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Hearing threshold differences between pre and post tympanoplasty in patients with chronic suppurative otitis media

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ABSTRACT

Background: Chronic suppurative otitis media (CSOM) often lead to sequelae of hearing loss. Tympanoplasty is one of the strategies to improve hearing function in patients with CSOM.

Aim: To evaluate hearing threshold differences in pre and post tympanoplasty in patients with CSOM.

Methods: Patients who undergo tympanoplasty (n = 21) were observed prospectively. Hearing threshold (air conduction, bone conduction, and threshold deviation) were assessed using pure tone audiometry before and 12 weeks after the surgery, at the frequency of 500 Hz, 1 kHz, 2 kHz, and 4 kHz.

Results: Significant difference between pre and post tympanoplasty was shown at all frequencies in air conduction (AC), while similar results are shown at 2 kHz and 4 kHz frequencies in bone conduction (BC). There is also an increase in the mean hearing threshold between pre and post tympanoplasty.

Conclusion: An average of 0-5 dB of AC enhancement in all frequencies were found after tympanoplasty. Nevertheless, further study is needed on hearing threshold improvement in various types of tympanoplasty.

Keywords: hearing threshold, tympanoplasty, chronic suppurative otitis media

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INTRODUCTION

Chronic suppurative otitis media (CSOM) is a middle ear disease with a relatively high prevalence, particularly in developing countries.[1] The disease generally afflicts young adults with low socioeconomic background.[2] CSOM affects the mucoperiosteal structure of the middle ear which might give rise to some long-term consequences and complications.[3] Irreversible sequelae due to severe destruction of the middle ear and mastoid bone in CSOM, either with the absence or presence of persistent cholesteatoma, could result in hearing disturbance, typically conductive hearing loss.[1] A study by Santosh et al. states that hearing impairment as a consequence of COSM mainly occurs to those who live in developing countries.[3]

The hearing disturbance in patients with CSOM is best assessed at low frequencies compared to high frequencies and is evaluated using pure-tone audiometry. The defective threshold of hearing loss owing to CSOM usually ranges in 16-46 dB.[2] The severity of deafness caused depends on the size and location of the tympanic membrane perforation as well as the integrity of sound transmission chain in the middle ear. Besides, edematous mucosal lining and the presence of granulation could affect the conductive mechanism.[4] Hearing impairments caused by malignant CSOM are typically severe conductive deafness due to the discontinuity of hearing bones. Bone conduction denotes the cochlear function, while air conduction represents the overall auditory function. Air bone gap stands for the variation between air conduction and bone conduction, which determines the degree of conductive deafness.[1]

Tympanoplasty is a surgery that aims to eradicate diseases in middle ear by reconstruction of the auditory organ, with or without tympanic membrane grafting. The method of tympanoplasty is evolving throughout the years to improve hearing function and overcome ear diseases. Tympanoplasty can be combined with either canal-wall-up (CWU) or canal-wall-down (CWD) mastoidectomy to eliminate mastoidal cavity disorders.[5,6] The success of tympano-mastoidectomy relies not only on the operating principle but also on the pathological conditions associated with the disease. The type of tympanoplasty is planned based on the status of the middle ear and the hearing chain.[7]

Middle ear surgeries hold a crucial role in the management of perforated tympanic membrane, termination of diseases and improvement of hearing disturbance attributed to CSOM.[1] The fundamental principle of tympanoplasty is to repair the

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perforated membrane; thus establishing an intact tympanic membrane, to prevent recurrence of otorrhea, and to restore hearing function.[8] On account of the hearing enhancement benefit of tympanoplasty, the present study intended to evaluate hearing threshold differences between before and 12-weeks after tympanoplasty on patients with CSOM.

MATERIALS AND METHODS

The present study was an observational study with a cohort of 21 patients with CSOM who will undergo tympanoplasty at Haji Mina General Hospital Medan. The procedures were carried out from January 1st to June 30th, 2016. This research has been approved by the ethics committee of Faculty of Medicine Universitas Sumatera Utara. Inclusion criteria of the subjects are: patients who planned to underwent tympanoplasty, willing to take part in the study and signed the informed consent form. Furthermore, the exclusion criteria are as follows: patients with congenital deafness, patients diagnosed with systemic disease that might interfere with hearing function (such as diabetes mellitus, dyslipidemia, hypertension), patients with history of moderate consumption of ototoxic drugs, patients with history of trauma or acoustic exposure, and patients who were not able to fulfill the 12 weeks follow up post surgery.

All of the patients included in the study were subjected to pure-tone audiometry examination prior to the surgery. The results were then appointed as the baseline threshold of the hearing function. Twelve-week following the tympanoplasty, their hearing threshold was examined once more to obtain the post-surgery values. The data were analyzed using Wilcoxon test, with statistical significance set at $p < 0.05$.

Table 1 Characteristic of the study samples

Characteristic		%
Gender	Male	42.9
	Female	57.1
CSOM type	Benign	71.4
	Malign	28.6
Tympanoplasty classification	I	66.7
	III	14.3
	IV	9.5
	V	9.5
Tympanic membrane perforation	Central	28.6
	Subtotal	38.1
	Total	33.3
Hearing impairment	Conductive Hearing loss	71.4
	Mixed Hearing loss	28.6

Table 2 Hearing threshold in pre and post tympanoplasty

	n	Mean ± SD (dB)		*p* value
		Pre operative	Post operative	
Hearing threshold (dB)	21	48.63 ± 18.828	41.72 ± 18.880	0.001*

* *p* value is derived using Wilcoxon test
* Statistically significant ($p < 0.05$).

RESULTS

Characteristics of the subjects are described in Table 1, with the mean age of 27.14 ± 14.43 years old.

A significant difference ($p = 0.01$) was found in the hearing threshold between pre and post tympanoplasty in CSOM patients. Hearing threshold average improved nearly 15% after the surgery, as shown in Table 2.

Sixteen out of 21 subjects demonstrated a decrease in their hearing threshold after the tympanoplasty compared to those of preoperative, which indicates an enhancement in the hearing function. One subject showed 5 dB higher hearing threshold after the surgery, and four subjects did not show any improvement between the pre and post tympanoplasty results.

There were significant differences found between pre and post tympanoplasty in all frequencies of air conduction. However, changes were only found in 2 kHz and 4 kHz frequencies of bone conduction.

The majority of improvements in hearing threshold were exhibited in type I tympanoplasty on subtotal tympanic perforations and conductive deafness. Deviations in the hearing threshold are classified into four groups, with the distribution as displayed in Table 4.

DISCUSSION

The present study did not show polarity in the incidence of CSOM between men and women. The highest prevalence was in the range of 20-30 years old, with the mean age of the patients is 27.14 ± 14.43 years old, with the youngest sample was eleven years old and the oldest sample was 64 years old. Such age distribution reflects the predominance of productive age in CSOM cases, which may be related to a good health seeking behaviour within the group of age.

A statistically significant difference was found between pre and post tympanoplasty hearing

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Table 3 AC and BC in pre and post tympanoplasty

Parameter	Mean ± SD (dB)	Intensity (dB) Min	Max	*p*-value
AC Pre tympanoplasty 500Hz	48.33 ± 19.386	20	100	$p = 0.002^*$
AC Post tympanoplasty 500Hz	42.14 ± 18.746	20	100	
AC Pre tympanoplasty 1000Hz	46.19 ± 19.615	15	90	$p = 0.001^*$
AC Post tympanoplasty 1000Hz	39.05 ± 18.750	15	85	
AC Pre tympanoplasty 2000Hz	46.43 ± 21.222	20	95	$p = 0.001^*$
AC Post tympanoplasty 2000Hz	39.05 ± 20.894	20	95	
AC Pre tympanoplasty 4000Hz	53.57 ± 22.811	25	105	$p = 0.001^*$
AC Post tympanoplasty 4000Hz	46.67 ± 23.840	15	105	
BC Pre tympanoplasty 500Hz	11.90 ± 16.161	-10	60	$p = 0.317$
BC Post tympanoplasty 500Hz	11.43 ± 15.584	-10	60	
BC Pre tympanoplasty 1000Hz	13.10 ± 17.064	-10	60	$p = 0.102$
BC Post tympanoplasty 1000Hz	11.67 ± 15.838	-10	60	
BC Pre tympanoplasty 2000Hz	22.86 ± 16.850	-5	65	$p = 0.003^*$
BC Post tympanoplasty 2000Hz	19.76 ± 17.283	-5	65	
BC Pre tympanoplasty 4000Hz	23.33 ± 20.207	0	70	$p = 0.041^*$
BC Post tympanoplasty 4000Hz	20.24 ± 20.885	-5	70	

All *p* values were derived using Wilcoxon test
* Statistically significant ($p < 0.05$).

Table 4 Hearing threshold variation between pre and post tympanoplasty

Hearing threshold variation	n	%
0-5 dB	12	57.1
>5-10 dB	4	19.0
>10-15 dB	3	14.3
>15 dB	2	9.5

thresholds ($p = 0.001$). The subjects underwent tympanoplasty along with either CWU mastoidectomy or CWD mastoidectomy, depending on the condition of the disease. A study by Khabdwal et al. in 2013 compared postoperative auditory function in patients who went through CWU and CWD mastoidectomy, which showed no significant difference between the types of mastoidectomy performed.[9] The similar results between the present study and the study by Khabdwal et al. indicates that post-tympanoplasty hearing threshold is independent of the type of mastoidectomy; hence the operator could assign any suitable types of mastoidectomy to perform regarding the patients' disease.

Four subjects in the present study did not show any distinction between pre and post tympanoplasty hearing threshold. Three out of those underwent type I tympanoplasty while the remaining one subject underwent type III tympanoplasty. Each of them had less than 50% size of central tympanic perforation with mild to moderate degree of hearing loss. Choi et al. stated that the diminishing function of sound conductivity in CSOM is in line with the extent of the perforated tympanic membrane.[10] Therefore, the absence of variation between pre and post surgery hearing threshold in those four patients might be related to the size and the location of the tympanic perforation.

Furthermore, there is one subject whose post-operative hearing threshold was deteriorated with an increase of 5 dB following the tympanoplasty. The tympanoplasty performed was type V, with total perforation and cholesteatoma on admission, as well as mixed type hearing loss. Occasionally, cholesteatomas in CSOM could play a role in enhancing the conduction of sound, which often causes post-operative thresholds to regress after the surgery.[8] Nevertheless, the presence of cholesteatoma is not a critical factor in determining the prognosis of graft successfulness.[11] In addition, minimal hearing improvement could be accounted to narrow disclosure and expansion during the surgery.[4] The reconstruction procedure in restoring hearing ability can be done with many innovations along with the use of excellent graft material.[4] Age at the time of surgery is not suitable to be a foundation in predicting favourable surgical outcome.[12]

In the present study, betterment in hearing function is considered when a minimum of 5 dB decrease in postoperative hearing threshold is achieved. The data obtained addressed the majority of hearing threshold improvement ranges from 0-5 dB. Following the reconstruction of the ossicles, bone conduction threshold might be improved primarily in low and medium frequencies, which is attributable to alteration in the conductive mechanism of the middle ear.[13] Up to this date, there is no fixed value set as a benchmark of post tympanoplasty hearing enhancement in patients with CSOM. Advancement of the hearing threshold is influenced by many aspects, especially in the surgical technique used together with the aptitude of the operator, and pre and post tympanoplasty pathological condition of the middle ear. To note, the subjects enrolled in this study is not normally distributed; besides, we did not encounter subjects undergoing type II tympanoplasty, which might contribute to the limitation of this study.

CONCLUSION

After tympanoplasty, air conduction showed improvement in all frequencies with a mean frequency of 0-5 dB. Further evaluation is needed on post tympanoplasty hearing thresholds for each type of tympanoplasty.

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