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# Cholesteatoma surgery by open technique with reconstruction together with same session ossiculoplasty

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## Abstract

**Background:** This study was designed to evaluate the effect of mastoid cavity obliteration with bone chips and reconstruction of canal wall with tragal cartilage after canal wall down tympanomastoidectomy with cartilage ossiculoplasty in the same session. Sixty-three patients with cholesteatoma underwent the technique mentioned above; patients were followed for 1 year postoperative.

**Results:** No cavity problems, median preoperative air bone gap was  $32.86 \pm 6.24$  db, while the median postoperative air bone gap was  $21.67 \pm 5.99$  db.

**Conclusions:** Canal wall down mastoidectomy with obliteration of mastoid cavity is an effective option for the complete removal of cholesteatoma and same session cartilage ossiculoplasty is a viable option.

**Keywords:** Bone chips, Cholesteatoma, Mastoidectomy, Mastoid obliteration, Tragal cartilage

## Background

Cholesteatomas are expansile, erosive lesions of the middle ear and mastoid composed of keratinized squamous epithelium [1]. Although considered benign, their osteolytic activity and infectious nature result in significant complications as mastoiditis, ossicular erosion, hearing loss, dural sinus thrombosis, CSF otorrhea, meningitis, and intracranial abscess [2–4]. Those lesions require surgical excision with variation of extent of tympanoplasty.

The choice of the extent of surgery and appropriate procedure is the role of the otosurgeon, depending on the extent of the pathology, anatomical features of middle ear, available microsurgical equipment, and expertise of the surgeon. The basic techniques for surgical treatment are either the closed, i.e., “canal wall up” (CWU) or open, i.e., “canal wall down” (CWD) tympanoplasty [5].

CWU technique has its advantages of keeping intact anatomy thus avoiding cavity problems and better postoperative hearing results than CWD [6, 7], although no

significant difference regarding hearing was observed in a recent meta-analyses [8, 9]; on the other hand, cholesteatoma recidivism (combined residual and recurrent disease) chances are higher after CWU. The main disadvantage after CWD is that an open cavity remains, requiring regular outpatient follow-up for cleaning, difficulty in hearing aid fitting if needed, and sometimes causes vertigo due temperature changes through water or air [8–10].

Reconstruction of the posterior canal wall after CWD surgery with or without obliteration of the mastoid seems to be a more appropriate solution combining low recidivism rate with a low ear discharge rate [10]. Several techniques of mastoid obliteration were suggested, using muscle flap [11, 12], cortical bone pate [11, 13], autogenous or allogeneous bone chips [13, 14], silicone [15], and hydroxyapatite [12, 16].

In this study, bone chips and tragal cartilage have been used for obliteration of the mastoid and reconstruction of the posterior canal wall. The objective of this study was to evaluate surgical outcome and recidivism rates of

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cholesteatoma surgery using this technique for reconstruction.

**Methods**

A prospective study was performed at our tertiary referral center for patients admitted with cholesteatoma in 2017. Inclusion criteria were patients with cholesteatoma, no previous mastoidectomy, and with no systemic debilitating diseases. Preoperative history taking, ear examination, audiometry, and CT temporal bone were performed for all included patients. They were followed up for 12 months postoperatively.

The study was performed on 63 patients, with cholesteatoma, 24 operated on the left ear and 39 on right ear, and 36 of them were males and 27 of them were females. Their ages ranged from 13 to 41.

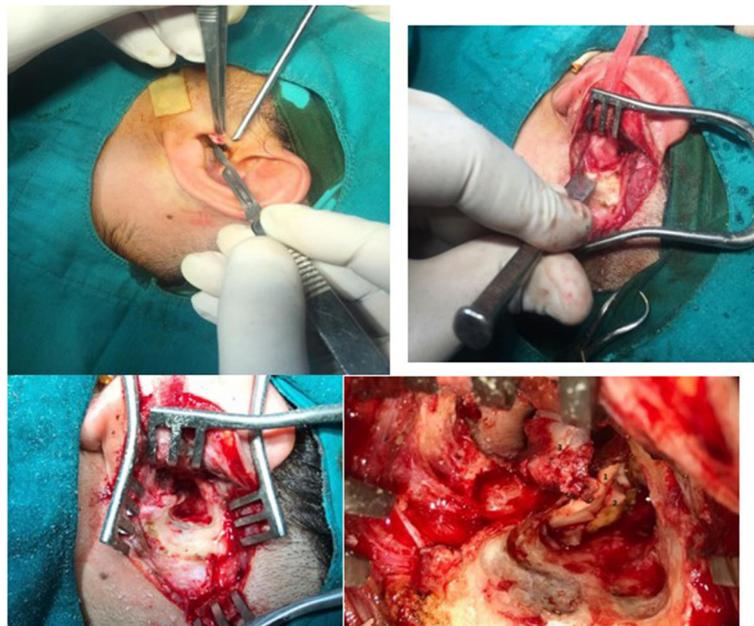
The main presenting symptom was ear discharge with offensive odor, followed by hearing loss. One case was presented with meningitis as a complication of cholesteatoma due to tegmen erosion.

**Surgical technique**

1. Starting the surgery by harvesting the tragal cartilage.
2. Post-auricular incision and harvesting temporalis fascia graft
3. Before starting cortical mastoidectomy, collection of fifteen to twenty C-shape bone chips using chisel

4 mm from the outer cortex of the mastoid bone is done to be used later in reconstruction.

4. Incision of the meatal skin transversely at the medial part of the cartilaginous external canal (a bit more lateral than the usual incision) in order to keep the meatal flap thick and tough to be used in reconstruction. Then, a vertical incision at 2 o'clock and dissection of the meatal wall flap pedicled inferiorly.
5. CWD mastoidectomy with excision of the cholesteatoma, without lowering the ridge.
6. Reconstruction of the posterosuperior canal wall by tragal cartilage and fixing it in place by drilling sulcus in the anterior buttress and facial ridge. Taking into consideration that, the tragal cartilage is placed more posteriorly just above tympanic segment of the facial nerve so the future external canal is wider than normal. Then, bone chips are placed to reconstruct mastoid bone just behind the tragal cartilage (Fig. 1 shows steps of the surgical technique).
7. Starting to fashion the ossicular status, in almost all cases excision of the head of malleus together with the incus and checking for stapes suprastructure if still present. The handle of malleus is kept to support the drum graft and to control the middle ear depth. Cartilage ossiculoplasty is performed in the same session. Only if the middle ear space was



**Fig. 1** Harvesting of tragal cartilage (a). Extraction of bone chips from mastoid cortex (b). Open cavity before reconstruction (c). Reconstruction of tympanomastoidectomy by cartilage [1], bone chips [2], meatal flap [3] (d)

unsatisfactory due to atelectasis (which was the case in four of our series), then ossiculoplasty is postponed as second stage using TORP. The tympanic membrane is grafted using perichondrium and fascia (2 layers). Finally, closure of the wound was done.

**Results**

Early and late postoperative complications were monitored, together with recording the air bone gap (ABG) preoperative and postoperative after 3 months. Follow-up CT was performed in patients 6 months postoperatively.

**ABG**

The mean ABG for our patients preoperative was  $32.86 \pm 6.24$  db, whereas postoperative was  $21.67 \pm 5.99$  db denoting improvement. Two patients failed to attend their postoperative audiogram date and thus were excluded from the audiogram results, while they kept their follow-up in the OPC.

Regarding the intraoperative ossicular chain state, 45 patients had intact stapes suprastructure (group 1), while 18 patients had stapes suprastructure necrosis (group 2).

Twelve patients needed second-stage ossiculoplasty with TORP, eight of them due to failure of cartilage ossiculoplasty to improve their ABG, while four patients were planned because the middle ear depth was unsatisfactory for primary reconstruction cause of severe atelectasis. Those twelve patients were all from group 2.

Thirty-six patients (61%) out of the fifty-nine who were performed same session cartilage ossiculoplasty had a postoperative ABG < 20 db.

**Cavity problems**

During post-operative follow-up, there was no continuous ear discharge or accumulation of keratin debris, all patients did not complain of any cavity problems postoperatively, and follow-up showed adequate reconstruction with taken graft (Fig. 2).

Also, follow-up CT showed mastoid obliteration using the bony chips (Fig. 3).

During the follow-up period, our series showed no recurrence of cholesteatoma.

**Anatomical conservation**

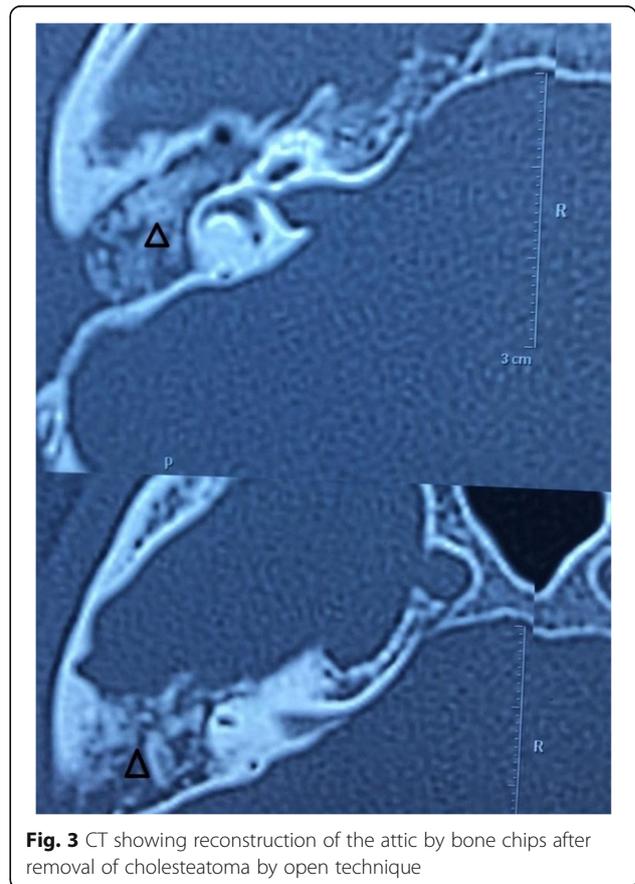
With reconstruction of the canal wall, after healing and during follow-up, the canal maintained its cylindrical shape. With tympano-ossicular reconstruction, there was adequate middle ear space.

In our series, one case needed second session (after 6 months) tympanic membrane grafting due to postoperative infection and perforation of the neomembrane; another case presented after 1 month with tympanomeatal



**Fig. 2** Arrow pointing at the bony chips used for reconstruction of the attic and posterosuperior meatal wall covered by flap, 1 is the handle of malleus

flap infection and necrosis; this was managed with Thiersch graft for relining the cartilage used for reconstruction and the meatus; eight cases presented with failure of cartilage ossiculoplasty and almost same ABG pre- and postoperatively; those cases were treated with second-stage ossiculoplasty using TORP; three cases presented with minor complication in the form of external canal granulations on top of the tympanomeatal flap



**Fig. 3** CT showing reconstruction of the attic by bone chips after removal of cholesteatoma by open technique

incision, and those were treated with repeated packing with steroid ointment.

## Discussion

Canal wall up technique is associated with increased risk of cholesteatoma recurrence (30–63%) in contrast to canal wall down, which is associated with lower risk of cholesteatoma recurrence (2–10%) [11]. Some complications occur with CWDT such as delayed healing of wound, chronic ear drainage, and inadequate canal contour for hearing aid.

Obliteration of the mastoid cavity was first reported by Mosheri [10], and this technique was further modified and popularized in the 1960s by Palva et al. [11]. Since Mercke [17] reported good outcomes in CWD surgery with obliteration for cholesteatoma surgery, the concept of obliteration has been taken up and improved by many otologists. Nowadays, different obliteration techniques with different obliteration materials are found in the literature.

The goal of all of these techniques is to provide the lower recidivism rates associated with CWD mastoidectomy, while eliminating common postoperative cavity problems [18]. Each technique has its advantage and disadvantage according to desorption, atrophy, curvature, and donor site morbidity and risk of infection [19].

During our follow-up period for the patients in our series, no cases were reported with recidivism that may be related to the short follow-up period in this series (1 year postoperative) or the method of follow-up as we do not perform routine second look or diffusion-weighted MRI unless indicated with persistent symptoms; two cases (3.2%) needed regrafting and 8 cases (12.7%) needed second-stage ossiculoplasty with TORP.

The greatest advantage of our series was the availability of the reconstructed autogenous material, bone chips, and cartilage. Autografts are the material of choice for reconstruction, with lower rate of infection and resorption, and these materials are biocompatible.

The rate of resorption and shrinkage of bone chips is minimal in contrast to the muscle that becomes atrophied, so bone and cartilage reconstruction prevents early necrosis of the skin of the canal wall and increases epithelization.

Hartwein and Hormann reported a decrease of epithelization, and Takahashi et al. reported a higher rate of exposure of obliterated apatite ceramic material when it was used [20, 21].

The wide surface area of bone chips improves diffusion of nutrients and growth factors than bone pate with increasing activity of osteoblast and osteoclast [22].

The reconstructed canal wall was covered completely by the healthy skin flap to protect the new posterior canal wall.

To prevent recurrence of cholesteatoma, the bone chips should be from the normal cortical bone with no

diseased mucosa and cholesteatoma must be removed completely before reconstruction.

The average period of complete epithelization and coverage canal skin and graft was 4 weeks in our study which is shorter than what is needed in cases of CWDT without reconstruction which is 8–12 weeks [23].

Thirty-six ears (61%) out of the fifty-nine who performed same session cartilage ossiculoplasty had a postoperative ABG < 20 db. This renders our results for same session cartilage ossiculoplasty similar to other studies for CWU mastoidectomy where 50 to 66% of ears had an ABG < 20 db [24–26] and better than standard CWD surgery where 28 to 45.7% of ears had an ABG < 20 db [26–28].

The reconstructed canal wall was associated with adequate middle ear space, which is sufficient for hearing gain with better results when associated with ossiculoplasty in the same stage.

## Conclusion

Reconstruction of the mastoid cavity after CWDT for cholesteatoma and reconstruction of canal wall together with tympan ossicular reconstruction in the same session is very effective in eradication of cholesteatoma, avoiding cavity problems and with good hearing results.

### Abbreviations

CWDT: Canal wall down technique; CWU: Canal wall up; CSF: Cerebrospinal fluid; ABG: Air bone gap; TORP: Total ossicular replacement prothesis

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### Authors' contributions

MH and PM have formulated the methodology and collected the patients and the results of the surgery. OM and AT have interpreted the data, reviewed the literature, and prepared the manuscript for publication with the help of other authors. All authors have read and approved the manuscript.

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### Availability of data and materials

The data and material used and/or analyzed during the current study are available from the corresponding author on reasonable request.

### Ethics approval and consent to participate

This study was approved by the Ain Shams University Faculty of Medicine Institutional Review Board. Written consents for participation in the study were taken from the patients.

### Consent for publication

Written consents for publication of the study were taken from the patients.

### Competing interests

The authors have no competing interest to disclose.

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