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Management of Cholesteatoma in the Petrous Apex

ABSTRACT—Two cases of congenital and acquired cholesteatoma in the petrous apex were operated on via the translabyrinthine approach. The cholesteatoma was removed, leaving a part of the matrix membrane in both cases as the matrix membrane was difficult to remove. Spaces including the mastoid and middle ear after removal of cholesteatoma were obliterated with only fibrin glue in order to pneumatize the operated space after surgery. Cerebrospinal fluid (CSF) leakage from the internal auditory meatus was prevented using a tiny fascia. The spaces occupied by the cholesteatoma were clearly pneumatized within 6 months after surgery in both patients. The advantage of creating pneumatized spaces after removal of cholesteatoma in the petrous apex was discussed.

Cholesteatoma in the petrous apex is rarely encountered, and most cases are congenital. Several approaches to the petrous lesion have been reported.¹⁻⁴ The middle cranial fossa approach is preferred by neurosurgeons, and the transmastoid and translabyrinthine approaches are preferred by otologists. After removal of a cholesteatoma in the petrous apex, most surgeons obliterate the postoperative cavity with tissue such as muscle or fat, regardless of the approach they choose. Otherwise, the cavity is opened to the orifice of the external auditory meatus. Cholesteatoma in the petrous apex is difficult to remove eradically because the matrix membrane is thin and adheres tightly to the internal carotid artery or dura in most cases. Moreover, the visual field for the operation is limited because of the anatomical complexity of the petrous apex, even if either the middle cranial fossa or translabyrinthine approach is used for the operation. This fact implies a high

potential of recurrence of cholesteatoma after the operation, which raises an important issue in that complete obliteration of the petrous lesion with muscle or fat may complicate removal of the recurrent cholesteatoma during subsequent surgery; the tissues used for obliteration often become organized and difficult to remove, preventing access to a recurrent lesion of cholesteatoma in the petrous apex. This may also induce severe, life-threatening complications such as rupture of the dura, internal carotid artery, or jugular vein. If the postoperative space of cholesteatoma in the petrous apex was filled by pneumatization, two important benefits could clearly be obtained for the postoperative management and evaluation of patients: One is an easy detection of recurrent cholesteatoma on computed tomography (CT) and magnetic resonance imaging (MRI) during follow-up. Another is easy access to the petrous apex lesion because of an absence of barriers in the approach to the re-

current lesion. Fortunately, most patients with congenital cholesteatoma have normal tubal function and normally developed air cells in the temporal bone, indicating a high possibility of re-pneumatization of the petrous apex lesion as well as of the middle ear and mastoid after surgery. This is supported by the fact that operative lesions are also often pneumatized in patients with acoustic tumors after surgery via the translabyrinthine approach if the operated space is not obliterated with muscle. We operated on 2 patients with cholesteatoma in the petrous apex, one congenital and the another acquired. The space occupied by the cholesteatoma was obliterated using only fibrin glue, which is rapidly absorbed, in both patients. In this article, we present the establishment of pneumatization in the operative space of the temporal bones and discuss the management of postoperated spaces after removal of cholesteatoma in the petrous apex.

CASE REPORTS

Case 1

A 32-year-old female noticed left tinnitus and hearing loss in the summer in 1994. Her left hearing level worsened gradually, but she received no treatment for 1 year after the initial symptoms. She had a history of recurrent otitis media during her childhood. A disability of left facial movement was noticed in November 1994 with no discrimination of sound by the left ear. She visited our clinic at the end of November. The tympanic membrane was intact on the right side, but appeared

Figure 2. Sonotubometry indicates normal tubal function in Case 1.

dull on the left side. A CT examination revealed a low density lesion with bony destruction in the left inner auditory canal and petrous apex region (Fig. 1). The mastoid air cells were poorly developed in both ears. Her left ear was diagnosed with cholesteatoma in the petrous apex. She was admitted for surgery on December 6, 1994. A pure tone audiogram revealed a normal hearing level on the right side and deafness with complete facial palsy on the left side. The results of sonotubometry were completely normal in both ears (Fig. 2).

The operation was performed on December 5, 1995. The middle ear cavity was exposed and found to be intact. Mastoidectomy was performed and the posterior wall of the external auditory canal was drilled. Cholesteatoma was located in the epitympanic space. When the cholesteatoma was removed, the bony wall of the lateral semicircular canal was found to be destroyed. The bony labyrinth was drilled away using transcoch-

Figure 1. Cholesteatoma in the petrous apex of Case 1 (asterisk, preoperation).

Figure 3. Cholesteatoma in the petrous apex of Case 1 (postoperation). Note that the operated region is well pneumatized (asterisk).

lear and translabyrinthine approaches, and for the most part, was occupied by cholesteatoma with invasion of the internal auditory canal. The seventh and eighth nerves were eroded and partly destroyed by compression due to the cholesteatoma. The cholesteatoma extended further internally, into the petrous apex lesion. After the removal of the cholesteatoma, the internal carotid artery and thinned dura were found to be adhered to the matrix membrane of the cholesteatoma. These matrix membranes were left *in situ* to avoid the severe complications which would be induced by forced removal of the matrix membrane. A small fascia was packed into the internal auditory meatus and the remaining hollow petrous lesion was filled with fibrin glue instead of obliteration by muscle or fat. The tympanic membrane was reconstructed laterally. The patient underwent plastic surgery for the left facial palsy 1 month after the surgery. The CT examination revealed complete pneumatization of the operated lesion without any evidence of recurrence at 6 months after surgery (Fig. 3).

Case 2

A 43-year-old female had not experienced any hearing impairment or vertigo in her life. She first noticed hearing loss in the right ear on September, 1996. The hearing loss worsened gradually.

On December 31, she suffered from a sudden onset of tinnitus in the right ear and severe vertigo with nausea and vomiting. She received steroid therapy for vertigo at a clinic, but with no effect. A CT examination revealed a cystic lesion with destruction of bone in the petrous apex, and lateral and posterior semicircular canals (Fig. 4). The cochlea appeared well preserved and the mastoid air cells were well developed. She was diagnosed with congenital cholesteatoma in the petrous apex and admitted to our clinic for surgery on January 21, 1997. Both tympanic membranes appeared intact. A pure tone audiogram revealed deafness in the right ear. Spontaneous nystagmus to the left side was found at all gazing positions. Electronystagmus was not performed due to her severe vertigo with nausea and vomiting. Facial movement was normal. Sonotubometry revealed normal tubal functions on both ears (Fig. 5).

The operation was performed on January 23, 1997. We tried to remove the cholesteatoma via the translabyrinthine approach. A retroauricular incision was used on the right ear. The tympanic cavity was intact. Mastoidectomy was performed. The mastoid air cells and tract were also intact, however, the mastoid antrum and epitympanic space were filled with the cholesteatoma, with destruction of the bony labyrinth. When the cholesteatoma was removed from this region, the horizontal and labyrinthine segments of the facial nerve were exposed. The cholesteatoma appeared to be

Figure 4. Cholesteatoma in the petrous apex of Case 2 (asterisk, preoperation).

extending toward the petrous apex. The lateral and posterior semicircular canals were destroyed by the cholesteatoma, but the bony plate of anterior semicircular canal remained. When this bony plate was drilled away, cholesteatoma was found in the apex of the petrous bone. The surrounding bone also was drilled away and the cholesteatoma was removed leaving a part of thin matrix membrane on the dura or the facial nerve of the labyrinthine portion. The facial nerve was preserved intact. A small amount of cerebrospinal fluid (CSF) leakage was found around the fundus of the internal auditory meatus, which was packed with a tiny fascia. The remaining space of the petrous apex lesion was filled with only fibrin glue. Postoperative CT examination revealed a well-pneumatized petrous apex, mastoid, and middle ear spaces at 6 months (Fig. 6). The operated ear showed deafness in a pure tone audiogram and complete canal paresis in a caloric test. The func-

Figure 5. Sonotubometry indicates normal tubal function in Case 2.

Figure 6. Cholesteatoma in the petrous apex of Case 2 (postoperation). Note that the operated region is well pneumatized (asterisk).

tion of the facial nerve was preserved intact. Her vertigo improved gradually, but an electronystagmograph examination demonstrated horizontal nystagmus characteristic of congenital nystagmus, which was assumed to have preexisted.

DISCUSSION

Cholesteatoma of the petrous apex is rarely encountered and is difficult to remove completely without complications. For this region is complex and dangerous anatomically, and it is difficult to obtain an adequate visual field for the operation. Many otoneurosurgeons dealing with this lesion recognize the difficulty of removing a cholesteatoma of the petrous apex completely because the thin matrix membranes often adhere to the dura or the internal carotid artery or jugular bulb.^{1,3} Nevertheless, most of them obliterate this region with muscle or other material together with the middle ear or/and mastoid cavity after removal of the cholesteatoma.¹⁻⁴ This procedure has the effect of squeezing the remnant of the cholesteatoma or matrix membrane in the dead space and makes it difficult to evaluate recurrence of cholesteatoma in this region even with use of CT and MRI during the follow-up. Moreover, the obliteration of the petrous apex makes it difficult to access this region again when recurrence is found, and also increases the possibility of inadequate removal of recurrent cholesteatoma in addition to severe complications such as rupture of the dura, internal carotid artery, or jugular bulb during revision surgery; the tissues used for obliteration often become organized and difficult to dissect.

It is well known that the intact mucosa of the middle ear and the normal function of auditory tube are im-

portant for maintenance of pneumatization in the middle ear and the mastoid cavity following the surgery of the ear.^{5,6} Our two patients showed normal tubal functions before surgeries, indicating that the operated lesions could be pneumatized after surgery if the region was not obliterated by soft tissues such as muscle. From extensive clinical experience of the middle ear surgery, we knew that fibrin glue in the middle ear is easily absorbed within a short period after surgery when the patient has normal function of the auditory tube (Fig. 7). Therefore, we obliterated the operated spaces only by fibrin glue to induce pneumatization after surgery. Indeed, the postoperative CT and MRI showed good pneumatization of the middle ear and the mastoid cavity in both patients within several months after the surgery. However, this may be puzzling because commercial fibrin glue is known to promote healing of the operative wounds by promotion of the production of granulation tissue. One possible explanation is that the lesion of the petrous apex is temporarily obliterated with granulation tissue, but the rapid growth of normal mucosa from the middle ear or mastoid cavity may overwhelm that of the granulation tissue. The fibrin glue may accelerate the growth of normal mucosal epithelium, as well as promoting the production of granulation tissue in the wound.

The normal mucosa in the mastoid air cells and middle ear cavity are also important for pneumatization of the operated space after surgery of the ear.^{5,6} Case 1 shows poorly developed air cells in the mastoid and Case 2, well developed cells. Considering the past his-

Figure 7. The postoperative region of acoustic tumor. Note that the region is well pneumatized (asterisk). This patient had well pneumatized mastoid air cells and a normal middle ear with normal function of the auditory tube. The operated spaces were obliterated with a tiny fascia in the internal auditory meatus and a fibrin glue in the remaining spaces.

tory of recurrent otitis media during childhood for Case 1, her cholesteatoma was probably acquired. Case 2 was undoubtedly congenital. It would be reasonable to assume that the operative spaces would be pneumatized in Case 2, considering the normal middle ear mastoid air cells and the normal tubal function. On the other hand, the mastoid air cells were poorly pneumatized in Case 1 at the operation. However, the operated spaces were well pneumatized after the surgery. We can assume that the volume of space to be pneumatized in Case 1 was small compared with that in Case 2 because of the poorly developed mastoid air cells in Case 1. Therefore, the function of the auditory tube alone may have been sufficient to pneumatize the operated spaces in Case 1.

The operative space was pneumatized completely within several months by obliteration with fibrin glue during surgery in both cases. This simple procedure offers at least two important advantages. Of most importance is the easy observation and evaluation of the post-operative region with CT and MRI for follow-up of recurrence of cholesteatoma. Of additional importance is that it is apparently safe and easy to access the region of the petrous apex when recurrent cholesteatoma is found because the mastoid cavity, middle ear, and

petrous apex are connected as a series of pneumatized areas.

In summary, where possible, we strongly advocate obliteration of the petrous region with fibrin glue instead of muscle or fat after removal of cholesteatoma in the petrous apex.

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