Surgical Strategy for Pediatric Cholesteatoma

AHMED S. EL-DEEB, M.Sc.; MAHMOUD A. YOUSEF, M.D.; YOUSEF K. SHABANA, M.D.; AHMED A. ABD EL-RAZEK, M.D. and ASSER A. EL-SHARKAWY, M.D.
The Department of Otolaryngology, Faculty of Medicine, Mansoura University

Abstract

Background: Eradication of cholesteatoma and hearing function restoration in paediatric patients present unique surgical challenges. The balance between these two goals is related to an individualized approach which is needed for the treatment of pediatric cholesteatoma.

Objective: To evaluate management strategy for pediatric cholesteatoma, by performing Canal Wall Up (CWU) and Canal Wall Down (CWD) technique if needed as regarding complete eradication of the disease, restoration of normal ear function and recurrence or residual disease.

Patients and Methods: This is a prospective study carried out over a period of three years from October 2011 and September 2014 at Mansoura University Otolaryngology Department. Forty cases with cholesteatoma irrespective of the presence or absence of complications were selected for the study. Otoscopic, otomicroscopic and tuning fork tests, when possible, were performed. Auditory Brain Response (ABR) or Pure Tone Audiometry (PTA) was done for all cases. Audiometric results were analysed according to the International Bureau for Audiophonology (BIAP) criteria. High Resolution Computerized Tomography (HRCT) temporal bone was done for all cases. Informed consent was obtained from all patients after counseling the parents. All of the cases underwent tympanomastoidectomy by a postauricular approach. Using suitable surgical technique (Atticotomy, modified CWU technique or CWD). Reconstruction of hearing mechanism was performed in all possible cases.

Results: There was significant difference in healing duration between both CWU and CWD. There was a strong correlation between HRCT and intra operative findings regarding ossicular status. There was significant difference in the mean postoperative AB gap in CWD but there was no significant difference in CWU and Atticotomy. Cholesteatoma recidivism in CWU (12.5%), and no cases of residual or recurrence in CWD and Atticotomy.

Conclusion: The type of mastoidectomy doesn't affect hearing outcome. The patient is better served by a single operation which selected and meticulously accomplished. Our management strategy for pediatric cholesteatoma is aiming at performing a single stage surgery with the help of preoperative HRCT and intraoperative otoendoscopes using suitable surgical technique (Atticotomy, modified CWU technique or CWD).

Key Words: Pediatric cholesteatoma – CWU – CWD-surgical strategy.

Introduction

CHOLESTEATOMA is a severe middle-ear pathology affecting both adults and children. Its etiopathogeny still unexplained. In children, there are two forms: Acquired cholesteatoma, which resemble the adult form, and the other is congenital cholesteatoma [1].

Although there is no definitely established theory for acquired cholesteatoma: Primary and secondary acquired cholesteatoma are classically distinguished: The primary evolves from a retraction pocket, while the secondary is due to epithelial migration through an ear-drum perforation or to implanted epithelium in the middle ear. This implantation may be iatrogenic, which occur during ear surgery, or due to epithelium which has been left in the tympanic cavity after healing of a blast injury, or arising post-traumatically at a petrosal bone fracture site [2].

Acquired cholesteatoma is more aggressive in children, because it is often more extensive at diagnosis; ossicular chain status is often poorer, due to more extensive lysis of ossicles, the recurrence rates and residual lesion are higher. The greater aggressiveness in children has been explained in terms of childhood specificities in the cholesteatoma matrix and/or persisting predisposing factors like impaired aeration of the ear [3].

The goals of cholesteatoma surgery are: (1) To eliminate mucosal and bone disease to produce a dry and safe ear; (2) To restore serviceable hearing; and (3) To prevent recurrent disease. It is not always possible to reach these goals and cholesteatoma may not be eradicated permanently following the initial surgery [4].
Management strategies for cholesteatoma in children are still under debate. There are two main operative procedures for cholesteatoma eradication: The cAnal-Wall-Down technique (CWD) and the Canal-Wall-Up technique (CWU) [5].

In general, there has been a long controversy between these two techniques. Nevertheless, the debate is still on due to new evidence, better imaging, high-tech endoscopes and intraoperative use of facial nerve monitoring [6].

Regardless of the technique, the mystery to surgical success is complete eradication of the disease. The selection of the procedures is depending on type, extension and grade of cholesteatoma [7].

Patients and Methods

This is a prospective study carried out over a period of three years from October 2011 and September 2014 at Mansoura University Otolaryngology Department. Forty cases of (CSOM) with cholesteatoma irrespective of the presence or absence of complications were selected for the study. Cases of congenital cholesteatoma were included from this study.

Study pathway:

The cases were subjected to detailed history taking and clinical examination. Otomicroscopic and tuning fork tests, when possible, were performed. Auditory Brain Response (ABR) or Pure Tone Audiometry (PTA) was done for all cases. Audiometric results were analyzed according to the International Bureau for Audiophonology (BIAP) criteria and were submitted to statistical analysis. Air-bone gap were analyzed at 0.5, 1, 2, and 4kHz. HRCT temporal bone with zooming axial and coronal thin cuts was done for all cases. Informed consent was obtained from all patients after counseling the parents regarding the nature of the disease and surgery. Outcome of the surgery and the possible complications were explained to them.

All cases underwent tympanomastoidectomy by a postauricular approach. All patients were operated under general anesthesia. Temporalis fascia was the graft material taken in all cases. Reconstruction of hearing mechanism was performed in all possible cases.

Surgical technique:
Atticotympanotomy:

First, a postauricular incision was made, then a posterior permeatal incision to enter the external auditory canal. Then a tympanomeatal flap along with the fibrous annulus was elevated and the posterior-superior bony annulus was drilled (otosclerosis drilling). Then transmeatal atticotomy with preservation of a thin bridge was done. Cholesteatoma in the middle ear is targeted first and followed to posterior attic.

*Tos modified intact canal wall tympanomastoidectomy (CWU):

It starts as atticotympanotomy, then cortical mastoidectomy and posterior atticotomy with intact and thin canal wall were performed [8] Cholesteatomas extending into the attic, antrum and mastoid process were removed. 30º otoendoscope is used to assess sinus tympani and anterior attic for residual cholesteatoma.

When the ossicular chain was intact, a type I tympanoplasty was done. When the long process of the incus was defective but with an intact stapes suprastructure, incus interposition with Malleus Relocation (MRL) was done and if whole incus is defective, Cortical Bone (CB) was used. MRL was done in all cases with intact malleus. When the stapes suprastructure was absent, Malleus-Stapes Assembly (MSA) was done (using incus if intact or CB if not). When malleus was absent with intact stapes suprastructure CB was placed on stapes head. Atticotomy was then reconstructed with Conchal cartilage, CB or bone cement and the eardrum was grafted with temporalis fascia using over-underlay technique.

*Canal wall down (modified radical) mastoidectomy:

Complete mastoidectomy is performed followed by removal of the posterior bony canal wall with lowering of the facial ridge. Cholesteatoma is completely removed and 30º otoendoscope is used to assess sinus tympani for residual cholesteatoma. The cavity is covered with fascia. Mastoid obliteration with periosteal flap was done in some cases with large cavity. A wide meatoplasty is done in all cases.

Intraoperative endoscopy-assisted surgery was performed in all possible cases used to verify the degree of eradication of the cholesteatoma, 30º endoscope was introduced either transcanally or transmastoidly. Thus the complete removal. The following areas were specifically inspected in the following order: Facial recess, sinus tympani, anterior epitympanic recess, hypotympanum and mastoid cavity. If a cholesteatoma remnant was noted, it was removed.
Follow-up:

All the patients were instructed to come for follow-up after 1 week. Then followed-up weekly for one month, and then every month for a minimum period of 3 months and then once in two or three months for 12 months. During every follow-up, cases were evaluated for the persistence of discharge, collection of debris or any other complications which the patient has experienced. (PTA) or (ABR) were done at three to six months or after the postoperative cavity had healed.

Results

This study included 40 patients, of age range 5-18 years. They were operated upon for middle ear cholesteatoma. These patients were divided into 24 patients in whom CWU was performed, 12 patients in whom CWD was performed in and 4 cases treated with atticotomy. The study included 40 patients 21 were females (52.5%), 19 were males (47.5 %) with ratio of 1. 11: 1. The mean age was 11.20 years (± 3.681) years with range of (5-18) years (Table 1).

Clinical findings:

Side of cholesteatoma:

In the 40 cases there were 22 right (55%) and 18 left (45%) middle ear cholesteatoma. CWU 15 males, 9 females. CWD 10 females, 2 males. And Atticotomy 2 males 2 females. Fig. (1).

Type of cholesteatoma:

In the 40 cases there were 30 attic pars flaccida (75%) and 10 tympanic Pars tensa (25%) middle ear cholesteatoma. Fig. (2).

Preoperative hearing:

The mean preoperative AB gap was 29.32 ± 10.38db, 36.77±13.21db and18.75±4.33db in CWU (24 cases), CWD (12 cases) and Atticotomy (4 cases) respectively. The mean preoperative AB gap for all cases (40 cases) was 30.5 ± 11.89db (Table 3). The mean preoperative bone conduction for all cases (40 cases) was 12.5 ± 2.067.
Operative data and surgical procedures:

Operation type:
4 cases were operated with postauricular permeatal atticotympanotomy, 24 cases were operated with CWU tympanomastoidectomy and 12 cases were operated with CWD tympanomastoidectomy.

Intraoperative location of the cholesteatoma:
Cholesteatoma involving attic (epitympanum) represent 4 cases (10%) and involvement of attic-antral 21 cases (52.5%) and involvement attic middle ear and mastoid 15 cases (37.5%) (Table 2).

Ossicular chain status:
By HRCT scan the ossicular chain status was classified into intact, partial erosion and complete erosion. There were 16 cases with intact chain, 18 cases with partial erosion and 6 cases with complete erosion. Intraoperative ossicular chain examination showed 11 cases with intact chain, 21 cases with partial erosion and 8 cases with complete erosion. The sensitivity of HRCT in detection of ossicular status was 72.5%. There was a strong correlation between HRCT and intra operative findings regarding ossicular status ($r=0.785, p=0.426$). (Table 4).

Malleus:
In CWU malleus was intact in 23 cases and with complete erosion in one case. In CWD it was intact in 3 cases, eroded handle in one case and with complete erosion in 8 cases. In atticotomy malleus was intact in all cases. In all cases malleus was intact in 30 cases (75% of cases), one case with eroded handle (2.5%) and 9 cases (22.5%) with complete erosion. (Table 5).

Incus:
In CWU incus was intact in 7 cases, with eroded long process in 7 cases and 10 cases with complete erosion. In CWD it was intact in one case and complete erosion in 11 cases. In atticotomy it was intact in all cases. In all cases incus was intact in 12 cases (30% of cases), 7 cases with eroded long process (17.5%) and 21 cases with complete erosion (52.5%). (Table 5).

Stapes:
In CWU stapes was intact in 15 cases and completely eroded suprastructure in 9 cases. In CWD it was intact in 5 cases and completely eroded suprastructure in 7 cases. In atticotomy was intact in all cases. In all cases stapes was intact in 24 cases (60%) and completely eroded suprastructure in 16 cases (40%). (Table 5).

Ossiculoplasty:
Ossiculoplasty was considered in the 17 cases of CWU and CWD. Ossiculoplasty was done according to the ossicular status combination. We referred to intact and eroded malleus as M+ and M− respectively, intact and eroded stapes as S+ and S− respectively and intact, eroded long process and completely eroded incus as I, L and E respectively.

The most frequent ossicular status combination was M+E S− (4 cases), and M+E S− (2 cases) and M+E S+ (2 cases) and M− S− (2 cases).

M+E S− (4 cases) were managed by MRL and MSA using CB. M+L S− (4 cases) were managed by MRL and MSA using incus. M+L S+ (3 cases) two of them were managed by MRL and incus interposition and one of them and M+I S+ (2 cases) were managed by incus remodeling and repositioning without relocation of malleus. M+E S+ (2 cases) were managed by MRL and CB interposition. M− S− (2 cases) were managed by CB over footplate directly. (Table 6).

Attic reconstruction:
It was done in all 21 cases of atticotomy and CWU. Conchal cartilage was used in 15 cases, CB was used in 4 cases and bone cement with bone pate was used in 2 cases.

Postoperative data:
Follow-up period:
It ranged from 6 to 24 months with mean of 13.1 months (±4.65).

Healing duration:
The overall mean duration for healing was 5.2821 weeks ± 1.89110. In CWU it was 4.0833 weeks ± 0.79296, in CWD it was 7.1667 weeks ± 1.64225 and in Atticotomy it was 2.75 weeks ± 0.5. There was significant difference in healing duration between both CWU and CWD ($p=0.000$).

Postoperative hearing:
The mean postoperative AB gap was 29.42 ± 10.33db, 31.25 ± 15.93db and 27.68 ± 14.013db in CWU (24 cases), CWD (12 cases) and Atticotomy (4 cases) respectively. The mean postoperative AB gap for all cases (40 cases) was 29.8 ± 12.28db. The mean postoperative bone conduction for all cases (40 cases) was 17.48 ± 1.63.

There was significant difference ($p=0.035$) in CWD but there was no significant difference in the mean postoperative AB gap in CWU and
Atticotomy ($p=0.959$ and $p=0.309$, respectively). (Table 3).

There was no significant difference between the mean pre and postoperative bone conduction ($p=0.77$).

In CWU: 8 cases showed improvement in hearing (33.33%) where 6 cases remain with no change (25%). In CWD: 6 cases showed improvement (50%), 2 cases with decreased hearing (16.67%) and 4 cases remain fixed (33.33%) in Atticotomy one case was improved (25%). And the other 3 cases were decreased (75%). (Table 8).

Average hearing presentation in preoperative cases were 1 1 cases within normal hearing (6 CWU, 2 CWD, 3 Atticotomy). 20 cases were mild hearing (14 CWU, 5 CWD, 1 Atticotomy) and 9 cases were moderate hearing (4 CWU, 5 CWD) in postoperative finding there were 9 within normal hearing (5 CWU, 3 CWD, 1 Atticotomy), 23 cases were mild hearing (15 CWU, 6 CWD, 2 Atticotomy) and 8 cases were moderate hearing (4 CWU, 3 CWD, 1 Atticotomy). (Table 7).

Postoperative complications:

There were one case of wound infection in CWU, failed with medical treatment and left residual postauricular fistula needed secondary closure.

Cholesteatoma recidivism:

Residual cholesteatoma was defined as regrowth of keratinizing squamous epithelium that was visually identifiable as cholesteatoma while recurrent cholesteatoma was defined as a new cholesteatoma developing from a postoperative retraction pocket. In the current study, both residual and recurrent cholesteatoma were designated as cholesteatoma recidivism. There were 5 cases of Cholesteatoma recidivism in CWU (12.5%), in the form of one residual and 4 cases of recurrence and no cases of residual or recurrence in CWD and Atticotomy.

Table (2): Intraoperative location of the cholesteatoma.

<table>
<thead>
<tr>
<th>Location</th>
<th>N cases</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cholesteatoma involving attic (epitympanum)</td>
<td>4</td>
</tr>
<tr>
<td>Attic-antral and middle ear</td>
<td>21</td>
</tr>
<tr>
<td>Attic-middle ear and mastoid</td>
<td>15</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
</tr>
</tbody>
</table>

Table (3): Pre and postoperative AB gap, AB gap for all cases ($p=0.673$).

<table>
<thead>
<tr>
<th>Pre AB gap</th>
<th>Post AB gap</th>
</tr>
</thead>
<tbody>
<tr>
<td>CWU:</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>24</td>
</tr>
<tr>
<td>Mean</td>
<td>29.3229</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>10.38641</td>
</tr>
<tr>
<td>Significance</td>
<td>0.959</td>
</tr>
<tr>
<td>CWD:</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>12</td>
</tr>
<tr>
<td>Mean</td>
<td>36.7708</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>13.21219</td>
</tr>
<tr>
<td>Significance</td>
<td>0.035</td>
</tr>
<tr>
<td>Atticotomy:</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>4</td>
</tr>
<tr>
<td>Mean</td>
<td>18.75</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>4.330127</td>
</tr>
<tr>
<td>Significance</td>
<td>0.309</td>
</tr>
<tr>
<td>Total:</td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>40</td>
</tr>
<tr>
<td>Mean</td>
<td>30.5</td>
</tr>
<tr>
<td>Std. Deviation</td>
<td>11.89160</td>
</tr>
<tr>
<td>Significance</td>
<td>0.28354</td>
</tr>
</tbody>
</table>

Table (4): Ossicular chain status. The sensitivity of HRCT in detection of ossicular status was 72.5% ($r=0.785$, $p=0.426$).

<table>
<thead>
<tr>
<th>Intact</th>
<th>Partial erosion</th>
<th>Complete erosion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Malleus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT</td>
<td>OP</td>
<td>CT</td>
</tr>
<tr>
<td>OP</td>
<td>CT</td>
<td>OP</td>
</tr>
<tr>
<td>CWU=24</td>
<td>10  7   14  16  0  1</td>
<td></td>
</tr>
<tr>
<td>CWD=12</td>
<td>2   1   4  4  6  7</td>
<td></td>
</tr>
<tr>
<td>Atticotomy=4</td>
<td>4  3  0  1  0  0</td>
<td></td>
</tr>
<tr>
<td>Total=40</td>
<td>16 11 18 21 6 8</td>
<td></td>
</tr>
</tbody>
</table>

Table (5): Ossicles operative findings.

<table>
<thead>
<tr>
<th>Malleus</th>
<th>Incus</th>
<th>Stapes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Intact</td>
<td>Eroded handle</td>
</tr>
<tr>
<td>CWU</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>CWD</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Atticotomy</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Total cases</td>
<td>30 (75%)</td>
<td>1 (2.5%)</td>
</tr>
</tbody>
</table>
Table (6): Ossicular operative findings combinations and their management.

<table>
<thead>
<tr>
<th>Management</th>
<th>Combination</th>
<th>Stapes</th>
<th>Incus</th>
<th>Malleus</th>
<th>Cases=17</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 cases incus interposition without MRL &amp; 2 cases MRL + incus interposition</td>
<td>M+ L S+</td>
<td>Intact</td>
<td>L.P. Erosion</td>
<td>Intact</td>
<td>3</td>
</tr>
<tr>
<td>2 cases bone interposition</td>
<td>M+ E S+</td>
<td>Intact</td>
<td>Comp.Erosion</td>
<td>Intact</td>
<td>2</td>
</tr>
<tr>
<td>4 cases MRL + MSA with incus</td>
<td>M+ L S–</td>
<td>SS.Erosion</td>
<td>L.P. Erosion</td>
<td>Intact</td>
<td>4</td>
</tr>
<tr>
<td>4 cases MRL+MSA with bone</td>
<td>M+ E S–</td>
<td>SS.Erosion</td>
<td>Comp.Erosion</td>
<td>Intact</td>
<td>4</td>
</tr>
<tr>
<td>2 cases bone over footplate</td>
<td>M– E S–</td>
<td>SS.Erosion</td>
<td>Comp.Erosion</td>
<td>Comp.Erosion</td>
<td>2</td>
</tr>
</tbody>
</table>

Table (7): Comparison pre and post hearing in (normal, mild and moderate).

<table>
<thead>
<tr>
<th>Pre-operative hearing</th>
<th>Post-operative hearing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal</td>
<td>Mild</td>
</tr>
<tr>
<td>CWU</td>
<td>6</td>
</tr>
<tr>
<td>CWD</td>
<td>2</td>
</tr>
<tr>
<td>Atticotomy</td>
<td>3</td>
</tr>
<tr>
<td>Total (40)</td>
<td>11 (28.21%)</td>
</tr>
</tbody>
</table>

Table (8): Comparison pre and post hearing in (improved, fixed and decreased).

<table>
<thead>
<tr>
<th></th>
<th>Improved (%)</th>
<th>Fixed (%)</th>
<th>Decreased (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CWU</td>
<td>8 (33.33%)</td>
<td>6 (25%)</td>
<td>10 (41.67%)</td>
</tr>
<tr>
<td>CWD</td>
<td>6 (50%)</td>
<td>4 (33.33%)</td>
<td>2 (16.67%)</td>
</tr>
<tr>
<td>Atticotomy</td>
<td>1 (25%)</td>
<td>0</td>
<td>3 (75%)</td>
</tr>
<tr>
<td>Total</td>
<td>15 (37.5%)</td>
<td>10 (25%)</td>
<td>15 (37.5%)</td>
</tr>
</tbody>
</table>

Discussion

The most debated topics about paediatric cholesteatoma surgery concern the timing for surgery, choice of surgical technique and outcomes.

The pediatric patient's definition varies across studies. In our study they were defined as patients <18 years of age according to Egyptian law. 21 were females (52.5%) 19 were males (47.5%) and with ratio of 1.11:1. The mean age was 11.20 years. In two other comparable studies, Sergi et al., [9] included children aged between 6 and 14 years and Shirazi et al., [10] included children age range from 3 to 16 years old (Mean age, 8 years).

Tos [11] proposed an otoscopic classification, for middle ear cholesteatoma into:

- Attic.
- Pars tensa I (marginal disease).
- Pars tensa II (central disease).

Both (marginal and central type) of pars tensa have been grouped into a common “Tympanic” group, because they usually are overlapped anatomically, etiologically and therapeutically [12].

In our study attic cholesteatoma was present in 30 cases (75%) and tympanic was in 10 cases (25%). Intraoperative location of the cholesteatoma involving attic (epitympanum) represent 4 cases (10%) and involvement of attic-antral and middle ear 21 cases (52.5%) and involvement attic middle ear and mastoid 15 cases (37.5%). Which close to study conducted by Shirazi et al., [10] state that 11 patients (10%) present in epitympanum, 35 patients (33%) in attic and antrum and 7 cases (7%) in mesotympanum, 32 patients (30%) attic and meso/hypotympanum, and 21 patients (20%) in all tympanic and mastoid cavities.

In study conducted by Darrouzet et al., [13] the pars tensa (tympanic): 127 cases (59%), pars flaccida (attic): 57 cases (26.5%), while Goh et al., [14] state that 5 cases (9%) present attic/middle ear, 11 cases (21%) attic-antrum and 37 cases (70%) attic/middle ear/mastoid.

This difference in results is due to the delay in presentation and diagnosis which results in more inflammation and extension and involvement of more than one site.

In 10 cases aural polyps were present that are large enough to obscure the type of cholesteatoma; we depended on HRCT to determine their type where attic cholesteatoma appears as nondependent soft tissue opacity lateral to the ossicles (in Chee and tan, [15] found good to strong radiological-surgical correlation when they studied the CT diagnostic features of otoscopically diagnosed cholesteatoma cases except for facial nerve integrity. Gaurano and Joharjy, [16] found that correlation between preoperative CT with surgical findings was 97%.
Alzoubi et al., [17] they found that the sensitivity of preoperative CT in cholesteatoma detection was 80%.

Prussak's space) with erosion of the scutum. While tympanic cholesteatoma fills tympanic space medial to the ossicles, usually with involvement of facial recess and sinus tympani.

The sensitivity of HRCT in detection of ossicular status was 72.5% There was a strong correlation between HRCT and intra operative findings regarding ossicular status \(r=0.785, p=0.426\).

Surgical technique:

The goals of surgery are to completely remove the disease without leaving residual cholesteatoma and with restoration the ear anatomy properly in order to prevent recurrence and improving the quality of life of the patient (good hearing and no cavity problems). An ideal technique is that technique allows a surgeon to reach these goals [18].

Reviewing the literature showed that management of middle ear cholesteatoma is based mainly on intraoperative findings. Technique selection is based on objective preoperative criteria to determine that the patient might safely undergo CWU do not exist. Even in recent studies technique selection is based mainly on intraoperative findings with exceptions of cases necessitated strictly a CWD technique [4,19].

All chronic ear surgery is a process of making decisions during surgery [20]. However, others thought that cholesteatoma should be approached with CWU technique and the decision might be altered to CWD at certain circumstances along the operation [21].

The concept of surgical strategy depend predominantly on the disease extension using the preoperative data as HRCT finding together with the state of residual hearing of the operated ear, ET function with intraoperative finding as the status of the middle ear mucosa canal wall status, mastoid pneumatization (contracted mastoid) and presence of complications like brain abscess or, labyrinthine fistula all of these factor influence the technique selection in the cholesteatoma surgery [22]. The appropriate surgical technique is chosen according to the disease extension. Therefore, a technique containing the advantages of both CWU and CWD techniques, which support a better visualization and cholesteatoma removal from hidden areas as (sinus tympani and anterior attic), with a reconstruction technique to prevents recurrence, seems to be ideal. So For complete disease resection and intact tympanic structures preservation many surgeons prefer the CWD technique then reconstructing the posterior wall of the external canal [23].

Where the cholesteatoma was limited to one region of the middle ear with no mastoid involvement, so the surgery was limited to postauricular permeal atticotympanotomy, and no mastoidectomy needed which represent 4 cases (10%) in our study.

On the attico-antral cholesteatoma (representing 21 cases (52.5%) 20 cases with CWU and one case CWD. Tos modified CWU tympanomastoidectomy assisted with 30° otoendoscope was used. Tos modified his CWU technique which consists of "otosclerosis drilling" of the postero-superior bony annulus and transcanal atticotmy with cortical mastoidectomy thin bridge preservation.

Where cholesteatoma extending to involve middle ear and mastoid 15 cases (37.5%) a debate was focused on the visualization degree of the cholesteatoma and its complete removal, and how much better the visualization by CWD technique with lower incidence of recidivism when compared to CWU technique.

Tos technique was claimed to provide a good exposure to hidden areas (sinus tympani and anterior attic) when compared with the classic CWU mastoidectomy with easier and safer cholesteatoma removal [8].

This was supported by [22]. In our study (Tos modified CWU) was done in 5 cases from 15 cases (involvement attic middle ear and mastoid (37.5%) and the remaining 10 cases with CWD technique.

Atticotomy and reconstruction:

When wide atticotomy can be performed enough with exposure of the whole extent of the cholesteatoma, it can be removed without leaving any residual. However, the opened epitympanic area will provide a space for postoperative retraction and allow the development of a recurrent cholesteatoma. Causes of the retraction are still controversial. With the need of procedures to reconstruct the epitympanic space to prevent recurrence [24,25].

In preventing retraction pockets, attic reconstruction was to be more important than procedures which target the tubal insufficiency a study conducted by [26].

Cartilage, cortical bone plate and bone pate are the most used grafts and they are more appropriate
Reconstruction was done in all 21 cases of (atticotomy and CWU). Conchal cartilage was used in 15 cases, while CB was used in 4 cases and bone cement with bone pate was used in 2 cases.

Staging the cholesteatoma surgery:
It has been decreased considerably during the last decade, this mainly due to the advancement of otoendoscopic cholesteatoma surgery assessment and the introduction of new Magnetic Resonance Imaging (MRI) techniques diffusion-weighted echo-planar imaging; (DWI EPI) which helps detection of the presence of residual cholesteatoma and avoid unnecessary re exploration. 2nd look operations and planned staged are associated with a strain on the patient and his family, in addition to their discomfort, irritation and cost to the patient and family.

From other author’s point of view, only patients with severe disease within the attic or posterior tympanic cavity, tympanosclerosis, acute inflammation or extensive granuloma who are needed a second-stage tympanoplasty [28].

On the other hand Dornhoffer [29], suggested that a one-stage tympanoplasty is needed where cholesteatoma within the attic and tympanic sinus was completely eradicated.

Our management strategy for pediatric cholesteatoma is aiming at performing a single stage surgery with the help of preoperative HRCT and intraoperative otoendoscopes using the modified CWU technique and CWD according to their appropriate usage.

Ossicular chain status:
By HRCT scan the ossicular chain status was classified into intact, partial erosion and complete erosion. The sensitivity of HRCT in detection of ossicular status was 72.5%. There was a strong correlation between HRCT and intra operative findings regarding ossicular status.

In all cases malleus was intact in 30 cases (75% of cases), one case with eroded handle (2.5%) and 9 cases (22.5%) with complete erosion, incus was intact in 12 cases (30% of cases), 7 cases with eroded long process (17.5%) and 21 cases with complete erosion (52.5%) and stapes was intact in 24 cases (60%) and completely eroded suprastructure in 16 cases (40%).

In our study incus was the most severely affect-ed ossicle 75% (eroded long process 17.5% and with complete erosion 52.5%) followed by stapes suprastructure (40%). This was shown by [30,31].

The most frequent ossicular status combination intact malleus, incus and stapes 25% the least frequent combination was eroded malleus or head and incus with or without eroded stapes suprastructure represent one case 2.5% for each.

Ossiculoplasty:
Ossiculoplasty was considered in the 17 cases of of CWU and CWD ossiculoplasty was done according to the ossicular status combination while no ossiculoplasty was done in atticotomy cases.

Incus interposition was done where whole or part of incus was intact together with intact malleus and stapes suprastructure with or without MRL.

In cases of absent stapes suprastructure with intact malleus MSA was done using incus directly on footplate when the whole or part of incus is present and with cortical bone in cases of completely eroded incus.

MRL technique has several advantages including better ossiculoplasty and graft stability together with specific benefits to prevent cholesteatoma recidivism by cutting tensor tympani fold to prevent attic dysventilation which prevent retraction and recurrence confirmed by Marchioni et al., [32], together with making wider space for exploration of supratubal recess and anterior attic space preventing residual cholesteatoma.

Hearing:
To preserve and/or to restore hearing is an important outcome goal and many authors reported that the canal wall has little effect on the hearing outcome [4,19].

The hearing prognosis seems to be depended on the status of the stapes especially the stapes superstructure (SS) preservation [13,33].

Shirazi et al., [10] state that an intact stapes being more decisive than posterior canal wall preservation where poor hearing results found to be significantly (p<.05) related to of (SS).

There was significant improvement in the mean postoperative AB gap in CWD cases (pre 36.77-post 31.25), while in CWU, there was no significant difference (pre 29.32-post 29.42) and in cases of atticotomy there was deterioration in mean post-operative AB (pre1 8.75-post 27.68).
Evolution of the ABG according to our study and to the literature For CWD cases, Mills and Padgham, [34] mean post op ABG (pre 29-post 29) Desaulcy et al., [35] (pre 29-post 29) Tos, [36] (pre 40-post 25), Darrouzet et al., [13] (pre 30-post 3 1) Roger et al., [37] (Pre 26.5-post 30).


For all cases as regard the quality of the post-operative hearing:

We found that 22.5% presented a post-operative ABG of 20 dB or less which is considered successful function outcomes, and 55% of (ABG of 30 dB or less) cases with socially acceptable hearing.

Our audiometric results are in line with Tos, (36) 62% of cases. Vartiainen and Nuutinen [38] 57% and for Darrouzet et al., [13] 66% cases are with a mean PTA% 30dB. Mutlu et al., [39] reported an air-bone gap of less than 25dB in 68% of cases. Shirazi et al., [10] 34 patients (89%) who underwent a CWU mastoidectomy and 22 patients (46%) who had a CWD procedure had PTA less than 25dB.

There was no significant difference between the mean pre and postoperative bone conduction.

Cholesteatoma recidivism:

Cholesteatoma recidivism includes both residual and recurrent cholesteatoma [40]. The residual cholesteatoma is due to insufficient primary resection of the cholesteatoma matrix. This may be due to in appropriate exposure by the approach. On the other hand, the recurrent cholesteatoma due to a de-novo tympanic retraction pocket formation. While recurrence can be diagnosed otoscopy, residual cholesteatoma is independent of the ear-drum and can be determined only by surgical revision for diagnosis throw second look surgery [41,42].

There were no cases of residual or recurrence in CWD and Atticotomy. While there were 5 cases of Cholesteatoma recidivism in CWU (12.5%), in the form of one residual and 4 cases of recurrence. Our result is in agreement in the literature with Schuring et al., [43] for 88 (40-49%, 24-27%) residual, recurrence receptively with no cases of residual or recurrence in CWD. Magnan et al., [44] for 210 (26%, 19.5%) residual, recurrence receptively with no cases of residual or recurrence in CWD. Desaulty et al., [35] for 80 cases (63.5%, 7.5%) residual, recurrence receptively with no cases of residual or recurrence in CWD. Mutlu et al., [39] for 83 (38%, 11%) residual, recurrence receptively with no cases of residual or recurrence in CWD. Recurrence for (CWU) and (CWD) mastoidectomy groups were similar (8% vs. 6%) in Shirazi et al., [10].

Healing:

Preservation of the posterior canal wall in CWU, allows for more rapid healing. The overall mean duration for healing was 5.28 weeks. In CWU I it was 4.08 weeks, in CWD it was 7.16 weeks and in Atticotomy it was 2.75 weeks. There was significant difference in healing duration between both CWU and CWD (p=0.000).

Conclusion:

Eradication of cholesteatoma and hearing function restoration in paediatric patients present unique surgical challenges. The balance between these two goals is related to an individualized approach and the choice of surgical technique should be based on anatomical, biological, radiological and social factors. Counseling the parents by the surgeon is a must that there is a probable need for multiple surgeries, especially if a CWU mastoidectomy is performed. Our management strategy for pediatric cholesteatoma is aiming at performing a single stage surgery with the help of preoperative HRCT and intraoperative otoendoscopes using suitable surgical technique (Atticotomy, modified CWU technique or CWD).

References


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