Original Research Article

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Correlation between degree of hearing loss and intraoperative findings in tubotympanic type of chronic suppurative otitis media

Ravi Dudda, Sowmya Tumkur Rangaiah*, M. Hanumantha Prasad, Nagavara Kalegowda Balaji

Department of ENT, Mandya Institute of Medical Sciences, Mandya, Karnataka, India

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*Correspondence:

Dr. Sowmya Tumkur Rangaiah, E-mail: sowmya.tr@gmail.com

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ABSTRACT

Background: The aim of tympanoplasty done for tubotympanic type of chronic suppurative otitis media (CSOM) should not only be to achieve a dry ear, but also to give hearing improvement to the patient. Aim of this study was to determine the correlation between size and site of tympanic membrane perforation with degree of hearing loss and correlation between ossicular chain status and degree of hearing loss on pure tone audiometry.

Methods: Patients with tubotympanic CSOM with hearing loss upto 60 dBHL undergoing tympanoplasty were examined to know the site and size of tympanic membrane(TM) perforation. Intraoperative findings pertaining to middle ear and ossicles were noted.

Results: Out of 52 patients of tubotympanic type of CSOM, hearing loss was least (31.18±7.46 dBHL) in small perforations of the TM and highest in subtotal perforations (48.74±7.83 dBHL) which was statistically significant. Hearing loss was significantly more in posterior perforation (46.61±7.02 dBHL) than in anterior perforation of TM (32.65±8.77 dBHL). There was a statistically significant difference in pure tone average hearing loss between intact ossicle group (32.87±9.77 dBHL) and eroded ossicle group (43.39±9.60dBHL). Difference in air bone gap was also significant between intact ossicle group (24.09±9.56 dB) and eroded ossicle group (31.02±9.83 dB). Multiple ossicles were eroded in nineteen patients with incus being the most commonly eroded ossicle.

Conclusions: In this study, hearing loss increased with increased size of TM perforation and also with posterior perforation. Incus was found to be the most commonly eroded ossicle. Multiple ossicles were seen eroded most commonly when hearing loss was moderate. The surgeon will be better equipped to do ossiculoplasty in view of these preoperative findings and also to counsel the patient better about their expectation of hearing improvement following surgery.

Keywords: Posterior perforation, Subtotal perforation, Ossicular erosion, Incus erosion

INTRODUCTION

Chronic suppurative otitis media is a commonly seen disease entity in the outpatient department of otolaryngology. Chronic suppurative otitis media (CSOM) is of two types: tubotympanic or mucosal disease and atticoantral or squamosal disease. Patients with CSOM present with history of ear discharge and

decreased hearing which can sometimes be troublesome for them as it impedes their routine activities. The aim of tympanoplasty done for tubotympanic type of CSOM should not only be to achieve a dry ear, but also to give hearing improvement to the patient. Between 40 and 90% of tympanoplasty require middle ear ossicular chain reconstruction. Hence it is imperative to know the factors which cause ossicular discontinuity in order to be better

prepared to do ossiculoplasty and also to give the patient a guarded prognosis regarding their hearing improvement following surgery. Many studies have used the Middle Ear Risk Index (MERI) as one of the most reliable measuring tools for evaluating the results of ossicular reconstruction and to compare the outcome among different studies.^{2,3} Kartush has divided these into intrinsic factors: eustachian tube function, disease severity, and status of the residual ossicular chain and extrinsic factors which are within the surgeon's control. Extrinsic factors included surgical technique, staging, design, and composition of the graft and prosthesis.⁴ The MERI stratifies these factors into prognostic categories. The MERI has been revised in 2001. Smoking is added as a middle ear risk and is given 2-risk points. Significant granulation tissue or effusions added 2-risk points. Furthermore, cholesteatoma risk value had been increased to 2-risk points.⁵

Table 1: Middle ear risk index (MERI)*- revised 2001.

Risk factor		Value-assigned risk			
Otorrhea (Otorrhea (belluci)				
I)	Dry	0			
II)	Occasionally wet	1			
III)	Persistently wet	2			
IV)	Wet, cleft palate	3			
Perforation	1				
Absent		0			
Present		1			
Cholesteat	oma				
Absent		0			
Present		2			
Ossicular s	tatus (Austin/Kartu	ish)			
0) M+I+S	+	0			
A) M+S+		1			
B) M+S-		2			
C) M-S+		3			
D) M-S-		4			
E) Ossicle head fixation		2			
F) Stapes fixation		3			
Middle ear	: granulations or ef	fusion			
No		0			
Yes		2			
Previous surgery					
None		0			
Staged		1			
Revision		2			
Smoker					
No		0			
Yes		2			

^{*}A value is assigned for each risk factor, and then the values are added to determine the MERI. (M-malleus, I-incus, S-stapes).

Aim of the study

This study was an attempt to understand the relationship between the degree of hearing loss and intraoperative findings in tubotympanic type of CSOM. The objectives were:-

- To determine the correlation between site and size of tympanic membrane perforation and degree of hearing loss.
- 2. To determine the correlation between ossicular chain status and degree of hearing loss in tubotympanic type of CSOM.

METHODS

This was a prospective cross sectional study done in the department of ENT at Mandya Institute of Medical Sciences, Karnataka from January 2016 to September 2017. The study was approved by the Institutional Ethical Committee. Informed consent was taken from all patients included in the study.

All patients of tubotympanic type of CSOM willing to undergo tympanoplasty, in the age group of 18 years to 60 years, both male and female patients were included in the study. Patients with minimal to moderately severe hearing loss upto 60 dB loss were included in the study. Patients with tubotympanic CSOM below the age of 18 years and above the age of 60 years were excluded from the study. Those with active disease with persistent ear discharge, those with atticoantral disease and patients presenting with complications of CSOM were excluded from the study. Patients with tubotympanic disease with mixed or conductive hearing loss of more than 60 dB were excluded from the study.

Fifty two patients of tubotympanic CSOM scheduled to undergo tympanoplasty were evaluated by otomicroscopy to know the site and size of tympanic membrane perforation, presence of polypoidal middle ear mucosa, tympanosclerosis and granulation tissue in the middle ear. Preoperative pure tone audiometry was done using Invertis Harp Plus diagnostic type 4 audiometer by Hughson-Westlake method to know the degree and type of hearing loss. Air bone gap was calculated as an average at 500Hz, 1000Hz and 2000Hz. Intraoperative findings pertaining to ossicles i.e., intact ossicular chain, ossicular chain ossicular erosion, discontinuity, pneumatisation of mastoid, aditus patency and middle ear findings were noted. All the findings were tabulated in an excel sheet and analysed by One way ANOVA statistical test using SPSS software.

RESULTS

Fifty two patients who underwent tympanoplasty for tubotympanic type of CSOM were included in the study. Of these, eighteen were male patients and thirty four were female patients. Thirty eight patients had unilateral

CSOM, whereas fourteen patients had bilateral tubotympanic CSOM. Twenty six patients underwent

tympanoplasty for the right ear and twenty six patients underwent left ear tympanoplasty.

Table 2: Size of perforation with hearing loss.

Hearing loss in dBHL	Small	Medium	Large	Subtotal
15-25	2	1	0	0
26-40	10	7	2	2
41-55	1	12	1	10
56-70	0	0	0	3
Total	13	21	3	15
dBHL	31.18±7.46	42.50±8.46	37.1±14.0	48.74±7.83

Differences are significant at p<0.01by One way ANOVA. p=0.000017.

Table 3: Site of perforation with hearing loss.

Site of perforation	Number	Mean hearing loss
Anterior	12	32.65±8.77 dBHL
Central	34	43.20±10.02 dBHL
Posterior	6	46.61±7.02 dBHL

Differences are significant at p<0.01 by One way ANOVA. p=0.002875.

Table 4: Degree of hearing loss seen in 52 patients.

Hearing loss in dBHL	Number
Minimal 16-25	3
Mild 26-40	21
Moderate 41-55	24
Moderately severe 56-70	4
Total	52

Table 5: Ossicles eroded in various degrees of hearing loss.

Pta	Malleus	Incus	Stapes	Incudostapedial joint
15-25	1	0	0	0
26-40	6	10	0	3
41-55	10	20	9	17
56-70	4	4	3	4
Total	21	34	12	24

Table 6: PTA and ABG in intact and eroded ossicle group.

Ossicles	Number	PTA dBHL	ABG dB
Intact	11	32.87±9.77	24.09±9.56
Eroded	41	43.39±9.60	31.02±9.83

p=0.002293 p=0.04; Differences in mean PTA and mean ABG among intact and eroded ossicle group were significant by One way ANOVA.

Table 7: Various ossicles eroded with mean hearing loss and mean air bone gap.

Ossicle eroded	Average hearing loss in dBHL	Air bone gap in dB
Malleus-21	45.27	31.00
Incus-34	45.18	33.20
Stapes-12	51.14	36.83
Malleus-incus-14	50.58	36.28
Incus-stapes-11	51.7	37.77
Malleus-incus-stapes-7	53.25	39.26

Differences are extremely significant at p<0.01by One way ANOVA. p value=0.000025.

Degree of hearing loss was seen to increase steadily from anterior tympanic membrane perforation to posterior quadrant tympanic membrane perforation. There was a statistically significant difference seen in the average hearing loss with various increasing sizes of tympanic membrane perforation.

Ossicular erosion with discontinuity of ossicular chain was present in forty one patients. In eleven patients who had intact ossicles, two had minimal hearing loss, six had mild hearing loss, three had moderate hearing loss. Incus (34 out of 52) was the most common ossicle eroded, with long process being the most commonly eroded part. Multiple ossicles were eroded in nineteen patients.

DISCUSSION

Both the intactness of tympanic membrane(TM) and continuity of ossicular chain is necessary for sound transmission from external ear to inner ear, where transduction of sound into nerve impulses occurs that results in hearing. In tubotympanic type of CSOM, there is perforation of tympanic membrane with/without erosion of ossicles with ossicular discontinuity. This results in varying degrees of hearing loss.

In this study, there was a statistically significant difference (p<0.01) noted in the pure tone averages with increasing sizes of tympanic membrane perforation from small central to medium, large and subtotal perforation. A study by Nahata et al showed that hearing loss increased with increasing size of tympanic membrane perforation with lower frequencies more affected than higher frequencies. 6 Dawood MR in his study on 71 patients of CSOM found a linear correlation between the sizes of TM perforation and hearing loss, as the highest degree of hearing loss detected with subtotal perforation with air conduction was 41.5dBHL with air bone gap(ABG) of 33.5dB; and this was attributed to impedance matching impairment of the hydraulic action of the tympanic membrane, as it is related to the reduction in its surface area as compared with that of the stapedial footplate.

As the inherent frequency of the tympanic membrane has been calculated to be at 2000 Hz, that is, the tympanic membrane vibrates the most at 2000 Hz, the least loss of sound transmission (or best hearing) has been observed around 2000 Hz. The primary mechanism of conductive hearing loss caused by tympanic membrane perforation is a reduction in ossicular coupling by a loss in the sound pressure difference across perforated tympanic membrane. Hearing loss was found to be frequency dependent, with the most maximum loss detected at lower frequencies. The sound pressure difference across perforated tympanic membrane. Hearing loss was found to be frequency dependent, with the most maximum loss detected at lower frequencies.

The average hearing loss was found to be steadily increasing with least hearing loss in anterior perforation to highest in posterior perforation of tympanic membrane. This was found to be statistically significant in our study (p<0.01). This was in accordance with the studies by Nahata et al and Dawood.^{6,7} Increasing hearing loss with posterior tympanic membrane perforation was attributed

to direct exposure of round window to sound waves with resultant cancellation of phase difference between the oval window and round window and non-movement of perilymph in study by Bianca et al and Malik et al. ^{10,11} Dawood MR attributed this increased hearing loss in posterior perforation to impairment of the potential round window baffle on hearing threshold. ⁷ Two studies by Mehta et al and Ibekwe et al found that hearing loss did not vary substantially with the site of perforation and any such variation was negligible. ^{12,13}

Out of 52 patients of CSOM, ossicles were intact in 11 patients, eroded in 41 patients and multiple ossicles were eroded in 19 patients. Incus was the most common ossicle eroded in this study (34 out of 52), followed by malleus(21 out of 52) and malleus-incus together(14 out of 52). Incus was found to be the most commonly eroded ossicle in studies by Tos et al, Srinivas et al, Rout et al and Varshney et al. Artush found erosion of long process of incus with an intact malleus handle and stapes superstructure (type A) as the most common defect. Austin reported the most common ossicular defect to be the erosion of incus with intact malleus and stapes. Mohanty et al in their study observed that incus necrosis is best predicted by the presence of moderate to moderately severe hearing loss (45 to 70dBHL).

The mean PTA in intact ossicle group in this study was 32.87±9.77dBHL and in eroded ossicle group was 43.39±9.60dBHL. The difference in the mean PTA between intact ossicle group and eroded ossicle group was statistically significant. The mean ABG in intact ossicle group was 24.09±9.56dB and eroded ossicle group was 31.02±9.83dB. There was a statistically significant difference in the mean ABG between the two groups in this study. Statistically significant differences in mean PTA and mean ABG in intact and eroded ossicle group were also noted in studies by Srinivas et al and Satyaki et al.^{15,20} In cases in which the tympanic membrane, malleus and incus are lost, the conductive hearing loss is on the order of 40 to 50dB. Complete disruption of the ossicular chain can result in a 60 dB hearing loss.²¹

Differences in pure tone average hearing loss was found to be statistically significant (p<0.01) with varying ossicular erosion. The differences in air bone gap (ABG) with ossicular erosion was also statistically significant. In this study, the air bone gap in patients with ossicular erosion varied from 31dB to 39.26dB. This was in accordance with the study of 162 patients of CSOM by Carrillo RJC et al who found that ABG >50 dB at 500 Hz, >30 dB at 2 kHz, and >50 dB at 4 kHz best predicted the presence of ossicular discontinuity. In their study, they concluded that frequency dependent ABG cut-off values could predict ossicular discontinuity in CSOM.²²

CONCLUSION

In this study, there was an increase in hearing loss with increased size of tympanic membrane perforation and also with posterior perforation. Incus was found to be the most commonly eroded ossicle when average hearing loss was 45dBHL and average air bone gap was 33dB. Multiple ossicles were seen eroded when hearing loss was moderate. Knowledge of these preoperative pure tone audiometry findings allows the surgeon to be better prepared for ossiculoplasty and also to counsel the patient better about hearing improvement before taking the patient for surgery.

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