Original Article

Canal Wall Reconstruction Mastoidectomy

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Abstract Objective To investigate the advantages of canal wall reconstruction (CWR) mastoidectomy, a single-stage technique for cholesteatoma removal and posterior external canal wall reconstruction, over the open and closed procedures in terms of cholesteatoma recurrence. Methods: Between June 2002 and December 2005, 38 patients (40 ears) with cholesteatoma were admitted to Sun Yat–Sen Memorial Hospital and received surgical treatments. Of these patients, 25 were male with ages ranging between 11 and 60 years (mean = 31.6 years) and 13 were female with ages ranging between 20 and 65 years (mean = 38.8 years). Canal wall reconstruction (CWR) mastoidectomy was performed in 31 ears and canal wall down (CWD) mastoidectomy in 9 ears. Concha cartilage was used for ear canal wall reconstruction in 22 of the 31 CWR procedures and cortical mastoid bone was used in the remaining 9 cases. Results At 0.5 to 4 years follow up, all but one patients remained free of signs of cholesteatoma recurrence, i.e., no retraction pocket or cholesteatoma matrix. One patient, a smoker, needed revision surgery due to cholesteatoma recurrence 1.5 year after the initial operation. The recurrence rate was therefore 3.2% (1/31). Cholesteatoma recurrence was monitored using postoperative CT scans whenever possible. In the case that needed a revision procedure, a retraction pocket was identified by otoendoscopy in the pars flacida area that eventually evolved into a cholesteatoma. A pocket extending to the epitympanum filled with cholesteatoma matrix was confirmed during the revision operation. A decision to perform a modified mastoidectomy was made as the patient refused to quit smoking. The mean air–bone gap in pure tone threshold was 45 dB before surgery and 25 dB after (p < 0.05). There was no difference between using concha cartilage and cortical mastoid bone for the reconstruction regarding air–bone gap improvement, CT findings and otoendoscopic results. Conclusion CWR mastoidectomy can be used for most patients with acquired middle ear cholesteatoma, including children. The CWR technique provides improved exposure of the middle ear, especially the anterior epitympanum, without creating a mastoid bowl and reduces the incidence of residual and recurrent disease, including cholesteatoma and otorrhoea.

Keywords Mastoidectomy; Ear canal; Reconstruction; Cholesteatoma

Introduction

Acquired middle ear cholesteatoma remains a common pathology nowadays. The main treatment is surgery. Surgeries for cholesteatoma are usually classified as open or closed procedures. The open procedure, also known as canal wall–down (CWD) operation, offers lower rate of cholesteatoma recurrence but frequently results in postoperative otorrhea, the latter being mainly due to the absence of the posterior canal wall and hence exposed mastoid bowl that quite often catches infection on its surface. The closed procedure, also called wall–up (CWU) procedure, yields high rate of "dry ear" but can lead to substantially high cholesteatoma recurrence rate \[1\] that limits its employment in patients with constraint health insurance and, as a consequence, unable to afford second look operations and in those patients who would, for any reason, be reluctant to accept a revision operation the following year after the initial operation.

Posterior canal wall hinders the eradication of cholesteatoma in the middle ear, especially the anterior epitympanum and posterior tympanum areas, including facial recess and sinus tympani. This explains the high rate of
cholesteatoma recurrence in patients subjected to closed procedure. Removal of the posterior canal wall significantly reduces the rate of postoperative cholesteatoma recurrence.

The concept of canal wall reconstruction (CWR) mastoidectomy has been created in an attempt to combine the advantages of both CWD and CWU techniques. The CWR mastoidectomy is a single-stage technique for cholesteatoma removal and canal wall reconstruction, and has been used by some authors in most patients with acquired cholesteatoma, including children. Herein we present our experiences in employing this technique.

Material and Method

Between June of 2002 and December of 2005, 38 patients with the diagnosis of cholesteatomatous otitis media (40 ears) were admitted to the Department of Otolaryngology, the Second Affiliated Hospital of Sun Yat–Sen University and were operated on by the author. Of these patients, 25 were male with an age range between 11 and 60 years (mean = 31.6 years) and 13 were female patients with an age range between 20 and 65 years (mean = 38.8 years). CWR mastoidectomy was performed in 31 ears and CWD mastoidectomy in the remaining 9 ears, which showed widespread cholesteatoma involving the posterior canal wall. The posterior canal wall had to be removed totally in these cases, which made reconstruction difficult if not impossible. For the 31 CWR operations, concha cartilage was used in 22 cases and cortical mastoid bone was used in the rest 9 for ear canal wall reconstruction. The cortical bone was the material we used when we first began using the CWR technique.

The retroauricular approach was used in all cases. The posterior canal wall skin flap was lifted all the way down into the tympanum through underneath the tympanic annula and transected in the middle for visualization of the tympanic membrane and the retraction pocket that was usually present in the pars flacida or in the postero–superior portion of the pars tensa. Decorticalization started either at the antrum if the cholesteatoma extended beyond the antrum or at the lateral wall of the epitympanum if the cholesteatoma was confined to the epitympanum. The upper portion of the posterior external ear canal wall and the lateral wall of the epitympanum were removed including the so-called “bridge”, an anterolateral border of the aditus of the antrum. Cholesteatoma was removed carefully with special attention paid to the anterior epitympanum and posterior tympanum including facial recess and sinus tympani. Following cholesteatoma removal, two grooves were created using 1 mm diamond bur, one on the anterior wall of the epitympanum and another on the facial ridge. Cartilage was harvested from the concha and cortical bone from behind the mastoid area. The grafts were shaped to cover the defect in the posterior canal wall and put in position with edges sliding into the two grooves. Fascia temporals was used to repair the perforation in the eardrum and PORP or TORP was used to reconstruct the ossicular chain if the stapes was identifiable. In some cases fibrin glue was used for additional fixation of the canal wall graft. Ear canal packing was realized with silastic strips lining the canal wall filled with Merocel soaked with antibiotic solution. The packing was removed in two weeks after the operation.

Patients were followed weekly in the first month after the operation with otoscopy and then monthly with otoendoscopy. They were subjected to audiometry two months after the operation, documenting the mean air–bone gap over speech frequencies (500 through 2000 Hz). Pre– and post–operative hearing results were compared using the Student’s t-test.

Result

![Fig 1. Schematic drawing showing structures during a mastoidectomy, mainly anterior epitympanum (AE) and tympanic segment of the facial nerve (arrow), exposed after removal of the upper part of posterior canal wall and lateral wall of the epitympanum. ME, middle ear cavity; Ma, mastoid cavity; FR, facial ridge; ICW, inferior canal wall.](image-url)
The follow up period was 0.5 to 4 years. All but one patients remained free of the signs of cholesteatoma recurrence, i.e., presence of retraction pocket and cholesteatoma matrix. Therefore, the cholesteatoma recurrence rate was 3.2% (1/31). Cholesteatoma recurrence was monitored using CT scans whenever possible. The patient who needed revision surgery at 1.5 year after the initial operation due to recurrence of cholesteatoma was a smoker. In this case, a retraction pocket was noticed in the pars flacida area under otoendoscope that eventually evolved into a cholesteatoma. The revision surgery revealed an epithelium pocket filled with cholesteatoma matrix in the epitympanum. Modified mastoidectomy combined with meatoplasty was undertaken because the patient refused considering smoking cessation, which was considered an important factor for cholesteatoma recurrence.

For patients subjected to CWR mastoidectomy, pre- and postoperative mean air–bone gaps were 45 dB and 25 dB respectively ($p<0.05$). Using cortical bone or cartilage for the reconstruction had no impact on pre–/ post–operative air–bone gap change, CT scanning results or otoendoscopic findings.

**Discussion**

It is not correct, in our opinion, to classify CWR mastoidectomy as one subtype of closed mastoidectomy. This is simply because of its significantly lower cholesteatoma recurrence rate than true closed procedures with preserved posterior canal walls, despite the fact that the middle ear and mastoid cavity are closed at the end of the CWR operation. The 3.2% recurrence rate in this series is an acceptable outcome and comparable to Dornhoffer’s result $^{3}$ with CWR mastoidectomy in 50 ears. The average follow–up in his study was 7.8 years (6.7–9 years), with recurrence occurring in 8 (16%) ears. He considered the results as an acceptable long–term results.

The case with cholesteatoma recurrence in our study is a heavy smoker at one pack a day. In such cases, placement of a tympanic membrane tube after the initial operation may be helpful in recurrence prevention because poor Eustachian tube function from tobacco use may be the cause of recurrence. Dornhoffer reported a long–term complication rate of 79% (15 of 19) in smokers in contrast to 16% (5 of 31) in nonsmokers. In our smoker case, the tube was not placed after the initial operation because we were not aware of his smoking history. Due to financial constraints that affects post–operative follow–up in this patient, a decision was made not to repeat CWR mastoidectomy with a tympanic membrane intubation.

Gantz et al. reported a 1.5% cholesteatoma recurrence rate during a mean postoperative follow up time of 48 months (range 2–94) in 130 ears (127 adults and 3 children) receiving CWR tympanomastoidectomy with mastoid obliteration $^{2}$. The 8 ears with disease recurrence subsequently received CWD mastoidectomy.

Regarding recurrence of cholesteatoma, Dornhaffer has pointed out that, although good short–term results are frequently reported for various techniques of cholesteatoma removal, validation of any approach can only come with a minimum follow–up of 5 years, preferably 10 years. In the study by Nyrop M, et al $^{1}$, at ten years, cholesteatoma had recurred in 70% of their patients having undertaken CWU mastoidectomy, requiring a later CWD operation. The recurrence rate in a retrospective study reported by Dornhoffer tripled with longer term follow–up, increasing from 5% to 16%. To reduce recurrence of cholesteatoma, Eustachian tube function should be carefully monitored and early tympanic membrane tube placement in patients with poor Eustachian tube function is warranted. In addition to tobacco use, other factors can also affect Eustachian tube function. These
factors should be carefully evaluated in all the patients after mastoidectomy, regardless of the type of the surgical technique used.

The availability of various reconstruction materials provides the ear surgeon with a variety of options in CWR mastoidectomy. Although hydroxyapatite cement, titanium micro-mesh and other artificial materials had been used with good results[4, 6, 8], autologous bone and cartilage grafts seem to be the materials that give the best results and are, therefore, preferred by ear surgeons[2, 3, 5, 7, 9]. However, simultaneous reconstruction of the canal wall, ear drum and ossicular chain can be a challenge for inexperienced surgeons.

Conclusion

CWR mastoidectomy can be used in most patients with acquired cholesteatoma, including children. This technique can improve exposure of middle ear structures, especially the anterior epitympanum, without creating a mastoid bowl, thus reducing the incidence of residual and recurrent cholesteatoma and otorrhea.

References