



Original Article

Clinical Characteristics of Chronic Perforated Otitis Media in Different Age Groups

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OBJECTIVE: We aimed to analyze preoperative and intraoperative clinical characteristics of chronic perforated otitis media by patient age.

MATERIALS and METHODS: We analyzed 137 tympanoplasties for chronic perforated otitis media in 133 patients. Exclusion criteria were ear adhesions, cholesteatoma, and a history of tympanoplasty. Patients were divided into a younger group (aged 15–39 years), a middle group (40–64 years), and an elderly group (≥ 65 years). We compared tympanoplasty technique (using Wullstein classification), mastoid air-cell area measured by temporal bone computed tomography, preoperative aeration of the temporal bone, mean preoperative hearing (at 500 Hz, 1000 Hz, and 2000 Hz), and patch effect calculated by the pre- and post-patch air–bone gap at frequencies of 250 Hz and 500 Hz among the three age groups.

RESULTS: Although type I tympanoplasty was performed most frequently in all age groups, it was performed significantly less often in the elderly group ($p < 0.05$). The mean mastoid pneumatization index was significantly lower in the elderly group ($p < 0.05$). Preoperative air-conduction hearing and bone-conduction hearing differed significantly among age groups ($p < 0.05$ for both). There were no significant differences in the air–bone gap among the three groups. The mean patch effect was significantly better in the younger group than in middle or elderly groups ($p < 0.05$).

CONCLUSION: The less pneumatized mastoid and ossicular diseases in elderly patients with chronic perforated otitis media suggest that they had longer lasting and more severe childhood middle ear pathologies than did younger patients.

KEYWORDS: Chronic perforated otitis media, age, tympanosclerosis

INTRODUCTION

Chronic perforated otitis media, which is usually caused by severe or recurrent otitis media in childhood, can cause gradual deterioration of residual hearing. Therefore, early surgical intervention is desirable. Many researchers have investigated the relationship between age and the results of tympanoplasty in chronic otitis media^[1,2]. Tympanoplasty in elderly patients is acceptable nowadays, and some have noted that postoperative hearing results are significantly improved in elderly patients and that there are no disadvantages in results compared to younger patients^[3,4], although preoperative bone-conduction thresholds gradually worsen with age. It is, however, often recognized during the operation that tympanoplasty can be technically more difficult in elderly patients than in younger patients because of severe middle ear conditions, including mucosal inflammation, tympanosclerosis, and destruction of the ossicular chain. To clarify the factors that influence the surgical outcomes in different age groups, in this study we investigated differences including mastoid maturation and surgical procedure among patients in younger, middle, and elderly age groups. Especially by comparing mastoid pneumatization in patients grouped in the different ages, the area of pneumatization might be a consequence of not only long lasting but also severe and intractable inflammation influenced by the therapeutic methods and surrounding environmental factors in early medical history.

MATERIALS and METHODS

Subjects

Patients diagnosed with chronic perforated otitis media who underwent tympanoplasty under general anesthesia by five board-certified otologists at our institution from January 2009 to December 2011 were included in this study. We examined 137 ears in 133 patients (42 males, 91 females; mean age 55.3 years; range, 15–78 years). Because mastoid pneumatization continues until the age of 10–15 years, patients younger than 15 years of age were excluded. Patients with cholesteatoma and who had previously

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undergone surgery for this condition at our institution or other hospitals were also excluded. We divided these patients into three age groups—a younger group (aged 15–39 years), a middle group (aged 40–64 years), and an elderly group (aged 65 years and older). Cases in which the contralateral ear had a normal tympanic membrane and normal findings on temporal bone computed tomography (CT) were defined as unilateral. Unilateral chronic otitis media was found in 88 ears in 88 patients (23 males, 65 females). Informed consent was obtained, and ethics committee approval was received for this study from the ethics committee of Jichi Medical University Saitama Medical Center (IRB RIN15-100).

Surgical Procedure

Patients were evaluated preoperatively to check the continuity of the ossicular chain using a patch test with chitin sheets or a piece of wet cotton. During the operation, we tried to preserve the ossicular chain if its mobility was good (Wullstein type I). If one of the ossicles was eroded or fixed, the ossicular chain was reconstructed with cartilage (Wullstein type III or IV). Perforation of the tympanic membrane was repaired using a periosteum or fascia graft by inlay technique (the graft was placed between the epithelial layer and the tympanic fibrous annulus).

Condition of the Ossicles

We retrospectively determined Wullstein classification from surgical records. In this study there was one case of fixed stapes. Patients with Wullstein type III or IV had eroded or fixed ossicles. The proportions of patients undergoing each type of tympanoplasty were compared among groups.

Mastoid Pneumatization Index (Maturation)

The areas of the mastoid air cells were measured on preoperative CT scans. The mastoid pneumatization index was defined as the sum of the areas of cross-sections of the mastoid air cells measured at the level of the lateral semicircular canal and 3 mm below that level^[5] using ZIOSTATION version 1.1 software (ZIOSOFT, Inc.; Tokyo, Japan) and compared among groups (Figure 1a, b). In cases of unilateral chronic perforated otitis media, the mastoid pneumatization index of the normal side was also measured and compared among groups.

Preoperative Aeration of the Temporal Bone

Aeration of the temporal bone was also evaluated by preoperative CT scan and divided into the following four categories: the mastoid air cells, the epitympanum, the mesotympanum, and non-aerated. The proportions of cases in each category were compared among groups.

Preoperative Hearing Condition

Preoperative air- and bone-conduction thresholds, calculated as the means at frequencies of 500 Hz, 1,000 Hz, and 2,000 Hz, were compared among groups. The preoperative air–bone gap was calculated as the means at 500 Hz, 1,000 Hz, and 2,000 Hz. Because bone-conduction thresholds increase with age at higher frequencies and patch gain is clear at frequencies of 250 Hz and 500 Hz, the patch effect was calculated as the sum of the differences between the pre- and post-patch air–bone gap at 250 Hz and 500 Hz and compared among groups.

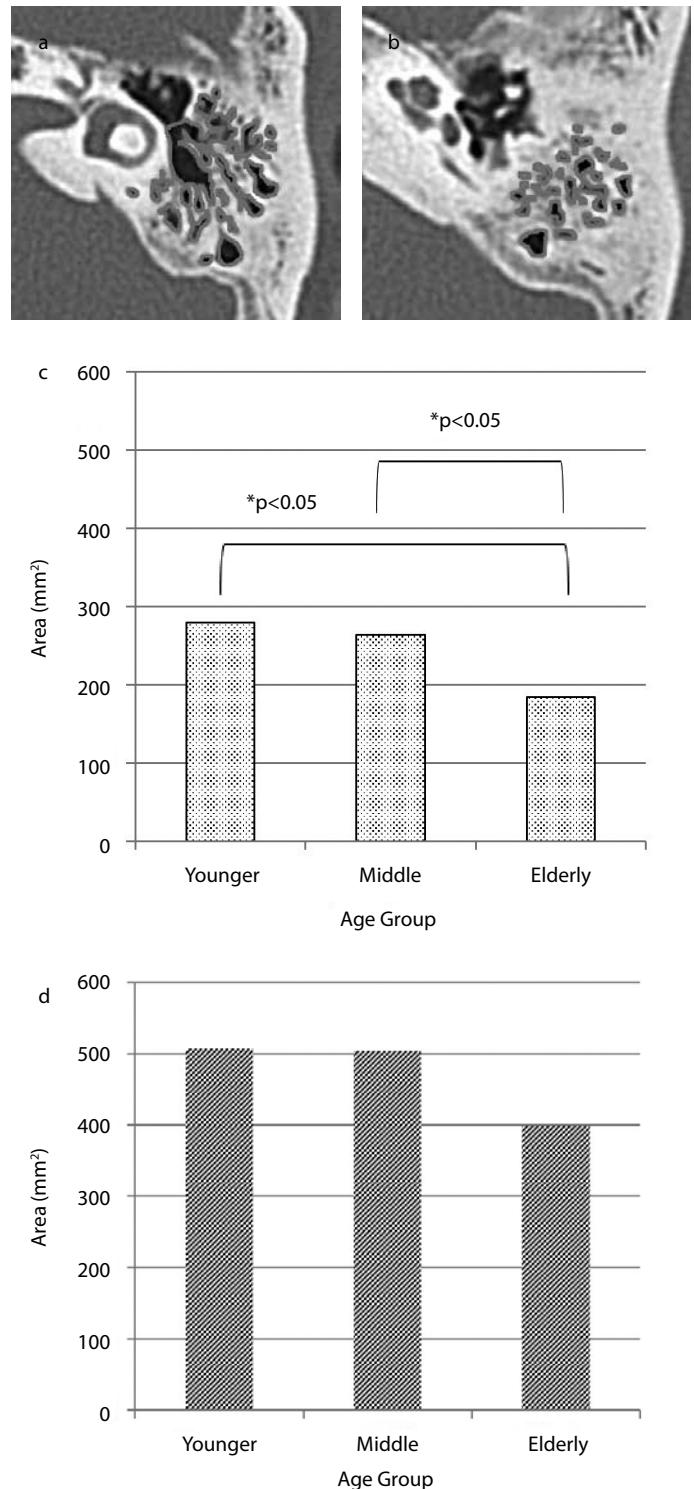


Figure 1. a-d. We defined the mastoid pneumatization index as the sum of the areas of the cross-section of the mastoid air cells measured at the level of the lateral semicircular canal (a) and 3 mm below that level (b). The mastoid pneumatization index for diseased ears (c) and contralateral, healthy ears (d) in the younger, middle, and elderly groups.

Statistical Analysis

Statistical analysis was performed using SPSS for Windows, version 18.0 (IBM Corp.; New York, USA). Continuous and discrete data were compared using Student's t-test and the chi-square test, respectively. A p-value of < 0.05 was considered statistically significant.

RESULTS

Table 1 presents patient characteristics, causes of chronic perforated otitis media, and Wullstein tympanoplasty type. The most frequent cause of perforation among the three groups was recurrent acute otitis media. Although Wullstein type I tympanoplasty was performed most frequently in all age groups (88.0%, 89.1%, and 72.9% in the younger, middle, and elderly groups, respectively), it was performed significantly less often in the elderly group than in the middle group ($p<0.05$).

The mean mastoid pneumatization index of diseased ears in the younger, middle, and elderly groups is shown in Figure 1c. In cases of unilateral chronic perforated otitis media, we also measured the mastoid pneumatization index of the normal side as a control and compared it among the groups (Figure 1d). There were significant differences between the younger and elderly group ($p<0.05$) and between the middle and elderly group ($p<0.05$) (Figure 1c). However, there were no significant differences in the mean mastoid pneumatization index of the contralateral, healthy ears among the groups (Figure 1d).

Temporal bone aeration for all age groups is shown in Figure 2. Aeration was most commonly to the level of the mastoid air cells in all age groups. However, aeration to the mastoid air cells occurred significantly more often in the younger group than in the middle group ($p=0.02$) or the elderly group ($p=0.004$).

Table 2 shows the mean preoperative air- and bone-conduction thresholds and reveals significant differences among all age groups ($p<0.05$). However, the mean patch effect was significantly greater in the younger group than in the elderly group ($p<0.05$) and was greater in the younger group than in the middle group ($p<0.05$).

DISCUSSION

Chronic perforated otitis media is a chronic infection of the middle ear and mastoid cells in which there is a persistent perforation of the eardrum with continuous or intermittent otorrhea. Although hearing prognosis varies from case to case, long duration of inflammation might have negative effects on the middle ear and the inner ear and lead to subsequent hearing loss, mainly conductive hearing loss because of a perforated membrane and ossicular chain failure.

It is well known that mastoid pneumatization and size develops after birth and reaches maximal size around puberty [6], and there are individual differences in the sizes of the mastoid air cells. It is still questionable whether the mastoid air-cell size is determined genetically or results from infection and inflammation. Previous studies using an animal model revealed that chronic middle ear inflammation in the early stages of life inhibited pneumatization by hindering the development of the air-cell system [7], and the more severe the inflammation found, the greater was the inhibition of pneumatization [8]. Although it is considered that the severity of chronic otitis media in childhood is related to growth inhibition of the mastoid air cells, there have been no studies comparing the areas of mastoid air cells in patients with chronic perforated otitis media grouped by age.

We found that the area of the mastoid air cells was significantly smaller in the elderly group than in the younger and middle groups of the diseased ears. The area of the mastoid air cells in the contralateral healthy ears was also smaller in the elderly group than in the others, but there

Table 1. Patient characteristics

Variable	Age Group			Total
	Younger	Middle	Elderly	
Ears (n)/patients (n)	25/25	64/62	48/46	137/133
Unilateral cases (n)	21	41	26	88
Age, years	23.6 (15–39)	56.9 (40–64)	69.7 (65–78)	55.3 (15–78)
Unilateral cases	23.4 (15–39)	56.4 (40–64)	69.6 (65–76)	52.5 (15–76)
Male:Female	8:17	17:45	17:29	42:91
Unilateral cases	5:16	10:31	8:18	23:65
Cause of COM (n)				
Tube insertion	6 (24.0%)	4 (6.3%)	2 (4.2%)	12 (8.8%)
Myringotomy	2 (8.0%)	0 (0.0%)	0 (0.0%)	2 (1.5%)
Trauma	2 (8.0%)	2 (3.1%)	1 (2.1%)	5 (3.7%)
Recurrent AOM	13 (52.0%)	34 (53.1%)	19 (39.6%)	66 (48.2%)
Other ^a	2 (8.0%)	24 (37.5%)	26 (54.1%)	52 (38.0%)
Wullstein classification				
I	22 (88.0%)	57 (89.1%)***	35 (72.9%)	114 (83.2%)
IIc	1 (4.0%)	0 (0.0%)	8 (16.7%)	9 (6.6%)
IIIi	1 (4.0%)	5 (7.8%)	3 (6.3%)	9 (6.5%)
IVc	0 (0.0%)	2 (3.1%)	0 (0.0%)	2 (1.5%)
IVi	1 (4.0%)	0 (0.0%)	2 (4.1%)	3 (2.2%)

*** $p=0.02$ vs. Elderly group. Data presented as mean (range) or n (%).

^aFungal, eosinophilic, and tubercular otitis media and perforation after steroid intratympanic injection.

AOM: acute otitis media; COM: chronic otitis media.

Table 2. Preoperative hearing

Variable	Younger (n=25)	Middle (n=64)	Elderly (n=48)
AC threshold (dB)	29.9±15.6 ^{b,c}	46.9±17.6 ^{a,c}	57.7±14.9 ^{a,b}
BC threshold (dB)	7.8±8.1 ^{b,c}	21.6±13.5 ^{a,c}	33.1±12.4 ^{a,b}
A–B gap (pre-patch)	22.1±12.4	25.3±11.5	24.6±10.4
Patch effect (dB) (at low frequencies)	33.2±20.6 ^{b,c}	22.3±22.3	19.4±23.3

Data presented as mean ± standard deviation.

A: air; B: bone; C: conduction.

^a $p<0.05$ vs. Younger

^b $p<0.05$ vs. Middle

^c $p<0.05$ vs. Elderly

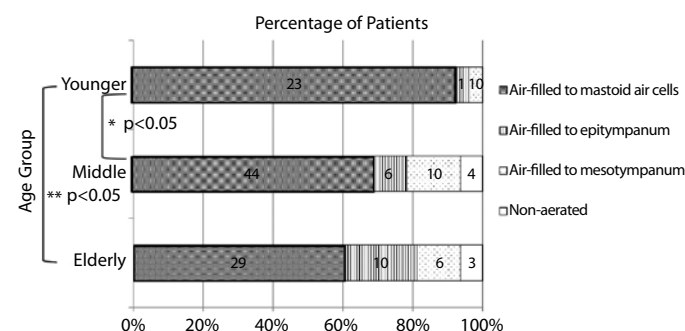


Figure 2. Temporal bone aeration for all age groups.

was no significant difference between the different age groups. Because the mastoid air cells grow poorly in the elderly even in the normal ears, there is a possibility that the physical size is involved in the difference in the size of the mastoid cells. Our results support the idea that the elderly patients had suffered from severe otitis media in childhood. One of the possible explanations is an immunologically compromised state because of poor nutritional intake and differences in therapeutic strategies that led to protracted inflammation of the middle ear. Previously, only local treatment such as tympanostomy was utilized as the primary treatment modality in Japan because of the absence of effective antibiotics, but the administration of antibiotics is now a standard treatment for severe acute otitis media in children [9, 10]. Because elderly patients over the age of 65 suffered from otitis media before antibiotics became a popular treatment, acute otitis media might have been hard to control and led to mastoiditis in those days, and recurrent acute otitis media might have inhibited the growth of their mastoid air cells in childhood.

Aeration to the level of the mastoid air cells occurred significantly more often in younger patients than in the middle or elderly groups in our study. A previous report found that hearing results were poorer in patients with significant mucosal disease [11]. Because mucosal disease was present in patients who had infection and poor aeration of the ear, we suggest that patients with a long history of otitis media might have lesions that could obstruct the ventilation route between the mastoid air cells and the tympanic cavity. We believe it is necessary to confirm a ventilation route during surgery if no aeration of the tympanic cavity is seen on preoperative CT scan and to consider performing additional procedures, such as granulation tissue or curable lesion removal, to maintain the ventilation route.

The present study indicates that preoperative air- and bone-conduction thresholds significantly increased with patient age. However, the increases in air-conduction thresholds were caused mainly by the increase in bone-conduction thresholds because there were no significant differences in the air–bone gap without patch among all age groups. Although bone-conduction thresholds increase gradually with age, and previous reports have also revealed elevated bone-conduction thresholds of 2000 Hz in cases of ossicular chain fixation (known as the Carhart effect) [12], it is still debatable whether chronic otitis media causes inner ear impairment and leads to sensorineural hearing loss. The mean bone-conduction thresholds were significantly worse in ears with poor pneumatization, and this indicated that the degree of bone-conduction threshold impairment might be related to the duration of the disease [13]. Chronic inflammation leads to cochlear damage, resulting in sensorineural hearing loss [14]. There was no relationship between the extent of tympanosclerosis and the severity of conductive hearing loss, but tympanosclerosis might result in sensorineural hearing loss depending on the involvement of the cochlea [15].

Clinical characterization of tympanosclerosis by preoperative audiometry shows a stiffness curve with elevated bone-conduction thresholds [16]. Because patch gain is obvious at 250 Hz and 500 Hz in patients with normal ossicular chain structure, we calculated the air–bone gap at those frequencies and found that the patch effect was significantly greater in the younger group. This suggested that ossicular chain failure due to chronic perforated otitis media was in progress in the middle and elderly groups. This result is consistent

with our finding of the higher proportions of Wullstein types III and IV tympanoplasty performed in elderly patients. The main causes of chronic perforated otitis media in the younger patients were tympanostomy and tube insertion. However, these procedures have been reported to be frequently followed by the development of myringosclerosis, a hyalinization and calcification of the tympanic membrane that is not related to significant hearing loss [17]. This could explain why hearing loss tended to be mild in younger patients.

Tympanosclerosis has an incidence between 11.6% and 43%, but the etiology and pathogenesis of tympanosclerosis are still not fully understood [18]. It is characterized by sclerotic and hyaline degeneration of the submucosal collagen layer of the middle ear [19] and can result in ossicular chain transection or fixation. In the present study, Wullstein type I was the most commonly performed tympanoplasty in patients of all ages with chronic perforated otitis media, which was consistent with previous reports [2, 4, 20]. We also found the proportions of Wullstein types III and IV tympanoplasty to be significantly higher in the elderly group than in the middle group, as suggested by a previous report that found that the proportion of patients undergoing Wullstein type III with columella increased with age [20]. Some of the subjects in our elderly group who underwent type I tympanoplasty had ossicular chain failure, but ossicular chain reconstruction was not performed because a minimally invasive and safe method was desirable due to their general conditions. Therefore, we speculate that the proportion of patients with ossicular chain failure who should have undergone Wullstein types III and IV tympanoplasty might actually have been greater. There was no significant difference, however, in the proportions of Wullstein types III and IV tympanoplasty between the elderly and younger groups. The number of patients in the younger group might have been too small to produce accurate results, so future studies with larger numbers of patients should be performed to verify this result.

CONCLUSION

The greater extent of mastoid and ossicular disease in elderly patients with chronic perforated otitis media suggests that the clinical history, including duration of inflammation in childhood, differs from that of younger patients. Prolonged inflammation from otitis media can cause varying degrees of tympanosclerosis, which might explain the differing pathological conditions in patients when grouped by age.

Ethics Committee Approval: Ethics committee approval was received for this study from the ethics committee of Jichi Medical University Saitama Medical Center (IRB RIN 15-100).

Informed Consent: Written informed consent was obtained from patients who participated in this study.

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