Surgical Outcome of Mastoid Cavity Obliteration Using Postauricular Composite Bone with Periosteum Flap

Aniket Kamlesh Shah¹ · Seema Patel¹ · Apurva Pawde¹

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Abstract This study was aimed to evaluate surgical outcome of patients undergoing obliteration of mastoid cavity with postauricular composite osteo-periosteal flap. This interventional study was carried out on 100 patients having unsafe CSOM from Nov. 2012 to Oct. 2014 who underwent canal wall down mastoidectomy with tympanoplasty and obliteration of cavity using composite osteo-periosteal flap. The primary outcome measure was control of supuration and creation of dry, low-maintenance mastoid cavity, which was assessed using Merchant et al. grading system. At the end of 1 year follow-up, 89% patients had Grade 0 summary score while Grade 3 which was considered as failure of control of infection was not obtained in any patient during the entire follow-up period. Mastoid cavity obliteration using composite osteo-periosteal flap is an effective technique to avoid cavity problems.

Keywords Cholesteatoma · Treatment outcome · Ear surgery · Mastoid obliteration · Osteo-periosteal flap · Tympanoplasty

Introduction

Chronic suppurative otitis media (CSOM) is fairly prevalent disease with symptoms of recurrent ear discharge and diminished hearing. It is defined as a long standing infection of a part or whole of the middle ear cleft. Atticoantral disease involves pars flaccida and is characterized by the formation of cholesteatoma. It is generally considered to be at risk of developing intracranial or extracranial complications [1]. Open cavity mastoidectomy technique has been the mainstay of the management of cholesteatoma for the past one and half century. Open cavity procedures can be broadly defined as those requiring the removal of the posterior wall of the external auditory canal. The purpose of the open cavity procedure is to exteriorize the mastoid cavity for future monitoring of recurrent cholesteatoma, provide drainage for unresectable temporal bone infection, and occasionally, provide exposure for difficult to access areas of temporal bone [2].

The concept of mastoid obliteration was first introduced by Mosher [3] to promote healing of a mastoidectomy defect. Mosher's original description was that of a superiorly based postauricular soft tissue flap. Over the course of this century, there have been numerous reports detailing a variety of techniques of obliterating the mastoid cavity. The vast majority of obliteration techniques consist of either free grafts (cartilage, bone, hydroxyapatite, and so on) or local flaps (muscle, periosteum, or fascia). Obliteration of the mastoid cavity leaves a smaller surface requiring epithelialisation and healing will thus be quicker. There is also reduced likelihood of developing cavity granulation. Small cavity is also more likely to retain its epithelial migratory potential and it is self-cleaning.

A canal wall down mastoid cavity can result in persistent otorrhea that can be difficult to control even with

✉ Aniket Kamlesh Shah
aniket.shah268@gmail.com

¹ Department of ENT, Government Medical College and Hospital, Nagpur, "Tara Kunj", Near P.V.M. School, Gujarati Lane, Chopda, District Jalgaon, Maharashtra 425107, India

topical antibiotic therapy and frequent cleaning of the cavity. Other problems associated with a mastoid cavity include the need for frequent cleaning, water intolerance due to a susceptibility to infection, difficulty with the use of a hearing aid, and propensity to vertigo by a caloric stimulus such as warm/cold air or water. Obliteration of the mastoid cavity is indicated to reduce the size of the cavity. It is ideally conducted as a primary procedure at the time of canal wall down mastoidectomy [4, 5].

To reduce the problem of chronically discharging mastoid cavity, we need to obliterate the mastoid cavity and study the end results and benefits of this procedure in the management of atticotympanic type of CSOM.

Aims and Objectives

Aims and objectives of this study are

1. To evaluate the surgical outcome of patients undergoing obliteration of mastoid cavity with postauricular composite bone and periosteum flap in canal wall down mastoidectomy.
2. To assess the improvement in hearing.

Materials and Methods

Study design: A hospital based interventional study.

Study setting: The present study was conducted in the Department of ENT of tertiary health care centre during period of November 2012 to October 2014. Sample size estimation was done. Total 100 patients satisfying the inclusion and exclusion criteria and willing for regular follow up, with written informed consent were enrolled in the study.

Inclusion Criteria

1. All cholesteatoma cases with complete extirpation of the disease.
2. All cases of CSOM with extensive granulations.
3. Cases of Recurrent cholesteatoma.

Exclusion Criteria

CSOM cases with intracranial complications.

Clinical Evaluation

All patients underwent detailed medical history and clinical examination. Each patient underwent otoscopic

examination, otomicroscopic examination, pure tone audiometry, bilateral mastoid x-rays (Schuller's view) and HRCT temporal bone (if required).

Surgical Procedure

All patients underwent CWD mastoidectomy with obliteration using composite bone & periosteum flap with tympanoplasty [6].

Surgical pearls for success for canal wall down mastoidectomy with mastoid obliteration include the following:

1. A smooth, well-saucerized mastoid cavity with no ridges or cavities.
2. Maximal lowering of facial ridge to level of facial nerve.
3. Drilling out the mastoid tip to allow the flap to smoothly lay into the mastoidectomy defect.
4. Complete coverage of raw bone with the postauricular soft tissue and bone flap.
5. Adequate meatoplasty [4].

Postoperative treatment and follow-ups:

All patients were given an antibiotic, analgesic and antihistaminic medication for one week. Patients were discharged on seventh postoperative day after suture removal. Ribbon gauze pack was removed two weeks after surgery. Patients were called for follow-ups 3 months, 6 months and 1 year after surgery for the assessment of postoperative mastoid cavity. Hearing assessment by pure tone audiometry (PTA) was done at the third follow up (1 year after surgery).

The primary outcome measure was the creation of a dry, infection free, low maintenance mastoid cavity which was assessed by a grading system developed by Merchant et al. [7].

1. Grade 0—No episode of otorrhea, and no pus or granulation tissue on otologic examination.
2. Grade 1—One episode of otorrhea of <2 weeks duration in a 1 year period or no otorrhea but a subjective feeling of wetness in the ear.
3. Grade 2—More than one episode of otorrhea in a 1 year period, or an episode of otorrhea lasting >2 weeks, or demonstration of localized granulation tissue/pus that was promptly cured with antibiotic drops, curettage or tri-chloro-acetic acid application.
4. Grade 3—Constant purulent otorrhea on a daily basis, or examination showing extensive granulation tissue, or need for a revision procedure to control infection.

The patients were graded at every follow up attendance and their summary grade was used to assess the outcome of the degree of control of infection. The summary grade is

defined as the worst score obtained at any point during the entire follow up. Grades 0, 1, and 2 are considered adequate control of infection, whereas grade 3 indicates failure of control of infection.

Secondary outcome measures included postoperative complications and hearing improvement which was assessed by pure tone audiogram 1 year after the surgery. Hearing improvement was assessed by comparing the mean preoperative air-bone gap with mean postoperative air-bone gap.

Statistical Analysis

Descriptive statistics like percentage, mean and range were used to summarize baseline characteristics of the patients. Comparison of preoperative mean pure tone air bone gap and postoperative mean pure tone air bone gap was done. The p value <0.05 was considered as statistically significant.

Results

Total 100 patients having unsafe type of CSOM, willing to get operated with written informed consent, and willing for regular follow up were registered for the study.

Age range was 7–68 years with mean age of 28.43 years. 60 cases (60%) were in the age group 11–30 years. There were 49 male and 51 female patients with Male: Female ratio of 0.9:1.

All 100 patients (100%) presented with ear discharge while 79 patients (79%) complained of impairment of hearing. All of them had scanty, continuous, foul smelling, yellowish, purulent discharge. Most of the patients were having attic perforation, postero-superior retraction or both with cholesteatoma.

Intra-operatively all 100 (100%) patients were found to have cholesteatoma sac in antrum, aditus and epitympanum and 50 (50%) patients had cholesteatoma in mesotympanum. Ossicular chain erosion was present in all 100 (100%) patients. Incus (98.7%) was the most commonly involved ossicle followed by stapes (70%) and malleus (62.5%).

Out of 100 patients 81 (81%) patients had conductive hearing loss, 9 (9%) patients had mixed hearing loss, 2 (2%) patients had sensorineural hearing loss & 8 (8%) had normal hearing. Those 2 patients with sensorineural hearing loss were having congenital hearing loss.

The patients were followed up 3 months, 6 months and 1 year after surgery respectively. There was no evidence of residual disease or recurrence of cholesteatoma in our study. On follow-up the following results were obtained.

At the 1st follow-up 89 patients (89%) had Grade 0 cavity which was considered as a complete control of infection, 9 patients (9%) had Grade 1 and another 2 patients (2%) had a Grade 2 cavity which was considered as an acceptably dry cavity. At the 2nd follow up 95 patients (95%) had Grade 0, 3 patients (3%) had Grade 1 and 2 patients (2%) had Grade 2 cavity.

And during the final follow-up visit that was 1 year after the surgery, all 100 patients (100%) had Grade 0 cavity and no-one had Grade 1 or Grade 2 cavity.

So the summary grades obtained were as follows: 89 patients (89%) had Grade 0, 7 patients (7%) had Grade 1 and 4 patients (4%) had Grade 2 cavities each. Grade 3 cavities which were considered as failure of control of infection was not seen in our study.

During the study period five patients had post aural wound gaping which required re-suturing of the wound in minor operation theatre. Three out of six patients with erosion of bony labyrinth continued to have giddiness on exposure to cold air postoperatively, which improved on treatment for 1 month. Four patients developed granulations in the mastoid cavity which was treated adequately with local antibiotic drops and Tri-chloro-acetic acid application.

Preoperative Mean pure tone average air-bone gap was compared with postoperative mean pure tone average air-bone gap and was found to be decreased from 37 ± 13.3 to 29.19 ± 12.16 dB. This difference was found to be statistically significant with p value of <0.001 (p value <0.001 highly significant and >0.05 not significant). Ten patients had deterioration of hearing postoperatively, they were the cholesteatoma hearers.

Discussion

Canal wall down mastoidectomy is the mainstay of treatment for cholesteatoma. The long-term goal of the surgery is to provide the patient with a safe, dry and self-cleaning ear. By obliteration of the mastoid cavity, the size of the mastoid cavity is reduced and the lining process is hastened if the pedicled graft is used [8]. When a soft tissue flap is placed over living bone, it gets nourishment from the live bone, and when it is placed over non vascular materials, such as hydroxyapatite or bone paste, it needs a pedicle for nourishment [9]. Histological investigations relating fracture healing process have shown that intra-membranous bone formation begins under periosteum in a few days after fracture formation and bridging between fracture fragments begins in 4 weeks [6]. In our study, bone lamellae with utmost 1 mm thickness were raised as a part of a fractured bone panel attached to the periosteum to obliterate the cavity. The bone lamellae beneath the periosteum were

supportive material to our flap and thus became a skeleton for the expected EAC.

Age and Gender Distribution

In this study, age range was 7–68 years with mean age of 28.43 years. Maximum numbers of cases were found in 2nd and 3rd decade of life. 60 cases (60%) were in the age group 11–30 years. This finding was comparable with the study by Deshmukh et al. [10].

Male to female ratio was 0.9:1 in present study (with 49 male and 51 female cases). This was comparable to the study by Uçar [6] and study by Kim et al. [7]. So this showed that there was almost equal gender predilection in all the above studies.

Symptoms

Ear discharge (100%) and impairment in hearing (79%) were the most common symptoms in the present study, followed by vertigo (11%) and tinnitus (5%). These findings were comparable with the following studies. In a study by Deshmukh et al. [10], all the patients (100%) presented with complaint of ear discharge, 86.6% presented with history of decreased hearing and only 13% presented with tinnitus. Vertigo was seen in only 6% of the patients. In a study by Wadhwa et al. [8], two most common presenting complaints were hearing loss (82%) and foul smelling discharge (80%). This showed that the most common modes of presentation in attic-antral type of CSOM were ear discharge and impairment of hearing.

Clinical Findings

Tympanic membrane findings on otomicroscopic examination included attic perforation alone (37%), postero-superior retraction alone (34%), attic perforation with postero-superior retraction (15%), granulations with attic perforation (10%) and polyp (4%).

Clinical findings of the present study were comparable with the study by Singh et al. [5]. In their study, attic perforation alone was present in 42.3% of the patients and posterosuperior retraction alone was present in 38.4% of the patients. Both the findings were present in 19.2% of the patients. Granulation with attic perforation was present in 3.8% of the patients.

Intraoperative Findings

In the present study, intraoperatively, all the cases (100%) had cholesteatoma in aditus, antrum and epitympanum. Ossicular chain erosion was also present in all cases (100%), with incus being the most common ossicle

involved (98.7%) followed by stapes (70%) and malleus (62.5%). These findings were comparable with the following study.

In a study conducted by Wadhwa et al. [8], the ossicles were necrosed in 90% of the cases. Incus was the most common ossicle involved (68%). It was followed by Stapes which was involved in 46% of the cases. The most common combination of the ossicle involvement was Incus with Stapes which was found in 26% of the cases.

Post Operative Results of Dry Mastoid Cavity

At the end of 1 year postoperatively no patient showed grade 3 mastoid cavity i.e. failure of control of infection. There were no major complications. There was no residual disease and no recurrence of cholesteatoma seen. Comparative analysis of the various interventions in the literature for mastoid obliteration is difficult because of the wide array of outcome measures used. This study can be compared directly with the techniques of Uçar [6] (osteoperiosteal flap) and Ramsey et al. [11] (inferiorly pedicled periosteal pericranial flap with bone pate). It can also be compared with the Kim et al. [7] (anteriorly based musculoperiosteal flap) by virtue of outcome tool used (Tables 1, 2).

Hearing Outcome

The secondary outcome measure in our study was assessment of hearing improvement. Preoperative mean pure tone average air-bone gap was compared with postoperative mean pure tone average air-bone gap and was found to be decreased from 37 ± 13.3 to 29.19 ± 12.16 dB. This difference was found to be statistically significant in our

Table 1 Postoperative dry mastoid cavity in various studies

Study	Dry mastoid cavity (%)
Kim et al. [7]	96
Deshmukh et al. [10]	100
Uçar [6]	100
Ramsey et al. [11]	90
Present study	100

Table 2 Post operative summary grades of dry mastoid cavity

Summary grades	Kim et al. [7] (%)	Present study (%)
Grade 0	83.2	89
Grade 1	8	7
Grade 2	4.4	4
Grade 3	4.4	0

study. This finding was comparable with the following studies.

In a study by Kim et al. [7] the average air-bone gap were 32.4 ± 13.8 dB preoperatively and 23 ± 13.2 dB postoperatively.

A study was carried out by Maniu et al. [12] on 56 patients, who found decrease in the mean pure-tone average air-bone gap from 33.4 ± 8.2 to 18.3 ± 9.7 dB.

Kang et al. [13] studied 200 adult patients. The average preoperative pure tone air-bone gap, postoperative pure tone air-bone gap, and air-bone gap closure were 31.5 ± 12.4 , 25.3 ± 12.2 , and 6.2 ± 12.6 dB respectively.

Summary and Conclusion

- Canal wall down mastoidectomy with mastoid obliteration with tympanoplasty was done in all patients.
- Postoperative dry and healthy mastoid cavity with adequate control of infection was seen in 100% patients after 1 year follow up.
- There was statistically significant improvement in hearing ($p < 0.001$) with decrease in mean pure tone air bone gap from 37 ± 13.3 to 29.19 ± 12.16 dB.
- Hence, from above findings we conclude that problems associated with canal wall down mastoid cavity were reduced significantly by using post auricular composite bone and periosteum flap. So it is a very good option for mastoid obliteration.

Compliance with Ethical Standards

Conflict of interest The authors declare that they have no competing interests.

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Ethical Approval The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national

and institutional guidelines on human research and with the Helsinki Declaration of 1964 and its later amendments. This study is approved by institutional Ethics Committee for research work.

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

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