



Original Article

Efficacy of Posterior Canal Wall Reconstruction Using Autologous Auricular Cartilage and Bone Pâté in Chronic Otitis Media with Cholesteatoma

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OBJECTIVE: This study was designed to investigate the long-term results using the technique of canal wall up mastoidectomy and reconstruction of the posterior canal wall using bone pâté and auricular cartilage in the treatment of chronic otitis media with cholesteatoma.

MATERIALS and METHODS: A retrospective review was performed on 42 patients who underwent canal wall up mastoidectomy and posterior canal wall reconstruction at a single institution between November 2005 and November 2012.

RESULTS: Of the 42 patients, postoperative tympanic membranes were normal in 38 (90.5%), perforated in 1 (2.4%), and retracted in 3 (7.1%). Mean preoperative and postoperative values of the air–bone gap (ABG) were 29.4 ± 12.8 and 23.4 ± 11.7 dB, respectively, which represented a significant average improvement. For patients with ossiculoplasty ($n=24$), the mean preoperative and postoperative ABG values were 34.7 ± 6.0 and 27.5 ± 8.0 dB, respectively, which also represented a significant average improvement. Thirty-one (73.8%) of the patients were followed up without any complication, but 5 had otorrhea (11.9%), 4 had dizziness (9.5%), and 2 had facial palsy (4.8%).

CONCLUSION: A canal wall up mastoidectomy with reconstruction of the posterior canal wall using auricular cartilage and bone pâté provides successful preservation of the anatomic structure and a significant improvement in hearing without the long-term disadvantages of a canal wall down mastoidectomy.

KEYWORDS: Chronic otitis media, cholesteatoma, posterior canal wall reconstruction

INTRODUCTION

The most important surgical objective in patients with chronic otitis media (COM) and cholesteatoma is the complete resection of diseased tissue, which is usually performed by canal wall down mastoidectomy. However, the canal wall down procedure requires periodic cleaning after surgery and a long recovery period, and in children compliance with restrictions such as refraining from swimming can be challenging. On the other hand, canal wall up mastoidectomy offers a more physiologic approach, as it preserves anatomic structures ^[1].

However, it is difficult to expose major anatomic structures during canal wall up mastoidectomy, because the posterior wall of the external auditory canal should be maintained and therefore complete removal of lesions may not be possible. Furthermore, incomplete removal of lesions has been suggested to be responsible for the higher recurrence rate in canal wall up mastoidectomy, which has been reported to be 5–20% ^[2].

During the surgical treatment of COM with cholesteatoma, if there is a bony defect of the posterior canal wall, attempts are made to preserve the normal structure and function of the ear after complete removal of the cholesteatoma without removing the bony portion of the external auditory canal. The bony defect is then reconstructed with, for example, cortical bone ^[3], bone pâté ^[4], cartilage ^[5], fascia ^[6], or a prosthesis ^[7]. However, limited data are available on the long-term follow-up of reconstructions performed using these materials.

In this study, we performed canal wall up mastoidectomy in patients with COM with cholesteatoma and reconstructed the posterior canal wall using bone pâté and auricular cartilage. The aim of this study was to investigate the efficacy of this procedure and to document its rates of recurrence and hearing preservation and the anatomic structures involved.

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MATERIALS and METHODS

Patients

The medical records of 42 patients with COM with cholesteatoma who underwent canal wall up mastoidectomy and posterior canal wall reconstruction at the Department of Otolaryngology of a Korean tertiary hospital between November 2005 and November 2012 were retrospectively reviewed. Patients who had undergone canal wall down mastoidectomy and patients lost to follow-up were excluded. The inclusion criterion was a bony defect size of $<1\text{ cm}^2$, as determined in the operative field. When the bony defect size exceeded 1 cm^2 , canal wall down mastoidectomy was performed. This study was approved by the ethics committee of the tertiary hospital involved (GCIRB2014-136). Written informed consent was obtained from all participants.

Pre- and Postoperative Tests

Before surgery, the 42 patients underwent pure-tone audiometry (PTA), speech audiometry (SA), and computed tomography of the temporal bone (Figure 1). For PTA, the air and bone conduction thresholds were measured using hearing thresholds of 500, 1,000, 2,000, and 4,000 Hz. PTA and SA values were also measured at 2 months postoperatively.

Surgical Techniques

All surgical procedures were performed using a retroauricular approach under general anesthesia by a single surgeon. Canal wall up mastoidectomy was performed in all cases to preserve the posterior wall of the external auditory canal and to remove cholesteatomas and granulation tissue in the mastoid cavities and epitympanum. Bone pâté and auricular cartilage were prepared only if a bony defect caused by the cholesteatoma was identified in the posterior wall of the external auditory canal. Bone pâté was produced by mixing bone dust collected from healthy mastoid bone with a few drops of fibrin glue (Greenplast kit®, Green Cross, Gyeonggi-do, Korea). Auricular cartilage was inserted according to the curvature of the bony defect, and bone pâté was applied between the auricular cartilage and the bony defect and then stabilized using fibrin glue (Figure 2). The tympanic membrane (TM) was then regenerated using temporalis fascia. In 24 patients, ossiculoplasty was performed.

Evaluation

Preoperative and postoperative differences in anatomic structures (attic retraction), recurrence, reoperation, hearing (air-bone gap

[ABG]) levels, and postoperative complications were investigated at 2 years postoperatively.

Statistical Analysis

Student's t-test was used to determine the significance of differences between pre- and postoperative bone conduction thresholds and ABG values. Results are reported as proportions or as means and standard deviations. Two-sided p-values of <0.05 were considered to be statistically significant. Statistical analysis was performed using

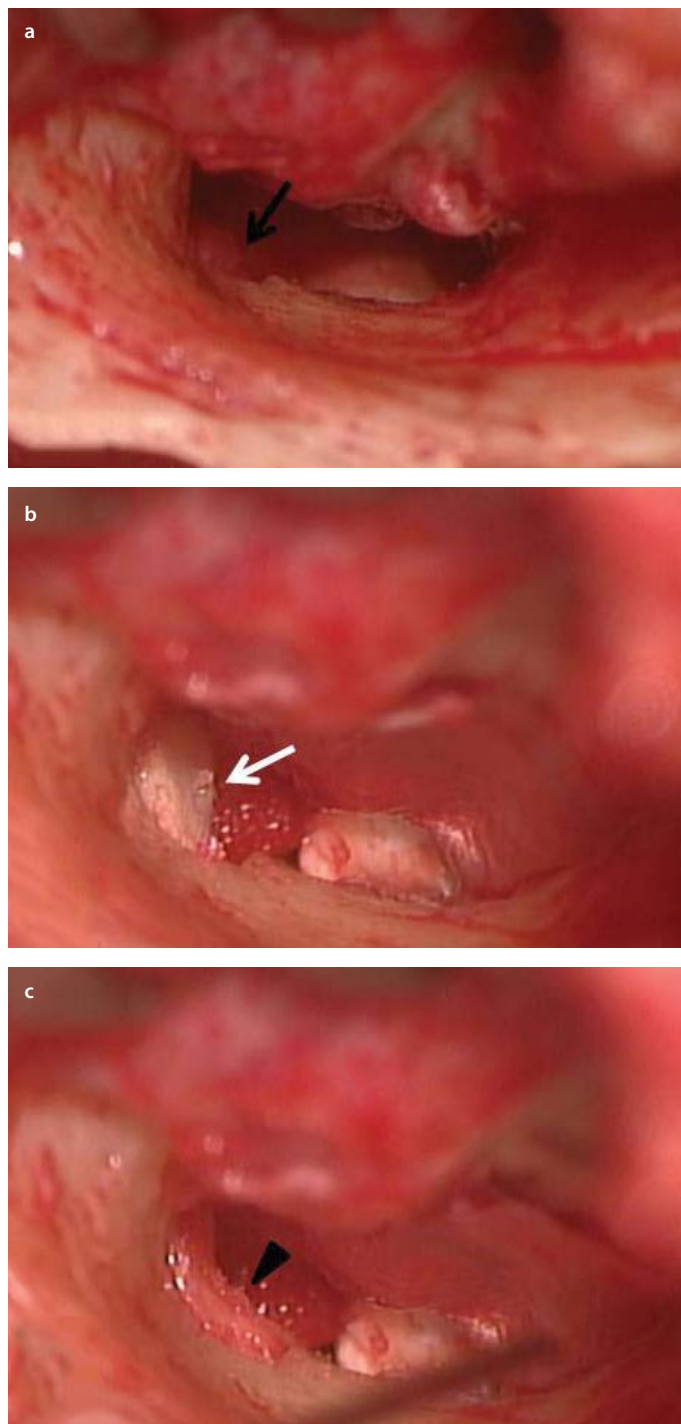


Figure 2. a-c. Intraoperative photographs of posterior canal wall reconstruction. (a) Bony defect of the posterior canal wall (black arrow) (a). Insertion of auricular cartilage (white arrow) (b). Application of bone pâté (black arrowhead) (c)

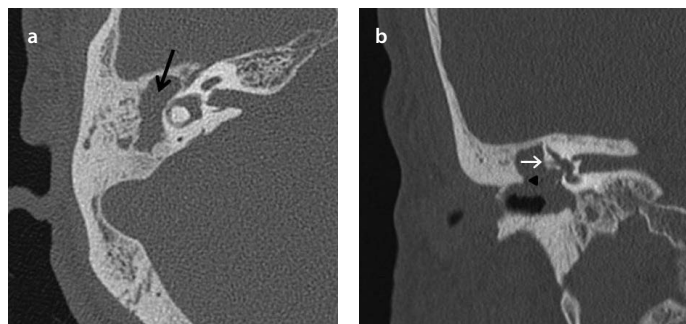


Figure 1. a, b. Preoperative computed tomography (CT) images. Axial view of a temporal bone without ossicles (black arrow) (a). Coronal CT image of a temporal bone showing a blunted scutum (black arrowhead). It was assumed that the horizontal semicircular canal had been eroded (white arrow) (b)

Statistical Package for the Social Sciences version 20 (SPSS, Inc.; Chicago, IL, USA).

RESULTS

Patient Characteristics

Nineteen men and 23 women with a mean age of 39.7 years (age range 18–65 years) were included in the present study. The average follow-up period was 35.7 months (range 24–109 months).

Preservation of Anatomic Structures, Recurrence, and Reoperation

Attic destruction of the preoperative TM was observed in 28 (66.7%) of the 42 patients, a retraction pocket in 5 (11.9%), and perforation in 9 (21.4%). Of the 9 cases of perforation, 1 had a retraction pocket and 1 had attic destruction. Two patients had previously undergone canal wall up mastoidectomy. A normal postoperative TM was observed in 38 (90.5%) patients, perforation in 1 (2.4%), and a retraction pocket in 3 (7.1%). Of the 3 patients with a retraction pocket, 2 were self-cleaning but 1 was inflamed (Figure 3). Periodic microscopic follow-up examinations (without imaging studies) yielded no evidence of the recurrence of cholesteatoma and thus no patient required postoperative imaging or reoperation.

Hearing Ability

For all 42 study subjects, the mean preoperative and postoperative ABG values were 29.4 ± 12.8 and 23.4 ± 11.7 dB, respectively, which represented a significant average improvement of 6.0 dB ($p < 0.05$). The mean preoperative and postoperative bone conduction values were similar (23.7 ± 16.7 and 25.2 ± 13.9 dB, respectively; $p = 0.667$). For patients with ossiculoplasty ($n = 24$), the mean preoperative and postoperative ABG values were 34.7 ± 6.0 and 27.5 ± 8.0 dB, respectively,

which represented a significant improvement of 7.2 dB ($p < 0.05$). The mean preoperative and postoperative bone conduction values were not significantly different (22.9 ± 14.8 and 25.6 ± 15.3 dB, respectively; $p = 0.377$).

Complications

Thirty-one (73.8%) patients were followed up without complication, but 5 had otorrhea (11.9%), 4 had dizziness (9.5%), and 2 had facial palsy (4.8%). Of the 5 patients with postoperative otorrhea, one experienced no inflammation or recurrence after medication. The second underwent reoperation after failure of medication owing to perforation of the TM and recurrent otorrhea, and newly formed granulation tissue was found in the middle ear and mastoid cavities during reoperation. The third patient had a normal TM, but intermittent otorrhea was observed after medication. The fourth underwent insertion of a ventilation tube to resolve a retraction pocket. The fifth improved after medication. No nystagmus was observed in the four patients that complained of postoperative dizziness, and the results of a fistula test were negative. No pathologic lesion that could potentially result in dizziness was observed in the operation field in any of these patients. Dizziness improved within 2 months of vestibular rehabilitation. After surgery, facial palsy occurred in 2 patients. One case of House–Brackmann (H–B) grade III developed at 2 days postoperatively, and this patient improved to H–B grade I after 6 months on oral steroid therapy. Prednisolone as 5 mg tablets was given as a single dose of 60 mg daily for 5 days; the dose was then reduced by 10 mg per day, with a total treatment time of 10 days. Another case of H–B grade III developed 3 days postoperatively and also improved to H–B grade I after 6 months on oral steroids at the same dosage.

DISCUSSION

Chronic otitis media with cholesteatoma is accompanied by bone destruction, purulent otorrhea, and hearing loss. Cholesteatoma in the epitympanic space initially forms a retraction pocket in the pars flaccida and is associated with bone destruction of the posterior canal wall. Furthermore, bone destruction in the lenticular process of the incus results in conductive hearing loss and dislocation of the incudostapedial joint. The objective of surgical treatment for cholesteatoma is the complete resection of diseased tissue,^[6] and the surgeon must decide whether to preserve the posterior canal wall or remove it owing to bony defects during the operative treatment of COM with cholesteatoma. In cases of extensive bone destruction, canal wall down mastoidectomy is the preferred treatment modality, but if the extent of destruction is limited to a small portion of the bone, preservation of the posterior canal wall should be considered. In comparison to canal wall up mastoidectomy, the canal wall down procedure has the advantages of providing good surgical exposure and favorable conditions for complete removal of lesions, and has a lower recurrence rate. However, it has several disadvantages, which include a longer healing period, cavity problems, the need for frequent removal of secretions, and a lower quality of life^[8]. In order to resolve cavity problems, surgeons perform mastoid obliteration using various materials such as surrounding muscle flaps, bone paste, and fat. During recent years, surgical techniques have been adopted that preserve the posterior canal wall. These techniques are more physiologic in nature in comparison to the canal wall down procedure, do not cause cavity problems, and have lower infection rates. However, these techniques have higher recurrence rates than the ca-



Figure 3. Postoperative tympanic membrane showing a well-reconstructed posterior canal wall

nal wall down procedure,^[9] which may be due to restrictions on the surgical field owing to poor exposure and dysfunction of the Eustachian tubes, which increase the risk of the postoperative formation of a retraction pocket in the pars flaccida^[10]. In order to reduce the risk of recurrence, some researchers removed the posterior canal wall integrally, resected the cholesteatoma tissue completely, and then reconstructed the posterior canal wall and obliterated the attic and mastoid antrum^[11].

During canal wall up mastoidectomy in COM with cholesteatoma, a bony defect may be encountered in the posterior canal wall. The reconstruction procedure used to correct this bony defect is called scutumplasty. In fact, Pfleiderer et al.^[12] recommended that during canal wall up mastoidectomy in cases of cholesteatoma, scutumplasty should be used for reconstruction of bony defects. The shapes of bony defects of the scutum depend on the degree of destruction caused by cholesteatoma and the original shape of the ear canal^[13]. Pieces of cartilage, bone, or synthetic materials are now widely utilized to reconstruct defect sites, and these materials are readily available and do not induce foreign body reactions. Autologous cartilage is one of the most suitable materials for posterior canal wall reconstruction. After shaping cartilage to fit the reconstruction site, it can easily be used. Cartilages in the same surgical field (auricular cartilage^[13] and tragal cartilage^[14]) have been widely used in otologic surgery, and the use of septal or costal cartilage has been found to produce similar postoperative results^[15].

Auricular cartilage can be harvested in the same surgical field during ear surgery, and an additional incision is not required. Weber and Gantz^[15] reported that auricular cartilage is thinner than tragal cartilage and has a constant thickness and natural curvature, and is thus suitable for reconstruction. In addition, they found that the rate of formation of a retraction pocket was significantly lower for reconstruction with cartilage than for no reconstruction. Koury et al.^[16] reported that posterior canal wall reconstruction with auricular cartilage produced better results than those obtained using bone pâté. Bony tissue has also been widely used to reconstruct the posterior canal wall. Gersdorff et al.^[17] performed reconstruction with bone pâté and used fibrin glue for additional fixation. In a histologic study of bone pâté, second-look operations were conducted one year after primary surgery, and the resorption rate of bone pâté was found to be 5.8%, whereas the complete resorption rate was 1.4% and the rate of formation of a retraction pocket was 4.4%^[4]. Therefore, bone pâté is easily manipulated and accessible, provides reliable organization with resistance to retraction, and is not absorbed when used to reconstruct bony defects of the scutum. Furthermore, Pfleiderer et al.^[12] reported that the rate of recurrence of cholesteatoma after reconstruction with bone pâté was significantly lower than that for reconstruction with tragal cartilage.

The most common causes of the formation of a retraction pocket after cholesteatoma surgery are dysfunctions of the Eustachian tubes and pneumatization problems, although the resorption of graft material has also been reported to be an important factor^[18]. Some problems may be encountered if the curvatures of the scutum and graft do not match. In such cases, the graft might move inferiorly and granulation tissue could form in the gap between the scutum and the cartilage graft and increase the risk of formation of a retraction pocket and recurrence of cholesteatoma. Koury et al.^[16] used com-

pressed tragal cartilage to eliminate this gap and achieved a low cholesteatoma recurrence rate. Bacciu et al.^[4] compared the surgical outcomes in patients treated using bone pâté or cartilage for posterior canal wall reconstruction, found that the incidence of formation of a retraction pocket was lower after reconstruction with bone pâté than after reconstruction with cartilage (2.5% vs. 5.2%), and reported estimated absorption rates of bone pâté and cartilage of 2.7% and 4.7%, respectively. Accordingly, they concluded that bone pâté is a more suitable material for reconstruction than cartilage. In the present study, we reconstructed posterior canal walls by inserting auricular cartilage, filling the auricular cartilage and the bony defect with bone pâté, and overlaying with fibrin glue. After surgery, 3 cases (7.1%) of a retraction pocket and 1 case (2.4%) of TM perforation occurred, the latter of which might have been due to dysfunction of the Eustachian tubes or pneumatization. No recurrence of cholesteatoma during follow-up occurred in any patient.

Sanna et al.^[19] found a 9.2% incidence of postoperative formation of a retraction pocket for the canal wall up procedure, and proposed that the criteria of surgical success for reconstruction were no formation of a retraction pocket and an ABG of less than 25 dB, as determined by PTA. In the present study, 26 (61.9%) of the 42 study subjects had an ABG of less than 25 dB after surgery, and only 3 (7.1%) patients developed a postoperative retraction pocket. Furthermore, 23 patients (54.8%) had no retraction pocket and a postoperative ABG of <25 dB, and thus surgical outcomes were considered to be satisfactory. Four patients complained of postoperative dizziness, but no pathologic lesion that could have resulted in dizziness was observed. This dizziness improved after vestibular rehabilitation, which suggests vertigo of uncertain etiology, stable vestibular lesions, central lesions or mixed central and peripheral lesions, head injury, psychogenic vertigo, elderly patients with dizziness, or benign paroxysmal peripheral vertigo^[20]. Pfleiderer et al.^[12] reported that approximately 50% of postoperative retraction pockets progressed to cholesteatoma and that the remainder were maintained by self-cleaning; no additional surgery or pharmacotherapy was required in cases that did not progress. These findings indicate that simple observation without reoperation is suitable in patients with a postoperative retraction pocket but without infection or evidence of progression. The limitations of this study were a small cohort size and a short study period, and thus we suggest that additional studies should be undertaken to confirm our findings and to identify factors that affect recurrence and hearing results.

We performed canal wall up mastoidectomy with posterior canal wall reconstruction in patients with COM and cholesteatoma using auricular cartilage and bone pâté. Cholesteatoma tissues were completely resected during surgery and anatomic structures were preserved in 39 of the 42 patients (92.9%). Furthermore, no postoperative complications were observed and hearing was preserved in comparison with the results of similar studies. However, long-term follow-up of these patients is required because of the risk of recurrence and attic retraction.

Ethics Committee Approval: The study was approved by the Local Ethics Committee of Gachon University Gil Medical Center, 136 - 13th May 2014.

Informed Consent: Written informed consent has been obtained from all participants.

Author Contributions: Concept - J.H.L.; Design - J.H.L.; Supervision - J.H.L.; Materials - M.K.B., S.H.C.; Data Collection and/or Processing - M.K.B., S.H.C., D.Y.K., C.H.C., Y.W.K.; Analysis and/or Interpretation - J.H.L., K.H.M.; Literature Review - M.K.B.; Writing - M.K.B., S.H.C.; Critical Review - J.H.L.

Conflict of Interest: No conflict of interest was declared by the authors.

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