

Middle Ear Risk Index Scores as a Predictor for Hearing Threshold after Tympanoplasty in Patients with Chronic Suppurative Otitis Media

RINA HAYATI¹, TENGKU SITI HAJAR HARYUNA²

ABSTRACT

Introduction: One of the main purposes of tympanoplasty is to improve hearing. Middle Ear Risk Index (MERI) Scores can be used to predict the average success in the procedure of the middle ear reconstruction.

Aim: To assess the change in hearing threshold after tympanoplasty, based on the assessment of MERI Scores.

Materials and Methods: An observational assessment was done on 21 patients with Chronic Suppurative Otitis Media (CSOM) who underwent tympanoplasty. Pure tone audiometry was done before and 12 weeks after tympanoplasty. MERI Scores were assessed before and during the operation. Change in hearing after tympanoplasty statistically was analyzed by using Willcoxon test. Correlation between hearing threshold and

MERI Scores was analyzed by using Spearman's Coefficient Correlation.

Results: Hearing threshold after tympanoplasty was much better in the subjects with no otorrhea, subtotal perforation type, no cholesteatoma and granulation, complete ossicular chain, who had never been operated and did not smoke. There was a significant negative correlation between MERI Scores as the predictor of hearing threshold which indicated that the lower the MERI Scores were, the better the improvement of hearing threshold after tympanoplasty ($p=0.039$; $r=-0.453$).

Conclusion: MERI Scores could be used as a measuring instrument to assess the prognosis of hearing threshold after tympanoplasty.

Keywords: Auditory threshold, Middle ear reconstruction, Prognosis, Pure tone audiometry

INTRODUCTION

Chronic Suppurative Otitis Media (CSOM), with or without persistent cholesteatoma, can cause serious destruction in middle ear and mastoid process which brings about an irreversible sequel. Surgery plays an important role in managing tympanic membrane perforation, disease eradication and improvement of hearing threshold. One of the main purposes of operation is to improve hearing [1,2].

The incidence of CSOM is mostly found in the developing countries because of low socioeconomic condition, lack of nutrition, and lack of education on health. This disease can attack all kinds of gender, irrespective of the age. The procedure of reconstruction to improve hearing can be done by doing a lot of innovations and using various kinds of graft [3-5].

Deafness caused by CSOM is usually conductive hearing loss. The degree of deafness depends upon size, position of defect in tympanic membrane, continuity of ossicular chain, and degree of inner ear development [5]. The goals of a successful tympanoplasty are the removal of the pathological and achievement of a mucosal-lined middle ear cleft with an intact tympanic membrane. It also provides the possibility of improved hearing [6].

Prognosis and the success of operation in CSOM is varied in several studies [7-9]. It can be a cause of some factors such as; degree of damage to the mucosa due to disease, the existence of cholesteatoma, mastoid management method, and ossicle reconstruction. Although, the success in CSOM management is found in some publications [7], however, even in the recent past there has been no uniformity in the criteria for monitoring the indicator for the success in the operation [3,10]. CSOM risk factor can be assessed by using MERI scores which can be used for predicting the average success in the procedure of middle ear reconstruction [11,12].

This study was conducted to evaluate the change in the hearing threshold after tympanoplasty, based on the assessment of MERI scores. This study hypothesized that the MERI score correlates with hearing threshold in CSOM patients undergoing tympanoplasty.

MATERIALS AND METHODS

This is an observational study with a cohort design on 21 patients with CSOM who were undergoing tympanoplasty treatment in the ENT Department, Faculty of Medicine, Universitas Sumatera Utara, conducted from March 1, 2016 to August 31, 2016. All subjects signed an informed consent.

Study sample of 21 subjects was obtained from the following formula:

$$n = \frac{(z_{\alpha} + z_{\beta})^2 s^2}{x_1 - x_2}$$

$$s = \sqrt{\frac{s_1^2(x_1 - 1) + s_2^2(x_2 - 1)}{x_1 + x_2 - 2}}$$

$$s = \sqrt{\frac{12.96^2(38 - 1) + 10.72^2(30 - 1)}{38 + 30 - 2}}$$

$$n = \left(\frac{(1.96 + 0.842)^2 11.59}{8} \right)$$

$$= 16.48517 \text{ (minimal sample required)}$$

- X1 : Pre tympanoplasty hearing threshold (37,8)
 X2 : Post tympanoplasty hearing threshold (29,8)
 Z α : Type i error ($\alpha=5\%$ à 1,96)
 Z β : Type ii error ($\beta=20\%$ à 0,842)

- S1 : Pre tympanoplasty hearing threshold standard deviation (12,96)
- S2 : Post tympanoplasty hearing threshold standard deviation (10,72=11,59)
- S : total tympanoplasty hearing threshold standard deviation (s1 and s2)

Patients diagnosed with CSOM and who were willing to participate, were included in the study.

Congenital deafness, those who suffered from the disease which could cause sensorineural deafness (like diabetes mellitus, dyslipidemia, and hypertension), history of/using ototoxic drugs, history of being exposed to noise/acoustics trauma and those who could not be present at follow-up post operation for the next three months were excluded from the study.

Tympanoplasty is defined as a procedure that is performed to eradicate diseases on the middle ear and reconstruct hearing mechanism with or without using grafts on the tympanic membrane, and is classified into type I-V [13-15]. In our study, we assumed that hearing changes were defined as changes in hearing threshold of a minimal of five decibels compared to the preoperative value, measure using the pure tone audiometry. MERI score is defined as the score used to predict mean success rates for middle ear reconstruction procedure [10, 13, 16]. The aspects that were assessed included, the presence of otorrhea, type of tympanic membrane perforation, presence of cholesteatoma, status of ossicular chains, presence of granulation on middle ear, history of prior surgery, and smoking status. Assessment was performed prior to and during surgery.

After anamnesis and routine ENT (ear, nose, throat) examination, pure tone audiometry examination was done at the pre-operation stage to determine hearing threshold. MERI Scores were summated and categorized into mild risk (Score 0-3), moderate risk (Score 4-6), and severe risk (Score ≥7) [10]. About 12 weeks after the operation, pure tone audiometry was repeated in order to determine hearing threshold in post-operation.

STATISTICAL ANALYSIS

Statistical analyses were performed using the SPSS ver. 17.0 (SPSS Inc., Chicago, IL, USA). Results were presented as mean, standard deviation and as percentages. Pre and post tympanoplasty hearing threshold were analyzed by using Willcoxon test (p-value <0.05 was regarded as statistically significant). The correlation between hearing threshold and MERI Scores was analyzed by using Spearman's Coefficient Correlation.

RESULTS

The mean age of 21 subjects in this study was 27.14±14.43 years. The incidence of chronic suppurative otitis media was 9 in men and 12 in women. Besides, it was also found that the majority of the type of deafness was conductive hearing loss (n=15; 71.4%), followed by mixed hearing loss (n=6; 28.6%).

The assessment of pre-hearing threshold, 12 weeks after the tympanoplasty based on MERI factors of 21 subjects who underwent tympanoplasty could be seen in [Table/Fig-1].

From [Table/Fig-1] above, it could be seen that hearing threshold after tympanoplasty was much better in the subjects without otorrhea, with subtotal perforation, without cholesteatoma, complete malleus-incus-stapes and without middle ear granulation in the subjects who had never been operated and had never smoked.

In this study, we found that subjects with MERI scores 0-3 (mild) were (n=7, 33.3%), MERI Score 4-6 (moderate) were (n=8, 38.2%), and MERI Score ≥7 (severe) were (n=6, 28.5%).

Statistically, there was significant negative correlation between MERI Scores as the predictor with hearing threshold after tympanoplasty

MERI Factors	n	ΔHearing threshold (dB)		p-value
		Pre (Mean±SD)	Post (Mean±SD)	
Otorrhea				
Present (2)	17	50.95±20.240	43.75±20.223	p= 0.003*
None (0)	4	38.75±4.208	33.12±8.569	p= 0.102
Type of tympanic membrane perforate				
Central (1)	6	42.29±18.698	37.08±14.930	p=0.066
Subtotal (1)	8	45.62±14.835	37.031±13.362	p=0.018*
Total (1)	7	57.50±22.126	51.07±25.325	p=0.084
Cholesteatoma				
Present (2)	8	57.81±22.832	52.03±23.125	p=0.048*
None (0)	13	42.98±13.999	35.38±12.954	p=0.005*
Ossicular chain status				
Malleus-incus-stapes present (0)	13	47.59±20.139	40.76±20.932	p=0.007*
Defect of incus (1)	2	55.62±27.400	41.25±21.213	p=0.180
Defect of incus and stapes/ ossicular head fixation (2)	2	51.25±19.445	43.75±22.980	p=0.180
Defect of incus and malleus/ stapes fixation (3)	3	49.16±21.372	46.66±19.618	p=0.414
Defect of malleus-incus-stapes (4)	1	41.25±0.000	36.25±0.000	-
Middle ear granulations				
Present (2)	13	48.84±21.737	44.51±21.031	p=0.015*
None (0)	8	48.28±14.235	37.18±14.906	p=0.027*
Previous surgery				
None (0)	20	46.25±15.743	39.00±14.52	p=0.001*
Stage I (1)	1	96.25±0.000	96.25±0.000	-
Smoker				
Yes (2)	6	59.58±25.819	55.62±24.376	p=0.257
No (0)	15	44.25±14.013	36.16±13.458	p=0.001*

[Table/Fig-1]: Pre-Post Tympanoplasty Hearing threshold based on MERI factors. *Willcoxon test (p<0.05 is considered statistically significant)

Scores	Δ Hearing threshold	
	p-value	R
MERI Scores	0.039*	-0.453

[Table/Fig-2]: Correlation between Middle Ear Risk Index (MERI) Scores with Δhearing threshold post tympanoplasty. *Spearman test (p<0.05 is considered statistically significant)

(p-value=0.039, r=-0.453), which indicated that lower the MERI Scores, better the improvement of hearing threshold after tympanoplasty [Table/Fig-2].

DISCUSSION

In the present study, pre and post tympanoplasty hearing thresholds significantly differed in subjects with otorrhea (p-value=0.003), therefore showing clinical improvement in hearing thresholds. Tympanoplasty has evolved from time to time and improvisation was done based mainly in terms of hearing improvement and disease free ear [17]. Complaint about otorrhea and hearing impairment are found in nearly all CSOM. Otorrhea influences the conductive mechanism in middle ear so that it affects the hearing of CSOM patients.

In patients with subtotal membrane perforation type, post tympanoplasty hearing threshold significantly differed from pre tympanoplasty hearing threshold (p-value=0.018). In a study, most of the patients (90%) suffered from central perforation, while there were only 4% of the patients suffered from attic perforation, and 6% of the patients suffered from posterosuperior marginal perforation [17]. Location of tympanic membrane perforation influences the success in tympanoplasty. Central perforation is better than the anterior and posterior parts. Technically, perforation in the anterior

and posterior parts is more difficult to access for placing graft than that in the central part. Perforation with the size of < 50% is better than perforation with the size of > 50%. More severe hearing impairment is found in large central perforation, compared with that in the anterior part. Perforation in the postero-inferior can cause worse hearing impairment than that in the antero-inferior parts. The difference in hearing impairment in anterior and postero-inferior is mainly seen in low frequency [17].

Subjects with malleus-incus-stapes, statistically post tympanoplasty hearing threshold significantly differed from pre tympanoplasty hearing threshold (p -value=0.007). The decision to choose the type of tympanoplasty was based on the condition of middle ear and hearing chain [17]. Besides that, clinically we found that post tympanoplasty hearing threshold differed from pre tympanoplasty hearing threshold in subjects without middle ear granulation and without cholesteatoma. The success in tympanoplasty not only depends on the condition of middle ear but is also related to pathological condition related to the illness. Although, with a well aeration and middle ear volume of > 0.7 mL, hearing improvement, indicated by transmission in the middle ear, was only 10 dB higher in patients undergoing canal wall down, compared to patients who underwent canal wall up mastoidectomy. This is due to limited extent of areas observed during the procedure [5,13,18]. Bone conduction threshold may improve after ossicle reconstruction, which is indicated by improvement in either low and moderate frequency of audiometry. Low and moderate represent conductive mechanism in the middle ear [2].

Hearing thresholds, prior to and after tympanoplasty, significantly differed in non smoking patients (p -value=0.001). Smoking has negative local, regional, and systemic effect in the middle ear mucosa [6]. Age is not an indicator for a successful surgery. Cholesteatoma is not an important factor in determining the prognosis of the success in graft [19,20].

This study showed that hearing thresholds significantly differed prior to and after tympanoplasty. The existence of otorrhea, subtotal type perforation, complete ossicle status, no history of previous middle ear surgery and the fact that the patients did not smoke contributed to this finding. Besides that, cholesteatoma and granulation of middle ear did not completely influence the disparity of hearing threshold in pre and post tympanoplasty in patients with CSOM.

A significant negative correlation was found between middle ear risk index (MERI) and hearing threshold after tympanoplasty (p -value =0.039, $r = -0.453$). Lower MERI scores indicated improvement of hearing threshold after tympanoplasty and vice versa. Patients with mild MERI Scores had a more favourable prognosis than patients with severe MERI scores. Moderate and severe MERI Scores indicated the existence of cholesteatoma, ossicular discontinuity, and a pathological condition on the middle ear that requires extensive operation. [6,13]. Previous studies have shown that patients with higher MERI scores have more severe air conductive hearing threshold damage, either pre or post tympanoplasty, compared to patients with lower MERI scores [10]. A high MERI score indicated a higher possibility for performing a canal wall down mastoidectomy and lower success rate after tympanoplasty [6]. MERI scores of 1-3 had a graft success rate of 86% whereas MERI score of 7-12 had a 100% failure rate [16]. This indicates that MERI score is a device

that maybe used to predict success rates after tympanoplasty in patients with CSOM.

The limitation of this study is that we were not able to assess the association of MERI score as a predictive factor for an improved post tympanoplasty hearing threshold for each tympanoplasty technique.

CONCLUSION

Middle ear risk index score can be used as a measurement to assess the predictor of the hearing threshold after tympanoplasty in patients with chronic suppurative otitis media.

REFERENCES

- [1] Palukuri S, Raju VG. One Year Follow Up Study on Audiological Profile in Chronic Otitis Media Patients, After "Type I Tympanoplasty". *International Journal of Recent Trends in Science And Technology*. 2014.9(3):343-45.
- [2] Choi HG, Lee DH, Chang KH, Yeo SW, Yoon SH, Jun BC. Frequency specific hearing results after surgery for chronic ear diseases. *Clin Exp Otorhinolaryngol*. 2011 Sep;4(3):126-30.
- [3] Santosh UP, Prashant KB, Sudhakar MS. Study of myringoplasty in wet and dry ears in mucosal type of chronic otitis media. *J Clin Diagn Res*. 2016 Sep; 10(9): MC01-MC03.
- [4] Khan A, Iqbal K, Khan MI, Marwat M, Khan MN. Outcomes of type I tympanoplasty: a surgical management of chronic suppurative otitis media. *Gomal journal of medical sciences*. 2015.14(1):07-10.
- [5] B Subrat K, Malik KC, B Sanjay K. Clinical assessment of tympanomastoid surgeries and tympanoplasty with special reference to hearing status. *Adisha journal of otolaryngology and head & neck surgery*. 2014.8(1):15-21.
- [6] Pinar E, Sadullahoglu K, Calli C, Oncel S. Evaluation of prognostic factors and middle ear risk index in tympanoplasty. *Otolaryngology-Head and Neck Surgery*. 2008.139:386-98.
- [7] Sarfaraz, Tabassum A. An observational study on tympanoplasty in terms of middle ear risk index (MERI) of patients with chronic suppurative otitis media. *International Journal of Medical and Health Research*. 2017.3(6):25-28.
- [8] Kalyanasundaram R, Narendra G. Correlation between middle ear risk index (MERI) and tympanoplasty- a prospective study. *Panacea Journal of Medical Sciences*. 2017.7(2):65-67.
- [9] Sharma A, Saxena RK, Verma IR, Bhandari S. Correlation between MERI and hearing after tympanoplasty. *Journal of Nepalgunj Medical College*. 2015. 13(2):06-09.
- [10] Chrobok V, Pellant A, Meloun M, Pokorny K, Simáková E, Mandysová P. Prognostic Factors for Hearing Preservation in Surgery of Chronic Otitis Media. *Int Adv Otol*. 2009.5(3):310-17.
- [11] Becvarovskí Z, Kartush JM. Smoking and tympanoplasty: implications for prognosis and the middle ear risk index (MERI). *Laryngoscope*. 2001.111:1806-11.
- [12] Kartush JM. Ossicular chain reconstruction capitulum to malleus. *Otolaryngol Clin North Am*. 1994.27:689-715.
- [13] Ahmed A, Sharma SC. Middle Ear Risk Index (MERI) as prognosis factor in tympanomastoidectomy with tympanoplasty. *Madridge J Otorhinol*. 2016. 1(1):15-22.
- [14] Kabdwal N, Varshney S, Bist SS, Bhagat S, Mishra S, Agarwal V. Pre and post operative evaluation of hearing in chronic suppurative otitis media. *Indian Journal of Otolaryngology*. 2013.19(4):164-67.
- [15] BL Shrestha, CL Bhusal, H Bhattarai. Comparison of Pre and Post-operative Hearing Results in Canal Wall Down Mastoidectomy with Type III Tympanoplasty. *J Nepal Med Assoc*. 2008.47(172):224-47.
- [16] Kumar N, Madkikar NN, Kishue S, Chilke D, J Kiran, Shinde. Using middle ear risk index and ET function as parameters for predicting the outcome of tympanoplasty. *Indian journal of otolaryngology and head & neck surgery*. 2012. 64(1):13-16.
- [17] Sharankumar S. Pre operative and post operative assessment of hearing following tympanoplasty. *Indian J Otolaryngol Head Neck Surg*. 2012.64(4):377-81.
- [18] Kim MB, Choi J, Lee JK, Park JY, Chu H, Cho YS, et al. Hearing outcomes according to the types of mastoidectomy: a comparison between canal wall up and canal wall down mastoidectomy. *CEO Journal*. 2010.3(4):203-06.
- [19] Echeverria NEB, Garcia ER, Delgado YS, Mariscal HA. Prognostic factors of successful tympanoplasty in pediatric patients: a cohort study. *BMC Pediatrics*. 2012.12:67.
- [20] Faramarzi M, Debozorgi MM, Heydari ST. Is cholesteatoma a risk factor for graft success rate in chronic otitis media surgery?. *Iran J Otorhinolaryngol*. 2015 Nov; 27(83): 417-22

PARTICULARS OF CONTRIBUTORS:

1. Resident, Department of Otorhinolaryngology Head and Neck, Faculty of Medicine, Universitas Sumatera Utara, Padang Bulan, Medan, Indonesia.
2. Professor, Department of Otorhinolaryngology Head and Neck, Faculty of Medicine, Universitas Sumatera Utara, Padang Bulan, Medan, Indonesia.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Dr. Rina Hayati,
Rumah Sakit Umum Pusat Haji Adam Malik Medan, Jl. Bunga Lau No. 17 Medan, Selayang-20136,
Sumatera Utara, Indonesia, Sumatera Utara, Indonesia.
E-mail: rinaalfa1@gmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None.

Date of Submission: **May 18, 2017**
Date of Peer Review: **Jul 22, 2017**
Date of Acceptance: **Oct 25, 2017**
Date of Publishing: **Apr 01, 2018**