Cholesteatoma Surgery in Pneumatized and Non-pneumatized Temporal Bones

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Background: This report compares the different surgical methods for large and pneumatized mastoid cavity (large cavity) and small and poorly pneumatized mastoid cavity (small cavity) cholesteatomas and their results for the facial nerve and mastoid cavity.

Methods: In the period from January 1996 to December 2000, 101 ears with cholesteatomas underwent tympanoplasty with mastoidectomy. In the large cavity group, the posterior canal wall was removed and the vertical portion of the facial nerve was skeletonized to lower the facial ridge. Partial obliteration with conchal cartilage and perichondrium at the epitympanum and mastoid tip was used to make the external auditory canal and the mastoid a smooth common cavity without reconstruction of the posterior canal wall. In the small cavity group, the facial ridge was not intentionally lowered as long as the cholesteatoma was completely removed. The whole mastoid cavity was obliterated and the posterior canal wall was reconstructed. The newly reconstructed posterior canal wall was composed of preserved facial ridge in the lower part and obliterated conchal cartilage in the upper part.

Results: There were 27 ears with large cavity cholesteatomas and 74 with small cavity cholesteatomas. The incidences of postoperative complications (large cavity versus small cavity) were: facial paralysis, 3 versus 0; minor wound infection, 2 versus 8; flap partial necrosis, 1 versus 4; cartilage partial necrosis, 0 versus 2; external auditory canal stenosis, 0 versus 2; residual drum perforation, 3 versus 3; otitis media with effusion, 3 versus 4; recurrent cholesteatoma, 0 versus 2; and residual cholesteatoma, 1 versus 2.

Conclusion: Significantly more postoperative facial nerve paralysis in the large cavity group was correlated to skeletonization of the facial nerve and treatment of the facial ridge. [*J Chin Med Assoc* 2005;68(10):458–462]

Key Words: cholesteatoma, facial nerve, mastoid cavity, mastoidectomy

Introduction

Canal wall down (CWD) mastoidectomy allows more radical removal of cholesteatoma than canal wall up (CWU) mastoidectomy.[1] Obliteration of the resulting mastoid open cavity with conchal cartilage eliminates cavity problems, prevents the formation of a retraction pocket, and causes less deformities to external and middle-ear structures.[2] However, the amount of conchal cartilage harvested is often limited and frequently insufficient for complete obliteration of a large and pneumatized mastoid cavity. Hence, the author's strategy for the obliteration of the mastoid cavity depends on the size of the mastoid. For large and pneumatized mastoid cavities, partial obliteration with conchal cartilage at the epitympanum and mastoid tip is used to make the external auditory canal (EAC) and the mastoid a smooth common cavity without reconstruction of the posterior canal wall. For small and poorly pneumatized mastoid cavities, the cavity is totally obliterated with conchal cartilage with reconstruction of the posterior canal wall. Therefore, the principles of treatment of the facial nerve and mastoid cavity are different in these 2 groups.

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For large and pneumatized mastoid cavities, the facial ridges must be lowered as far as possible for easier inspection and local care of the common cavities postoperatively. For small and poorly pneumatized mastoid cavities, the retained facial ridge and the obliterated conchal cartilage constitute the reconstructed posterior canal wall. As long as the cholesteatoma can be removed, the facial ridge is not routinely lowered intentionally. The purpose of this paper is to report and compare the methods and results of facial ridge treatment between cholesteatomas in large and small mastoid cavities.

Methods

From January 1996 to December 2000, the author performed tympanoplasty with mastoidectomy on 101 ears with middle ear cholesteatomas. Only primary operations are included in this report.

The degree of pneumatization of the mastoid cavity and the size of the cholesteatoma were evaluated preoperatively using computerized tomography (CT). In large and pneumatized mastoid cavity cholesteatomas, CT usually showed extensive involvement of the cholesteatoma in the originally pneumatized mastoid cavity and/or middle ear cavity. A large mastoid cavity results after removal of the cholesteatoma. In small and poorly pneumatized mastoid cavity cholesteatomas, CT often disclosed a relatively small and sclerotic mastoid cavity. After eradication of cholesteatoma, the remaining mastoid cavity is relatively small and can be completely obliterated with cartilage.

An endaural approach was used in all operations. After elevation of the tympanomeatal flap (TMF) from the posterior canal wall, the EAC was enlarged, exposing the eardrum and cholesteatoma pocket under the microscope. The ossicles and horizontal part of the facial nerve were identified and protected with care; the incudostapedial joint was separated carefully. Removal of the cholesteatoma started from the incudostapedial joint, stapes, and facial nerve, and extended along the route of involvement. During the procedure of cholesteatoma sac removal, an appropriate-sized suction tip was used to keep tension in the squamous epithelium as it was dissected and detached from structures of the middle ear.

In the large and pneumatized mastoid cavity group, the facial ridge was lowered and the vertical portion of the facial nerve was skeletonized to expose the whole cholesteatoma content and epithelium. All parts of the cholesteatoma sac in the epitympanum, antrum, and mastoid air cells were totally removed, and the mastoid air cell system became a radical atticoantromastoid open cavity at the same time. The mastoid tip was also cleared with special care to remove the cholesteatoma and all air cells. In the small and poorly pneumatized mastoid cavity group, the mastoid cavity was obliterated and the posterior canal wall was reconstructed from retained facial ridge (lower part) and conchal cartilage (upper part). Therefore, provided that exposure of the whole mastoid cavity including the mastoid tip was sufficient, there was no need to intentionally lower the facial ridge. Accordingly, the potential risk for facial nerve injury was minimal. Sometimes, a 70° telescope was used to examine the Eustachian tube opening, sinus tympani, round window, and inner surface of the open cavity for residual squamous epithelium.

An incision was made in the conchal bowl to harvest conchal cartilage and perichondrium. The cartilage and attached perichondrium were excised together with special attention not to tear the perichondrium from the cartilage. The cartilage and perichondrium were cut into small pieces and divided into groups that were connected with continuous perichondrium. For large and pneumatized mastoid cavities, the graft was carefully placed in the mastoid tip to the level of the facial ridge to obliterate this space. The epitympanic area was also obliterated with graft above the horizontal portion of the facial nerve. Pieces of cartilage were carefully aligned to make a smooth surface without any pocket. In small and poorly pneumatized mastoid cavities, the conchal cartilage and perichondrium were used to completely obliterate the atticoantromastoid cavity. A piece of temporalis fascia and TMF were used to cover the graft in both groups.

In the large and pneumatized mastoid cavity group, the mastoid cavity was partially obliterated and the ossicles were removed. The middle ear became a small and shallow cavity with a superior border composed of the horizontal part of the facial canal and a posterior border composed of facial ridge. The eardrum perforation was repaired with temporal fascia and the ossicular chain was reconstructed, if needed. The newly formed tympanic cavity became an independent cavity not connected to the partially obliterated mastoid cavity. In the small and poorly pneumatized mastoid cavity group, the reconstructed tympanic cavity resembled the normal tympanic cavity because the posterior canal wall was reconstructed and the mastoid cavity was completely obliterated.

The incidence of complications was compared between the 2 groups using Fisher's exact test. Differences were considered significant at p less than 0.05.

Results

There were 27 ears with large and pneumatized mastoid cavity cholesteatomas and 74 with small and poorly pneumatized mastoid cavity cholesteatomas. The position of the facial nerve was recognized after identification of the stapes and/or oval window location. Removal of the cholesteatoma and epithelium was performed after identification of the horizontal portion and the second genu of the facial nerve. Dehiscence of the horizontal portion of the facial nerve was noted in 11 ears. Dehiscence of the second genu was found in 5 ears. Manipulation of the dehiscent part of the facial nerve was minimized to avoid facial nerve injury.

In the large and pneumatized mastoid cavity group, 1 patient developed immediate postoperative grade III facial paralysis that partially recovered to grade II in 3 weeks. Two cases suffered delayed-onset partial facial paralysis (grade III and IV) in the week after surgery. Both recovered completely. Two patients had minor wound or flap infection that was treated using oral antibiotics and local care and which resolved in 2–3 weeks. TMF and/or fascia partial necrosis were found in 1 case. No partial necrosis of obliterated cartilage and perichondrium was noted. No external ear canal stenosis developed. Residual or recurrent eardrum perforations were repaired by transcanal myringoplasty in 3 ears. Ventilation tube insertion was performed in 3 ears with postoperative otitis media with effusion. Residual cholesteatoma was found in 1 ear with difficult-to-remove cholesteatoma epithelium at the opening of the Eustachian tube, sinus tympani, oval window, stapes, or epitympanum in the first operation. Obliteration was performed only at the mastoid tip in this ear. No recurrence or residual disease occurred in graft obliteration areas.

In the small and poorly pneumatized mastoid cavity group, the cholesteatoma and epithelium were removed along the edge of the mastoid antrum, and mastoid air cells were exenterated. The cavity was then obliterated with conchal cartilage and perichondrium. Hence, the posterior canal wall was reconstructed. No immediate or delayed facial paralysis developed in this group. Minor wound or flap infection occurred in 8 patients. TMF and/or partial fascia necrosis were found in 4 cases. A small area of partial necrosis of obliterated cartilage and perichondrium was noted in 2 ears and was revised by removal of necrotic cartilage and modification of the resulting cavity. EAC stenosis developed in 2 cases. Residual or recurrent eardrum perforations were repaired by transcanal myringoplasty in 3 ears. Four ears showed postoperative otitis media with effusion and needed ventilation-tube insertion. Residual cholesteatomas occurred in 2 ears. Retraction pockets containing debris and squamous epithelium were found in 2 cases with severe atelectasis of the drum, which was considered recurrence. All recurrent/residual ears underwent revision radical mastoidectomy.

The statistical significance of the differences in incidence of complications between the 2 groups is listed in Table 1.

Discussion

The treatment of the posterior canal wall and mastoid cavity is a controversial issue in cholesteatoma surgery.[2] The generally accepted advantages of CWU surgery include preservation of the normal external canal and middle ear structures, shorter wound healing time, fewer postoperative cavity problems, and better hearing results.[3] The preservation of the posterior canal wall also avoids the problem of facial ridge treatment. However, limited exposure of the epitympanum and posterior mesotympanum often results in high residual rates.[4] Hence, a second-look operation is frequently

Table 1. Postoperative complications

	Large and pneumatized	Small and poorly pneumatized	*p*
Facial paralysis	3	0	0.018
Minor wound infection	2	8	0.468
Partial flap necrosis	1	4	0.596
Partial cartilage necrosis	0	2	0.535
Canal stenosis	0	2	0.535
Residual drum perforation	3	3	0.192
Otitis media with effusion	3	4	0.276
Recurrent cholesteatoma	0	2	0.535
Residual cholesteatoma	1	2	0.611

advised. Revision operations are usually more difficult and carry a higher risk of complications than the primary procedure.[5] CWD mastoidectomy provides good surgical exposure for cholesteatoma removal and gives a significantly lower rate of residual/recurrent cholesteatomas than the CWU procedure.[6] The surgery can often be performed as a single-stage operation. Although there is debate about the results of various surgical methods, eradication of the disease is often the major concern in performing cholesteatoma surgery. Since the CWD approach gives the best access to eradicate the disease, the author routinely uses this approach, except for special considerations such as only hearing ear surgery.

Treatment of the facial ridge is quite an important procedure in performing CWD mastoidectomy. A high facial ridge often leads to a chronic draining cavity and a low facial ridge sometimes results in unnecessary manipulation of the facial nerve and puts the nerve at risk.[2] Moreover, extensively lowering the facial ridge increases the total volume of the atticoantromastoid open cavity after removal of the cholesteatoma and saucerization of mastoid air cells, thus making the conchal cartilage inadequate for complete obliteration. Hence, whenever complete obliteration of the atticoantromastoid open cavity and reconstruction of the posterior canal wall is considered, the facial ridge should not be extensively lowered as long as exposure and removal of the cholesteatoma is satisfactory. These results also support this point of view and reveal that no facial paralysis developed in the small and poorly pneumatized mastoid cavity group, and that skeletonization of the facial ridge in the large and pneumatized mastoid cavity group carried significant risk of postoperative facial paralysis.

A generous canaloplasty allows for good exposure of the surgical field and removal of the cholesteatoma from the middle ear and mastoid cavity. Potentially risky areas such as the epitympanum, oval window, Eustachian tube orifice, and mastoid tip can then be visualized directly. A large meatoplasty provides access to conchal cartilage and further enlarges the opening of the EAC. A wide EAC also helps in postoperative follow-up for inspection and local care.

Retained, infected mastoid air cells with granulations are found in a high percentage of ears with persistent discharge after surgery but without recurrent cholesteatoma. Moreover, infected unexenterated cells are detected during revision surgery in a significant proportion of ears with recurrence of cholesteatoma.[5] Incomplete mastoidectomy is the most common cause of persistent suppuration in chronic ears undergoing surgical revision,[7] so skillful and delicate surgical technique in performing mastoidectomy cannot be overemphasized. Hence, the author removes all mastoid air cells during surgery, especially in patients with a large and pneumatized mastoid that contains many air cells. The facial ridge must be lowered in these patients for complete removal of the air cells. On the contrary, in patients with a small and poorly pneumatized mastoid, the number and volume of air cells are quite limited. Frequently, these sclerotic mastoids harbor only small mastoid antrums with a few air cells. The cholesteatoma in such a sclerotic mastoid is easily removed *en bloc* with careful dissection and traction. The chance of epithelium left in the cavity is minimal. The internal surface of the atticoantromastoid cavity can also be further inspected using a 70° telescope to ensure complete removal of all possible cholesteatoma epithelium.

A "problem cavity" is characterized by a small meatus, a high facial ridge with incomplete posterior EAC wall removal, a dependent mastoid tip that sequesters debris, persistent discharge from chronic infection, eardrum perforation with weeping mucosa, extensive granulation tissue, mucosalization of the cavity, retained cholesteatoma, and impacted debris.[8] Ears with problem cavities require constant personal as well as professional attention. In the large and pneumatized mastoid cavity group, the total volume of the harvested conchal cartilage was usually far less than the volume of the cavity. Since complete obliteration is impossible, the strategy is to partially obliterate the cavity to make the resulting EAC–mastoid space a smooth common cavity. The solution is to extensively lower the facial ridge and partially obliterate the mastoid cavity at the epitympanic space and mastoid tip, although there might be risk of some facial nerve complications. On the other hand, for small and poorly pneumatized mastoid cavities, the surgeon removes all of the mastoid air cell system and completely obliterates the cavity with live autograft so that only a wide and smooth EAC can be seen through the meatus postoperatively. The mastoid cavity is obliterated and the posterior canal wall reconstructed. Therefore, provided that the exposure of the whole mastoid cavity including the mastoid tip is sufficient, there is no need to intentionally lower the facial ridge as far as possible. Accordingly, the potential risk for facial nerve injury is minimal. The surface of raw bone is covered with TMF and temporalis fascia. Hence, epithelialization of the EAC, reconstruction of the eardrum, and grafting can be almost complete in 3–4 weeks, making a trouble-free EAC that can usually maintain self-cleaning and which requires little long-term local care.

Among the postoperative complications, only postoperative facial nerve paralysis was different in the 2 groups. Theoretically, permanent facial nerve injury might arise from direct mechanical injury that leads to facial nerve dysfunction. Delayed and reversible facial paralysis is usually due to swelling of nerve fibers or compromise of circulation as the result of excessive manipulation of the nerve during surgery. In the large and pneumatized mastoid cavity group, 3 cases developed postoperative facial nerve paralysis as the result of facial ridge treatment and facial nerve skeletonization. However, 2 of these had delayed and temporary injury and the only permanent facial nerve injury was mild and the patient partially recovered in weeks. The risk of facial nerve injury should be regarded as minimal even when the facial ridge is lowered and the facial nerve is skeletonized. In the small and poorly pneumatized mastoid cavity group, the facial nerve was left almost undisturbed and no cases of postoperative facial paralysis were observed.

Recurrent cholesteatoma, a new cholesteatoma mass that develops frequently as a consequence of Eustachian tube dysfunction from a retraction or atelectatic pocket of the eardrum with a non-visible bottom,[5] was found in 2 cases with severe atelectasis of the eardrum in the small and poorly pneumatized mastoid cavity group. Residual cholesteatoma, often resulting from residual epithelium left in the middle ear mainly due to inadequate surgical field exposure and incomplete removal in certain areas,[5] was found in 1 ear in the large and pneumatized mastoid cavity group and in 2 ears in the small and poorly pneumatized mastoid cavity group. The differences in residual and recurrent rates between groups were not statistically significant. Patients with possible residual disease were informed of the high risk of residual disease and asked to attend follow-up regularly. The overall recurrence rate (both recurrence and residual) is estimated to be 5%, compatible with a previous report of a low recurrence rate of less than 10% with the CWD technique.[9]

References

1. Nyrop M, Bonding P. Extensive cholesteatoma: long-term results of three surgical techniques. *J Laryngol Otol* 1997;111: 521–6.
2. Black B. Mastoid elimination. *Laryngoscope* 1995;105:1–30.
3. Brackmann DE. Tympanoplasty with mastoidectomy: canal wall up procedures. *Am J Otol* 1993;14:380–2.
4. Cook JA. Hearing results following modified radical versus canal-up mastoidectomy. *Ann Otol Rhinol Laryngol* 1996; 105:379–83.
5. Vartiainen E, Virtaniemi J. Findings in revision operations for failures after cholesteatoma surgery. *Am J Otol* 1994;15: 229–32.
6. Quaranta A, Cassano P, Carbonara G. Cholesteatoma surgery: open vs closed tympanoplasty. *Am J Otol* 1988;9:229–31.
7. Nadol JB. Causes of failure of mastoidectomy for chronic otitis media. *Laryngoscope* 1985;95:410–3.
8. Jackson CG, Schall DG, Glascock III ME, Macias JD, Widick MH, Touma BJ. A surgical solution for the difficult chronic ear. *Am J Otol* 1996;17:7–14.
9. Roden D, Honrubia VF, Wiet R. Outcome of residual cholesteatoma and hearing in mastoid surgery. *J Otolaryngol* 1996;25:178–81.