



Acquired Cholesteatoma Surgery: The Hybrid Approach

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ABSTRACT

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Background: Cholesteatoma is a dangerous disease. It carries the risk for intracranial, cranial and extra-cranial complications. The standard surgical techniques used to remove cholesteatoma from the middle ear cleft for the sake of safety, dryness and possibly hearing is the canal wall up (CWU) and the canal-wall down (CWD). Canal-wall reconstruction (CWR) approach is associated with posterior canal wall reconstruction which combines the advantages of the two techniques. Cartilage, bone and different alloplasts have been used to reconstruct the meatal wall after its removal. **Aim of the study:** To assess the efficacy of the surgical techniques in which the posterior canal wall is removed and reconstructed after proper cleaning of cholesteatoma. **Materials and Methods:** Thirty-five patients suffering from CSOM with cholesteatoma (41 ears) were included and admitted at the Otorhinolaryngology (ORL) department, Assiut University Hospitals, between 2012-2015. Patients were subjected to preoperative clinical, audiological and radiological evaluation. Three surgical techniques have been used to reconstruct the posterior meatal wall (PMW) after removing cholesteatoma. Primary ossiculoplasty was done in 25 ears (61 %). Patients were followed up after surgery to evaluate the anatomical and functional success and complications. **Results:** All patients complained of ear discharge and hearing loss. The majority presented by either attic perforation 12 ears (29.3 %) or retraction pocket 10 ears (24.4%). Twenty eight ears (68.3%) had extensive cholesteatoma eroding the ossicles. Temporary removal of PMW and reposition in place in CWU mastoidectomy was done in 26 ears (63.4%), cortical bone to reconstruct part of the PMW (in ears of retrograde mastoidectomy) in 7 ears (17%), and cortical bone to reconstruct the whole PMW (after CWD mastoidectomy) in 8 ears (19.6%). The mean postoperative follow-up was 14 months. Good postoperative healing was achieved in 36 ears (87.5%) with no narrowing of the external auditory canal. Postoperative complication included otorrhea in 9 ears (21.9%), broken graft in 2 ears (4.9%), granulation tissue in 3 ears (7.3 %), extruded material in 1 ear (2.4%), and recidivism of cholesteatoma 3 in ears (7.3 %). There was a significant improvement of hearing postoperatively in the 25 ears that underwent ossiculoplasty. **Conclusion:** Surgical management of cholesteatoma and reconstruction of the ear in a single surgery is a highly successful procedure for the eradication of cholesteatoma. Radical cavities can be avoided if the posterior auditory canal wall is removed only temporarily at operation and is reimplanted finally.

Introduction

Cholesteatoma of middle ear is one of the most fascinating topics and one of the greatest and most complex problems in otology, and may have serious consequences. Most otologic surgeons agree on the fact that cholesteatoma treatment is surgical. However, the kind of surgery varies considerably.(1)

The primary goals of the surgical treatment are to eradicate the cholesteatoma and prevent its recurrence. The secondary goals are to obtain a dry ear and/or to improve hearing loss. Several approaches to achieving these goals have been proposed and debated over many years.(2)

The canal-wall-down (CWD) mastoidectomy finds favor with otologists primarily for one reason: the technique reduces the risk of persistent or recurrent cholesteatoma. Nevertheless, after a CWD mastoidectomy, a patient is left with several problems inherent in the open cavity. The exposed bone of the mastoid leaks tissue fluid, which is a rich medium for bacterial growth. Recurrent aural discharge afflicts 10 to 60% of patients with an open mastoid cavity. (3) Other problems, include cosmetic problems due to enlarged meatus, poor hearing aid fit, impaction with debris.(4) Less than accurate performance of CWDT invariably results in a poor outcome, and none of the goals of surgery can be attained, including the functional and anatomic goals. (5)

To overcome the inconveniences derived from the open cavity, canal-wall up techniques (CWUT) can be used. The major advantage of the CWU procedure is that it preserves the canal wall and other key structures of the middle ear. That preservation enables patients to get the ear wet and eliminates the need for repeated cleaning of the large surgical cavity left behind by the more invasive CWD approach. Better hearing results are likely cost of higher rates of recidivism of

cholesteatoma. (6)

Canal-wall-reconstruction (CWR) combines the advantages of the low rates of residual disease of the CWD approach with the retention of the EAC of the CWU approach. With CWR, the rate of residual disease seems to be lower than with CWU. This approach is associated with posterior canal wall reconstruction. (2)

Various autologous and synthetic materials have been used to reconstruct the posterior canal wall, such as bones taken from the EAC and later put back (5, 7, 8, 9), bones sculpted from the mastoid cortex (10, 11, 12), cartilage (10, 13) and synthetic material.(14)

CWR is not indicated when it is not certain that total extirpation of lesion will occur or when there are severe surrounding complications. (1)

Materials & Methods:

Patients:

This work is a prospective study that has included thirty five patients suffering from chronic suppurative otitis media with cholesteatoma (41 ears). They presented to ENT department of Assiut University Hospital, Egypt, from March 2012, to March 2015. Diagnosis of the disease was established by clinical and microscopic examination, and confirmed by multi-slice CT scan temporal bone and surgical exploration. Ears with intracranial complication and previous ear surgery were excluded.

Methods:

Each patient was subjected to the following scheme:

- 1- History and examination.
- 2- Investigation:
 - a) Routine laboratory investigation.
 - b) Pure tone audiometry.
 - c) Radiological investigation including Multi-slice CTscan temporal bone.
- 3- Active infection in the ear is treated prior to surgery by appropriate cleaning and antibiotics.

4- Surgical intervention.

5- Follow up.

The extent of cholesteatoma was staged according to **Belal et al., 2012**⁽¹⁵⁾ from stage I to stage V depending on the site of disease in the tympanic (T) the mastoid cavity (M), and the presence of any complication (C). Staging of any case is made according to the office clinical (otoscopic \microscopic\ endoscopic) examination, the radiologic study (axial, coronal, and sagittal reconstruction views of high definition CT Petrous bone), and the clinical and radiological correlation.

table (1 A,B).

Table (1A): TMC Staging system of tympano-mastoid cholesteatoma.

(T) Tympanic cavity involvement:

T0: No tympanic cavity involvement

Trp: Retraction pocket (precholesteatoma)

T1: Cholesteatoma involving one side of one region

T1a: One side of epitympanum

T1b: One side of mesotympanum

T2: Cholesteatoma involving both sides of one region

T1a: Both sides of epitympanum

T1b: Both sides of mesotympanum

T3 : Cholesteatoma extending from one region of the middle ear to another (vertical spread)

T4: Holotympanic cholesteatoma filling the whole middle ear

Regions (epity- or meso-, and hypotympanum)

Sides (anterior or posterior in relation to a line along handle of malleus)

(M) Mastoid cavity involvement:

M0: No mastoid cavity involvement

M1: Cholesteatoma extending to the mastoid antrum only

M2: Cholesteatoma extending to mastoid cavity other air cells.

(C) Presence of complications:

C0: uncomplicated Cholesteatoma

C1: cranial or extra cranial complication

C2: intracranial complications

Table (1B): TMC Staging system of tympano-mastoid cholesteatoma

Staging	
Stage –I	Trp-1 M0 C0
Stage – II	T2 M0 C0
Stage – III	T3 M0 C0 Trp-3 M1 C0
Stage – IV	T4 M0 C0 Any T M2 C0 Any T Any M C1
Stage – V	Any T Any M C2

The condition of the ossicular chain was classified according to Saleh and Mills 1999⁽¹⁶⁾, as following:

O zero: if the ossicular chain is intact.

O 1: if the incus is eroded with discontinuity of the ossicular chain.

O2: if the the incus and stapes arch are eroded.

O3: if the malleus handle and incus are absent and the stapedia arch is eroded.

Surgical techniques used in this study:

All surgeries were done under general anesthesia using hypotensive technique. All patients received intraoperative 3rd generation cephalosporine antibiotic. Working through a post-auricular incision, one of the following surgical techniques was used to deal with cholesteatoma according to the site and extension:

1- Canal wall-up Technique (CWU).

A complete cortical mastoidectomy with proper thinning of the posterior meatal bone wall is then performed, including total exenteration of the

sinodural angle and mastoid tip air cells. (Fig.1A,B).

The external canal skin was elevated off the posterior canal. The annulus was elevated out of the annular sulcus. The tensor tympani tendon was transected, allowing exposure of the entire mesotympanum. A microurgical saw or 1 mm diameter diamond drill is used to create superior and inferior cuts in the posterior canal wall at 11 and 7 o'clock.

The inferior cut extends from the inferior margin of the facial recess to the lateralmost portion of the external auditory canal. The superior cut starts at the scutum and extend to the lateral-most portion of the external auditory canal. The posterior canal wall segment was then removed and placed aside in a diluted antiseptic solution for reconstruction. The canal wall piece needs to be carefully examined to ensure all cholesteatoma and squamous epithelium have been removed..

(Fig.2A,B, 3A,B,C)

Cholesteatoma is removed completely from the tympanic cavity, anterior attic, and mastoid. A generous temporalis fascia graft is harvested. This must be large enough to extend up the posterior canal wall, over the canal wall cuts, and used in an underlay fashion to reconstruct the tympanic membrane.

The posterior canal wall segment is then repositioned in its normal place, fixed by fibrin glue, supported with small pieces of cotton or gelatin sponge and when the bone gets cemented well, these supporters are removed.

(Fig.4A,B)

The external canal is packed by several pieces of gelfoam over the tympanoplasty graft, followed by strip gauze impregnated with antibiotic ointment. The Palva flap is then closed and after that the wound was closed in two layers. A standard mastoid dressing is applied.

2-Canal wall-down Technique (CWD)

The PCW was drilled out and not removed in one piece as before, this procedure was used in ears the PCW was markedly eroded by the cholesteatoma.

For reconstruction of the meatal wall, a piece of cortical bone was harvested at the beginning of mastoid bone drilling; the free autologous bone is put in the desired place, fixed by fibrin glue.

3. Retrograde mastoidectomy.

A technique in which the upper canal (the bridge) wall is drilled down to gain maximum exposure in the epitympanum, the cholesteatoma is removed in a retrograde approach for better visualization, and the canal defect is reconstructed using autologous cortical bone, fixed by fibrin glue.

Ossiculoplasty by different methods was done in the same setting whenever possible.

Postoperative follow up:

Postoperative antibiotics for 2 weeks.

First post operative visit is at one week where the dressing, pack and stitches are removed and where local drops (Antibiotic mixed with steroid) usually starts.

The second visit is usually at 3rd week-to 4 weeks where local cleaning is done and the graft is checked and local drops are given if needed.

Clinical follow up after 1, 2, 3, 6 and 12 months and then once a year. The patient was told to come if having ear discharge, obstruction or extruding any material from ear.

A- Postoperative clinical assessment included:-

- The healing of tympanic membrane, discharge and complication.
- Subjective hearing improvement.

- The build PMW.

B- Postoperative hearing assessment

Postoperative hearing assessment was done using pure tone audiometry at 3-6 months of follow up. We used the postoperative

air bone gap (ABG) as the key parameter for hearing evaluation.

C- Postoperative multi-slice CT scan temporal bone at 6-12 months.

Data Analysis: by using the SPSS version 19 statistical software package.

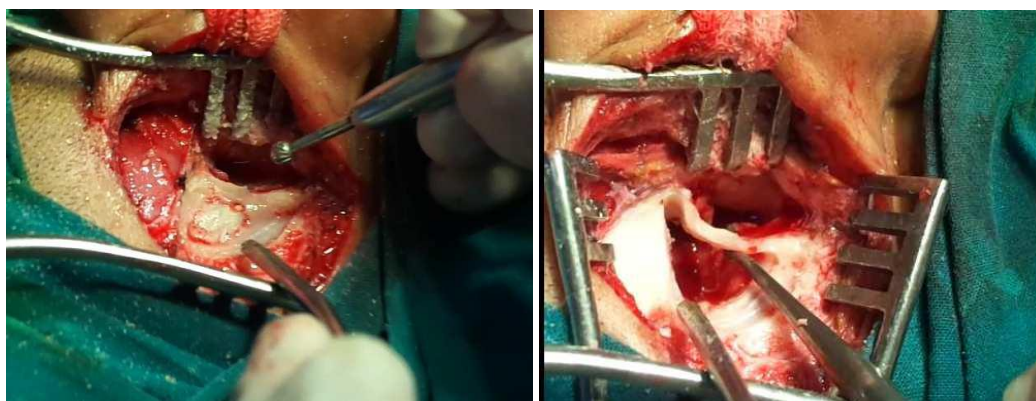


Fig. (1A^{left},B): A complete cortical mastoidectomy was performed.

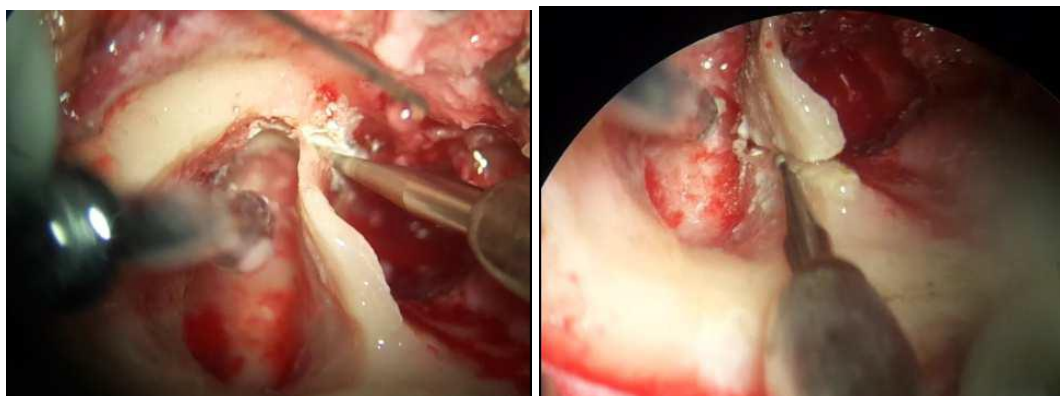


Fig. (2 A^{left},B): The superior and inferior cuts in the posterior canal wall.

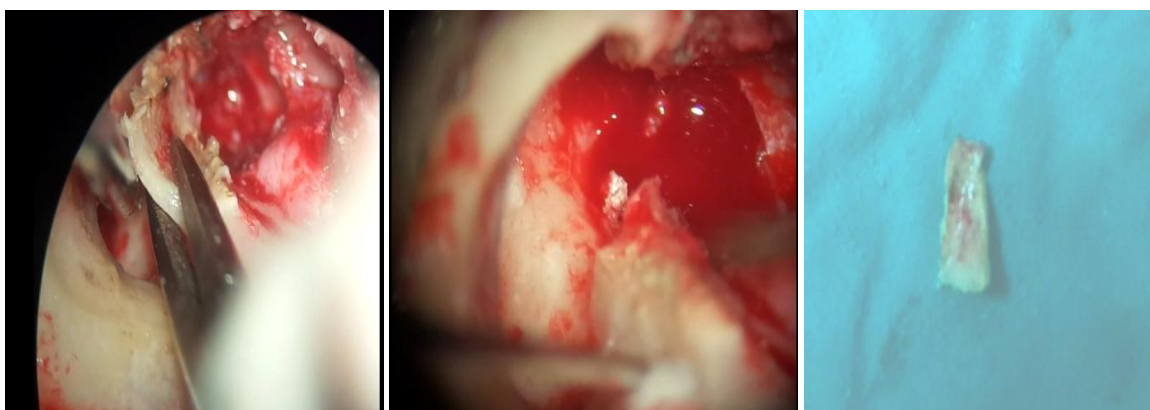


Fig. (3A^{left},B,C): The posterior canal wall segment was then removed and placed aside for reconstruction.

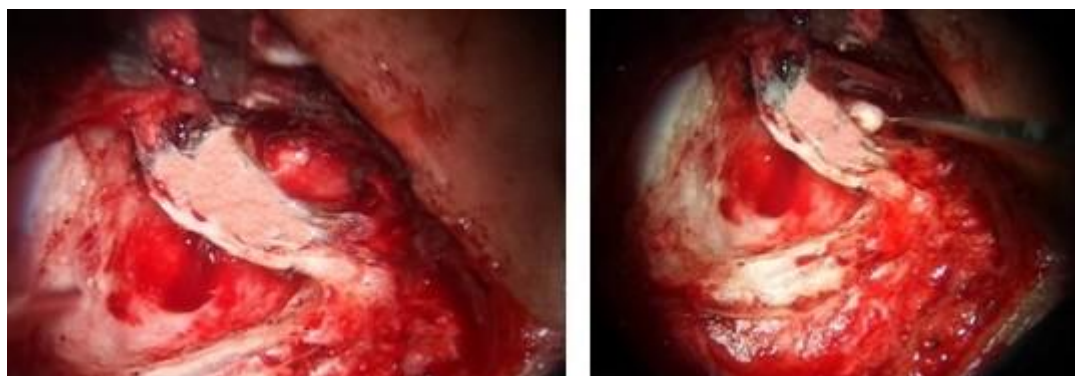


Fig. (4A^{left},B): The posterior canal wall segment was then repositioned in normal place fixed with fibrin glue.

Results:

The study included 35 patients (41 ears) with CSOM and cholesteatoma. The technique utilized was reconstruction of posterior meatal wall using cortical bone fixed with fibrin glue or temporary removal of posterior meatal wall (PMW) and repositioning in place fixed with fibrin glue.

1- Patients distribution according to age:

The age of patients ranged from 9 to 46 years old with a mean \pm SD of (22.9 \pm 9.4).

2- Patient distribution according to sex:

Twenty patients (57.2%) were female and 15 (42.8%) were males.

3- Side of the affected ear:

Right in 13 patients, Left in 16 patients, Bilateral in 6 patients.

4- Duration of ear disease

The duration of ear disease ranged from 2 month to 20 years with mean of 3.9 \pm 0.332 years.

5- Symptoms:

All patients complained from ear discharge and deterioration of hearing.

6- Clinical examination: table (4).

7- CT scan findings

The main finding was presence of soft tissue shadow at different sites of temporal bone.

I- Cholesteatoma extension:

According to **Belal et al., (2012)** staging system of tympano-mastoid cholesteatoma (15), there was 28 ears(68.3%) were found in **stage-IV**, 9 ears(21.9%) were found in **stage-III** and 4(9.8%) in **stage II**. No ears in **stage-I**, and **V**.

II- Other findings

Erosion or dehiscence of the tegmen in 11 ears(26.8%), sigmoid sinus plate in 5 ears(12.2%), facial nerve in 7 ears(17%), and lateral semicircular canal in 3 ears (7.3%).

III- Ossicular pattern

According to **Saleh and Mills 1999** (16), we found the incus was eroded in 17 ears (41.4%), incus and stapes arches were eroded in 5 ears (12.2%) and the malleus handle and incus are absent and the stapedia arch is eroded in 19 ears (46.4%). Table (5)

7- Results of reconstructions:

I-Reconstruction of meatal wall:

table(7).

II-Reconstruction of hearing mechanism:

In our study the ossicular chain was discontinuous in all ears and primary ossiculoplasty was done in 25 ears (61 %), and remaining 16 ears (39 %) for second stage. There was an overall improvement in PTA of 11.45 dB and P-value was 0.002* with a highly significant improvement in hearing post-operatively, table (8)

The **postoperative follow-up** ranged from 6 months to 3 years, the mean postoperative follow-up was 14 months. Good postoperative healing was achieved in 36 (87.5%) of ears with no narrowing of the external auditory canal.

8- Complication after surgery: table (9).

9- Revision surgery

Five ears (12.2%) required revision surgery, three of them were explored for cholesteatoma recidivism, the fourth we found granulation tissue only, the fifth; we explored it because the extrusion of the reconstructed material.

Table (2): Patient distribution according to sex and age groups

Age group	0-15	16-30	31-45	> 45	Total	%
Female	4	14	2	0	20	57.2%
Male	3	7	4	1	15	42.8%
Total	7	21	6	1	35	100%

Table (3): Shows patients symptoms.

Symptom	No. of patients	Percentage
Otorrhea	41	100%
Hearing loss	41	100%
Otalgia	7	17%
Tinnitus	17	41.4%
Vertigo	3	7.3%

Table (4): shows otoscopic and oto-microscopic examination of patients

Otosopic Findings	Frequency	%
Central perforation	1	2.4 %
Attic perforation	12	29.3 %
Marginal perforation	6	14.6 %
Retraction pocket	10	24.4 %
Aural polyp	3	7.3%
Granulation tissue	9	21.9 %
Total	41	100.0 %

Table (5): Shows the different ossicular pattern in relation to staging of cholesteatoma.

Stagel	Ossicular pattern			Total
	O1	O2	O3	
Stage II	1	3	0	4
Stage III	6	0	3	9
Stage IV	10	2	16	28
Total	17	5	19	41
Percent %	41.4%	12.2%	46.4%	100 %

Table (6): Type of surgical procedures according to staging of cholesteatoma.

Stage of cholesteatoma	Surgical procedures done			Total
	Canal wall up mastoidectomy	Canal wall down mastoidectomy	Retrograde mastoidectomy	
Stage -I	-	-	-	-
Stage -II	-	-	4	4
Stage -III	6	-	3	9
Stage -IV	20	8	-	28
Stage -V	-	-	-	-
Total	26	8	7	41

Table (7): Type of reconstruction technique

Reconstruction technique	No. of cases	Percentage
Temporary removal of PMW and reposition in place	26	63.4%
Cortical bone to reconstruct part of the PMW(in cases of retrograde mastoidectomy)	7	17%
Cortical bone to reconstruct the whole PMW(after CWD mastoidectomy)	8	19.6%

Table (8): Comparison between pre-operative and post-operative ABG groups of canal wall reconstruction in patients underwent ossiculoplasty.

ABG	Preoperative			Postoperative			P value
	No.	Mean ± SD	%	No.	Mean ± SD	%	
0-10	1	7.5 ± 0.00	4%	4	8.75 ± 2.08	16%	0.002*
11-20	2	16.25 ± 5. ±30	8%	9	17.01 ± 3.48	36%	
21-30	6	25.02 ± 3.05	24%	7	24.64 ± 2.62	28%	
>30	16	38.26 ± 7.83	64%	5	36.9 ± 4.32	20%	
Total	25	33.28 ± 11.86	100%	25	21.83 ± 9.7	100%	

Table (9): Overall complications.

Complication	Number of cases	Percent %
Broken graft	2	4.9 %
Granulation tissue	3	7.3 %
Extruded material	1	2.4 %
Recidivism of cholesteatoma	3	7.3 %
Otorrhea	9	21.9 %

Discussion:

Besides, the cavity problems after classical radical cavity operations, the acoustic relationships of the auditory canal and middle ear change, and removal of the posterior wall of the auditory canal leads to fall in resonance frequency through volume expansion.⁽¹⁷⁾ Also, in radical cavities a further acoustic effect arises because of the reduced air volume behind the tympanic membrane. ⁽¹⁸⁾

The major downside to the CWU approach is a high rate of recurrent disease.

The recurrences often occur because it is difficult to see the entire middle ear and epitympanum when the canal wall is left intact during surgery. As a result, disease is left behind and can recur six to 12 months later. In CWU, the rate of residual cholesteatoma with this technique is high (between 10 and 40 %).^(22,23)

The published rates of residual disease in CWD are low and between 0 and 15 % .^(19, 20,21)

Cholesteatomas that are initially located in areas that are difficult to reach via the CWU approach (i.e., in the anterior attic, window areas, facial recess or tympani sinus) are known to be associated with a high incidence of residual disease. ⁽⁹⁾ Gaillardin et al.2012, demonstrated that 38 % of residual cholesteatomas were located in the anterior attic following the CWU approach, which rendered their control via the CWU approach much difficult. ⁽²²⁾

In CWR, the combination of the two techniques provides a quality of removal of the cholesteatoma that is as high as that of the CWD approach due to good visualization of the cholesteatoma after the removal of the posterior canal wall; on the other hand, this combination prevents troublesome skin and mucosa reactions within the mastoid bowl and preserves the external auditory canal (EAC) similar to the CWU approach. ⁽²⁾

The CWR procedure is used to reconstruct the posterior canal wall after its removal, either primarily in a single stage or secondarily in a second stage after CWD mastoidectomy. Many reconstructing materials are used. When using bone it can be fixed in place by different materials such as fibrin glue⁽⁹⁾, bone cement^(8, 9, 29, 31) microplates^(7,9) , or even just supported without fixation.⁽³⁷⁾

Many authors used the autologous material (bone or cartilage). ^(5, 7, 8, 9, 13, 14)

Autologous materials, such as bone and cartilage, are resistant to infection, but bone has the disadvantage of the risk of resorption with loss of volume over time. Cartilage might maintain its shape and volume, but its quantity is more limited. Conversely, synthetic materials, such as hydroxyapatite, exhibit no resorption and, the principal disadvantage of such materials is the risk of postoperative infection. ⁽²⁾ Also, sourcing of this material requires second site surgery with associated prolonged operative time and potential added morbidity. There are also issues of limited availability. ^(25, 26, 27, 28)

Other studied materials include hybrid bone-substitute ionomeric cement ⁽²⁹⁾, porous polytetrafluoroethylene-carbon filament composite ^(30, 31) and titanium mesh.^(24,32, 33). However, biocompatibility does not relate to bioactivity, and all such synthetic grafts are unable to bond to soft tissue, ⁽³⁴⁾ and so reports of early or late postoperative extrusion continue.

Bioactive glasses, such as Bioglass and Ceravital, are likely the most suitable synthetic substitutes for conchal cartilage due to their ability to bond to both soft and hard tissues ⁽³⁵⁾ and produce an antimicrobial effect ⁽³⁶⁾.

Our study included 35 patients (41 ears) with CSOM and cholesteatoma. The technique utilized was reconstruction of posterior meatal wall using cortical bone fixed with fibrin glue or temporary removal of posterior meatal wall (PMW) and repositioning in place fixed with fibrin glue.

Their ages ranged from 9 to 46 years old with a mean±SD of (22.9± 9.4). 7 patients were children, 21 patients were less than 30 years old and only 7 patients were older than 30 years, this shows the importance of this disease that affects young people.

Twenty patients (57.2%) were female and 15 (42.8%) were males. All patients suffered from ear discharge and hearing loss, while the most common otoscopic finding was attic perforation and retraction pockets.

According to Belal et al, 2012⁽¹⁵⁾ staging of cholesteatoma, 28 ears (68.3%) were found in stage-IV which means a late

presentation to our hospital. In accordance the ossicles were eroded or absent in most of ears. Due to the late presentation and extensive cholesteatoma, we performed the retrograde mastoidectomy and using a cortical bone to reconstruct part of the PMW in 7 ears only (17%), while in 34 ears (83%) temporary removal and repositioning of PMW or using a cortical bone to reconstruct the whole PMW after doing CWD mastoidectomy.

In Kronenberg et al. 2012⁽⁴⁵⁾ study 8 patients out of 49 underwent ossiculoplasty, in our study primary ossiculoplasty was done in 25 ears (61 %), and remaining 16 ears (39 %) for second stage. There was an overall improvement in PTA of 11.45 dB and P-value was 0.0002 with a highly significant improvement in hearing post-operatively.

Good postoperative healing was achieved in 36 (87.5%) of ears with no narrowing of the external auditory canal. Ear discharge was the most common postoperative complication in 9 ears (21.9%), other complications included: Broken graft 2(4.9%), granulation tissue 3(7.3 %), extruded material 1(2.4%), and recidivism of cholesteatoma 3(7.3 %).

Five ears (12.2%) required revision surgery, three of them were explored for cholesteatoma recidivism, the fourth we found granulation tissue only, the fifth; we explored it because the extrusion of the reconstructed material. No other complications like facial paralysis or wound infection occurred.

Definitely our rate of cholesteatoma recidivism is much better than reports of CWU technique. ^(22,23) Also, we had a low rate of complications in comparison to other studies like Roux et al. 2014, reported 9.6% recidivism following CWR, Kronenberg et al.2012, recurrent cholesteatoma was found in 12.2%.^(2,45)

In 113 ears with cholesteatoma Deveze et al. 2010 used titanium ear canal implant by to reconstruct the posterior canal wall. 88% patients had dry ears, 85% had normal tympanic membrane, no extrusion of the material, 13 patients (11.5%) had otorhea, 12 patients had recurrence of cholesteatoma and 5 patients with residual perforation. ⁽²⁴⁾

Using this technique of temporary removal of PMW, Gantz and colleagues in 2005, the rate of recurrent cholesteatomas was 1.2 percent of 130 patients. Residual cholesteatoma was

evident in only 6.6% of subjects in Blanco et al, 2014 study. ^(37, 47)

We had no bone resorption in our study unlike Kronenberg et al. 2012⁽⁴⁵⁾ who had 2 ears of bone resorption, this was because of good fixation of bone with fibrin glue and the good coverage by a big temporalis fascia which gave better nourishment. We disagree with Van der Gucht et al 2014⁽⁹⁾, who made temporary removed the posterior canal wall in 32 ears with cholesteatoma, at the same setting, they rebuilt the posterior bony canal, in 26 of them they used microplates to refix the posterior bony canal, and glass ionomeric cement in 4 ears, and fibrin glue in 2 ears. They had 39% recidivism of cholesteatoma. They noted that the use of bone cement was associated with granulations formation and bone lysis and use of microplates was superior in fixation of the temporary removed posterior bony canal wall with good stability, better skin healing, and no extrusion or exposure. They explained this high rate of recidivism by extensiveness of cholesteatoma , the defective healing, and the lack of mastoid obliteration. We think that fixation with microplates is technically difficult, time consuming and much more expensive.

To minimize the complications of granulation tissues, bone resorption and extrusion we agree with McElveen et al, 2003⁽⁸⁾ who did not use much of the bonding material and used it only on the mastoid side of PMW with good coverage by a big temporalis fascia. Excess of the bonding material is not necessary and can impair the blood supply to the displaced bone segment.

Comparing reconstruction of PMW in a single stage with reconstruction in a second stage, by Kronenberg et al.2013, the rate of recurrence in single stage reconstruction was 3\29 (10.3%) while in second stage reconstruction it was 4\16(25%).⁽⁴⁶⁾

We believe in temporary removal and immediate repositioning of the original bony canal wall in the same procedure as it further benefits the patient by avoiding a second surgery and benefits the institution through decreased costs.

Some authors associate the obliteration of the mastoid cavity with the CWR procedure. Gantz et al 2005 think that negative pressure in the middle ear and

mastoid also likely contributes to recurrent disease. A primary determinant of middle ear pressure is the rate of gas absorption across the mastoid mucosa, and negative middle ear pressure may result from increased nitrogen absorption from diseased mucosa. (10, 11, 12, 37, 38, 39, 40)

We are against mastoid cavity obliteration while reconstructing the posterior meatal wall, and we think like Tong et al.(2013) who made a study to analyze the results of repair defect of the ear canal with autologous bone containing periosteum and hearing reconstruction and postoperative inflation. They stressed on the function of mastoid antrum to maintain normal middle ear function, they added that mastoid filling methods could only narrow the huge chamber to a smaller one, but not to form really gasified mastoid antrum with function of air conditioning and communicated with tympanic cavity. (41, 42, 43)

To support this, Takahashi et al (1997) said that, while mastoid antrum and lung were both gas storage organs; in spite of respective other complex functions. This reminded us that Eustachian tube and mastoid antrum complemented one another indispensably in regulating the functions of whole middle ear. (44)

We agree with Palva 1987, that a precondition for the use of this technique is good pneumatisation of the mastoid in order to drill free the wall of the auditory canal before removing it. (48)

But we do not think that intact lateral attic wall is necessary to do this technique because we can reconstruct it.

We found like Gantz et al 2005 that, it does take some time to learn and requires some finesse to do this technique which is certainly more complicated than a traditional CWU. They added that some surgeons are hesitant to adopt this technique because the facial nerve is thought to be at risk during the procedure. (37) We had no facial nerve injury in our study. A limitation of CWR is the extra operation time spent in removal and refixing the posterior canal wall. This is largely compensated by the time that is won with easier and complete dissection of the cholesteatoma. Also,

reconstruction in the same setting serves the time of a second stage operation.

We agree with Aquino et al 2007⁽¹⁾ that, bone reconstruction is not indicated when it is not certain that total extirpation of lesion will occur or when there are severe surrounding complication and so we excluded all patients with complications.

We agree with Blanco et al, 2014⁽⁴⁷⁾, that, for patients who are difficult to follow, or have disease in an ear with severe to profound hearing loss, we prefer to use an open technique with meatoconchoplasty.

Conclusions:

Cholesteatoma is a potentially life threatening disease, that requires a surgical approach. Surgery aims to produce an ear that is easy to care for and is free of recurrent or residual cholesteatoma. Hearing improvement is of secondary importance. There are various possible methods of dealing with a cholesteatoma: (i) preserving or reconstructing the posterior meatal wall with an aerated mastoid (closed technique) or obliteration of the mastoid completely or partially after removal of the posterior wall (closed technique); and (ii) leaving the cavity open for inspection (open technique). Both techniques have their specific advantages and disadvantages.

Radical cavities can be avoided if the posterior auditory canal wall is removed only temporarily at operation and is finally reimplanted again. Surgical management of cholesteatoma and reconstruction of the ear in a single surgery is a highly successful procedure for the total eradication of cholesteatoma.

The use of this technique would decrease the rate of residual cholesteatoma. Additionally benefits of this approach include the ability to fit patients with hearing aids because the rebuilt PMW enables the wetting of the ear.

Mastoid cavity obliteration while reconstructing the posterior meatal wall should not done routinely.

Recommendations:

We believe we can improve our results by:

- Better selection of patients who present with cholesteatoma.
- To be a very meticulous to be sure not trapping cholesteatoma-prone skin in the area of reconstruction.
- Using new bio-materials in the future.
- The use of a cartilage graft to reinforce the tympanic membrane has to decrease the rate of recurrence
- During follow-up, micro-otoscopic examination is essential for the diagnosis of recurrence.
- Diffusion-weighted imaging and delayed post-contrast T1-weighted MR imaging are more efficient than CT scans in the detection of residual and recurrent cholesteatomas . MRI may obviate the need for systematic surgical second looks.
- Long term follow up is very important to evaluate the ear after single stage rehabilitation.

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