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Original Article

Canal Wall Down Timpanoplasty with Partial Mastoid Obliteration in Children and Adults Affected by Chronic Otitis Media with Cholesteatoma

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BACKGROUND: The aim of the study is to evaluate the incidence of recurrence of acquired cholesteatoma and functional outcomes in patients who underwent CWD tympanoplasty with cavity obliteration using an inferior-based musculoperiosteal flap. A comparison between children and adults was conducted.

METHODS: All surgeries performed by the same expert surgeon from 2016 to 2019 were considered for the study. Patients younger than 18 years old, operated on at Meyer's Children Hospital, formed group A. Patients older than eighteen, operated on at Santo Stefano Hospital, formed group B. Clinical, audiological, and radiological data were collected from medical records. The Air Bone Gap (ABG) was used to assess the audiological results, and outpatient evaluations were considered to detect cases of recurrence.

RESULTS: Group A and Group B are composed of 23 and 25 patients, respectively. The postoperative ABG is 30.7 dBHL in group A and 29.5 dBHL in group B. The rate of recurrence is 17.2% in children and 8% in adults. The recurrence of cholesteatoma occurred in five children (21.8%) after an average follow-up of 18 months and in three adults (12%) after an average follow-up of 24 months.

CONCLUSION: The surgical approach to CCOM in children aims to be as conservative as possible. The greater extension of the pathology is correlated with a greater erosion of the ossicular chain. According to our experience, open tympanoplasty with the obliterative technique allows us to obtain good anatomical and audiological outcomes, both in adults and children.

KEYWORDS: Children, cholesteatoma, ear surgery, otitis media, tympanoplasty

INTRODUCTION

In literature, the incidence of acquired cholesteatoma in the early 2000s is described to be 3:100 000 in the pediatric population and 9:100 000 in adults.[1]

More recent data regarding the epidemiology of cholesteatoma report the incidence to be 8.1-8.6 per 100,000 person-years for 2007-2008 and 2017-2018, respectively. The cholesteatoma's annual incidence is actually estimated at 6-15 cases in 100 000 people.[2,3]

Acquired cholesteatoma is due to a diffusion of keratinized squamous epithelium within the cavities of the middle ear. This pathology does not have a system of blood vessels therefore treatment with systemic antibiotics is not useful, while local antibiotics are able to treat the infection of the most lateral portion of the mass without removing the pathology, which could be persistent or recurrent.[4]

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Surgery is the main treatment, and tympanoplasty is the scheduled procedure. Wullstein and Zollner were the first to use tympanoplasty as a therapy for this pathology in the 1950s. Since that time, tympanoplasty has undergone numerous surgical changes in the following years.[5]

Canal wall up (CWU) and canal wall down (CWD) tympanomastoidectomy are the two main techniques to treat a cholesteatoma. The first one, in a single stage or in two stages, guarantees a better quality of life, especially in children since it doesn't need regular cleaning and water precautions. On the other hand, CWD creates a unique cavity between the middle ear and mastoid that could require regular debridement but reduces the risk of recurrence.[6-9] However, to avoid problems related to an open cavity, an obliterative technique could be performed, and in literature several different techniques and materials were described for mastoid obliteration.[10-14]

The aim of the study is to evaluate the incidence of recurrence of acquired cholesteatoma and the functional outcomes by comparing the pediatric and adult populations who underwent CWD tympanoplasty with cavity obliteration using an inferior-based musculoperiosteal flap (Palva Flap) and ossiculoplasty without staging.

MATERIALS AND METHODS

A retrospective review was performed on a series of patients affected by acquired cholesteatoma who underwent CWD mastoidectomy with cavity obliteration using postauricular inferior-based musculoperiosteal flap (Palva flap) and ossiculoplasty in one stage.

Exclusion criteria were patients with congenital cholesteatomas, revision surgery, and patients lost during the follow-up.

All patients considered were classified into two Groups: group A (under 18 years old) and Group B (over 18 years old).

All subjects were operated on by the same senior surgeon from 2016 to 2019, and the minimum follow-up was 12 months. A pre-operative CT scan was performed in all cases in order to assess the extent of disease.

All procedures performed in studies involving human participants were in accordance with the national research committee and the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. The study was approved by the Ethics Committee of the site of the coordinating investigator, the Comitato Etico Regione Toscana-Pediatrico (CERT-P), Italy (approval number 117/2024, date: July 19, 2024).

Informed consent was obtained from all individual participants included in the study.

The research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Procedure Description

A retroauricular incision was performed, with the subsequent anterior elevation of the musculo-periosteal flap. The mastoidectomy was performed, and the facial ridge was lowered while remaining slightly higher than the profile of the lateral semicircular canal. To ensure more accurate removal of the pathology, the incus was disjointed from the stapes, then the incus and the head of the malleus were removed to explore the anterior attic. After complete cleaning of the middle ear structures, meatoplasty was carried out.

The autologous conchal cartilage was used to seal off the epitympanum and to reconstruct the ossicular chain. The eardrum was restored using autologous temporal muscle fascia with the underlay technique. Finally, the vascularized inferior-based musculoperiosteal flap was used for the obliteration of the mastoid cavity.

Data Collection and Statistical Analysis

The medical records were reviewed, and data regarding demographics, pre- and post-operative hearing, site and extension of cholesteatoma, intra-operative findings, recurrence, and residual cholesteatoma were collected. For each procedure, intraoperative, early, and delayed postoperative complications were evaluated.

The median (as well as the interquartile range [IQR] and total range) ABGs for four frequencies (500, 1000, 2000, and 3000 Hz) as recommended by the American Academy of Otolaryngology-Head Neck Surgery System were calculated pre-operatively and at 6months post-operatively.[15] The distribution of the different characteristics was compared between the two groups by means of Fisher's exact test and Wilcoxon's test for categorical and continuous variables, respectively.

RESULTS

Demographics and Clinical Aspects

The groups A and B were composed of 22 and 25 patients, respectively. Table 1 shows the demographics and clinical characteristics. Table 2 summarizes the cholesteatoma anatomical location, and Table 3 the condition of the ossicular chain according to Austin classification.[16]

Pre and Postoperative Hearing outcomes

The median preoperative ABG between 0.5 and 3 kHz in group A was 27 dB HL (IQR 20-35, range 5-43), and in group B was 19 dB HL (IQR 9-31, range 5-44), *P*-value for the difference 0.060. Regarding the postoperative ABG, the median value was 35 in group A (IQR 20-42, range 8-47) and 27 in group B (IQR 20-37, range 5-55), *P*-value for the

Table 1. Patients Demographics of Groups A and B.

	Group A (<18 years) (n = 22)	Group B (> 18 years) (n = 25)	*P*-value
Median age (yrs)	11.3 (IQR 8.6-13-3, range 3.9-19.8)	63.4 (IQR 52.0-72.6, range 22.9-79.7)	<.001
Male/Female	19 (86.4%)/3 (13.6%)	20 (80.0%)/5 (20.0%)	.706
Right/left ear	12 (54.5%)/10 (45.5%)	9 (36.0%)/16 (64.0%)	.248
Median follow-up (months)	39 (IQR 14-43, range 10-48)	25 (IQR 14-28, range 13-48)	.110

IQR, interquartile range.

Table 2. Cholesteatoma Anatomical Locations

Location	Group A (<18 years) (n = 22)	GroupP B (> 18 years) (n = 25)	*P*-value
Epitympanum	1 (4.5%)	2 (8.0%)	<.001
Mesotympanum	0 (0.0%)	2 (8.0%)	
Mastoid	3 (13.6%)	0 (0.0%)	
Epitympanum + Mastoid	6 (27.3%)	11 (44.0%)	
Epitympanum + Mesotympanum	1 (4.5%)	2 (8.0%)	
Epitympanum + Mesotympanum + Mastoid	2 (9.1%)	8 (32.0%)	
Mesotympanum + Mastoid	9 (40.9%)	0 (0.0%)	

difference 0.616. In both groups, no complications occurred during and after the surgery.

Cholesteatoma Recurrence

Five children (group A) and 3 adults (group B) had cholesteatoma recurrence. The rate of cholesteatoma recurrence was 22.73% in children and 12.0% in adults, *P*-value for the difference of .329. The odds ratio is 2.16 (95% CI 0.35-15.61).

DISCUSSION

The best surgical choice regarding chronic otitis media with cholesteatoma is still a debated topic, especially for children. The aim of the surgery is to create a dry, safe, and self-cleaning ear postoperatively, and the cavity performed should be easy to inspect and monitor for recurrent/residual disease.[17] The advantages and disadvantages of CWU and CWD techniques have been the subject of discussion for many years.[18-20] Many authors argue that the CWU technique has a high rate of recurrence and residual disease due to limited intraoperative exposure and the occurrence of postoperative retraction pockets, especially if a dysfunctional Eustachian tube is present, as often occurs in children. Therefore, to decrease the risk of recurrence and retraction, the addition of a second look surgery and positioning of cartilage in the attic region are recommended.[21] The CWD is the surgery of choice in situations like extensive disease, the presence of a low-lying dura, or an anterior sigmoid sinus.[22] Mastoid obliteration could be performed in patients undergoing CWD mastoidectomy to reduce the volume of the cavity and for aesthetic reasons (smaller meatoplasty), as a primary procedure in the same sitting or as a secondary revision.[23] The size of the cavity could be reduced by partial obliteration of the retrofacial space and the sinus-dura angle. Some authors suggested that obliteration of the mastoid cavity decreases the surface area of mucosa that can absorb nitrogen, making the tympanic membrane less prone to retraction.[24] To perform mastoid obliteration, biologic and non-biological free grafts and local flaps could be used.[25,26] Among the different types of flaps, the Palva flap, described and used since the early 1950s for mastoid obliteration and simultaneous reconstruction of the posterior canal wall, remains the most commonly adopted.[27] It was designed to have a wide and long pedicle at the level of the posterior and superior sides, placed on the facial ridge in the mastoid cavity and extended to the aditus ad antrum.[10] In our surgical practice, we perform a CWD tympanoplasty with partial mastoid obliteration both in children and adults for extensive cholesteatomas in which the intact ear canal does not allow us to adequately explore adequately the tympanic cavity and remove the entire cholesteatoma. We generally prefer the single-stage technique, but in children, it is generally recommended to perform two stages, with the second stage 10-12 months after the first one. The modified Palva flap we use is cut horizontally at the EAC level, pedunculated inferiorly, and rotated into the mastoid cavity (Figure 1). The attic is obliterated using autologous conchal cartilage. The benefit of a properly obliterated cavity is a correspondingly smaller conchomeatoplasty than that performed in the CWD technique without cavity obliteration.

Table 3. Ossicular Chain Status Intraoperatively.

State of Ossicular Chain	GROUP A (<18 years) (n = 22)	GROUP B (> 18 years) (n = 25)	*P*-value
OC normal	2 (9.1%)	0 (0.0%)	.146
M+S+	7 (31.8%)	15 (60.0%)	
M+S–	6 (27.3%)	3 (12.0%)	
M–S–	5 (22.7%)	3 (12.0%)	
M–S+	2 (9.1%)	4 (16.0%)	

M–, malleus absent; M+, malleus present; OC, ossicular chain; S–, stapes absent; S+, stapes present.

According to the EAONO/JOS Staging System for acquired middle ear cholesteatoma, postoperative hearing results are worse when the disease is diagnosed in advanced stages. Most patients with cholesteatoma at stage I have favorable hearing outcomes (< 20 dB). In literature, some authors reported similar hearing outcomes in children who underwent CWU or CWD techniques.[8,28] The hearing level may not be not used to make decisions regarding the most useful surgical treatment; CWD can also result in good hearing outcomes.[29]

In CWD tympanoplasty with mastoid obliteration, good hearing results have been reported with a post-operative ABG of 16.59 dB HL compared with 25.83 dB HL before surgery, without distinguishing children and adults. The ABG after a CWU technique with reconstruction of the ossicular chain by total ossicular replacement prosthesis (TORP) or partial ossicular replacement prosthesis (PORP) procedures could not be significantly better than after a CWD technique. The presence or absence of the superstructure of the stapes seems to

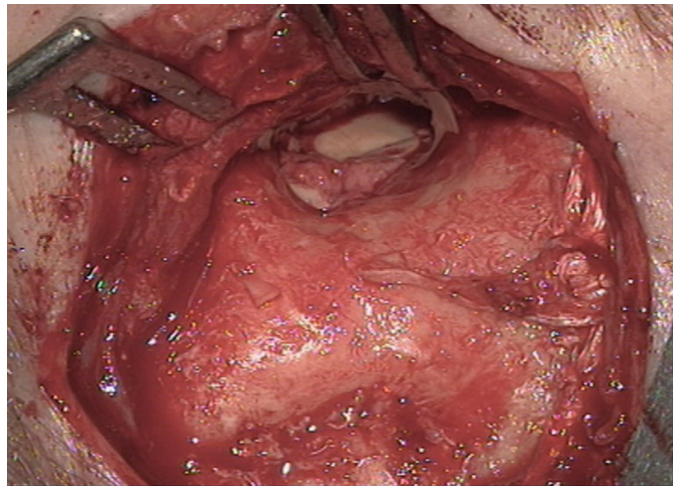

Figure 1. The musculoperiosteal flap is cut horizontally at the EAC level, pedunculated inferiorly, and rotated into the mastoid cavity.

influence the result.[30] In our study, the average postoperative hearing is worse in children (30.7 dB HL) than adults (29.5 dB HL), according to the status of the stapes at the end of the surgery, which was present in 10 children and 19 adults.

According to Jackson et al., pediatric cholesteatoma is more extensive and destructive compared to adult cholesteatoma, representing a more aggressive disease.[31]

Regarding the recidivism rate of cholesteatoma, some authors claim that the recurrence is higher in children than in adults, others found no correlation between recidivism and age.[32-34] Vartiainen et al. reported a higher recurrence rate in ears discharging at the time of operation than in dry ear.[34,35]

According to the recent literature, the recurrence rate is 23.3% in adults and 45.5% in children. Adriaansens et al. argue that predictors of cholesteatoma recurrence are younger age and a low tegmen.[29] In a previous study, the authors established that the extension of cholesteatoma is the most important factor that can promote recidivism, followed by negative preoperative middle ear ventilation and ossicular chain resorption.[30]

Many factors are involved in the prediction of recurrence, such as infections, the status of ossicular chain, and extension of the disease.[31] Furthermore, limited exposure of the epitympanum and posterior mesotympanum often results in high residual rates.[32] Until the 2000s, the residual childhood cholesteatoma rate ranged from 22 to 54% for the CWU technique and from 7.5 to 29% for the CWD technique. Instead, recurrent cholesteatoma rates ranged from 3 to 40% for CWU and from 6 to 29% for CWD.[33,34]

In our experience, recurrence of cholesteatoma occurred in five children (21.8%) and in three adults (12%). The postoperative diffusion-weighted imaging (DWI) MRI revealed the presence of recurrence of cholesteatoma after an average follow-up of 18 months in group A and after an average follow-up of 24 months in group B.

In group A, the primary cholesteatoma involved the epitympanum and mastoid in three cases, and epitympanum, mastoid, and mesotympanum in the other two cases. In the three adult patients with recurrence, the primary cholesteatoma involved the epitympanum, mastoid, and mesotympanum. In all these patients, the primary cholesteatoma was not well encapsulated, both in children and adults.

It is known that the mastoid air system is important in terms of the functional equilibrium of the middle ear, and its growth appears completely mature at 15 years old in males and at 10 years old in females.[34,35]

In our study, 19 children were male and 4 were female; all five children with recurrence of cholesteatoma were male and the average age was 9. Although the patient group is limited, the difference between males and female was statistically significant, as reported in Table 1.

In small and poorly pneumatized mastoids, the number and volume of air cells are limited and the cholesteatoma is mostly easily removed with minimal chance to leave the disease in the cavity.[32] A weak pneumatized mastoid seems to be associated with chronic middle ear disease and recurrent cholesteatoma.[34] A residual cholesteatoma is more correlated to inadequate surgical field exposure and/or incomplete removal of the disease and it is mostly associated with large and pneumatized mastoids. Large and pneumatized mastoids in fact, contain many air cells and the surgeon should remove all cells to be sure to completely eradicate the pathology. For this reason, CWD with obliteration technique should be preferred in small and poorly pneumatized mastoids and a staged CWU tympanoplasty should be performed in large and pneumatized mastoids.[34] In our study, the preoperative CT scan showed a large and pneumatized mastoid in all five children with recurrence of cholesteatoma.

The limits of the study are the small specimen size; therefore, although the odds ratio in children is more than double that in adults, statistical significance for cholesteatoma recurrences is not obtained.

CONCLUSIONS

Comparing adults and children submitted to CWD mastoidectomy with obliteration, the rate of recurrence of cholesteatoma is higher in children with a higher tendency to recur up. The greater extension of the disease is related to a higher level of erosion of the ossicular chain, both in children and adults. An other aspect that confirms the higher morbidity of pediatric cholesteatoma is the audiological results, in fact the ABGs are worse in children since the stapes superstructure is often absent/eroded. Most of children evaluated and all five children with recurrence of cholesteatoma were male, in fact it is known that the complete functional balance maturation of the middle ear and its development ends earlier in females than male. According to our knowledge no study reports this statistically significant association between recurrence of cholesteatoma and male children.

An early diagnosis of cholesteatoma is essential because a diagnostic delay entails a more extensive disease, often not encapsulated, with ossicular chain deterioration and an increased tendency to relapse.

Availability of Data and Materials: The data that support the findings of this study are available on request from the corresponding author.

Ethics Committee Approval: This study was approved by the Comitato Etico Regione Toscana-Pediatrico (CERT-P) University (approval no: 117/2024, date: July 19, 2024).

Informed Consent: Verbal informed consent was obtained from the participants who agreed to take part in the study.

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