differences in all subgroups of ossicular status was found to be statistically significant. These observations were in concurrence with the finding of Iurato S, et al[9] and Mills RP.[10] Similarly, Chrobok et al[4] reported statistically significant difference in hearing improvement between the patients with intact ossicular chain as compared to the group with ossicular erosion. In our study, there were 68 patients with intact ossicles and 20 with ossicular erosion but no statistical significance was seen in terms of hearing improvement postoperatively. This could be attributed to meticulous clearance of disease and stable ossicular reconstruction.

Chrobok et al[4] found that the patients with TM perforation had a statistically significant worse hearing compared to patients with an intact eardrum before and after surgery. Ahmad and Sharma[8] reported that the post operative hearing gain was more in the patients with larger perforations but the difference was not statistically significant. Risvana and Mubeena[11] in their retrospective observational study of 96 cases in the age group of 18 to 50 years spanning over 7 years did not find any association of the size of the perforation or presence of bilateral disease with graft uptake (p value 0.750). In a study by Pinar et al[5] it was found that bilateral disease and type of surgery were significantly associated with graft uptake whereas size and site of perforation had no significant

association. The present study did not consider the size, shape or site of TM perforation in different subgroups because we believe that the standard underlay grafting does same justice to all the subgroups. We found statistically significant hearing gain (p value 0.017) in TM perforation cases 6 months after the surgery.

In terms of cholesteatoma, no significant relationship with hearing improvement was seen in our study between the group with cholesteatoma and without. In the study done by Ahmed and Sharma,[8] the p-value for mean audiological gain in the group of patients with or without cholesteatoma was 0.001 and 0.002 at 3 and 6 months after surgery, the difference being statistically significant. Chrobok et al[4] opined that the patients with cholesteatoma had a much greater air conduction hearing loss at all frequencies both pre-op and post-op compared to patients without cholesteatoma. Harugop et al[12] in their retrospective observational study of 287 cases in the age group of 21 to 80 years spanning over 12 years recorded a success rate of only 23.3% in cholesteatomatous ears with MERI 'severe' index where the presence of cholesteatoma reduced the graft uptake and hearing outcome.

The factor of otorrhea and middle ear granulation/ effusion were not significantly found to affect the hearing outcome statistically in our study. This was in concurrence with the findings of Chrobok et al.[4] However, Ahmed and Sharma[8] found that the p-value for mean audiological gain in the group of the patients with or without granulation tissue was (p value 0.006) and (p value 0.009) at 3 and 6 months after surgery, the difference being statistically significant. Other studies have only considered graft uptake as a variable in the cases with middle ear granulations, not the audiological gain.

Compared to cases with no previous surgery, patients with revision surgery showed significant deterioration in hearing both in AC and BC in the present study, whereas Chrobok et al[4] found worsening only in the AC thresholds in patients undergoing revision surgery who already had raised AC thresholds preoperatively. Ahmed and Sharma[8] reported statistically significant difference in the post-operative audiological gain between the patients undergoing tympanomastoid surgery for first time and the patients undergoing the revision surgery with p value 0.01 and p value 0.03 at 3 months and 6 months after surgery.

Ahmed and Sharma[8] found that smokers had post op success rate of 57.5% while the non-smokers had marginally better success at 61.9%, and hence concluded that as long as the disease is completely cleared, even though, pre-operative severity was more, the hearing outcomes are still achievable. Chrobok et al[4] showed that smokers had a lower pre-op and post-op hearing threshold and a significant difference was found only in post-op AC at high frequencies. In our sample size, smokers constituted only 6.81%. It, therefore, would not be wise to deduce any statistical significance of the predictive value of smoking.

Chrobok et al[4] reported that in their sample size of 155 patients, the patients with lower MERI score had better pre-op and postoperative AC and BC thresholds than patients with higher scores and that the aggregate MERI score was a good prognostic factor for hearing. In the present study, with a sample size of 88, the patients with MERI score >8 were 6.81% and with score between 5 to 8 were 20.45%; thus together constituting only 27.27%. Compared to the 'mild' MERI category, the 'moderate' and 'severe' category patients did show gain in hearing improvement both in AC and BC thresholds but the results were not statistically significant in our 'not so robust' sample size. However, when analyzed with AB gap >12dB, hearing improvement in cases with severe MERI scores showed statistically significant improvement in hearing outcomes.

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