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Petrous Bone Cholesteatoma

Abstract—Petrous bone cholesteatoma is a rare pathologic entity and may be a difficult surgical challenge because of potential involvement of the facial nerve, carotid artery, dura mater, otic capsule, and risk of cerebrospinal fluid leak. The objective of this article is to present a personal classification of petrous bone cholesteatomas, a survey of recent surgical attitudes, and our present surgical strategy based on our experience with 54 operations between 1978 and 1990. Radical petromastoid exenteration with marsupialization and the middle cranial fossa approach were used only for small pure infra- or supralabyrinthine cholesteatomas, respectively. The enlarged transcochlear approach with closure of the external auditory canal was used for infralabyrinthine, infralabyrinthine-apical, and massive petrous bone cholesteatomas. Five cases with petrous bone cholesteatomas in different locations are described in detail to present the signs and symptoms together with the management. (*Skull Base Surgery, 3(4):201–213, 1993*)

Improvements in skull base surgery and recent advances in radiologic imaging have changed attitudes in management of petrous bone cholesteatoma. In particular high resolution computed tomography (CT) and magnetic resonance imaging (MRI) allow the exact pathologic definition preoperatively and an accurate follow-up of any possible recurrence after surgery. This advance has made it possible to switch from open techniques to more obliterative techniques that avoid exposure of the carotid artery, dura, and the internal auditory canal to the exterior environment.

DEFINITION AND CLASSIFICATION

We have used the term "petrous bone cholesteatoma" to define an epidermoid cyst of the petrous portion of the temporal bone. We have divided petrous bone cholesteatomas into five types: supralabyrinthine, infralabyrinthine, massive labyrinthine, infralabyrinthine-apical, and apical. A supralabyrinthine cholesteatoma (Fig. 1A, B) is characteristically congenital or may result from deep ingrowth of an acquired epitympanic cholesteatoma. It involves the anterior epitympanum and extends medially toward the internal auditory canal and anteriorly toward the carotid artery. The basal turn of the cochlea may be involved. Posteriorly, the cholesteatoma may spread toward the posterior aspect of the bony labyrinth and the retrolabyrinthine mastoid cells.

An infralabyrinthine cholesteatoma (Fig. 2A, B) arises in the hypotympanic and infralabyrinthine regions and extends anteriorly toward the internal carotid artery and posteriorly toward the posterior cranial fossa.

A massive labyrinthine cholesteatoma (Fig. 3A, B) is a diffuse type and involves the entire posterior and anterior labyrinth. The site of origin within the petrous bone is not certain, but it may result from an extension of supralabyrinthine or infralabyrinthine cholesteatoma. It often develops from a primary acquired cholesteatoma. It is usually asymptomatic, but slight unsteadiness, facial palsy, and partial or total sensorineural hearing loss may occur.

An infralabyrinthine-apical cholesteatoma (Fig. 4A, B) may arise in the infralabyrinthine or the apical compartments. The first extends anteriorly into the petrous apex and may involve the sphenoid sinus and the horizontal portion of the internal carotid artery. The latter arises in the apical compartment and then extends superiorly to the sphenoid sinus and inferoposteriorly to the infralabyrinthine compartment. These are generally congenital in origin.

An apical cholesteatoma (Fig. 5A, B) is an uncom-

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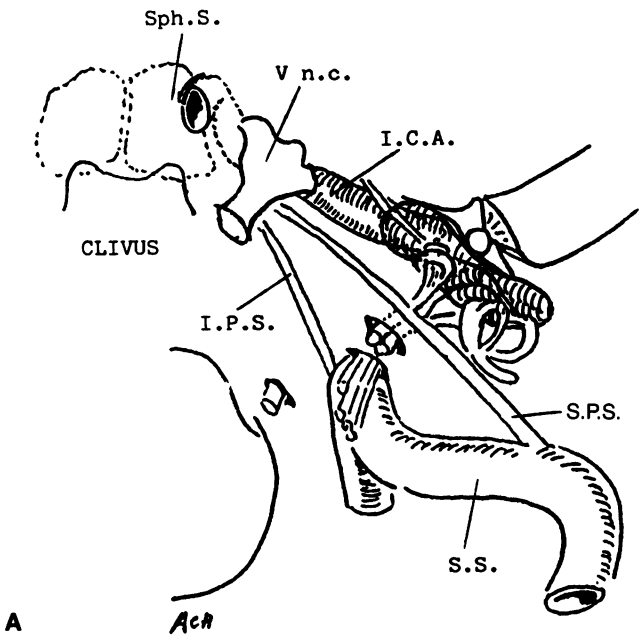

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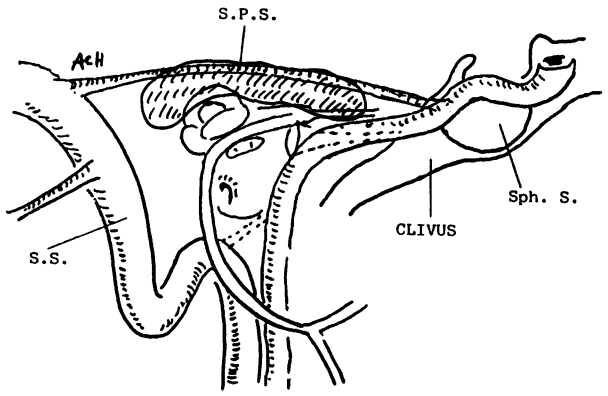
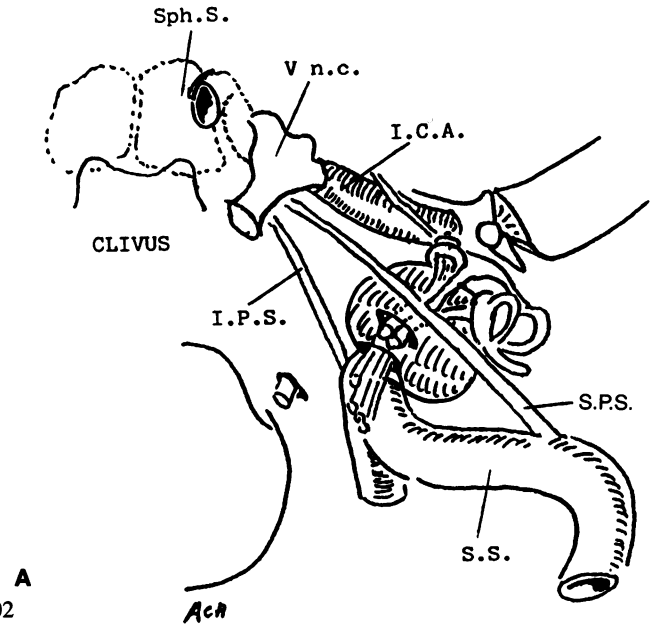


B

Figure 1. A, B: The supralabyrinthine type of cholesteatoma. I.C.A.: internal carotid artery; I.P.S.: inferior petrosal sinus; Sph.S: sphenoid sinus; S.P.S.: superior petrosal sinus; S.S.: sigmoid sinus; V n.c.: trigeminal nerve.



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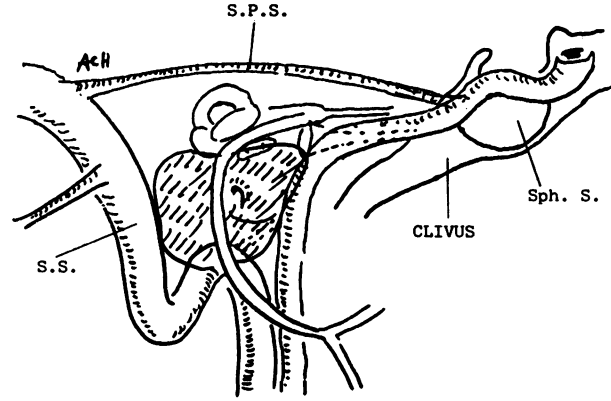
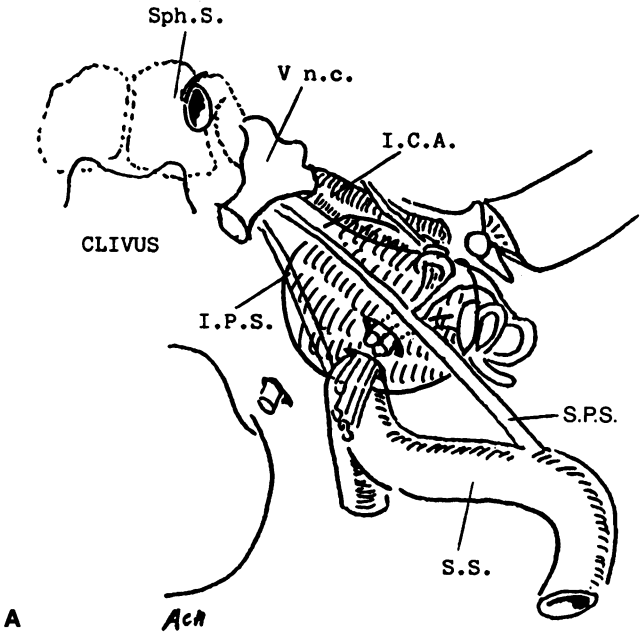


B

Figure 2. A, B: The infralabyrinthine type of cholesteatoma. See Figure 1 for abbreviations.



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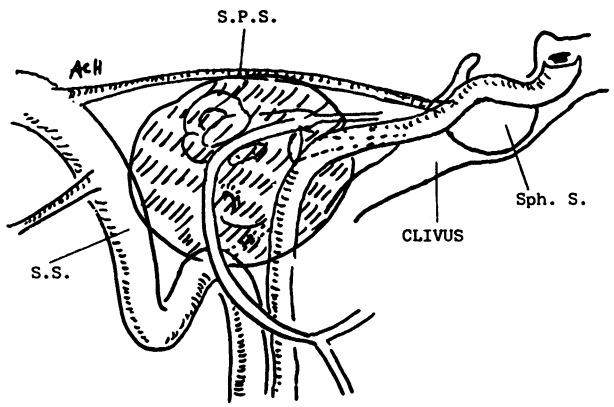

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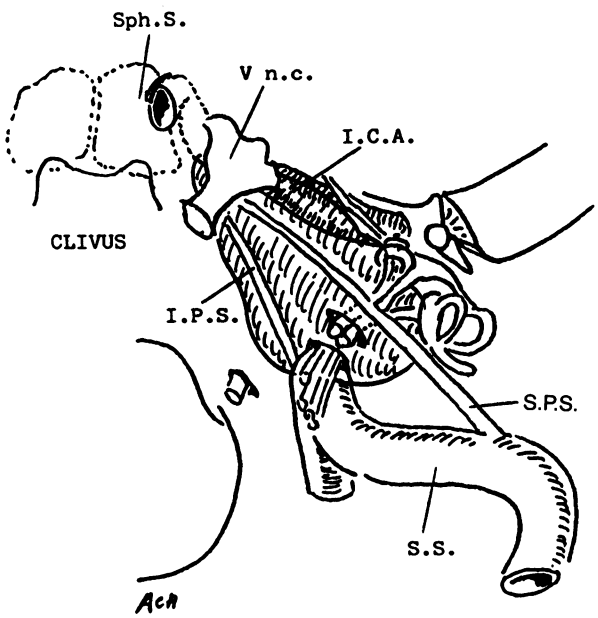
Figure 3. A, B: Massive labyrinthine cholesteatoma. See Figure 1 for abbreviations.



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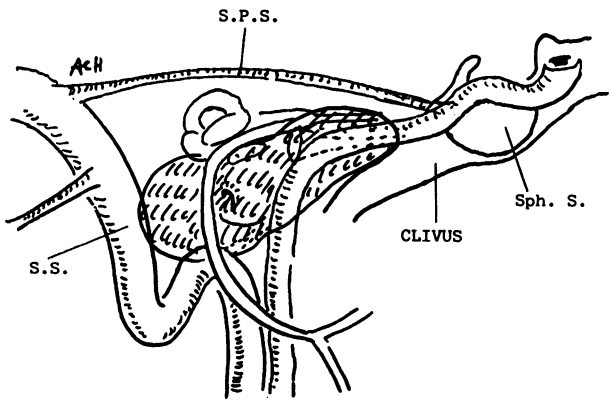

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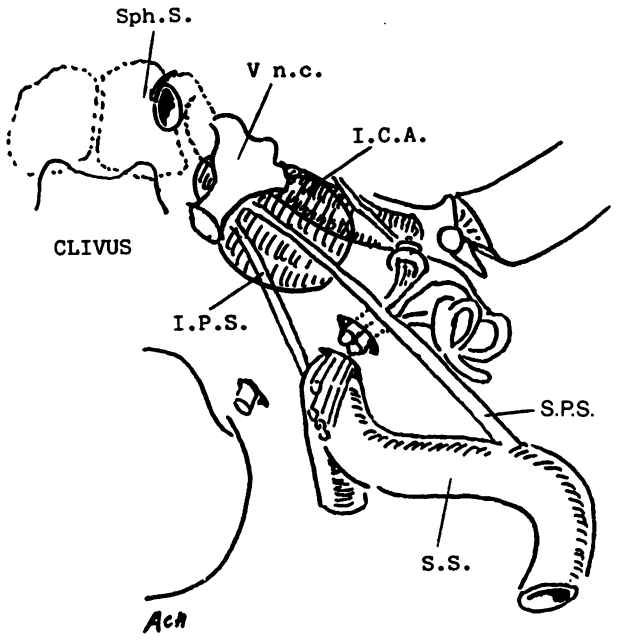
Figure 4. A, B: The infralabyrinthine-apical type of cholesteatoma. See Figure 1 for abbreviations.



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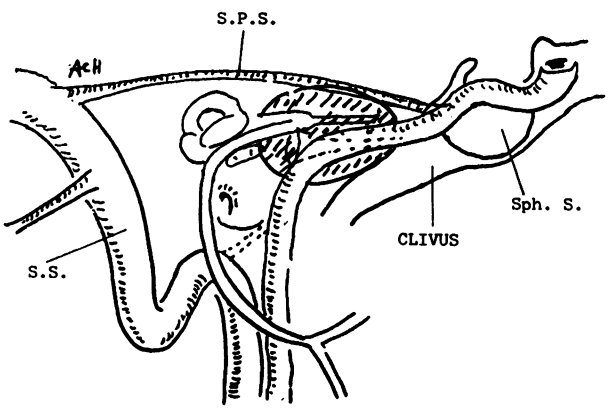

B

Figure 5. A, B: The apical type of cholesteatoma. See Figure 1 for abbreviations.

mon congenital lesion. It may involve only the apical compartment of the temporal bone. It can cause erosion of the internal auditory canal. It may extend toward the posterior cranial fossa or anteriorly to the trigeminal nerve.

SURGICAL MANAGEMENT

The ideal treatment for petrous bone cholesteatomas is radical surgical removal, although destruction of the labyrinth and rerouting of the facial nerve may be required. This approach may have to be modified, depending on the status of the contralateral ear. The choice of the actual surgical approach is based on the location and extent of the lesion, but it must provide adequate and safe exposure of the middle and posterior fossa dura, carotid artery, lateral sinus and jugular bulb, and facial nerve.

Our attitude in the management of petrous bone cholesteatoma has evolved from 1984 and the present guidelines can be summarized as follows. Radical petromastoid exenteration with marsupialization of the cavity is done only in cases of infralabyrinthine cholesteatoma with limited extension. Radical petromastoid exenteration with closure of the eustachian tube, obliteration of the cavity with abdominal fat, and blind sac closure of the external ear canal, is done in those large and deep cavities resulting from infralabyrinthine cholesteatomas. We use the middle cranial fossa approach only for small supralabyrinthine cholesteatomas without posterior or anterior extensions when hearing of the affected ear is normal. The modified transcochlear approach is performed for massive labyrinthine, infralabyrinthine-apical, and apical cholesteatomas extending to the clivus, and in all cases of internal auditory canal involvement and cerebrospinal fluid (CSF) leak.

The modified transcochlear approach is based on a wide petrosectomy with exposure and rerouting of the facial nerve exposure of the middle and posterior cranial fossa dura, sigmoid sinus and jugular bulb, and petrous carotid artery. The external and middle ear are removed with blind sac closure of the external ear canal, the eustachian tube is closed, and the cavity is obliterated with abdominal fat. The infratemporal approach type B is used when petrous bone cholesteatoma involves the horizontal portion of the internal carotid artery or the sphenoid sinus. This approach can be extended to the neck (type A) when the sigmoid sinus and jugular bulb are involved by cholesteatoma and are to be removed with ligature of the jugular vein in the neck.

PROBLEMS IN SURGERY

Surgical Removal Versus Inner Ear Function Preservation

At the beginning of our surgical experience, we attempted to preserve inner ear function despite labyrinthine involvement by petrous bone cholesteatoma. Our results, however, showed that we were rarely able to pre-

serve hearing. Therefore now we do not hesitate to remove the otic capsule when it is required. Of course, the status of the contralateral ear determines our therapeutic approach in fact; an only hearing ear with petrous bone cholesteatoma is managed with regular radiologic follow-up and watchful waiting.

Facial Nerve Involvement

Involvement of the facial nerve poses particular problems. In some instances the cholesteatoma can be easily dissected and simple decompression is the treatment of choice. When preoperative facial palsy is present, the involved segment may be compressed but anatomically intact, interrupted, or replaced by fibrous degeneration. In the first instance the nerve may be freed and decompressed. When the nerve is interrupted, continuity is reestablished by rerouting and direct anastomosis or with a cable graft. In the third instance the degenerated portion is removed and continuity is reestablished with the methods already mentioned. If facial nerve palsy dates back more than 2 years, a hypoglossal-facial anastomosis is done.

Carotid Artery Involvement

The surgeon should plan an approach that allows the complete control of the artery. When the horizontal portion is involved, only the infratemporal fossa approach type B with downward dislocation of the mandible gives direct control of the vessel. The dissection of the matrix from the artery poses no particular problems but requires extreme caution and skill.

Sigmoid Sinus and Jugular Bulb Involvement

Complete removal of pathologic tissue from the sigmoid sinus is difficult and problems increase when the jugular bulb is involved because of its fragility. In such cases it is necessary to ligate the sigmoid sinus and the jugular vein. This allows the removal of the dome of the jugular bulb and the external wall of the sigmoid sinus covered by matrix. Cranial nerves IX, X, XI, and XII are identified and preserved. Bleeding from the inferior petrosal sinus is controlled by packing it with Surgicel.

Dural Involvement

Dural involvement occurs very often and makes radical removal of pathologic lesions a challenge to the otologist. The matrix can be so adherent to the dura that removal is nearly impossible, and even a skilled surgeon is unable to distinguish between them. In this case the surgeon has three options: (1) if the cavity is not infected, the involved dura can be removed and the defect is closed with fascia; (2) use 90% ethyl alcohol, as proposed by Fisch; and (3) bipolar coagulation of all the suspected portions of dura mater to destroy all the possible remnants of cholesteatoma matrix (this is our method of choice). This method can be used in all instances without exceptions.

Cerebrospinal Fluid Leaks

CSF leaks may result from dural tears occurring during matrix removal. Leaks are stopped by inserting a free muscular flap into the subarachnoid space through the dural opening. Large dural tears are repaired with muscle plugs and suturing of the dural margins over the muscle.

PATIENTS AND METHODS

Fifty-four cases of petrous bone cholesteatomas have been treated at the E.N.T. Department of the University of Parma, Italy, and at The Gruppo Otologico, Piacenza, Italy, from January 1978 to January 1990 (24 supralabyrinthine, 12 infralabyrinthine, 13 massive labyrinthine, and five infralabyrinthine-apical cholesteatomas). A draining ear was the most frequent complaint (39 cases), followed by vertigo (25 cases), facial nerve function disturbances (23 cases), otalgia (11 cases), tinnitus (four cases), and headache (two cases). Symptoms were present for more than 1 year in 76% of the patients.

Otoscopy showed an epitympanic perforation in 28 cases, a subtotal perforation in 11 cases, a radical cavity in nine cases, a closed tympanoplasty in four cases, and a normal eardrum in two cases. A mixed hearing loss was present in 56% of cases, a conductive hearing loss in 33%, total deafness in 9%, and normal hearing in 2%.

The surgical approach has evolved from open techniques adopted in the majority of cases from 1978 to 1985 to closed techniques adopted in over 70% of cases in the last 4 years. The surgical approach versus localization of pathologic lesions is reported in Figures 6 through 9.

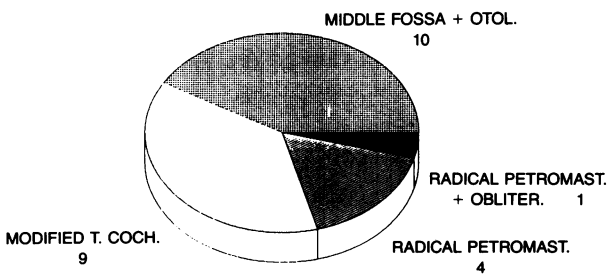

Figure 6. In 24 cases of supralabyrinthine cholesteatoma, the results of surgical technique versus localization is shown.

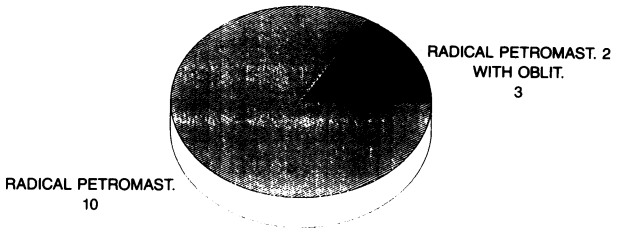

Figure 7. In 12 cases of infralabyrinthine cholesteatoma, the results of surgical approach versus localization is shown.

Figure 6 shows the surgical techniques used over the years for supralabyrinthine cholesteatoma management. At the beginning of our experience, we adopted the radical petromastoidectomy, but later, with the goal of hearing preservation, we switched to the middle cranial fossa approach combined with an otologic approach. The modified transcochlear approach was used in cases in which a labyrinthine fistula was detected preoperatively. Today, the middle cranial fossa approach is used only in small supralabyrinthine cholesteatomas.

Figure 7 shows that the radical petromastoidectomy is used in infralabyrinthine cholesteatoma. Obliteration and closure of the external auditory canal was adopted in deep cavities.

Figure 8 shows that in cases of infralabyrinthine-apical cholesteatoma a radical petromastoidectomy was used at the beginning of our experience. Later, the modified transcochlear approach became the technique of choice and the infratemporal approach A-B was adopted in one case in which the pathologic lesion involved the sphenoid sinus.

Figure 9 shows that in cases of massive labyrinthine cholesteatoma early in our experience we used the radical petromastoidectomy, but later we changed to the modified transcochlear approach to avoid cavity problems (skin entrapment, recurrence of disease).

The management of the facial nerve involved by cholesteatoma is reported in Table 1.

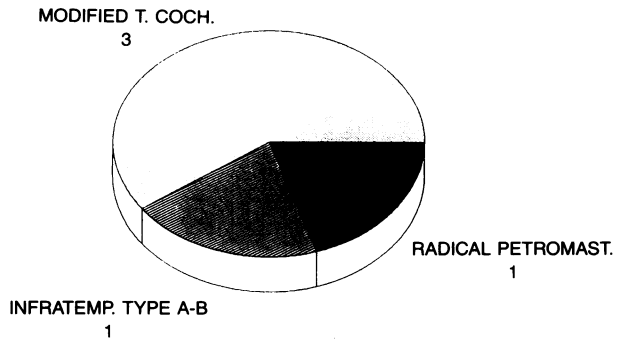

Figure 8. In five cases of infralabyrinthine-apical cholesteatoma, the surgical technique versus localization is shown.

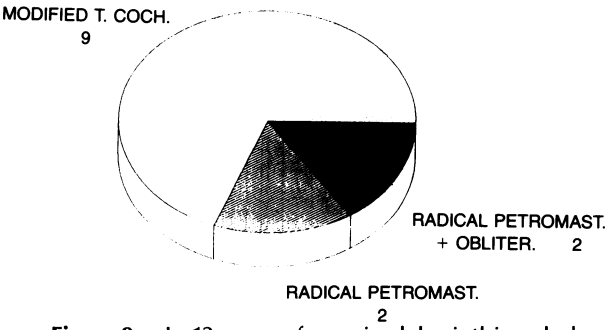

Figure 9. In 13 cases of massive labyrinthine cholesteatoma, the surgical technique versus localization is shown.

RESULTS

Fifty cases were available for this study and four were lost to follow-up. Seven cases had a minimum follow-up of 12 years, 13 cases had a follow-up of 7 years, 20 cases had a minimum follow-up of 5 years, and 10 cases had a minimum follow-up of 2 years. Follow-up of cases was done with CT or MRI in 36 cases and with clinical examination in 14 cases; these latter were all treated with radical petromastoid exenteration and marsupialization.

Residual disease was found in 2 of 50 (4%) cases: both were radical petromastoid exenterations in which a stenosis between the cavity and the exterior had occurred. These two cases underwent revision surgery and obliteration with abdominal fat.

Postoperative hearing was normal in only one case. Four cases had a conductive hearing loss and 19 had a mixed hearing loss. One dead ear occurred in 30 cases.

Postoperative facial nerve function was evaluated according to the House-Brackmann grading system. Eleven cases treated within 1 year after the onset of facial nerve palsy had a grade III score. Twelve cases with more than 1 year duration of facial palsy had no recovery of facial nerve function postoperatively.

Complications of surgery included wound infection (three cases), facial nerve palsy (three cases), CSF leak (one case), cerebritis (one case), and brain abscess requiring drainage (one case). No death occurred in the present series.

The following five cases of petrous bone choles-

Table 1. Petrous Bone Cholesteatoma: Treatment of Facial Nerve Palsy

Treatment	*No.*
Decompression	11
XII-VII Anastomosis	2
Interposition graft	2
End-to-end anastomosis (with rerouting in two cases)	4
Rerounting	4

teatoma (one for each location) describe signs and symptoms together their management.

CASE REPORTS

Supralabyrinthine Cholesteatoma

Case 1

A 29-year-old man presented with right facial palsy and spasms that began 45 days before admission. He complained of hearing loss in the right ear. On inspection, a complete right facial palsy was present, and the tympanic membranes were normal. A right mixed hearing loss was present, hearing on the left being normal. A CT scan showed a mass involving the first and second portion of the fallopian canal plus the anterior and posterior labyrinth (Fig. 10). The patient underwent surgery: a modified transcochlear approach with removal of the posterior bony canal wall, tympanic membrane, and ossicles. A congenital cholesteatoma was found involving the oval window, the vestibule, the superior and lateral semicircular canals, the cochlea, and the second portion of the facial nerve. The geniculate ganglion was involved and cholesteatoma extended to the internal auditory canal. The middle cranial fossa dura was exposed by the cholesteatoma. The facial nerve was partially rerouted to assure complete dissection from matrix. The cavity was obliterated with abdominal fat after closure of the eustachian tube with cartilage and bone paté. The external auditory canal was closed as a blind sac. No recurrence was present at MRI 3 years after surgery (Fig. 11). The facial nerve recovery is grade II.

Infralabyrinthine Cholesteatoma

Case 2

A 28-year-old man presented with left aural discharge from a radical cavity and a left conductive hearing loss. He underwent a revision operation. At surgery the second and third portions of the facial nerve were surrounded by cholesteatoma and a labyrinthine fistula in the region of the promontorium was present. Cholesteatoma involved the hypotympanic cells under the cochlea, it extended toward the posterior cranial fossa and the jugular bulb, and anteriorly it was under the eustachian tube. The operation was stopped because of the deep infiltration of the matrix. A CT study was done and confirmed the presence of a large infralabyrinthine cholesteatoma.

One month later the patient underwent a left petromastoid exenteration: cholesteatoma involved the entire infralabyrinthine region eroding the jugular septum, extended to reach the labyrinthine portion of the facial nerve, and involved the promontory. The removal of matrix was complete. Six months after surgery, the cavity was healed, dry, and hearing was lost. Eleven years from surgery, the patient is free from any recurrence.

Massive Labyrinthine Cholesteatoma

Case 3

A 56-year-old woman presented with right aural discharge of several months' duration, dizziness, and a right facial nerve palsy. On examination, a right epitympanic perforation and a grade VI facial nerve palsy were present.

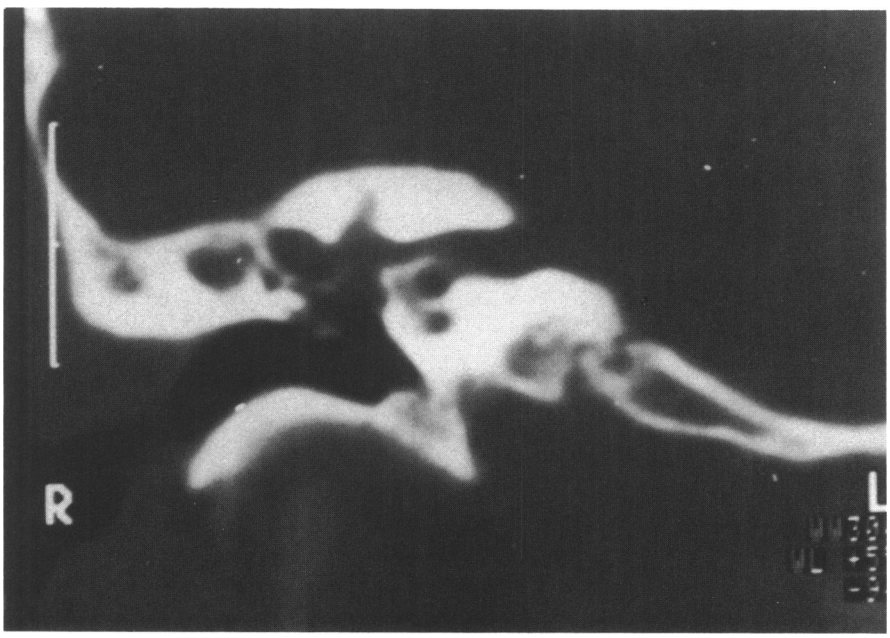

Figure 10. Supralabyrinthine cholesteatoma. CT, coronal section, shows a large osteolytic lesion in the supralabyrinthine compartment of the petrous bone with involvement of the lateral and superior semicircular canals, the geniculate ganglion, and the first portion of the facial nerve.

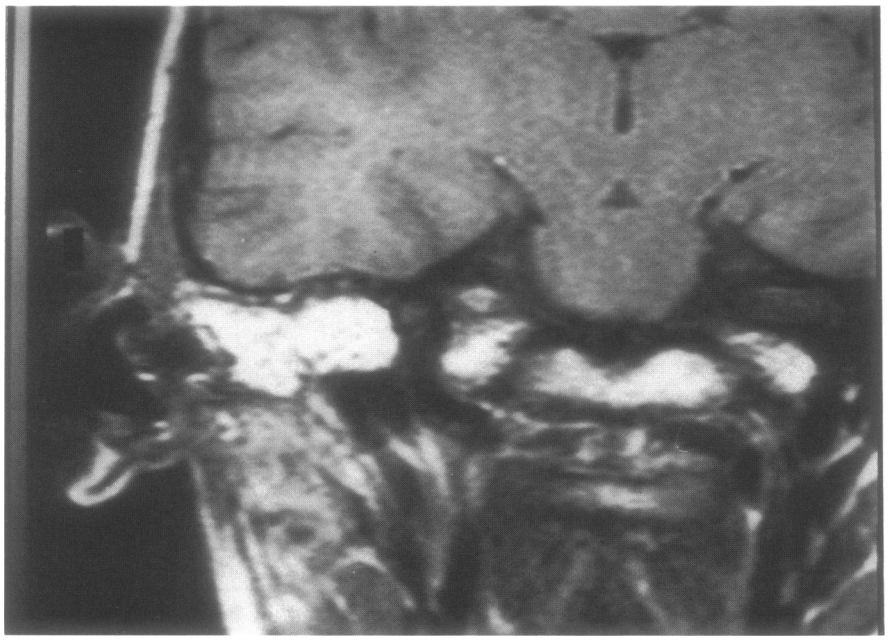

Figure 11. Supralabyrinthine cholesteatoma. MRI, coronal section, 3 years postoperatively shows that the cavity is completely obliterated with abdominal fat. No sign of residual disease is present.

High-resolution CT scan showed an osteolytic lesion massively involving the petrous bone (Fig. 12).

The patient underwent a modified transcochlear approach. Cholesteatoma had spread from the epitympanum to involve the posterior and anterior labyrinth, uncovering the jugular bulb and the internal carotid artery. The facial nerve was nearly absent in its first portion between the internal auditory canal and the geniculate ganglion. Removal of the matrix required mobilization of the horizontal and vertical portions of the internal carotid artery. The cerebellopontine angle was opened and the proximal stump of the facial nerve was identified. The facial nerve was rerouted and an end-to-end anastomosis was performed. The cavity was obliterated with abdominal fat, the

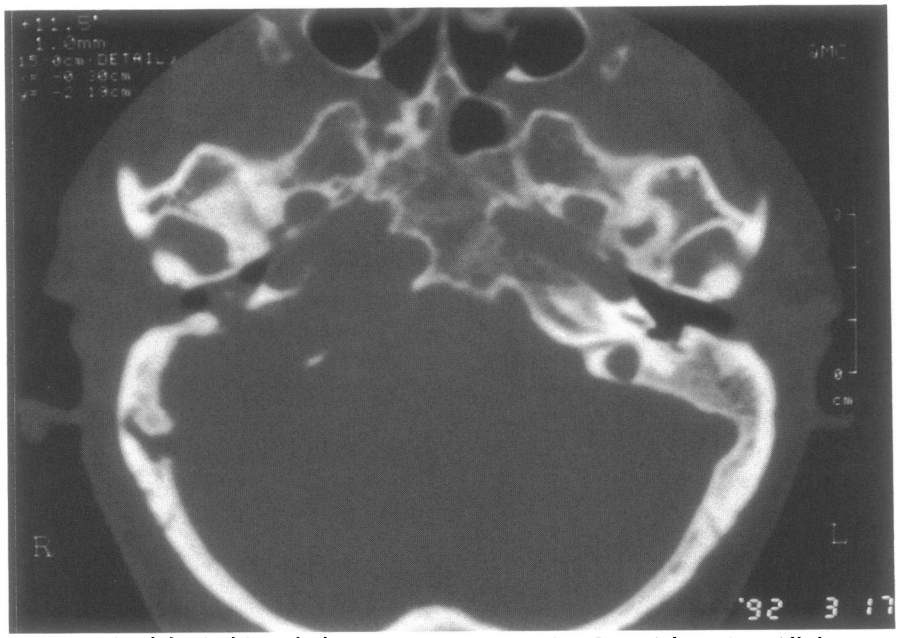

Figure 12. Massive labyrinthine cholesteatoma. Preoperative CT, axial section. All the temporal bone is involved by the disease. The horizontal portion of the carotid artery is surrounded by cholesteatoma, the clivus is eroded and the matrix is adherent to the posterior fossa dura.

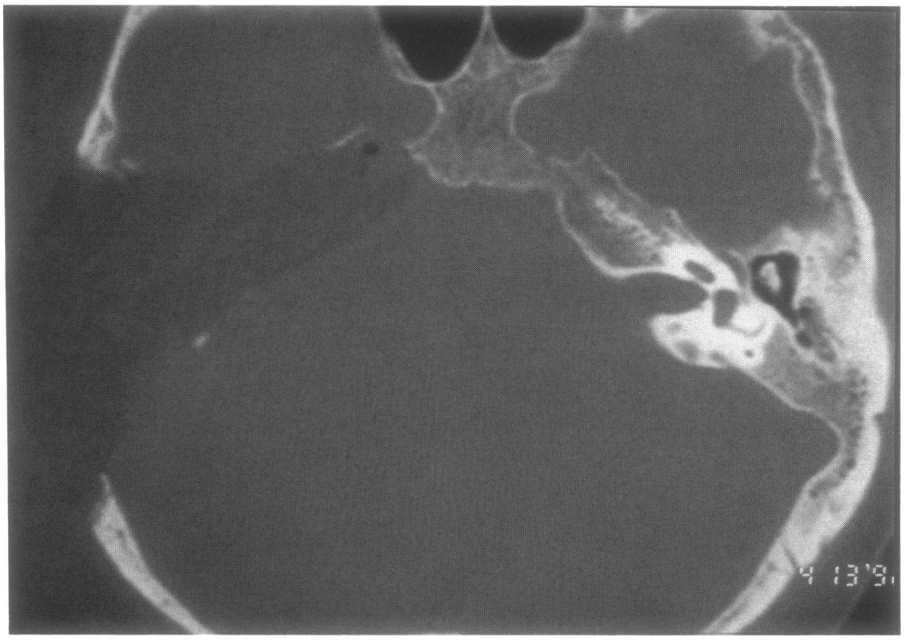

Figure 13. Massive labyrinthine cholesteatoma. Postoperative CT, axial section. All the temporal bone is absent and the cavity is completely filled with abdominal fat. The cavity is free from recurrence.

eustachian tube was closed, and blind sac closure of the external auditory canal was performed. The postoperative course was uneventful. Four years after surgery, the patient is free from recurrence by CT evaluation (Fig. 13). Facial nerve recovery is absent with the exception of rare reinnervation signs from the contralateral nerve.

Infralabyrinthine-Apical Cholesteatoma

Case 4

A 34-year-old woman presented with a left facial nerve palsy of 2 month's duration. She had had recurrent episodes of left aural discharge since she was 20 years old. She had a left subtotal tympanic membrane perforation with aural polyps and a left mixed hearing loss. Preoperative CT scan showed a large defect of the apex of the temporal bone that had eroded the internal auditory canal and the carotid canal (Fig. 14).

A modified transcochlear approach was performed. Cholesteatoma involved the infralabyrinthine region where the jugular bulb and the vertical portion of the carotid canal were uncovered. The matrix also uncovered the geniculate ganglion and the first portion of the fallopian canal where the facial nerve was interrupted. Cholesteatoma reached the petrous apex, the horizontal portion of the internal carotid artery, and the clivus. The jugular vein was ligated in the neck with an independent skin incision and the sigmoid sinus ligated under the superior petrosal sinus. The external wall of the sigmoid sinus and the dome of the jugular bulb were removed. Pathologic lesions were removed and facial nerve was repaired with an end-to-end anastomosis. The cavity was obliterated with abdominal fat and the external auditory canal closed as a blind sac. Four years after surgery the facial nerve recovery is grade III and no recurrence is detected with CT scan (Fig. 15).

Infralabyrinthine-Apical Cholesteatoma Involving the Sphenoid Sinus

Case 5

A 46-year-old man presented with discharge and complete hearing loss in the right ear but without tinnitus or vertigo. He had had recurrent episodes of otitis since childhood. At age 35 years, he underwent a tympanoplasty but lost the hearing in the right ear after surgery. He remained troublefree for 10 years.

On inspection, stenosis of the external auditory canal with erosion of the posterior canal wall and aural discharge were present. He had a total hearing loss on the right. High-resolution CT scan showed an osteolytic lesion involving the horizontal portion of the internal carotid artery, the lateral aspect of the clivus, and the right sphenoid sinus (Fig. 16).

MRI confirmed the presence of the mass found at CT; the lesion was hypointense in T_1 and hyperintense in T_2 (Fig. 17). The patient underwent an infratemporal fossa approach type A-B. Cholesteatoma involved the intersinusofacial cells, the sigmoid sinus, the jugular bulb, the vertical and horizontal portions of the internal carotid artery, the sphenoid sinus, and the clivus. The internal jugular vein was ligated in the neck and the sigmoid sinus was packed with Surgicel. The external wall of the sigmoid sinus and the jugular bulb were removed together

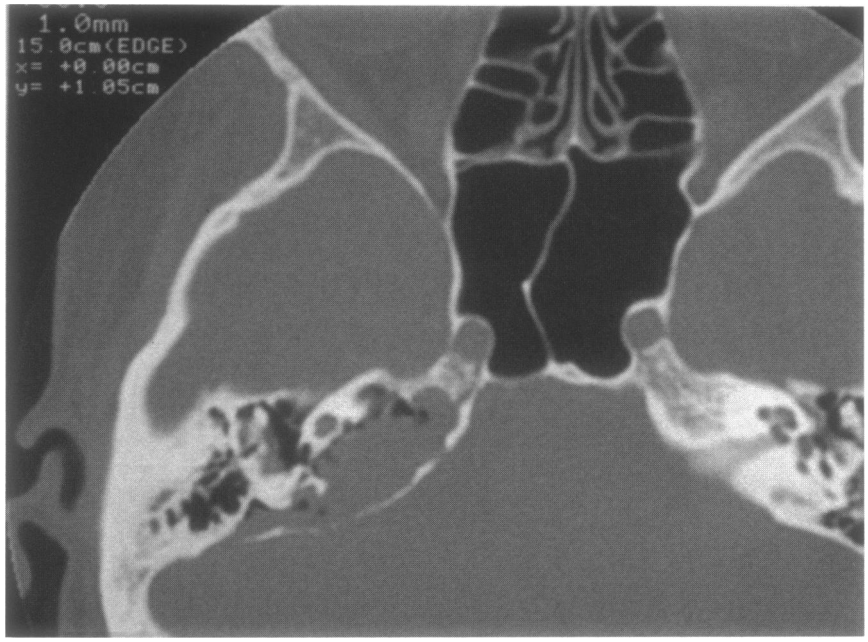

Figure 14. Infralabyrinthine apical cholesteatoma. CT, axial section, shows a large osteolytic defect of the petrous bone and apex reaching the clivus.

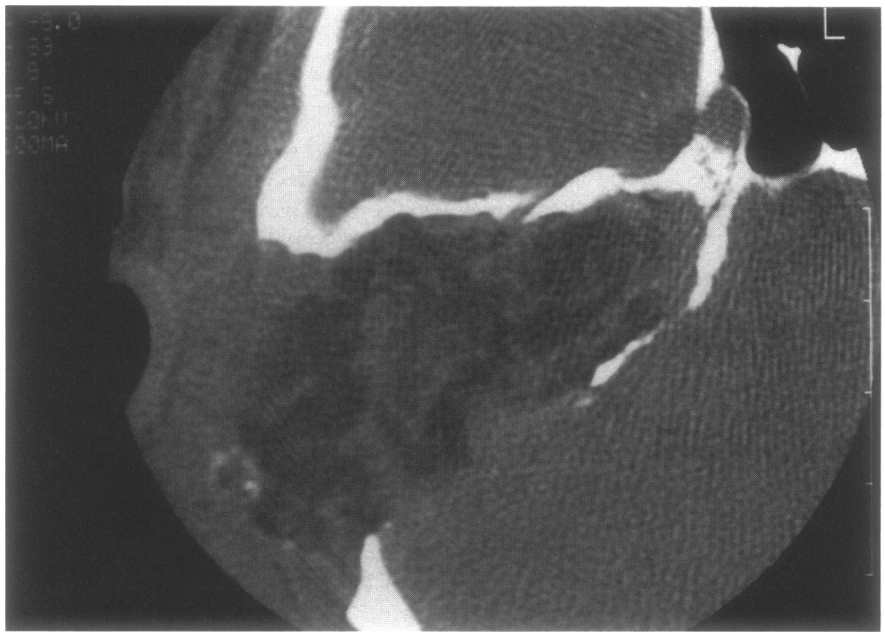

Figure 15. Infralabyrinthine apical cholesteatoma. Postoperative CT, axial section, shows a large defect with complete absence of the petrous bone filled with fat.

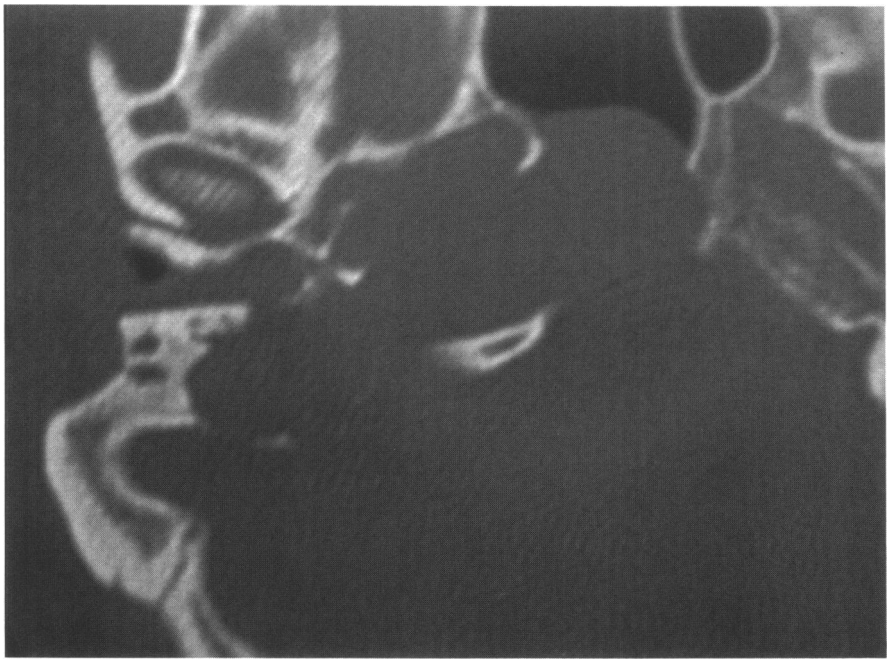

Figure 16. Infralabyrinthine-apical cholesteatoma extending to the sphenoid sinus. CT, axial section. The whole petrous bone and the lateral aspect of the clivus are completely eroded by an osteolytic lesion. The horizontal portion of the carotid canal is surrounded by the tumor, the posterior wall of the sphenoid sinus is missing and the tumor involves the sinus itself.

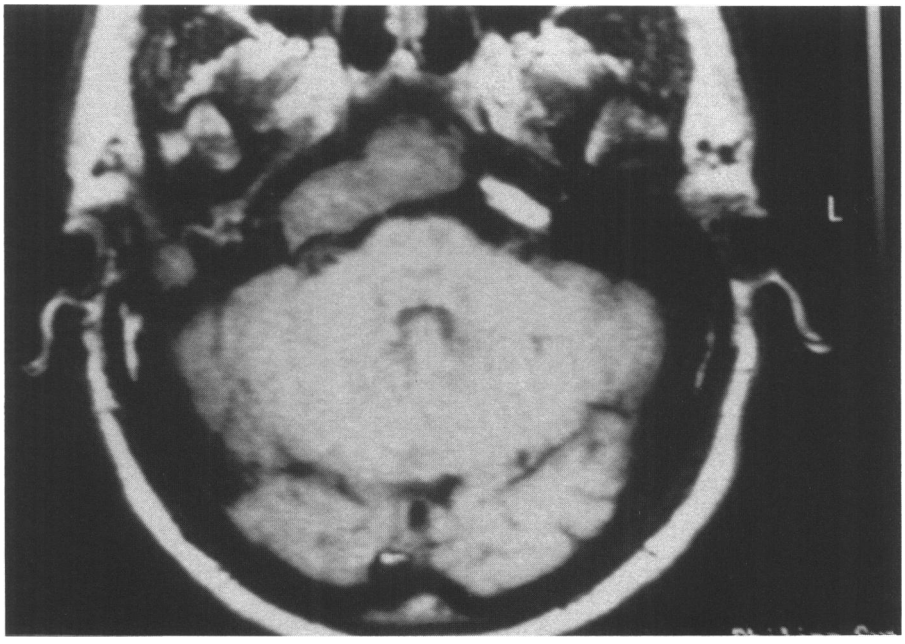

Figure 17. Infralabyrinthine-apical cholesteatoma. MRI demonstrates a large mass reaching the clivus and crossing the midline.

with the matrix. The matrix was dissected from the internal carotid artery and from the dura mater; the latter was widely bipolar coagulated. The external auditory canal was closed and the cavity was obliterated with a pedicled temporalis muscle flap.

Postoperatively, the patient had wound infection and a CSF leak treated with medical therapy, compressive dressing, and lumbar drainage. Twenty-four months after surgery, the patient is well, facial nerve recovery is a grade II. CT confirmed the absence of any cholesteatoma recurrence at 4 years postoperatively (Fig. 18).

DISCUSSION

In recent years the diagnosis of petrous bone cholesteatoma has changed because of the improvements in radiologic imaging and to the complementary role of CT and MRI.[1] At the same time, the introduction of the lateral approaches to the skull base has modified the surgical treatment.

In 1991 an inquiry was sent by us to leading surgeons dealing with petrous bone cholesteatomas to obtain an updated survey of their management. Eleven questionnaires were complete and returned. The answers have been summarized and tabulated by us as follows. Bagger-Sjoback, Smyth, House, Sterkers, Yanagihara, Charachon agreed with the classification we have proposed. Brackmann did not use a classification but described the involved structures. Fisch believed that petrous bone cholesteatomas are best classified as supralabyrinthine and infralabyrinthine-apical; the term "massive labyrinthine" was confusing and inadequate in his opinion. Glasscock answered that most petrous bone cholesteatomas are apical in origin and later extend posteriorly or invade the labyrinth; anyway a classification is difficult.

Nearly all respondents agreed that the treatment of choice is total removal of pathologic processes. Exteriorization is considered a second choice option when eradication is not possible. Most of those questioned did not consider a radical cavity as the treatment of choice for petrous bone cholesteatoma and believed that a closed technique is a desirable procedure. Nearly all had found cases of preoperative hearing preservation despite radiologic evidence of inner ear involvement by cholesteatoma and believed that in rare and favorable cases hearing can be preserved despite radical removal of pathologic tissue.

The involvement of dura by matrix is treated by all surgeons with delicate dissection. Fisch removes matrix from the carotid artery with the aid of small biopsy forceps. Glasscock leaves the matrix around the involved carotid artery and follows-up with MRI. Most gently dissect the matrix from the involved facial nerve, which is sometimes transposed to obtain a radical removal. If this is not possible, the involved segment is resected and continuity is reestablished with end-to-end anastomosis or cable graft interposition.

The management has evolved as time passed. At the beginning of our experience, radical petromastoid exenteration with marsupialization of the cavity was usually used. The middle fossa approach associated with an otologic procedure was used for hearing preservation. In the 1980s we adopted the modified transcochlear approach.[2] It is based on the association of the transcochlear approach introduced by House and Hitselberger[3] in 1976 with the infratemporal fossa approach described by Fisch[4] in 1977, together with the concept of obliteration described by Coker et al.[5] This approach has the advantage of prevent-

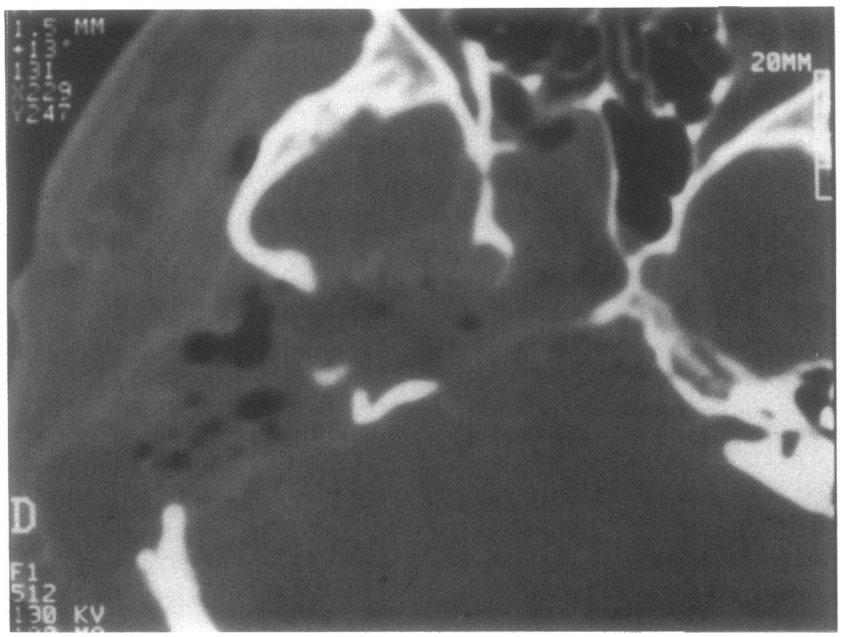

Figure 18. Infralabyrinthine-apical cholesteatoma. Postoperative CT, axial section, shows the complete absence of any cholesteatoma recurrence. The temporal muscle has completely obliterated the homolateral sphenoid sinus.

ing CSF leaks and controlling vital structures. Furthermore, the primary closure of the cavity prevents skin entrapment deep into the cavity, avoids an exteriorized cavity that carries the risk of infection and periodic need of toilette. Disadvantages of this technique include the removal of the otic capsule and the risk of residual cholesteatoma that cannot be detected at inspection and requires regular follow-up with CT and MRI.

When the cholesteatoma extends to the sphenoid sinus, the infratemporal approach type B combined with the modified transcochlear approach allows the complete control of the vertical and horizontal portions of the internal carotid artery and of the sphenoid sinus.

Involvement of the dura mater may be treated with bipolar coagulation of the involved portions, but only time and regular radiologic follow-up will tell whether this is adequate for complete control.

In conclusion, radical removal of pathologic tissue is the goal of surgical treatment and the otologist should not hesitate to remove the otic capsule to accomplish it when the contralateral ear is normal. In our experience radical petromastoid exenteration is suitable for patients with small infralabyrinthine cholesteatomas that cannot be followed up regularly and in only hearing ears. The middle cranial fossa is indicated in an attempt to preserve hearing only in small supralabyrinthine cholesteatomas without radiologic signs of cochlear or labyrinthine fistula. The modified transcochlear approach is our technique of choice for the remaining types of petrous bone cholesteatomas.

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