FACTORS AFFECTING THE AIR-BONE GAP IN PATIENTS WITH CHRONIC OTITIS MEDIA INDICATED FOR SURGERY AT THAI BINH MEDICAL UNIVERSITY HOSPITAL

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Abstract

Objective: To analyze some affected factors on the air-bone gap (ABG) in patients with chronic otitis media who were indicated for surgery at Thai Binh Medical University Hospital.

Method: A retrospective case series study was conducted on 94 patients with chronic otitis media who underwent tympanoplasty at Thai Binh Medical University Hospital from 2017 to 2023.

Results: Large perforations had the highest incidence (39.4%). Conductive hearing loss accounted for the majority of cases (75.5%), with most cases being mild (54.3%). The site and size of the perforation, as well as ossicular chain lesions, had a statistically significant effect on ABG. The anterior perforation group and the small perforation group exhibited the least hearing loss, both with a median ABG of 17.5 dB. In the presence of ossicular chain lesions, the ABG was even greater, with a value of 32.5 dB. Only ossicular chain lesions had a statistically significant effect on the ABG in multivariate linear regression.

Conclusion: The condition of ossicle chain lesions significantly affects the ABG in chronic otitis media.

Keywords: air-bone gap*;* chronic otitis media

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1. Introduction

Chronic otitis media is a prolonged inflammation of the middle ear and mastoid cavity that persists for more than 3 months. This condition often leads to tympanic membrane perforation, ossicular chain lesions, and tympanosclerosis, which ultimately results in hearing loss.[1] The degree of hearing loss depends on factors such as the condition of the tympanic membrane and ossicles.[2,3] Pure-tone audiometry is typically performed to determine the degree and type of hearing loss. Patients suffering from chronic otitis media usually experience mild conductive hearing loss.

The air-bone gap (ABG) is a critical value in evaluating the extent of damage to the auditory conduction system in patients with chronic otitis media. The magnitude of the ABG indicates preoperative middle ear lesions and guides tympanoplasty.[4] Assessment of the ABG is essential for planning middle ear surgery and evaluating patients' recovery after tympanoplasty.[5]

In Vietnam, several studies have analyzed the symptoms of chronic otitis media and the middle ear's hearing function. However, most of these studies investigate these factors separately, without exploring their interrelationships.

The study aimed to evaluate the correlation between various affected factors and the air-bone gap (ABG) in patients with chronic otitis media who were indicated for surgery at Thai Binh Medical University Hospital.

2. Patients and methods

2.1. Patients

Patients were diagnosed with chronic otitis media underwent tympanoplasty at Thai Binh Medical University Hospital from January 2017 to December 2023. Patients with chronic otitis media selected for the study meet the following conditions: medical reports containing ear endoscopy images, prep-operative audiometric reports and operative reports that fully document middle ear damages. Patients will be excluded from the study if operative reports show cholesteatoma in the middle ear or if the patient has a history of prior middle ear surgery. A total of 94 patients were recruited for the study, with a mean age of 36.1 ± 16.8 years (range: 7–73 years), of which 60 (63.8%) were female.

2.2. Method

A retrospective case series study was conducted, with data collected from medical records. All patients with chronic otitis media who met the inclusion criteria were selected.

The independent variables included patient characteristics such as age, gender, and tympanic perforation characteristics, including the site of perforation (anterior-inferior, posterior-inferior, anterior-superior, posterior-superior, central, subtotal, or total) and the size of the perforation relative to the pars tensa of the tympanic membrane,

categorized as small (<1/4), medium (1/4–1/2), or large (>1/2). Additional middle ear damages, i.e., tympanosclerosis and ossicular chain lesions, were also assessed. Data collection included evaluating the condition of the tympanic membrane using ear endoscopic images. The pure-tone average (PTA) and air-bone gap (ABG) averaging were calculated by thresholds at 0.5, 1, 2, and 4 kHz from audiometric reports. Tympanosclerosis and ossicular chain lesions were further evaluated using operative reports.

All collected data will be entered into a pre-designed form created using the REDCap system. Data were analyzed using the SPSS software, version 20.0. For quantitative variables, the median was calculated, and the medians of independent groups were compared using the Kruskal-Wallis test. Correlation was assessed through linear regression analysis.

2.3. Research Ethics

The study was conducted with the approval of the Board of Directors of Thai Binh Medical University Hospital. All collected data were used for research purposes only. Patients' personal information was kept confidential.

3. Results

Tympanic Membrane and Pure-Tone Audiometry Test Characteristics

According to Table 1, subtotal perforation accounted for the highest rate at 39.4%. Meanwhile, a minority of patients present with posterior perforation (1.1% for posterior-superior and 9.6% for posterior-inferior). Regarding the size of perforation, 39.4% were classified as large. There were 28 out of 94 subjects with small perforations (29.8%) and 29 out of 94 subjects with medium perforations (30.9%). Tympanosclerosis was found in 38.3% of patients. During surgical procedures, 8.5% of patients were diagnosed with ossicular chain lesions.

Table 1: Characteristics of Middle Ear Damages

Characteristics	n (%)
Site of perforation (N=94)	
Anterior-inferior	28 (29.8)
Anterior-superior	5 (5.3)
Posterior-inferior	9 (9.6)
Posterior-superior	1 (1.0)
Central	14 (14.9)
Subtotal	37 (39.4)
Size of perforation (N=94)	
Small	28 (29.8)
Medium	29 (30.9)
Large	37 (39.3)
Tympanosclerosis (N=94)	36 (38.3)
Ossicular chain lesions (N=94)	8 (8.5)

According to Table 2, the mean PTA was 37.8 ± 14.9 dB, while the mean ABG was 23.4 ± 8.0 dB. The median (P25 – P75) for PTA and ABG were 34.4 dB (28.4 – 45.3) and 22.5 dB (17.5 – 27.5), respectively. Most patients had mild

hearing loss, accounting for 54.3%. The percentages of subjects with moderate, moderate-severe, and severe hearing loss were 17.0%, 11.7%, and 2.1%, respectively. Additionally, 11.7% of patients had normal hearing levels, and no patients were diagnosed with profound hearing loss. A total of 71 individuals had conductive hearing loss (75.5%), while 12.8% had mixed hearing loss. No cases of sensorineural hearing loss were reported.

Table 2: Audiogram Values in Chronic Otitis Media

	N	Median (dB)	Min. (dB)	Max. (dB)
PTA	94	34.4	16.25	75.0
ABG	94	22.5	8.75	43.75

Factors Affecting The Air-Bone Gap

Table 3: Correlation of Various Factors with ABG

Factors		N	Median ABG (dB)	Univariate	Multivariate		
				p	B	Beta	p
Age	<20	19	18.8	0.158	-	-	-
	20-50	59	22.5				
	>50	16	21.9				
Gender	Male	34	22.5	0.934	-	-	-
	Female	60	22.5				
Site of perforation	Anterior	33	17.5	0.000	0.530	0.097	0.566
	Posterior	10	23.1				
	Central	14	23.8				
	Subtotal	37	25.0				
Size of perforation	Small	28	17.5	0.000	2.307	0.266	0.119
	Medium	29	23.8				
	Large	37	23.8				
Tympanosclerosis	Yes	36	24.4	0.197	-	-	-
	No	58	21.9				
Ossicular chain lesions	Yes	8	32.5	0.001	6.371	0.394	0.000
	No	86	21.9				

According to Table 3, there were no significant differences across age groups, gender, and tympanosclerosis condition groups ($p > 0.05$). Univariate analysis results indicated that the site and size of tympanic perforation, as well as ossicular chain lesions, were associated with ABG ($p < 0.05$). However, only ossicular chain lesions affected ABG when we conducted multivariate analysis.

4. Discussion

The purpose of this study was to evaluate the relationship between middle ear lesions and middle ear hearing function.

According to the pure-tone audiometry analysis, most individuals suffered from conductive hearing loss, with a percentage of 75.5%, which is reasonable given that the damages were primarily found in the middle ear (tympanic membrane and ossicles). A small number of patients had mixed hearing loss, which may be due to the spread of inflammation into the inner ear or be associated with presbycusis. The ABG is the most suitable value for assessing middle ear hearing function using audiometry, allowing for the evaluation of middle ear damage that may impair a patient's hearing ability. In the study, the ABG was not significantly affected by age or gender ($p > 0.05$). These results are similar to Dobrev's study on ABG average, with differences observed at frequencies of 0.5 and 4 kHz, which may be related to the widening of the joint space of the incudo-malleolar joint with age.[6]

The characteristics of tympanic membrane perforation are often described in preparation for tympanoplasty, alongside audiometry. It is one of the prognostic factors for hearing improvement during surgery. In this study, the site and size of the perforation were associated with the preoperative ABG in univariate analysis with both $p=0.000$, but in multivariate analysis, they did not have a statistically significant impact on patients' ABG with $p=0.566$ and $p=0.119$, respectively. These results suggest a synergistic role of perforation site and size in middle ear lesions. Patients with anterior perforations had the lowest ABG, with a median ABG of 17.5 dB, while those with subtotal perforations had the highest ABG, with a median ABG of 25.0 dB. These results were similar to those reported in Rana AK's study[7]. There was only one patient who had a posterior-superior perforation, with an ABG of 35dB. This site corresponds to the ossicular chain, which might explain the higher ABG. However, further studies with more subjects are needed to confirm this finding. The ABG was also lower in patients with small perforations, with a median ABG of 17.5 dB, and higher in the groups with medium and large perforations, both having a median ABG of 23.8 dB. This is physiologically relevant, as larger perforations cause a greater impact on tympanic membrane function, reducing the ability to transmit sound to the inner ear. The synchronous vibration of both round and oval windows due to large perforations also contributes to the reduced hearing function in these patients. The size of perforation may correlate with the duration of the disease. Large perforation could result from repeated inflammation of the middle ear, including the tympanic membrane. The larger the perforation, the less effective the surgery tends to be. We found that the tympanosclerosis did not affect the degree of hearing loss. Similarly, Zheng Y's study concluded that the tympanosclerosis was not a factor contributing to conductive hearing loss.[8]

There was a significant difference in the ABG between ears with ossicular chain lesions and those without in multivariate analysis ($p=0.000$). In the presence of ossicular chain lesions, the ABG was even greater, with a value of 32.5 dB. There are several types of ossicular chain lesions,

such as ossicular fixation and ossicular discontinuity, with incudo-stapedial joint discontinuity being the most commonly observed. These damages are consistent with Bayat's study.[9] Carrilo RJ's research indicated that ABG can be used to predict the status of the ossicles in chronic otitis media patients without cholesteatoma, which can help surgeons determine the most appropriate surgical approach.[4]

5. Conclusion

Our result showed that only ossicular chain lesions had a statistically significant effect on the ABG in multivariate linear regression. In the presence of ossicular chain lesions, the ABG was greater, with a value of 32.5 dB.

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