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Postoperative tympanic membrane retraction and recurrence rate in primary acquired cholesteatoma

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ABSTRACT

Objective: To investigate and compare the clinical characteristics and follow-up results of postoperative tympanic membrane (TM) retraction (without formation of a retraction pocket) and the recurrence rate (reformation of the retraction pocket) of different types of acquired cholesteatomas.

Methods: Ninety-nine patients (99 ears, one ear per patient) with primary acquired cholesteatoma who had undergone surgery between January 2011 and July 2012 were divided into pars flaccida, pars tensa, and combined groups according to the initial location of the retraction pocket with cholesteatoma. Canal wall up (CWU) and canal wall down (CWD) tympanomastoidectomies were performed in 17 and 82 patients, respectively. We analyzed the clinical data and followed up the patients every 6 months. Postoperative TM retraction and recurrence rates were calculated by Kaplan-Meier survival analysis. Cox regression model analysis was used to calculate the relative risk of each potential confounding factor of postoperative TM retraction and cholesteatoma recurrence.

Results: Surgical techniques, Eustachian tube (ET) function, stapes integrity, preoperative TM adhesion rates, and postoperative TM retraction rates were significantly different among the three groups. We found a significant difference in the cumulative postoperative TM retraction rates among the three groups; however, the cumulative recurrence rates were not significantly different among the groups. Combined cholesteatoma, ET dysfunction, and preoperative TM adhesion, which increased the risk of postoperative TM retraction showed no significant correlation with cholesteatoma recurrence.

Conclusion: Different types of cholesteatomas have different clinical characteristics. CWD tympanomastoidectomy combined with mastoid obliteration and soft-wall reconstruction is a reliable surgical technique for pars tensa and combined cholesteatoma.

Keywords: Cholesteatoma, classification, recurrence, surgical methods, tympanic membrane retraction

Introduction

Middle-ear cholesteatoma is a common disease in otolaryngology. Although cholesteatoma is a benign space-occupying lesion, it can invade the middle ear and adjacent structures, causing conductive and sensorineural deafness, labyrinthine fistula, peripheral facial paralysis, and intracranial infection, and it can even be life-threatening if not treated (1, 2). Cholesteatoma is classified into congenital and acquired types. Acquired cholesteatoma is not present at birth and is associated with a primary cause [a retraction pocket of the tympanic membrane (TM)] or secondary cause (a perforation or implantation from trauma or iatrogenic causes) (3). Primary acquired cholesteatoma can result from the development of a retraction pocket from the pars flaccida, pars tensa, or both, which could in turn result from middle-ear pressure adjustment disorders (3, 4). Therefore, primary acquired cholesteatoma can be divided into pars flaccida, pars tensa, and combined cholesteatoma, according to the originating location on the TM (4, 5). Pars flaccida cholesteatoma, also called attic cholesteatoma, is defined as a retraction of Shrapnell's membrane that extends into the attic through the superior incudal space and then invades the head of the malleus and incus body backward into the antrum and mastoid and downward into the posterior mesotympanum (1). Pars tensa cholesteatoma originates from the retraction or perforation of the pars tensa and tends to occur in the posterosuperior portion of the pars tensa, which is distant from the tympanic orifice of the auditory tube, in the incudostapedial joint and lenticular process. The route of extension is backward into the posterior tympanum; it involves the tympanic sinus and facial recess and passes upward into the epitympanum and antrum and even into the entire middle-ear area (6). Combined cholesteatoma is defined as a retraction pocket originating from both the pars flaccida and the pars tensa (3, 4).

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Because the pathogenesis and originating location on the tympanic membrane are different for the three types of cholesteatoma, each is associated with different clinical features, surgical options, and postoperative outcomes (3, 4, 7). The classification is important in selecting a surgical approach and making a prognosis (4, 7). However, studies on the follow-up and prognostic factors of different types of cholesteatoma are still lacking (8, 9).

TM retraction indicates Eustachian tube (ET) dysfunction and continuous negative pressure in the middle ear (3, 10, 11). If a retraction pocket forms and the middle ear loses its ability to self-clean, keratin debris begins to accumulate and develop into a cholesteatoma (3). Clinically, many patients with cholesteatoma who have undergone tympanoplasty continue to have ET dysfunction and disturbance of middle-ear pressure modulation, accompanied by postoperative TM retraction. However, there is a lack of relevant reports on whether postoperative TM retraction will develop into a retraction pocket and then cholesteatoma.

The surgical methods for cholesteatoma mainly include canal wall up (CWU) and canal wall down (CWD) tympanomastoidectomy. The CWU technique has advantages, which include restoration of anatomical and physiological structures, better hearing, and less postoperative care (12, 13). However, recurrences occur more frequently than in CWD (13). Sometimes a second look after 6 to 12 months is necessary before placing artificial ossicles (14-16). CWD tympanomastoidectomy combined with mastoid obliteration and soft-wall reconstruction alleviates the disadvantages of CWD to some extent (17). For patients with poor ET function, mastoid and attic filling can also prevent the risk of reformation of the retraction pocket in the mastoid cavity.

The purpose of this study was to investigate and compare the clinical characteristics and follow-up results of postoperative TM retraction and recurrence rates in different types of primary acquired cholesteatoma to help determine surgical strategies for patients with cholesteatoma.

Methods

Study population

This is a retrospective cohort study. We screened 99 patients (99 ears) with primary acquired middle-ear cholesteatoma who were treated at the First Affiliated Hospital of China Medical University between January 2011 and July 2012. The exclusion criteria were as follows: 1. secondary cholesteatoma, 2. congenital cholesteatoma, 3. previous tympanomastoidectomy, and 4. need for second-look surgery. We retrospectively analyzed the patients' clinical data, including sex, age at surgery, classification, surgical approach, stapes integrity, ET function, preoperative TM adhesion, and follow-up results, including postoperative retraction of TM and recurrence. The patients were divided into three groups according to the initial location of the retraction pocket with cholesteatoma, including pars flaccida cholesteatoma, pars tensa cholesteatoma, and combined cholesteatoma, which is defined as a cholesteatoma with an initial location involving both the pars flaccida and pars tensa that could not be categorized into one of the former two types. This study was approved by the ethic committee of the First Affiliated Hospital of China Medical University (approval no: [2016] 2016-4-2).

Main Points:

- It is important to recognize the classification of primary acquired cholesteatoma to select the appropriate surgical method for the different clinical characteristics.
- Compared with pars flaccid, Pars tensa and combined cholesteatoma were more likely to have postoperative tympanic membrane retraction.
- There was no difference in recurrence among the three types of primary acquired cholesteatoma.
- CWD tympanomastoidectomy combined with mastoid obliteration and soft-wall reconstruction is a reliable surgical technique.

There were 54 men and 45 women, ranging in age from 5 to 87 years, with an average of 43.36±18.83 years at the time of operation. Thirteen patients (13.13%) were children aged 5 to 17 years. The mean follow-up period was 50.46 months (range 12-76 months). Among the patients, there were 42 cases (42.42%) of pars flaccida cholesteatoma with a mean follow-up period of 54.48 months (range 12-74 months); 32 cases (32.32%) of pars tensa cholesteatoma with a mean follow-up period of 48.84 months (range 12-75 months); and 25 cases (25.25%) of combined cholesteatoma with a mean follow-up period of 45.44 months (range 12-76 months).

Surgical methods

Two surgical approaches were used: CWU tympanomastoidectomy and CWD tympanomastoidectomy combined with mastoid obliteration and soft-wall reconstruction. In CWD tympanomastoidectomy, autologous bone powder was collected and filtered for mastoid obliteration. A temporalis myofascial flap and temporal fascia were used to underlay the external auditory canal skin and TM, to reconstruct the removed posterior canal wall (soft-wall reconstruction) and TM (Figure 1. a, b.). Intraoperative endoscopy might be used in the some difficult cases to resolve any doubt about the complete removal of cholesteatoma (18). An ossicular chain reconstruction was completed simultaneously without a staged operation. According to the ossicular condition and the level of hearing loss, ossicular chain reconstruction was performed using partial ossicular replacement prosthesis or total ossicular replacement prosthesis or no ossicular chain reconstruction. The cartilage is placed on the ossicular prosthesis to support the TM.

Before surgery, ET function was examined using a modified pressure-equilibration inflation-deflation test (19). Pressures of +300 daPa and -300 daPa were applied to the middle ear. The patient was asked to swallow 5 times at intervals of 5 seconds. If the applied positive and negative pressures were equilibrated after swallowing, ET function was judged to be good. If positive pressure was equilibrated but negative pressure could not be equilibrated or if neither positive nor negative pressure could be equilibrated, ET function was judged to be poor.

In the preoperative evaluation, the attachment of TM and the promontory was considered TM adhesion. Postoperative TM

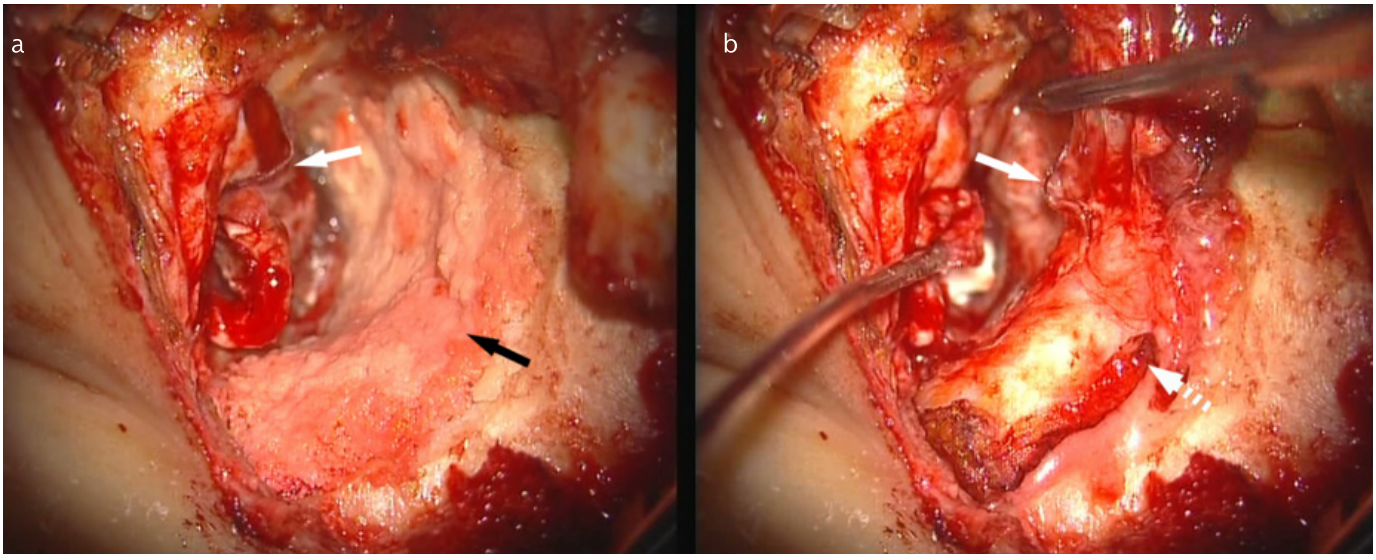

Figure 1. a, b. CWD tympanomastoidectomy and mastoid obliteration combined with soft-wall reconstruction (left ear). The mastoid cavity is filled with autologous bone powder (black arrow) (a), which is held together with biological glue. The temporal fascia (white arrow) and temporalis myofascial flap (white dashed arrow) cover the bone powder and underlie the residual external auditory canal skin and tympanic membrane as a posterior canal wall (soft-wall reconstruction) (b)

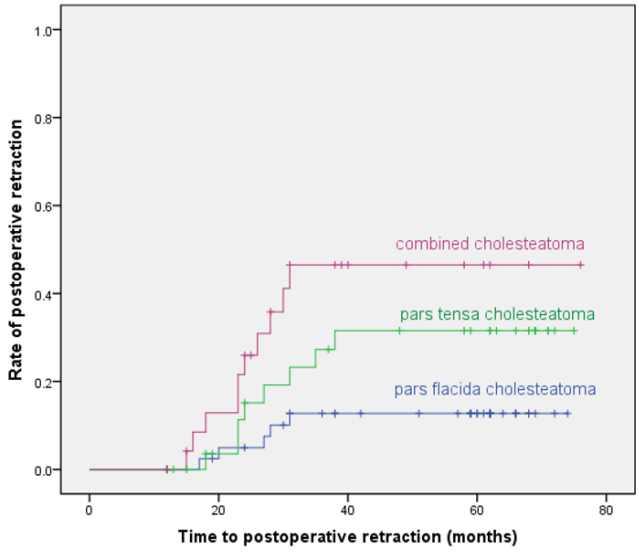

Figure 2. Postoperative TM retraction curves for the patients in the pars flaccida, pars tensa, and combined groups. The cumulative rates of postoperative TM retraction were significantly different among the three groups (Kaplan-Meier, p=0.010, log-rank test)

retraction is defined as retraction of the reconstructed TM to the tympanic cavity. All surgeries were performed by the same doctor with 20 years of surgical experience. Preoperative and postoperative observations and evaluations were performed by a mid-level otolaryngologist.

Statistical analyses

The screened patients were followed up every 6 months at our department. Clearing of the postoperative external auditory canal and observation of the tympanic membrane were conducted at every follow-up. Patients with a suspected reappearance of cholesteatoma (recurrence and residual) underwent computed tomography and a second operation. We calculated the postoperative TM retraction and recurrence rates using Kaplan-Meier survival analysis. Potential confounding factors of postoperative TM retraction and recurrence were inputted into the Cox regression model for univariate analysis, which included age, sex, surgical procedure, stapes integrity, ET function, preoperative TM adhesion, and cholesteatoma classification. The categorical variables were analyzed using chi-square tests and Fisher's exact test. A p value <0.05 was set as the criterion for statistical significance. The Statistical Package for Social Sciences version 22.0 software (IBM Corp.; Armonk, NY, USA) was used to analyze the data.

Results

Among all 99 ears, closed tympanomastoidectomy (CWU) was performed in 12 cases of pars flaccida cholesteatoma, 5 cases of pars tensa cholesteatoma, and 0 cases of combined cholesteatoma. The rest of the patients underwent open tympanomastoidectomy (CWD) combined with mastoid obliteration and soft-wall reconstruction. In addition to the surgical technique, ET function, integrity of the stapes, preoperative TM adhesion, and postoperative TM retraction were significantly different among the three groups (Table 1).

Postoperative retraction of the TM began during postoperative years 2-3 and generally did not occur after year 3. The postoperative retraction rates in the pars flaccida, pars tensa, and combined groups were 11.9%, 25%, and 40%, respectively, which were significantly different (chi-square tests, p=0.03, Table 1). A significant difference in cumulative postoperative retraction rates among the pars flaccida, pars tensa, and combined groups is shown in Figure 2 (Kaplan-Meier, log-rank, p=0.01).

No residual cholesteatomas were found in this study. Recurrent cholesteatomas were observed in 5 ears during the observation period. They included 1 ear in the pars flaccida group, 2 ears in the pars tensa group, and 2 ears in the combined group. Recurrent disease was diagnosed at 15 months, 37 months,

Table 1. Characteristics of the patients in the pars flaccida, pars tensa, and combined cholesteatoma groups

	Pars flaccida (42)	Pars tensa (32)	Combined (25)	p
Sex				0.933
Female	20 (47.6%)	14 (43.8%)	11 (44.0%)	
Male	22 (52.4%)	18 (56.2%)	14 (56.0%)	
Age				0.648
Adult	35 (83.3%)	28 (87.5%)	23 (92.0%)	
Child	7 (16.7%)	4 (12.5%)	2 (8.0%)	
Surgery				0.006
CWD	30 (71.4%)	27 (84.4)	25 (100.0%)	
CWU	12 (28.6%)	5 (15.6%)	0 (0.0%)	
Stapes				0.003
Destroyed	10 (23.8%)	16 (50.0%)	16 (64.0%)	
Intact	32 (76.2%)	16 (50.0%)	9 (36.0%)	
ET function				0.037
Good	33 (78.6%)	21 (65.6%)	12 (48.0%)	
Bad	9 (21.4%)	11 (34.4%)	13 (52.0%)	
Preoperative TM adhesion				0.046
No	32 (76.2%)	18 (56.3%)	12 (48.0%)	
Yes	10 (23.8%)	14 (43.8%)	13 (52.0%)	
Postoperative retraction of TM				0.030
No	37 (88.1%)	24 (75.0%)	15 (60.0%)	
Yes	5 (11.9%)	8 (25.0%)	10 (40.0%)	
Recurrence				
No	41 (97.6%)	30 (93.8%)	23 (92.0%)	0.605
Yes	1 (2.4%)	2 (6.2%)	2 (8.0%)	

CWD: canal wall down; CWU: canal wall up; ET: Eustachian tube; TM: tympanic membrane

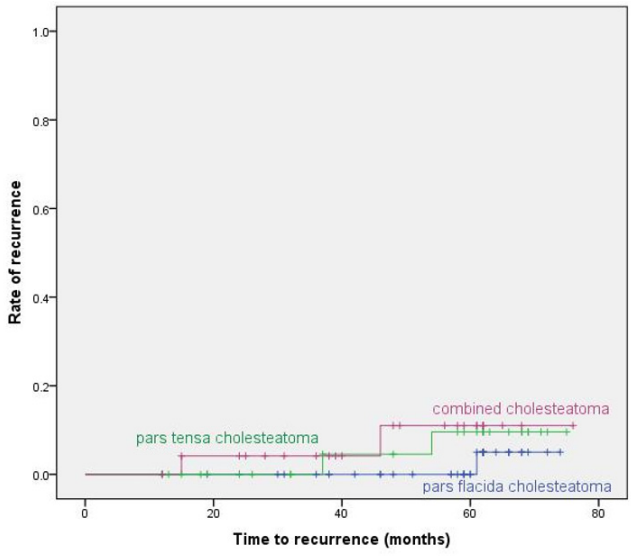

Figure 3. Recurrence curves for the patients in the pars flaccida, pars tensa, and combined cholesteatoma groups. The cumulative recurrence rates are not significantly different among the three groups (Kaplan-Meier, p=0.422, log-rank test)

46 months, 54 months, and 61 months. The recurrence rates within the observation period in the pars flaccida, pars tensa, and combined groups were 2.4%, 6.2%, and 8%, respectively, which were not significantly different (chi-square tests, p=0.556, Table 1). Likewise, the cumulative recurrence rates were not significantly different among the three groups as calculated using the Kaplan-Meier method (log-rank, p=0.422, Figure 3).

Table 2 presents the relative risk of each potential confounding factor for postoperative TM retraction and cholesteatoma recurrence using a Cox regression model for univariate analysis. Damaged stapes, ET dysfunction, preoperative TM adhesion, and combined cholesteatoma significantly predicted postoperative retraction of the TM (Table 2). The surgical method was significantly correlated with cholesteatoma recurrence. Moreover, age and stapes integrity were somewhat correlated with cholesteatoma recurrence but not to a statistically significantly extent (Table 2). Interestingly, ET dysfunction, preoperative TM adhesion, and combined cholesteatoma, which predicted the risk of postoperative TM retraction, showed no significant relationship with recurrence in the Cox regression model (Table 2).

Table 2. Cox regression univariate analysis of potential confounding factors for postoperative TM retraction and recurrence.

		Postoperative retraction of TM			Recurrence		
Factors	Cases	Events, n	Hazard ratio	p	Events, n	Hazard ratio	p
Sex				0.256			0.768
Female	45	13	1		2	1	
Male	54	10	0.62 (0.27-1.4 2)		3	1.31 (0.22-7.84)	
Age				0.126			0.088
Adult	86	18	1		3	1	
Child	13	5	2.17 (0.81-5.86)		2	4.75 (0.79-28.43)	
Surgery				0.236			0.041
CWD	82	17	1		2	1	
CWU	17	6	1.76(0.69-4.46)		3	6.51 (1.08-39.12)	
Stapes				0.003			0.074
Intact	57	7	1		1	1	
Destroyed	42	16	3.94 (1.62-9.62)		4	7.41 (0.82-66.79)	
ET function				0.000			0.228
Good	66	1	1		0	1	
Bad	33	22	70.91 (9.49-529.75)		5	0.004 (0.00-32.69)	
Preoperative TM adhesion				0.000			0.217
No	62	1	1		0	1	
Yes	37	22	25.57 (5.96-109.63)		5	0.008 (0.00-17.57)	
Classification				0.019			0.473
Pars flaccida	42	5	1		1	1	
Pars tensa	32	8	2.60 (0.85-7.95)	0.094	2	2.97 (0.27-32.84)	0.374
Combined	25	10	4.67 (1.59-13.72)	0.005	2	4.47 (0.40-49.44)	0.222

CWD: canal wall down; CWU: canal wall up; ET: Eustachian tube; TM: tympanic membrane. Values in parentheses are 95% CI

The time to a dry ear for all patients was 4-10 weeks after surgery. The operative complications included sensorineural hearing loss in 2 cases, transitory facial paresis in 1 case, and otorrhea in 3 cases. All the patients with postoperative otorrhea caused by surgery-associated infection had undergone mastoid obliteration with autologous bone powder and temporalis myofascial flap. The infection was caused by an unhealthy lining under the auditory canal skin and TM and the need for repeated dressing and treatment with antibiotic ear drops.

Discussion

Because of the different pathogenesis and the originating locations of the retraction pocket, the three types of cholesteatomas have different clinical features, surgical options, and postoperative effects. The pars tensa and combined cholesteatomas had higher proportions of ET dysfunction, stapes superstructure destruction, preoperative TM adhesion, and postoperative retraction, and they were subjected to CWD more often (Table 1).

ET dysfunction maintains continuous negative pressure in the tympanic cavity, which may play a key role in the formation of a TM retraction pocket and then cholesteatoma (3, 10). Many patients with cholesteatoma have ET dysfunction that cannot be effectively improved after surgery. Negative pressure caused by ET dysfunction leads to recurrent postoperative TM retraction. In our current study, the pars tensa and combined groups had a greater proportion and risk of postoperative TM retraction (Table 1, 2). This could well be due to their having an increased proportion of ET dysfunction and preoperative TM adhesion (Table 1), both of which had a significant correlation to postoperative TM retraction (Table 2). There may be other reasons as well. First, pars tensa and combined cholesteatoma present more serious damage to the pars tensa and mesotympanic mucosa because of the ulcer, granulation tissue, and perforation caused by inflammation. Second, the handle of the malleus, which plays an important supporting role, is compressed by the adhesive TM and becomes thinner and deformed, even partially or completely disappearing. Third, the adhesive pars tensa TM becomes atrophic and thinned because of the absence of collagens in the TM (20). Therefore, in the cases of pars tensa and combined cholesteatoma, the TM is more likely to undergo postoperative retraction, fibrosis, and adhesion.

Postoperative retraction of the TM began to appear in postoperative years 2-3 and produced a significant difference in the cumulative postoperative retraction rates among the three types of cholesteatoma (Figure 2, p=0.01). Cox regression analysis showed that combined cholesteatoma had a relative risk of postoperative retraction that was 4.67 times that of pars flaccida cholesteatoma (Table 2). Pars tensa cholesteatoma also had a higher rate of postoperative retraction than that of pars flaccida cholesteatoma (Table 1), despite not being a significant predictor of postoperative retraction according to the Cox regression analysis (Table 2, p=0.094). Interestingly, however, there was no significant difference in recurrence between the pars flaccida, pars tensa, and combined groups (Tables 1 and 2; Figure 3). This implies that postoperative TM retraction does not necessarily develop into recurrent cholesteatoma. There may be two possible reasons for this. First, it is clear that CWD tympanomastoidectomy combined with mastoid obliteration and soft-wall reconstruction is a reliable surgical method for preventing recurrence. The obliteration of the mastoid and attic prevented a retraction pocket from forming again in the mastoid cavity, despite the continued presence of both ET dysfunction and postoperative TM retraction in the patients who had undergone surgery. Second, we usually choose the CWU procedure with caution.

In addition, there were differences in the integrity of the stapes between the three groups (Table 1). Different parts of the invaginated TM determine the degree of damage to the ossicular chain. The numbers of cases of stapes superstructure destruction in the pars tensa and combined groups were obviously greater than that in the pars flaccida group. This finding could well be due to pars tensa and combined cholesteatomas tending to invade the middle and posterior portion of the tympanum where the stapes is located. In addition, stapes integrity showed some degree of correlation with recidivism despite there being no significant difference (Table 2, p=0.074). The invasion into the posterior tympanum that causes advanced destruction of the stapes has been reported as a risk factor for recidivism of cholesteatoma (15, 18). A p value greater than 0.05 may be due to the small number of cases and the shorter follow-up time (21).

The main goal of surgical treatment for cholesteatoma is to thoroughly remove the cholesteatoma and avoid residuum and recurrence (12). Because of the surgeon's experience and the use of endoscopy, there was no residual cholesteatoma in this study. However, CWU had a relative disadvantage as its risk for recurrence of cholesteatoma was 6.51 times that of CWD (Table 2, p=0.041). Given the characteristics of pars tensa and combined cholesteatoma, we suggest that CWU should be chosen carefully for these categories of cholesteatoma. We usually select CWU in the following cases: pediatric patients, a generally well-pneumatized mastoid, normal ET function, and good middle-ear mucosa status without TM adhesion. Thus, in this study we had a higher proportion of CWU in the pars flaccida group (Table 1). It is also due to our cautious choice of CWU according to the indications. The prevalence of postoperative TM retraction did not differ significantly between CWU and CWD. Actually, cases that meet these indications are not common, especially those with pars tensa or combined cholesteatoma. Therefore, the CWD tympanomastoidectomy combined with mastoid obliteration and soft-wall reconstruction is the most frequently used surgical method at our hospital (Figure 1a, b). It combines the advantages of both CWU and CWD tympanomastoidectomy in that it can provide a wide field of vision during operation, maximally avoid residual cholesteatoma, and approximately restore the normal anatomical structures of the external auditory canal, which can simplify postoperative care and, more importantly, prevent retraction pocket formation in the mastoid cavity even if ET function is difficult to recover (17, 22). The filling of the mastoid cavity and attic relieves the negative pressure load on the TM, avoids the development of postoperative retraction into a retraction pocket, and further prevents the reformation of cholesteatoma. In addition, filling the attic to the level of the tympanic annulus deepens the tympanic depth, relieves the retraction and adhesion of the TM, and is conducive to vibration of the TM for improved hearing. However, the number of cases was limited, and a long-term study with a large sample is still needed to confirm these findings.

Different types of cholesteatoma have different clinical characteristics and prognoses. It is important to correctly recognize the classification of cholesteatoma to select the appropriate surgical method and reasonably evaluate the postoperative effect. The disease is best treated by removing the lesion completely and avoiding recurrence to the greatest degree possible. Here, pars tensa cholesteatoma and combined cholesteatoma were more likely to have postoperative TM retraction, but there was no difference in recurrence among the three types of cholesteatoma. This indicates that CWD tympanomastoidectomy combined with mastoid obliteration and soft-wall reconstruction is a reliable surgical technique that solves this problem very well.

Ethics Committee Approval: This study was approved by the ethic committee of the First Affiliated Hospital of China Medical University (approve no: 2016-4-2).

Informed Consent: This is a retrospective cohort study, and the data collection of the patients does not involve patient privacy and personal information, the informed consent is exempted.

Peer-review: Externally peer-reviewed.

Author Contributions: Concept – J.Z.; Design – J.Z., X.J.; Supervision – J.Z., X.J.; Resources – J.Z., S.F.; Materials – J.Z., S.F.; Data Collection and/or Processing – J.Z., S.F.; Analysis and/or Interpretation – X.J., S.F.; Writing Manuscript – J.Z.; Critical Review – J.Z., X.J.

Conflict of Interest: The authors have no conflicts of interest to declare.

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