CEO Clinical and Experimental Otorhinolaryngology Vol. 2, No. 1: 39-43, March 2009 DOI 10.3342/ceo.2009.2.1.39

Original Article

Clinical Results of Atticoantrotomy with Attic Reconstruction or Attic Obliteration for Patients with an Attic Cholesteatoma

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Objectives. We aimed to investigate the clinical results of atticoantrotomy in patients with an attic cholesteatoma.

Methods. Ninety-eight ears in 98 patients were operated on using atticoantrotomy between October 2002 and December 2006. A retrospective review of the otology database (operative findings and methods, postoperative physical examination and pre- and postoperative audiometry) was performed.

Results. There were 58 female and 40 male patients with a mean age of 40 yr. The cholesteatoma was limited to the attic region in 24 patients (24.5%); attic with antrum in 18 (18.4%); and attic with antrum and middle ear in 56 (57.1%). Attic obliteration was performed in 59 patients (60.2%), attic reconstruction in 39 (39.8%) and ossicular reconstruction was performed in 59 (60.2%). The mean preoperative and postoperative air-bone gaps were 29.2±13.5 dB and 25.0±15.4 dB, respectively (P=0.01) and the mean preoperative and postoperative high-tone bone conduction levels were 14.5±9.7 dB and 15.23±14.0 dB, respectively (P=0.411). A recurrent cholesteatoma was detected in 3 ears (3%) and revision surgery was performed on these patients.

Conclusion. Atticoantrotomy showed a low recurrence rate and no deterioration in hearing levels. If there is a intact malleus head or body of incus, attic reconstruction was possible and this procedure could lead to improved hearing. However, postoperative retraction occurred in 18% of patients, a problem that will need to be solved in the future.

Key Words. *Cholesteatoma, Surgery, Hearing, Reconstructive surgical procedures, Recurrence*

INTRODUCTION

The pathogenesis of an acquired attic cholesteatoma has been described variously as the retraction of Sharpnell's membrane caused by Eustachian tube dysfunction, proliferation of the basal layer of Sharpnell's membrane, immigration of squamous epithelium, or metaplasia of inflamed middle ear epithelium into keratinizing squamous epithelium. An attic cholesteatoma develops from Prussack's space of the pars flaccida; it usually extends laterally to the mastoid cavity and medially to the mesotympanum. Cholesteatomas invading the mesotympanum appear to destroy the ossicles and to induce frequent complications (1).

The goals of surgery for attic cholesteatoma are the complete removal of the mass, the restoration of hearing if possible and the prevention of residual or recurrent cholesteatomas. The major surgical techniques for attic cholesteatoma are the 'canal wall down' (CWD) and 'intact canal wall' (ICW) tympanomastoidectomy procedures. The CWD approach can give improved exposure but produces significant clinical problems after surgery, such as late healing, postoperative hearing loss and the need for long-term care of the mastoid cavity. The advantages of the ICW technique are rapid wound healing and avoidance of the need to clean the ear periodically. However, residual and recurrent cholesteatomas are common after this approach because it is difficult to access the epitympanum.

With opening of the attic (atticotomy), the epitympanic space can be visualized and there is no mastoid bowl problem because the posterior canal wall does not need to be opened in this approach. Therefore, atticotomy has been used for the management of attic cholesteatoma. Stankovic (2) reported that attic cholesteatomas treated with ICW showed postoperative retraction of the tympanic membrane in 1% of patients, a residual cholesteatoma in 5.9% and a recurrent cholesteatoma in 1%. DeRowe et al. (3)

• Received December 19, 2008
Accepted after revision February 3, 2009

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reported that 21% of children who underwent atticotomy subsequently required complete CWD tympanomastoidectomy because of residual or recurrent cholesteatomas.

If the atticotomy can be performed widely enough to expose the whole extent of the cholesteatoma (atticoantrotomy), the mass can be removed without leaving any residual matrix. However, the opened epitympanic area will act as a space for postoperative retraction and might allow the development of a recurrent cholesteatoma. Consequently, procedures that can reconstruct or obliterate the epitympanic space are needed to prevent recurrence and complications. Attic reconstruction with cartilage palisades or large cartilage graft has been applied in middle ear with rather good Eustachian tubal function (4, 5). In cases with poor Eustachian tubal function, mastoid and epitympanic obliteration has been applied (6). Authors have performed attic reconstruction with cartilage palisades in the cases of remaining head or short process of malleus and/or body of incus. If there was no intact ossicle or only malleus handle without short process, opened epitympanic space was obliterated with cartilage blocks.

In the present study, we investigated the clinical results in patients with attic cholesteatoma who were managed using a atticoantrotomy technique with attic reconstruction or obliteration. We evaluated postoperative complications, postoperative hearing levels and the presence of any residual or recurrent cholesteatomas.

MATERIALS AND METHODS

Ninety-eight patients who underwent tympanomastoidectomy with a atticoantrotomy in Asan Medical Center (Seoul, Korea) between 2002 and 2006 were included in this retrospective study. There were 40 male and 58 female patients with a mean age at surgery of 41 yr (range, 5-65 yr). In all patients, surgery was undertaken by one surgeon. The mean follow-up duration was 27.4 months (range, 19-63 months). We reviewed the medical records for intraoperative findings, pre-and postoperative hearing levels, postoperative complications and any problems arising during follow-up.

Surgery was performed via a postauricular approach with the patient under general anesthesia. A tympanomeatal flap was elevated and the mesotympanum was exposed. The status of the ossicular chain and the extent of the cholesteatoma in the middle ear were both evaluated. The lateral epitympanic wall was removed with drill burrs to make a wide opening into the epitympanum and thus visualize the extent of the cholesteatoma. If necessary, the malleus head and/or incus were also removed. Mastoidectomy was performed to expose the antrum. The whole matrix of the cholesteatoma was removed as completely as possible from the epitympanum, mesotympanum and mastoid cavity.

To reconstruct the lateral bony wall of Prussak's space, conchal cartilage was harvested. Using a knife, the cartilage was sliced into a thin sheet and used for coverage over the attic space. If the malleus head, short process or incus remained intact, the reconstructed cartilage could be supported by the ossicle. However, when there was only the malleus handle without short process or no ossicle at all, the attic was obliterated with cartilage. In this procedure, small pieces of cartilage were packed into the epitympanum to prevent any retraction of the tympanic membrane. Defects of the tympanic membrane were repaired with temporalis muscle fascia grafts. If necessary, ossiculoplasty was performed with partial or total ossicular replacement prosthesis (TORPs or PORPs). Synthetic prostheses made of porous plastic (Polycel) were used for the ossicular reconstruction.

Extent of cholesteatoma was determined by the operative findings. Preoperative and postoperative hearing results were reported according to the guidelines of conductive hearing loss recommended by the Committee on Hearing and Equilibrium of the American Academy of Otolaryngology-Head and Neck Surgery (AAO-HNS) (7). Air and bone conduction values were measured at 500, 1,000, 2,000, and 3,000 Hz and the air-bone gap was calculated. High-tone bone conduction was measured at 1,000, 2,000, and 4,000 Hz. The audiometric results were compared using paired Student's t-tests.

RESULTS

Among the 98 patients, the cholesteatoma was confined to the attic area in 24 patients (24%), extended into the antrum in 18 patients (18%) and extended into the mastoid cavity or mesotympanum in 56 patients (56%) (Table 1).

Table 1. Intraoperative findings and types of ossiculoplasty in attic cholesteatomas according to the extent

Disease extent	Status of ossicle			Ossicular reconstruction			
	Intact	Loss of continuity with intact SS	Only footplate remained	Tympanoplasty type 1	PORP	TORP	None
Attic (24)	6	15	3	6	15	2	1
Attic+antrum (18)	6	8	4	6	8	4	0
Attic+mastoid cavity or masetympanum (56)	12	24	20	12	24	10	10
Total (98)	24	47	27	24	47	16	11

SS: stapes suprastructure; PORP: partial ossicular replacement prosthesis; TORP: total ossicular replacement prosthesis.

Of the 24 patients with cholesteatoma confined in attic area, the ossicle was found to be intact in 6 ears, the malleus or incus was destroyed with an intact stapes suprastructure in 15 and only the footplate of the stapes remained in 3. For the patients with cholesteatoma involving adjacent structures, ossicular destruction was severer; an intact ossicle in 6 and 12 ears, a destroyed malleus or incus with an intact stapes suprastructure in 8 and 24 ears, and only the footplate of the stapes remained in 4 and 20 ears among the patients with cholesteatoma extending into the antrum and mastoid cavity or mesotympanum, respectively (Table 1). A PORP was used in 47 ears that had erosion of the malleus or incus but with an intact stapes. A TORP was used in 16 of 27 ears with loss of the stapes.

Type I tympanoplasty or ossiculoplasty was performed in 45 of 59 ears with attic obliteration and in 38 of 39 ears with attic reconstruction.

The mean preoperative and postoperative air-bone gaps (AAO-NHS) of all the patients (n=98) were 29.2±13.5 dB and 25.0±15.4 dB, respectively, suggesting significant improvement of postoperative hearing (P=0.01). The mean preoperative and postoperative high-tone bone conduction values (AAO-NHS) were 14.5±9.7 dB and 15.2±14.0 dB, respectively; these values were not significantly different (P=0.411), suggesting that there was no deterioration of high-tone bone conduction after surgery (Table 2). In patients with attic obliteration, the mean postoperative pure tone average (25.5±16.6 dB) was not significantly different from the mean preoperative pure tone average (28.8±13.4 dB). High-tone bone conduction also did not deteriorate (preoperatively 15.6±10.7 dB and postoperatively 17.5±16.1 dB). In patients with attic reconstruction, their postoperative hearing (20.8±15.0 dB) was much better than their preoperative hearing (29.6±14.0 dB). The postoperative high-tone bone conduction was not different from the preoperative bone conduction hearing level (Table 3).

In 28 of the 98 ears, facial nerves were found to be exposed because of the cholesteatoma. The entire matrix was carefully removed from the facial nerve and there was no postoperative facial paralysis. A recurrent cholesteatoma was detected in 3 ears. For these, revision CWD tympanomastoidectomy was performed in 2 of these patients with recurrent cholesteatomas in the sinus tympani, and ICW tympanomastoidectomy was performed in 1 patient with a recurrent cholesteatoma in the mesotympanum. Retraction of the pars tensa was found in 11 patients in the attic reconstruction group and in 7 patients in the attic obliteration group.

Table 2. Changes in hearing levels in patients with an attic cholesteatoma

All patients (n=98)	AB gap	BC threshold
Preoperative hearing (dB)	29.2±13.5*	14.5±9.7
Postoperative hearing (dB)	25.0±15.4*	15.2±14.0

The average air-bone gap improved postoperatively. The bone conduction level was unchanged after surgery in all the patients. *P<0.05.
AB gap: air-bone gap (0.5, 1, 2, and 3 kHz); BC: bone conduction (1, 2, and 4 kHz).

DISCUSSION

Atticotomy is the removal of the lateral epitympanic wall. This technique allows better visualization of middle ear and attic, and also gives more chance to preserve the postoperative canal wall (8, 9). The defect of scutum is generally repaired with cartilage. Though the surgical exposure of atticotomy is wider than ICW technique, the exposure is sometimes limited by the complex anatomy of attic region and other anatomical features, such as facial nerve (8). Because of these, the chance of recurrent or residual cholesteatoma is higher than the CWD technique. Contrary, Atticoantrotomy is rather a limited procedure requiring shorter operation time and allowing quicker postoperative recovery than CWD procedure (10).

Austin reported that rate of recurrence of cholesteatoma was 4% for the CWD technique and 39% for the ICW technique (11). Brown reported that adult patients with cholesteatoma had a recurrence rate of 13% for the CWD procedure and 34% for the ICW procedure (12). Likewise, for ICW mastoidectomy, the risk of a recurrent or residual cholesteatoma is higher than that for CWD mastoidectomy. Open cavity mastoidectomy has the advantages of allowing the surgeon to examine the operative field and to remove all the cholesteatomas in the mastoid and middle ear as well as in the epitympanum. Consequently, the postoperative recurrence rate of cholesteatoma with this approach is far

Table 3. Changes in hearing levels in the patients undergoing attic reconstruction or attic obliteration

Patients with type 1 tympanoplasty or ossiculoplasty (n=83)	Attic obliteration (n=45)		Attic reconstruction (n=38)	
	AB gap	BC threshold	AB gap	BC threshold
Preoperative hearing (dB)	28.8±13.4	15.6±10.7	29.6±14.0*	12.7±7.9
Postoperative hearing (dB)	25.5±16.6	17.5±16.1	20.8±15.0*	11.8±9.1

In the attic obliteration group, the average postoperative air-bone gap was not different from the preoperative hearing and the average gap improved in the patients with attic reconstruction. Bone conduction did not deteriorate in either group. *P<0.05.
AB gap: air-bone gap (0.5, 1, 2, and 3 kHz); BC: bone conduction (1, 2, and 4 kHz).

lower than with ICW mastoidectomy (11-14). On the other hand, atticoantrotomy also has shown a lower rate of recurrence than ICW mastoidectomy (15) Abramson et al. have reported that the recurrence of cholesteatoma was occurred after atticotomy in 17% and ICW in 35%. Even though these results containing the results from pediatric cholesteatomas, the recurrence was significantly higher after intact canal wall surgery compared to other surgical methods. Atticoantrotomy could compensate for the disadvantages of CWD mastoidectomy. It also allows easy access to the any cholesteatomas extending to the anterior or posterior epitympanum. In particular, when a cholesteatoma extends under the head of the malleus or incus, removal of these elements secures the operative field and prevents residues or recurrence of the cholesteatoma. In addition, if the cholesteatoma is limited to the attic, this approach can avoid unnecessary opening of the mastoid air cells. In our study of atticoantrotomy cases, cholesteatomas recurred in only 3% of patients during 19 to 63 months of follow-up (mean 27.4 months). This result is similar to other studies on attic cholesteatomas managed with atticotomy (9, 16). Uyar et al. (9) have reported 4.8% of recurrence of cholesteatoma among 83 patients who received anterior atticantrotomy. Sakai et al. (16) also have shown 5.1% of recurrence of cholesteatoma in the patients with atticotomy and scutumplasty. These results including our result show a much lower recurrence rate than that for ICW mastoidectomy. Atticoantrotomy could decrease the recurrence rate because the attic, which is difficult to approach through ICW mastoidectomy, can be easily accessed. In 2 of 3 patients with a recurrent cholesteatoma in this study, cholesteatomas recurred in the sinus tympani, which is difficult to approach with an intact posterior canal wall. These patients later underwent revision CWD mastoidectomy.

Although CWD mastoidectomy can have better visualization of the cholesteatoma, it decreases the middle ear cavity and enlarges the external auditory canal. Because of these problems, patients usually require long-term postoperative management, must limit their exposure to water, and experience problems with wearing hearing aids. Atticoantrotomy can compensate for these disadvantages because the size of the external auditory canal is unchanged.

The most important disadvantage of atticoantrotomy is postoperative retraction and pocket formation in the postoperative period. To solve this problem, Sakai et al. (16) used autologous cortical bone grafts instead of tragal cartilage and reported that retraction appeared in 3.8% of ears, a rate much lower than in other studies. Uyar et al. (9) proposed a reconstruction of the bony wall with tragal or conchal cartilage grafts and provided support of the posterior surface of the cartilage with a periosteal flap to prevent transition of the cartilage grafts, to promote vascularization and to strengthen resistance against retraction. They showed that a retraction pocket occurred in 6.3% of ears. For preventing a retraction pocket and recurring cholesteatoma, obliteration of mastoid cavity and epitympanum with bone pate and abdominal fat has been suggested as one of the surgical options (17).

In the present study, retraction occurred in 18 ears (18%), a rate that is higher than reported in the literature. The retraction rate in ears undergoing attic reconstruction (11%) was higher than in ears with attic obliteration (7%). During attic reconstruction, we retained the incus and/or malleus head or short process in the epitympanum and placed a cartilage sheet on it to prevent retraction of the tympanic membrane. In such cases, if hypertrophied mucosa and granulation in the epitympanum were removed insufficiently, ventilation might be diminished and pressure in the middle ear cavity would decrease. As a result, retraction might occur more frequently. However, the most important factor determining postoperative retraction is ventilation in the middle ear cavity (18). Therefore, in ears with poor Eustachian tube function, retraction could not be avoided.

Other factor responsible for the attic retraction seems to be an aeration of Prussak's space. Natural aeration pathways, such as lower and upper floor units (19), could be blocked by the obliterated cartilage and the tissue fluid interfering the reestablishment of the aeration route (20). According to this observation, retraction may occur easily in the postoperative attic area, especially in the obliterated cases, even though the Eustachian tube function is normal.

No postoperative perforation of the tympanic membrane was detected in any of the 98 patients in our series. Cartilage was used to repair the epitympanum as a palisade technique and temporalis fascia or perichondrium was inserted under the tympanic membrane. In this way, a strong and resistant tympanic membrane could be established.

There have been various results published in terms of hearing status. Some authors reported better results with the ICW technique (13, 21), whereas others found no difference between the ICW and CWD procedures (14, 22, 23). Recently, it has been reported that the hearing improvement (reduction of air-bone gap) shown in short-term follow up (1 yr after operation) got worsened during long-term follow up (>5 yr after operation) in the patients with acquired cholesteatoma (24).

In our patients, the mean preoperative and postoperative air-bone gaps (AAO-NHS) were 29.2±13.5 dB and 25.0±15.4 dB, respectively and the hearing outcomes improved significantly (P= 0.01). Particularly in patients with attic reconstruction, all groups with a Type I tympanoplasty or ossiculoplasty showed better hearing in the postoperative period. The bone conduction hearing level did not deteriorate after surgery. This means that if bone can be removed carefully with a diamond burr during atticoantrotomy, the attic can be opened without injury to the ossicle. In this study, type 1 tympanoplasty or ossiculoplasty was possible in 38 among 39 patients with attic reconstruction. Because attic reconstruction was performed in the patients with an intact malleus head or the body of incus, the presence of these ossicles was probably related to the extent of disease. Therefore, the hearing improvement shown in the patients with attic reconstruction was possible due

to the limited extension of the cholesteatoma.

The present findings thus indicate that in attic cholesteatomas, if the mass is removed by atticoantrotomy and the attic is reconstructed or obliterated with cartilage, the rates of recurrence can be decreased. Attic reconstruction with cartilage could improve the hearing postoperatively, while attic obliteration could not. Thus, atticoantrotomy is a relatively effective procedure that can be used in the management of cholesteatomas extending from the attic.

In conclusion, Atticoantrotomy is a useful technique for managing cholesteatomas extending from the attic. It showed a low recurrence rate and no deterioration in hearing levels. If there is a intact malleus head or body of incus, attic reconstruction was possible and this procedure could lead to improved hearing. However, postoperative retraction occurred in 18% of patients, a problem that will need to be solved in the future.

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