Original Paper

Long-Term Outcomes after Performing Tympanoplasty without Mastoidectomy for Active and Inactive Noncholesteatomatous Chronic Otitis Media

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Keywords

Epitympanic patency · Tympanoplasty · Chronic otitis media · Surgery

Abstract

Objective: This study aimed to assess long-term outcomes after performing tympanoplasty without mastoidectomy (TWOM) for active and inactive noncholesteatomatous chronic otitis media (COM) and to estimate the optimal time for surgery. **Methods:** The patients were placed into an active ear group (group A) and an inactive ear group (group B). All patients were followed up for 5 years after TWOM. **Results:** Ninety-two cases among 113 achieved dry ears in half a month to 1 month. The tympanic pressure gradually improved 3–6 months after the operation. A total of 69/72 ears achieved dry ears in the active ear group, and 37 ears had effective hearing improvement. In all, 40/41 ears achieved dry ears in the inactive ear group, and 20 ears had effective hearing improvement. There was no difference in the recurrence rate or hearing improvement in the two groups. **Conclusion:** With good quality control of the surgical treatment of TWOM, there are no differences in long-term outcomes in noncholesteatomatous COM in different chronic infection conditions.

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Background

Chronic otitis media (COM) is a common ear disease. Different surgeries are commonly performed during disease progression [1–5]. The technique of retrograde mastoidectomy is widely used to remove the lesion in the middle ear. Both the canal wall up and the canal wall down technique can be applied with acceptable audiometric results [6]. Although the mastoid and tympanic antrum seem to be filled with lesions as shown by high-resolution computerized tomography (HRCT) and magnetic resonance (MR) imaging, the available literature supports the notion that therapeutic mastoidectomy does not have any additional benefits for the management of noncholesteatomatous COM [3, 7–10]. However, we are not sure if it has the same long-term outcomes without performing mastoidectomy for noncholesteatomatous COM in variable preoperative infections. In this paper, we analyzed the impact of an active infection on the recurrence rate and hearing improvement over 5 years of follow-up after performing tympanoplasty without mastoidectomy (TWOM), particularly on recrudescence infections.

Materials and Methods

Clinical Data

The sample consisted of 160 patients with noncholesteatomatous COM, where 47 patients were lost to follow-up and 113 patients had complete clinical data. In all, 61 males and 52 females, ranging in age from 21 to 68 years, with an average age of 46.8 years, were subjected to surgical treatment from January 2010 to May 2012. The disease course was 1.5 years to 60 years, with an average course of 11.3 years. In these cases, 55 mastoid air cells were pneumatic, 13 mastoid air cells were sclerotic, and 45 mastoid air cells were diploetic. Eleven ears were complicated by tympanosclerosis. The cases included the following conditions: (1) ossicular chain damage, granulations or tympanosclerosis found in the middle ear; (2) space-occupying inflammatory lesions in the mastoid and tympanic antrum shown by HRCT of the temporal bone with no cholesteatoma found on intraoperative exploration; and (3) normal Eustachian tube function during the Valsalva maneuver or no mechanical obstructions confirmed while a catheter was used to probe the Eustachian tubes.

Methods

These patients were admitted and treated with TWOM. The patients were either placed into the active ear group (group A) based on chronic hyperemia and swelling of the tympanic membrane and the patients' description of liquid or pus draining from the ear canal at the time of admission or findings of obvious moisture or secretions in the external auditory canal and tympanic cavity during surgery. Other patients were placed into the inactive ear group (group B) if they experienced no pus or liquid draining from the canal at the time of admission and the tympanic mucosa was clean during the surgery. All of the patients were divided into stages I–IV according to the condition of the ossicles using the Wullstein classification. The surgical method was as follows: a posterior auricular groove incision was used, and the lateral attic wall was partly resected to expose the anterior epitympanic recess in the front and the tympanic antrum region in the back. To the bottom, we abraded part of the external auditory canal to remove all obstructive lesions. German Spiggle, a partial or total ossicular replacement prosthesis, was used for the ossicular chain reconstruction. The conchal cartilage or skull bone was used to reconstruct the lateral attic wall. The temporal fascia was used to reconstruct the tympanic membrane using the underlay technique. Routine oil gauze was used to fill the ear canal for 10 days after the operation. Patients were followed up for more than 5 years. The ear was considered dry if there were no complaints about fluid draining from the ear canal or local inflammation. The air conduction hearing threshold, bone conduction hearing threshold and air-bone gaps of patients at 0.25, 0.5, 1.0, 2.0, and 4.0 kHz were observed. Ears with air-bone gaps not more than 20 dB were considered effective ears [11]. The outcomes were analyzed using SPSS 18 software, and χ^2 tests were conducted for count data. If the *p* value was less than 0.05, the difference was statistically significant.

Results

Among the 113 patients (ears) with complete clinical data, there were 72 ears in the active ear group (group A). A large amount of purulent secretion without acute diffuse mucosal congestion was observed in the tympanum cavity of 4 ears in this group. There were 41 ears in the inactive ear group (group B). Of all cases, 92 ears had dry ears 1/2 to 1 month after surgery. The average time of achieving dry ear was 13.22 ± 3.95 days in group A, and it was 13.45 ± 3.07 days in group B. Three to 6 months after surgery, 13 patients complained of aural fullness and hearing fluctuations, and the tympanograms of 22 patients showed type B or C curves. Six months after surgery, 3 patients still had aural fullness or possible Eustachian tube dysfunction (C curves), with no improvement after the Valsalva maneuver, and 2 patients required postoperative tympanic membrane catheterization. No cases of facial paralysis, vertigo, or formation of cholesteatoma were found during the follow-up period.

Sixty-nine ears in group A (72 ears), among which 4 ears had large amounts of purulent secretion in the tympanic cavity, achieved dry ear status after surgery. There were 3 relapse cases, with a dry ear rate of 95.8%. Two cases underwent tympanoplasty later, and 1 case received additional mastoidectomy. Three ears showed small dry tympanic membrane perforations. The average preoperative air conduction hearing threshold was 53.22 ± 12.24 decibel hearing level (dB HL), and the average postoperative air conduction hearing threshold was 39.11 ± 10.93 dB HL. The average preoperative bone conduction hearing threshold was 21.32 ± 8.24 dB HL, and the average postoperative bone conduction hearing threshold was 20.63 ± 7.88 dB HL. The postoperative air-bone gaps decreased by 8.68 dB HL; the air-bone gaps were less than or equal to 20 dB in 51.4% of cases. Among the 41 ears in group B, 40 ears achieved dry ear status, with a dry ear rate of 97.6%. Only 1 case achieved dry ear after reoperation. Two ears showed small dry tympanic membrane perforations. The average preoperative air conduction hearing threshold was 51.33 ± 11.32 dB HL, and the average postoperative air conduction hearing threshold was 38.07 ± 11.24 dB HL. The average preoperative bone conduction hearing threshold was 20.89 ± 8.55 dB HL, and the average postoperative bone conduction hearing threshold was 20.03 ± 8.72 dB HL. The postoperative air-bone gaps decreased by 9.01 dB HL; the air-bone gaps were less than or equal to 20 dB in 48.8% of cases. Statistical analyses showed that there were no differences in the dry ear rate (corrected χ^2 test $p > 0.05$) or the hearing gain among the patients ($\chi^2 = 0.07$, $p > 0.05$) in the two groups (Table 1).

Discussion

Paparella et al. [12] proposed a continuous theory for otitis media, suggesting that all categories of otitis media represented different stages in a continuum of events. Active and inactive mucosal COM are considered part of a spectrum of otomastoiditis due to the anatomical connection between the middle ear cleft and the mastoid air cell system. Using HRCT and MR imaging, we found that the regions of the mastoid and tympanic antrum appeared to be filled with lesions in masked otitis media or quiescent COM. These observations suggest that the inflammatory proliferative lesions in the air cells are not consistent with clinical symptoms. During the mastoidectomies, we found that the lesions in the mastoid and tympanic antrum might not necessarily be consistent with the CT scan findings, which showed that the lesions filled up the air cells. This inconsistency might be due to the imaging technique or drainage of the secretions. In recent years, more and more evidence has shown that mastoidectomy does not improve outcomes in the management of noncholesteatomatous COM [13]. Studies have shown that the infection condition of the middle ear, the morphology

Table 1. Long-term outcomes after performing tympanoplasty without mastoidectomy in active and inactive noncholesteatomatous chronic otitis media

Infection state	Relapse			Hearing reconstruction (Wullstein)				Pure tone average, dB HL		Bone conduction, dB HL		Affected ear, <i>n</i>	Un-affected ear, <i>n</i>
	relapse	dry ear		I	II	III	IV	preop.	postop.	preop.	postop.		
		<i>n</i>	time, days										
A (active ear)	3	69	13.22±3.95	12	25	33	2	53.22±12.24	39.11±10.93	21.32±8.24	20.63±7.88	37	35
B (inactive ear)	1	40	13.45±3.07	8	12	19	1	51.33±11.32	38.07±11.24	20.89±8.55	20.03±8.72	20	21
Statistical analysis	correct χ^2 test, $p > 0.05$	$p > 0.05$										$\chi^2 = 0.07$ $p > 0.05$	

of the tympanic mucosa and blockage of the middle ear cleft could all affect tympanic membrane transplantation and tympanoplasty [14]. Toros et al. [9] conducted a retrospective comparison of the reconstruction of the tympanic membrane with or without mastoidectomy in 92 patients with sclerotic mastoids. The results showed that there was no difference in hearing improvement or tympanic membrane reconstruction. Mastoidectomy does not produce any additional benefits for the patients. Mishiro et al. [10] performed tympanoplasty in 213 patients with tympanic membrane perforations caused by chronic suppurative otitis media and followed them for more than 5 years. Logistic regression analysis showed that the ossicular chain was the only factor for evaluating long-term hearing outcomes after surgery, and even in active infection conditions, mastoidectomy was unnecessary. Hall et al. [15] summarized a number of clinical retrospective analyses and showed that there was no difference between reconstruction of the tympanic membrane and tympanoplasty with mastoidectomy.

In previous studies in gerbils, the mucosal epithelium of the middle ear cavity had an important impact not only on absorption but also on effusion clearance [16]. It is partially responsible for middle ear pressure. When the middle ear is under physiological conditions, the front and bottom of the tympanic mucosa are composed of columnar ciliated epithelium or stratified columnar epithelium, and the back is cuboidal epithelium or low columnar ciliated epithelium, containing goblet and intermediate cells. There are a number of mucosal folds in the tympanum in which the exudate tends to be gathered. Studies have shown that the high accumulation of exudate might mainly be due to obstructions in the middle ear cleft rather than Eustachian tube dysfunction. The granulation occurs in the inflammatory process. The lesions in the mastoid, tympanic antrum, and tympanum using HRCT could be divided into exudate, tympanosclerosis or other lesions by further examination, such as with an endoscope, enhanced MR or diffusion-weighted technology. According to the anatomical features of the temporal bone, the inflammatory lesions mainly involve the epitympanum, the tympanic antrum, and the region around the ossicular chain. The middle ears are more likely to escape from the risks of recurrence after surgery if the lesions are completely removed.

In the early stage of the process, postoperative recovery begins with hyperemia, edema, and increased secretions. The stuffing in the surgical cavity is gradually absorbed, and scar adhesion and contracture occur in the late stage 1–3 months after surgery. Mastoid mucosal metabolism could also affect the postoperative pressure in the tympanic cavity. In the follow-up with 113 patients, 13 patients complained of aural fullness and hearing fluctuations 3–6 months after surgery. The tympanograms of 22 patients showed type B or C curves. Half a year after surgery, 3 patients still had aural fullness or acoustic impedance examinations that

were considered relative dysfunction of the Eustachian tube (type C curves), and there was no improvement after the Valsalva maneuver, which required postoperative tympanic membrane catheterization. Tympanic pressure varied constantly during this process. In the early stage, the tympanic pressure might have caused artificial ossicle displacement and tympanic membrane perforation. In the late stage, the traction of the adhesion resulted in tympanic atelectasis and artificial ossicle displacement. Therefore, we must reconstruct the lateral attic wall, which is very important for maintaining the pressure in the middle ear, and relative dysfunction of the Eustachian tubes could be treated with drugs, Eustachian tube insufflation, and tympanic membrane catheterization if necessary.

It was previously suggested that maintaining a dry ear preoperatively as much as possible was important in otological practice. We wanted to determine the difference in outcomes between the different preoperative infection conditions after surgical intervention for noncholesteatomatous COM. Therefore, we conducted a long-term follow-up of patients in a state of active infection, setting inactive ears as the control group. During the surgery, the lateral attic wall was appropriately resected. We enlarged the external auditory canal and removed the important inflammatory obstructions, especially from the anterior tympanic isthmus, isthmus tympani posticus, and tympanic antrum. We checked the anterior epitympanic recess, the stapes footplate, and the posterior tympanum. If the lesions were located in a hidden corner, endoscopy was used for observation and treatment. Some granulation and sclerosis might be located in the side of the posterolateral tympanic antrum cavity, which does not need to be resected completely. Only if the tympanic antrum was totally blocked did we drill into the tympanic antrum to remove the blockage. Statistical analyses showed that there was no difference in the dry ear rate after TWOM in active and inactive ears, and the dry ear rates in the 2 groups were more than 95%. Moreover, among the 72 patients with active ears, 4 cases had large amounts of purulent secretions in the tympanic cavity, one of which experienced perioperative acute inflammatory attack and received preoperative antibiotic treatment for 7 days. All 4 cases achieved dry ears. All outcomes suggested that there was no impact on recurrence after performing TWOM, even though the ears were in different infection conditions.

Although many factors affect postoperative hearing results, the degree of ossicular destruction and the space surrounding the stapes are very important for hearing improvement [17–19]. In our study, we chose higher ossicular replacement prosthetics after reconstruction of the lateral attic wall. We chose NasoPore (Polyganic BV) with antibiotic ointment to fill the tympanic cavity to avoid adhesion around the auditory ossicles. We followed the 113 patients over 5 years. Hearing decreases in the air-bone gaps of the active and inactive ear groups were 8.68 and 9.01 dB HL, respectively. Statistical analyses showed that the hearing outcomes of the patients were not different in the 2 groups, and there were no significant differences in noncholesteatomatous COM in any infection condition, although there was some possible hearing bias in the 2 groups.

Regardless, improvements in surgical skills and equipment have come to change the management of noncholesteatomatous COM. We perform TWOM for noncholesteatomatous COM in any infection condition. We must screen the ear to control the quality of the operation. TWOM is not recommended if there is an unsuitable middle ear environment with antimicrobial resistance or in cases where prior tympanoplasty has failed, which means another surgical method should be chosen. Sensitive antibiotic therapy must be used at least 1 week before the operation and 3–5 days after the operation to control the acute inflammation in the middle ear, and it is not necessary in periods of persistent chronic infection and quiescence.

Conclusion

The middle ear with noncholesteatomatous COM may be in an inactive or active infection condition. Inflammatory proliferative lesions are usually found in the mastoid and tympanic antrum using HRCT scan. We believe that therapeutic mastoidectomy is not beneficial for noncholesteatomatous COM. Therefore, we have performed TWOM for active and inactive ears since January 2010. During the surgery, we resected the important inflammatory obstructions, especially in the anterior tympanic isthmus, isthmus tympani posticus, and tympanic antrum, to resolve obstructions of the Eustachian tube and to reconstruct the lateral attic wall and ossicular chain. For good quality control of the operation, there was no difference either in recurrence or hearing improvement when the middle ear was in different infection conditions. It did not affect the graft success of the tympanic membrane, even if there was a large amount of purulent secretions in the tympanum.

Statement of Ethics

The patients gave their informed consent, and the study protocol was approved by the institute's committee on human research.

Disclosure Statement

The authors have no conflicts of interest to disclose.

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