

CASE REPORT

Petrous bone cholesteatoma removed by trans-superior semicircular canal approach: Long-term hearing results in three cases

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Abstract

The aim of this report is to describe the long-term hearing prognosis of the transmastoid trans-superior semicircular canal approach. Three patients with small petrous bone cholesteatoma of the supralabyrinthine type removed by partial removal of the superior semicircular canal (SSCC) were followed up for 13, 9, and 10 years, respectively. All patients showed good bone conduction hearing during the follow-up period without postoperative complications, including longstanding disequilibrium causing a reduction in the quality of life. As an approach to petrous bone cholesteatoma of supralabyrinthine type that occupies a small area medial to the SSCC, the transmastoid trans-superior semicircular canal approach is less invasive and is considered to be a recommended approach.

Keywords: Superior semicircular canal, supralabyrinthine type, hearing preservation

Introduction

In 1997, the senior author of the present communication (T. Kobayashi) reported that it was possible to remove small supralabyrinthine petrous bone cholesteatoma by partially resecting the superior semicircular canal (SSCC) [1].

There was no change in the bone conduction threshold at about 1 year after surgery in the three cases reported at that time [1]. Although two of those three cases were lost to follow-up, long-term follow-up has been carried out in one case. Although there are some short-term observation reports about hearing preservation after partial labyrinthectomy [1–4], long-term postoperative hearing results after this kind of surgery have rarely been discussed. We herein report on the long-term follow-up in three cases after such surgery. One case has been followed up for 13 years from the previous report, and two additional cases have been followed up for 9 and 10 years, respectively, after such surgery.

Case reports

Case 1

A 3-year-old boy was previously reported in 1997 with short-term follow-up results [1]. He had suffered repeated aural discharge in his right ear every time he had a cold. He started to have bloody otorrhea and was introduced to our hospital 6 months later in 1994. In the right external auditory meatus, there was a purulent discharge with red polypoid granulation tissue at the pars flaccida of the tympanic membrane accompanied by bone destruction of the scutum. Computed tomography (CT) demonstrated soft tissue density occupying the whole middle ear cleft, and continuous to the medial portion of the SSCC (Figure 1A). Under a diagnosis of petrous bone cholesteatoma, surgery on the ear was performed in 1994. The duct of the bony SSCC was partially removed by drilling (Figure 1B) and the cholesteatoma medial to the SSCC was removed. The stumps

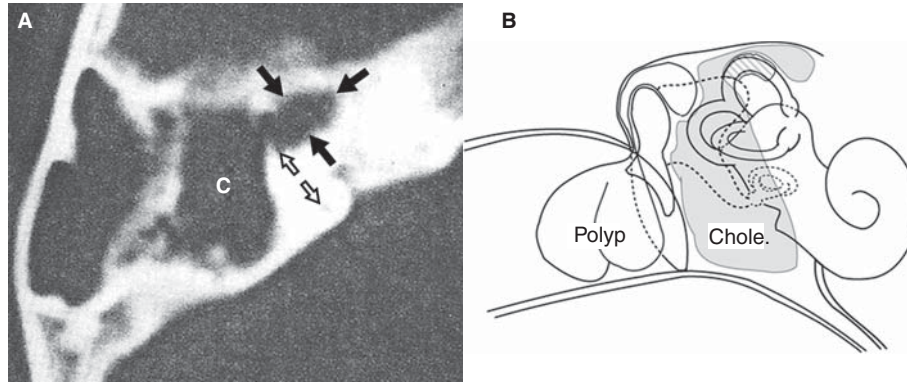


Figure 1. CT findings for case 1. (A) CT scan of the right middle ear showing the cholesteatoma (C) with extension to the petrous portion (black arrows) medial to the superior semicircular canal (SSCC) (white arrows). Reproduced from Kobayashi et al. [1]. (B) Schema indicating the extension route of the cholesteatoma medial toward the SSCC. Chole, cholesteatoma; Polyp, aural polyp in the external auditory meatus.

of the SSCC were covered with small pieces of fascia and bone chips were firmly applied. His postoperative progress was good and no hearing aggravation or dizziness occurred. He was too young for standard pure-tone audiometry at the time of the initial surgery, but a play audiogram was performed 10 months after the operation. The bone conduction threshold, obtained with a carefully performed test with adequate masking, was within normal range (Figure 2). A hearing test in 2007 (13 years after surgery) showed unchanged bone conduction threshold, but the presence of a considerable air-bone gap persisted (Figure 2). CT demonstrated evidence of the partially removed SSCC (Figure 3). We conducted exploration of the middle ear in an attempt to improve

hearing and found the stapes to be fixed. This patient was then regularly followed up.

Case 2

A 54-year-old woman experienced dizziness when she sneezed. She had undergone surgery for chronic otitis media on the left ear 15 years previously. A local physician suspected cholesteatoma and she was sent to our hospital. CT showed a soft tissue density in the middle ear, which was continuous to the medial portion of the SSCC, passing anterior to the SSCC. There were suspected fistulas to the SSCC. The diagnosis of petrous bone cholesteatoma with fistula to the SSCC was made (Figure 4A–C). Surgery was performed on the left ear in

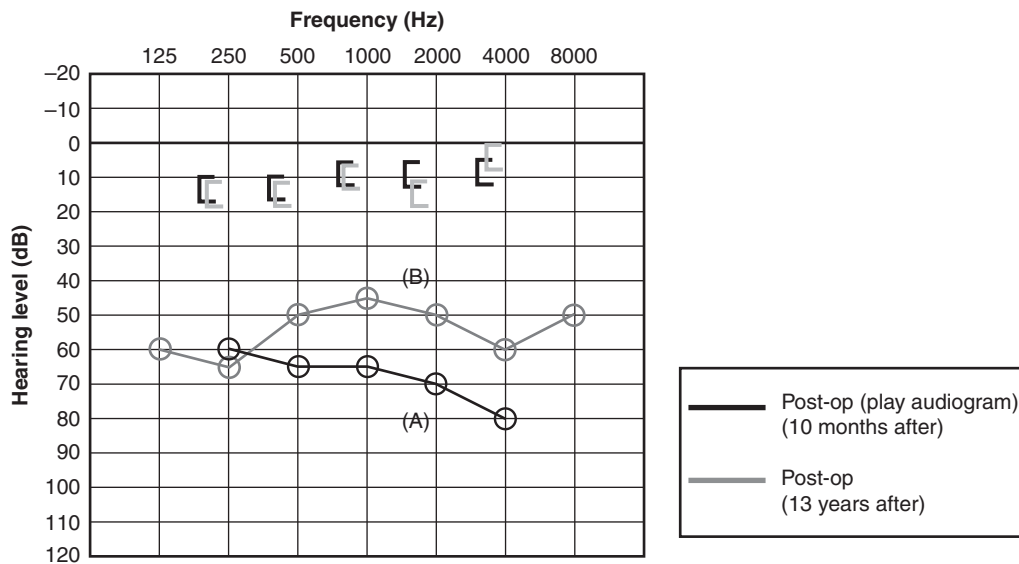


Figure 2. Case 1. Audiogram of the right ear. (A) The patient was only 3 years old and too young to have an accurate hearing test at the time of surgery, so a play audiogram was performed 10 months after the operation. It showed that the bone conduction threshold value was normal. (B) Hearing test 13 years after the surgery showing that the bone conduction threshold was unchanged. The pure tone air and bone conduction threshold audiometry with masking in these cases was administered according to an examination method recommended by British Society of Audiology, i.e. BS EN ISO 389-3 and BS EN ISO 389-4.

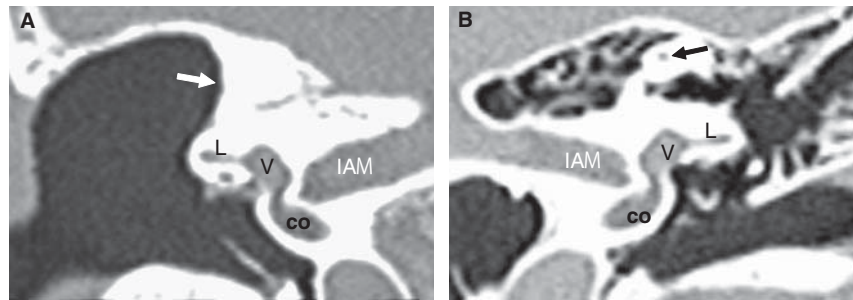


Figure 3. Case 1. CT scans of the middle ear 13 years after the surgery showing the right ear (operated) with the superior semicircular canal (SSCC) removed (A, white arrow), and left ear (normal) with the intact SSCC (B, black arrow). co, cochlea; IAM, internal auditory meatus; L, lateral semicircular canal; V, vestibule.

2002. A cholesteatoma was found to be present in the attic and extended from the prelabrynthine cell to the inside of the SSCC and around the upper part of it. We drilled the SSCC, preserving the ampulla, and extracted the cholesteatoma. Multiple labyrinthine fistulas were discovered at the ampulla of the SSCC, at the crus commune, and at the posterior semicircular canal (PSCC). These fistulas were opened surgically and filled with bone wax and bone pate (Figure 4D). Immediately

after the surgery, she temporarily suffered severe nausea and nystagmus, which disappeared 6 days later. Hearing showed little change after the surgery. The caloric test performed after surgery was normal. No apparent change has occurred in the bone conduction threshold for 9 years since the surgery (Figure 5). She has remained in good condition with no symptoms of dizziness. Postoperative CT showed that the SSCC had been partially removed (Figure 6).

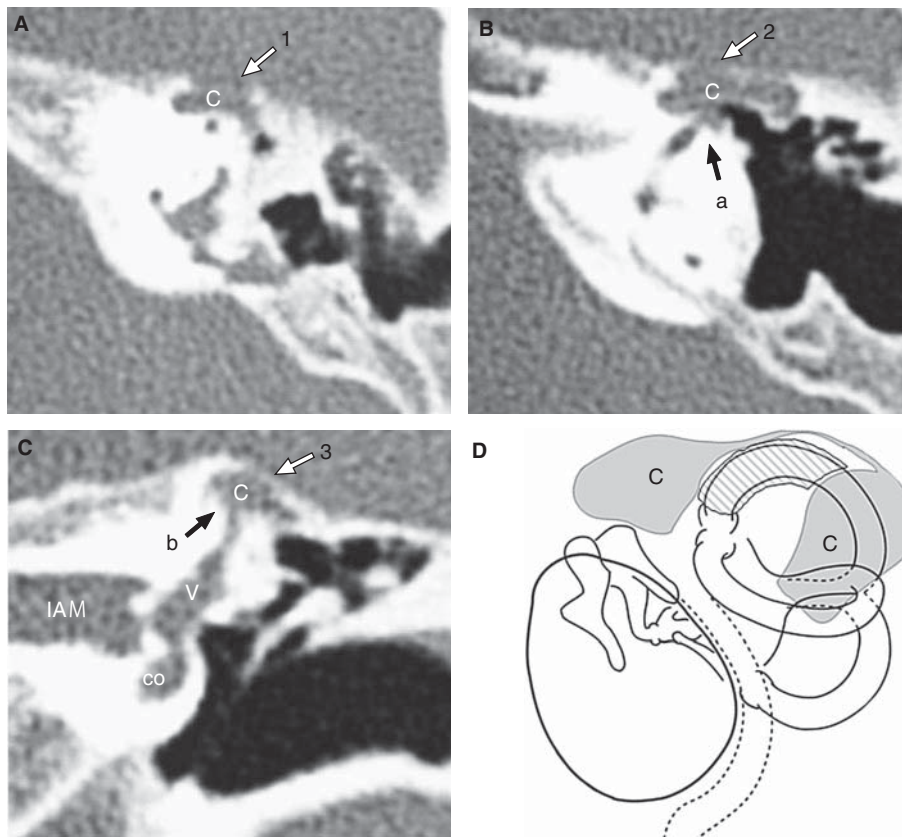


Figure 4. Case 2. (A–C) CT scans (A, B, axial; C, coronal) of the left ear showing soft tissue density (cholesteatoma) (white arrows 1, 2, 3) extending to the medial portion of the superior semicircular canal (SSCC), and apparent fistula involving the SSCC (black arrows a and b). (D) Scheme of extension of the cholesteatoma based on the operation findings. Cholesteatoma extended medial to the SSCC and PSCC. C, cholesteatoma; co, cochlea; IAM, internal auditory meatus; V, vestibule.

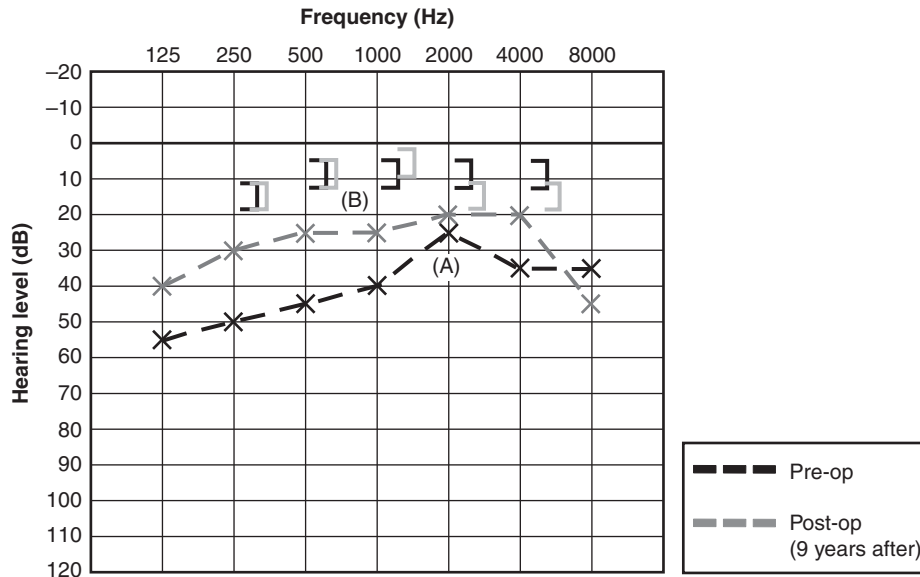


Figure 5. Case 2. Audiogram of the left ear. (A) Before and (B) 9 years after the surgery. The bone conduction threshold was unchanged.

Case 3

A 58-year-old woman, with a past history of right ear surgery in her primary school days, had pain in her right ear after cleaning it and visited an ENT department in Sendai in November, 2000. On inspection, the right ear had an open mastoid cavity with sign of slight infection with the eardrum being adherent to the promontory. There was effusion in the middle ear. After cleaning the open mastoid cavity, cholesteatoma debris was found to be connected to the area medial to the bony labyrinth. CT of the temporal bone showed a small and round soft tissue density occupying the area

medial to the SSCC and a diagnosis of petrous bone cholesteatoma was made (Figure 7A and B).

Surgery was undertaken to remove the cholesteatoma located medial to the SSCC (Figure 8A and B). In the removal of the cholesteatoma, the duct of the SSCC was partially drilled (Figure 8C), and the site was covered with a piece of bone fragment and bone pate (Figure 8D). A piece of fascia, cartilage, and a superiorly based periosteal flap were then used to cover the area and to obliterate the small cavity created by removal of the cholesteatoma and the partial resection of the SSCC. The other portion of the mastoid cavity was left untouched, the adhered eardrum was elevated,

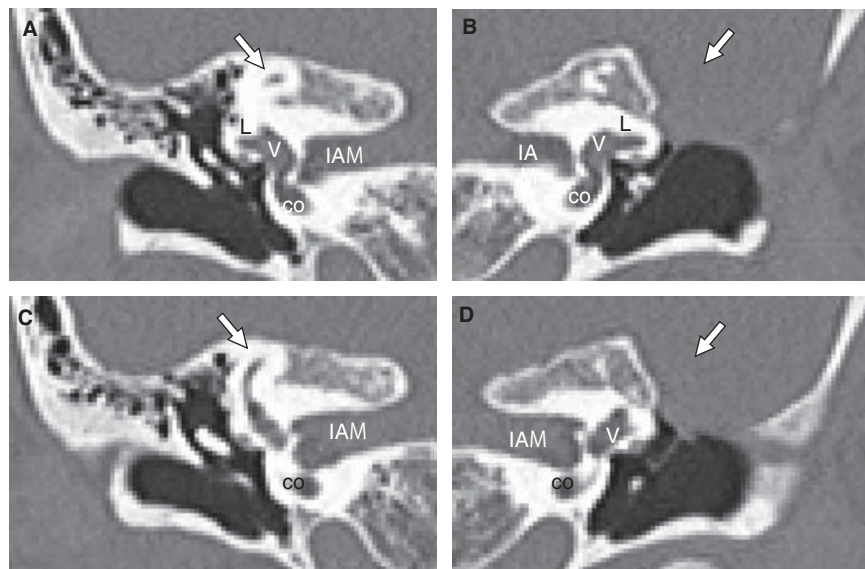


Figure 6. Case 2. CT after the surgery. (A, C) Right ear (normal). The superior semicircular canal (SSCC) is normally detectable. (B, D) Left ear (operated). SSCC is not detectable (arrow). co, cochlea; IAM, internal auditory meatus; L, lateral semicircular canal; V, vestibule.

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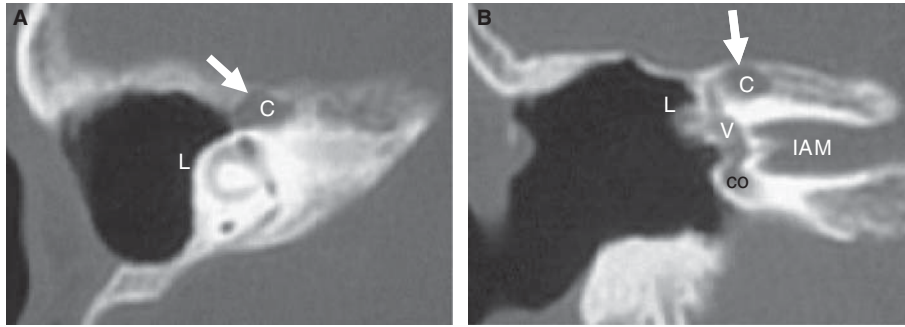


Figure 7. Case 3. CT (axial and coronal) before surgery. Round soft tissue density (arrow) medial to the SSCC. C, cholesteatoma; co, cochlea; IAM, internal auditory meatus; L, lateral semicircular canal; V, vestibule.

and tympanoplasty was attempted using a cartilage-apatite composite columella. Shortly after the surgery, she experienced dizziness and nystagmus directed leftward, which subsided 2 days after the surgery. Her hearing did not change after surgery. Thereafter, she remained in good condition without dizziness and no apparent change has occurred in the bone conduction threshold for 10 years since the surgery (Figure 9).

Discussion

The petrous apex lies between the inner ear and the clivus, and lacerated foramen in the front and internal auditory canal in the rear are generally regarded as its borders. Meanwhile, there is an opinion that the part behind the internal auditory canal and that medial to the semicircular canal should be included in the

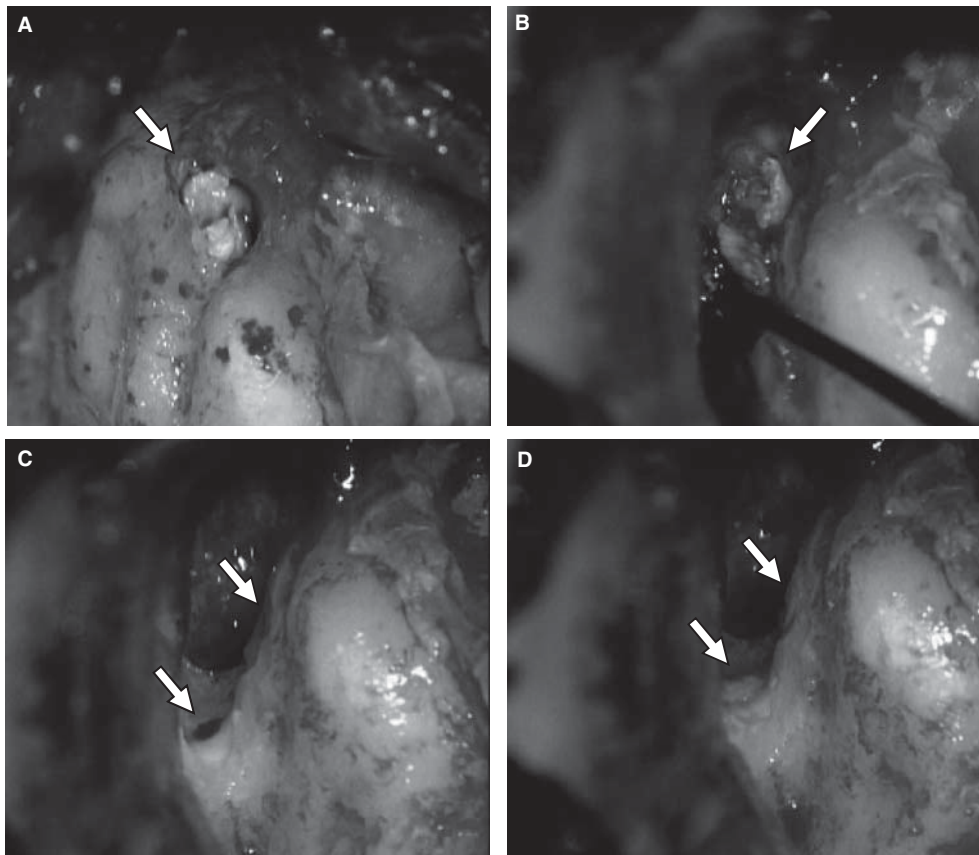


Figure 8. Case 3. Surgical procedures and findings. (A) Small cholesteatoma mass seen at the attic extending medial to the superior semicircular canal (SSCC) (arrow). (B) Drilling of a portion of the bony SSCC to expose the cholesteatoma mass medial to the SSCC (arrow). (C) After cleaning the cholesteatoma. Two stumps of the SSCC (arrows). (D) Two stumps of the SSCC were covered with bone chips (arrows).

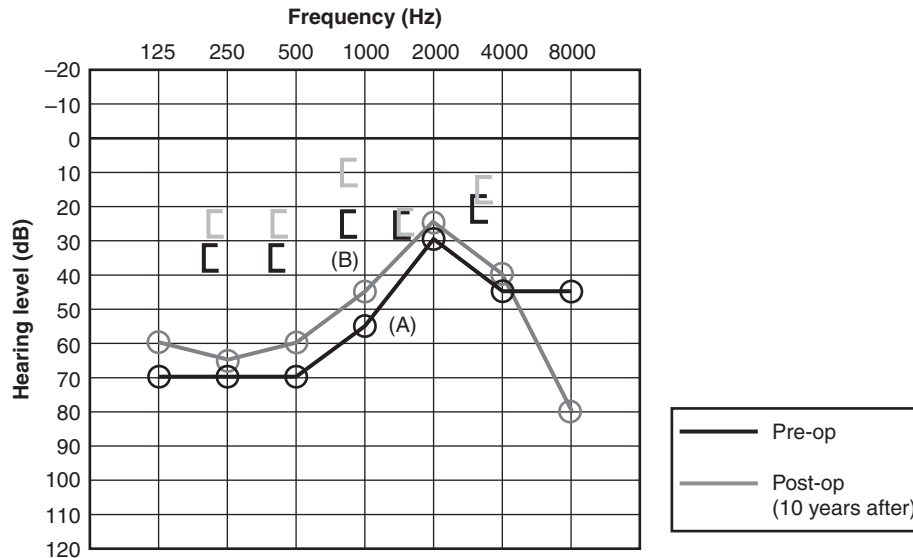


Figure 9. Case 3. Audiogram of the right ear. (A) Before and (B) 10 years after the surgery. The bone conduction threshold was unchanged.

petrous apex and termed the posterior petrous apex (PPA), while the area anterior to the internal auditory canal should be called the anterior petrous apex (APA) [5].

There are various disorders involving the petrous apex [6], petrous bone cholesteatoma especially being one of the most difficult to handle. Treatment of petrous bone cholesteatoma is ideally total removal including the matrix; however, the most appropriate treatment for each patient must be carefully considered, taking into account the residual hearing, facial nerve function, and other factors that differ from one case to another.

According to Sanna et al. [7], petrous bone cholesteatomas were classified into five types, i.e. supralabyrinthine, infralabyrinthine, infralabyrinthine-apical, massive, and apical. Moffat et al. added two more types, i.e. supralabyrinthine-apical and massive labyrinthine-apical [8]. Relatively small cholesteatomas in patients with good hearing are often of the supralabyrinthine type or apical type. In such cases, the middle cranial fossa approach has been used in an attempt to preserve hearing, an endoscope being recently employed to improve visibility in the hidden area of this approach [9,10]. In addition, a report has recently been published on the successful removal of a supralabyrinthine petrous bone cholesteatoma without damaging the integrity of the SSCC by the transmastoid subarcuate supralabyrinthine approach (through the center of the arch of the superior semicircular canal) [11]. However, this approach seems possible only in some particular cases with suitable anatomy.

Small cholesteatomas localized only medial to the SSCC and not reaching the internal auditory canal can

be treated with hearing preservation by the transmastoid trans-superior semicircular canal approach [1]. In an initial report, we described the short-term follow-up results of successful hearing preservation in the patient denoted in the present report as Case 1 [1].

The reasons for using the transmastoid trans-superior semicircular canal approach for the first case were as follows. First, the patient was very young (3 years old) at the time of the surgery, and the cholesteatoma medial to the labyrinth was very small, so the middle cranial fossa approach did not seem to be readily feasible. Second, before this case, PSCC plugging had been reported in cases of benign paroxysmal positional vertigo (BPPV) to be successful in preservation of hearing as well as in control of the vertigo [12], and we had personally experienced several cases of partial resection of the semicircular canals (mainly of lateral semicircular canal), for the treatment of a labyrinthine fistula due to a middle ear cholesteatoma [13]. Third, earlier experimental studies had shown that cochlear function could be preserved even after partial removal of the semicircular canal [14].

There have been several clinical reports – some from nearly half a century ago – that hearing was preserved after removal of the semicircular canal [15–17], and there have also been some reports on hearing preservation after removal of larger portions of the labyrinth. Rapado et al. reported a case of giant cholesteatoma in the middle cranial fossa, treated by removal of the labyrinth, including both the semicircular canal and the vestibule, without causing worsening of the bone conduction hearing [18]. Springborg et al. reported that hearing was preserved (although with considerable decrease) after classical

translabyrinthine surgery for vestibular schwannoma for 5.5 years after surgery [19]. However, hearing worsened several years later [19]. Therefore, long-term (even more than 5 years) follow-up is necessary to ensure real hearing preservation. In the present report, long-term hearing preservation was verified in all the three cases in which follow-up was carried out more than 9 years after surgery by the transmastoid trans-superior semicircular canal approach.

Some rules that we maintained during our operative procedures for manipulation of the opened semicircular canals are as follows. (1) Conduct continuous dripping of saline solution into the operative field, starting shortly before opening of the semicircular canals, for the preparation of the inadvertent suction of perilymph to prevent dry labyrinth. (2) Avoid manipulating the ampulla of the semicircular canals as much as possible. (3) Close opened semicircular canal ducts as firmly as possible with pieces of bone chips, bone pate, and fascia, to prevent signs or symptoms of fistula after the surgery.

This report seems to suggest that in some cases of supralabyrinthine petrous bone cholesteatoma, the transmastoid trans-superior semicircular canal approach is feasible and affords patients a long stable life without postoperative complications, including hearing aggravation or longstanding disequilibrium.

Declaration of interest: The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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