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Endoscopy of the posterior fossa and dissection of acoustic neuroma

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Object. The authors evaluated the importance of endoscopes in eliminating the disadvantages of the posterior fossa approach, such as the lack of adequate visualization of the lateral aspect of the internal acoustic canal (IAC).

Methods. Between 1989 and 1998, 32 patients underwent removal of acoustic neuroma (AN) via a combined retrosigmoid–retrolabyrinthine approach. Endoscopes were used at different stages of the operation, and their use was evaluated with regard to elimination of the disadvantages of the posterior fossa approach. All patients in whom AN had been diagnosed underwent surgery in which a standard retrosigmoid–retrolabyrinthine approach was used. Standard sinus endoscopes of 0˚, 30˚, and 70˚ were introduced into the cerebellopontine angle before debulking the tumor, and the IAC was inspected at the end of the operation. Neurovascular integrity as well as the relationship between the AN and surrounding structures were evaluated. The IAC was inspected for residual tumor, and if any was found, endoscopically guided tumor dissection was performed.

Conclusions. Endoscopes have facilitated an understanding of the anatomy between an AN and neighboring neurovascular structures. For surgery in which the posterior fossa approach is used, endoscopes can make operations safer by eliminating the disadvantages of the approach. In addition to allowing inspection of the fundus, it is possible to perform endoscopically guided tumor dissection within the IAC.

KEY WORDS • acoustic neuroma • endoscopy • posterior fossa approach

ACOUSTIC neuroma (AN) is the most common tumor of the cerebellopontine angle (CPA). In general, the tumor occurs within the internal acoustic canal (IAC) and grows medially into the brainstem. Tinnitus and hearing loss are the most frequent symptoms. The superior vestibular nerve is the most common site of origin. As the tumor enlarges (> 25 mm), symptoms related to involvement of other cranial nerves, such as trigeminal and facial nerves, begin.[1,8] The objectives of surgical management are total excision of the tumor, preservation of facial nerve function, conservation of hearing, and preservation of neighboring neurovascular structures.

There are several surgical approaches for removal of an AN, and there are advantages and disadvantages to each approach. The posterior fossa approach is one of the surgical techniques used for the removal of acoustic tumors. However, inadequate visualization of lateral ends of the IAC or fundus is the major disadvantage of this technique because the IAC is located in an obtuse angle in relation to the petrous ridge, and further, the labyrinth contributes to this difficulty by blocking 2 or 3 mm of the lateral IAC. Therefore, removal of the posterior wall of the IAC is necessary for total excision of a tumor located within its lateral end. Although the surgical landmarks have been defined to facilitate removal of the posterior wall of the IAC while sparing the labyrinth, failure to conserve hearing is not an uncommon outcome in the posterior fossa approach.[2,3]

For the purpose of this study, we tried to overcome the main disadvantages of the posterior fossa approach by using endoscopes. We present our results of endoscopic inspection and tumor dissection in AN surgery.

Clinical Material and Methods

Between 1989 and 1998, 32 patients who harbored CPA tumors underwent surgery via the posterior fossa approach in which the combined retrosigmoid–retrolabyrinthine technique was used. All operations were performed by the senior author (N.G.) and his team. Diagnosis of CPA tumor was based on patient history, complete otolaryngological examination, audiometric investigations, and radiological evaluation. Pure-tone averages (PTAs) and speech discrimination scores (SDSs) were calculated using audiometry. Patients whose hearing ability exceeded a PTA of 50 dB and who had an SDS greater than 50% were

considered to have serviceable hearing and those whose hearing ability exceeded a PTA of 50 dB but whose SDS was less than 50% were considered to have unserviceable hearing. A postoperative PTA change of less than 10 dB or an SDS less than 15% of the preoperative values was considered hearing conservation, and otherwise it was considered that hearing could not be preserved. Radiological assessment included computerized tomography scanning and/or magnetic resonance imaging studies obtained pre- and 1 year postoperatively. A diagnosis of AN was confirmed by postoperative pathological examination of the surgically excised specimens.

Intraoperative facial nerve monitoring was performed in 26 patients by using the Silverstein facial nerve monitor. During surgery, either inspection of the fundus for residual tumor or endoscopically guided tumor dissection within the IAC was performed whenever necessary. The endoscopes were standard 0˚, 30˚, and 70˚ sinus endoscopes (Karl Storz Inc., Culver City, CA).

Description of Technique

The senior author performed all surgeries by using the retrosigmoid–retrolabyrinthine technique as described by Silverstein, et al.[10] Tumors were removed in the standard fashion, and endoscopes were used to determine if residual tumor existed and to observe the integrity of the cochlear and facial nerves. When the tumor was located in both the CPA and IAC, initial debulking of the tumor was performed in the CPA preceding the drilling, under guidance of a surgical microscope, of 4 to 5 mm of bone in the posterior lip of the IAC. Subsequently, 0˚, 30˚, and 70˚ endoscopes were introduced into the CPA, and the IAC and related neurovascular structures were inspected. If a residual tumor was encountered within the IAC, in particular at its lateral end, the tumor was dissected under endoscopic view. Neuroendoscopically guided dissection could be performed until the IAC was free of tumor and the cochlear and facial nerves were left intact. Endoscopes with different angles (0˚, 30˚, and 70˚) facilitate inspection of all sites from the tentorium to the jugular foramen and brainstem, as well as the IAC up to the fundus. However, it is not possible to see inside the IAC with the 0˚ endoscope. The best exposure of the IAC up to its lateral end can be obtained by 30˚ and 70˚ endoscopes, and these also are used when tumor dissection within the IAC is necessary.

During direct endoscopically guided dissection, the surgeon needs to wear sterile eye glasses so the naked eye does not contaminate the endoscopes and the surgical field. Sterile eye glasses do not need to be worn when the surgeon performs endoscopically guided dissection by looking at a monitor. During the operation, the surgeon holds the endoscope in one hand and uses the other hand for tumor dissection. At this step, care should be taken not to drop the tumor or its pieces into the CPA.

Results

The patients were 12 men and 20 women whose ages ranged from 20 to 63 years. Preoperatively all patients complained of hearing loss. Thirty-one patients (96.9%) had tinnitus, 27 (84.4%) experienced dizziness, 10 (31.3%) had vertigo, and eight patients (25%) had horizontal rotary–type nystagmus.

In 24 of 32 surgeries, endoscopes were used only for inspection of the CPA and IAC. The patients in this group had small (< 20 mm), medium (20–39 mm), or large (> 40 mm) tumors; 11 had serviceable and 13 had nonserviceable hearing. Ten patients had small tumors with an average diameter of 11.4 mm (range 4–19 mm). A medium-sized tumor with a mean diameter of 23.6 mm (range 20–30 mm) was seen in six patients, and eight patients had large tumors with a mean diameter of 49.8 mm (range 40–65 mm). As confirmed by postoperative MR imaging, total removal of the tumor was managed in all patients except one who had neurofibromatosis Type 2 with multiple sites of involvement throughout the central nervous system. During the surgeries on some of the large tumors, the senior author had to sacrifice the cochlear nerve, but in a majority of cases this nerve was left intact.

Postoperatively, Grades II, III, and IV facial weaknesses[4] were documented in six, two, and one patients, respectively. Grade I facial nerve function was demonstrated in the others. In cases in which endoscopically guided tumor dissection was not performed, in spite of observing intact cochlear nerves at the end of the operation, hearing preservation could not be achieved except in one.

Postoperatively, cerebrospinal fluid leakage was noted in one patient who received local care and revision of the wound sites; lumbar spinal drainage was performed as well.

Utilizing 0˚, 30˚, and 70˚ endoscopes, the IAC and CPA were inspected, and in eight of 32 patients tumor dissection was performed within the IAC. All patients in this group had serviceable hearing. These patients had small ANs with a mean diameter of 13.7 mm, and total tumor removal was achieved in all cases, as was confirmed on postoperative magnetic resonance imaging, except in one patient who has not completed the 1-year postoperative follow up. Despite preservation of the cochlear nerves, hearing preservation was achieved in only four cases. None of the patients had facial nerve paralysis postoperatively.

Discussion

Although it is a benign tumor, AN is an entity that necessitates surgical removal. If the tumor settles within the IAC and/or CPA, some disadvantages may arise that unfavorably affect the operative procedure performed via the posterior fossa approach.

The CPA is a place rich in neural and vascular structures, and therefore, it presents a challenge when functional operations are attempted. Improvement of the surgical techniques and instrumentation are essential to perform functional operations and to minimize complications. What we understand from the term “functional” in AN surgery is that it is necessary to preserve hearing, facial nerve functions, and related neurovascular integrity while completely removing the tumor. In this pilot study we have not referred to hearing results of the endoscopically guided AN surgery; we mainly deal with the importance of using the endoscopes in surgery performed via the posterior fossa approach, as well as eliminating the disadvantages of the aforementioned otoneurosurgical procedure.

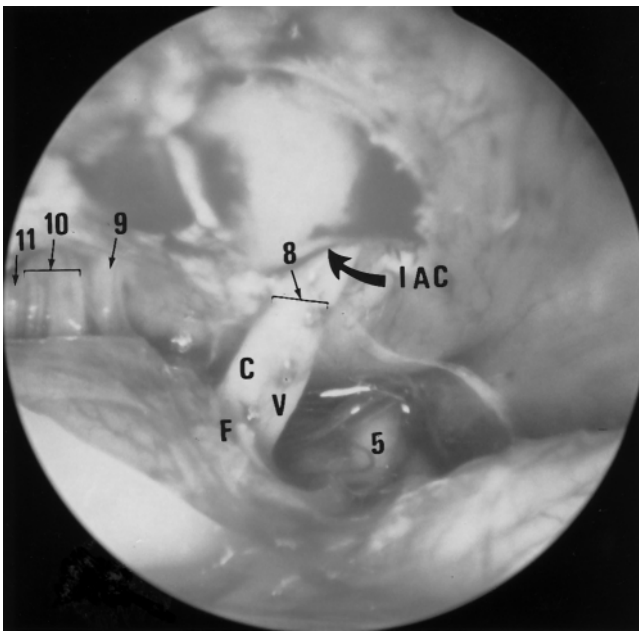


FIG. 1. Inspection of the posterior fossa through a 0˚ endoscope. C = cochlear nerve; F = cerebellar flocculus; V = vestibular nerve; 5, 8, 9, 10, 11 = fifth, eighth, ninth, 10th, and 11th cranial nerves.

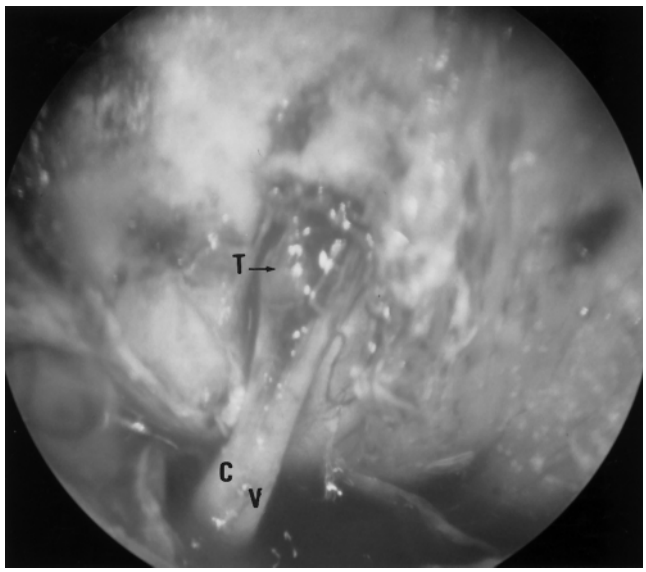


FIG. 2. View through a 30˚ endoscope after drilling approximately 4 mm of the posterior lip of the IAC. Note the small tumor (T) and its relationship to the vestibular (V) and cochlear (C) nerves.

Selection of the surgical approach for removal of AN depends on the size and location of the tumor, and the medical and hearing status of the patient, as well as the preference of the surgeon. In a patient with serviceable hearing, the middle fossa approach is considered appropriate for resection of tumors localized to the IAC and, in particular, for those localized at the lateral aspect of the IAC. However, the inferior half of the fundus cannot be viewed fully when the middle fossa approach is used, which may potentially lead to recurrences, particularly if the tumor arises from the inferior vestibular nerve. Use of the posterior fossa approach is mostly preferred for large tumors of the CPA with less extension to the IAC because it allows for hearing preservation in most cases.

In the combined retrosigmoid–retrolabyrinthine approach, lack of adequate visualization of the lateral aspect of the IAC or fundus limits the assessment of the anatomical relationship between the tumor and facial and cochlear nerves within the IAC. Because of the obtuse angle between the petrous ridge and the IAC, and because of the location of the labyrinth, the lateral 2 to 3 mm of the IAC cannot be visualized using a standard posterior fossa approach; furthermore, unless the labyrinth is violated, 2 to 3 mm of the fundus cannot be exposed in the vast majority of cases. Therefore, the likelihood of leaving some residual tumor within the IAC is higher due to limitation of the view.[5] For this reason, the majority of surgeons recommend either translabyrinthine or middle fossa approaches for tumors settled laterally within the IAC. However, when the posterior fossa approach is performed, endoscopes can be used to inspect the lateral end of the IAC or fundus for residual tumor tissue.

Use of endoscopes during otoneurosurgical procedures has facilitated both visualization of and access to the sites that otherwise cannot be visualized when using an operative microscope. Standard sinus endoscopes with angles of 30˚ and 70˚ can be used for both inspection and to view the tumor during dissection procedures within the IAC. In addition, early identification of the relationship between the tumor and neighboring neurovascular structures is possible when using 0˚, 30˚, and 70˚ endoscopes (Figs. 1 and 2). In the early part of the operation, the surgeon can plan how to dissect the tumor while preserving the related neurovascular structures. According to McKennan,[7] neuroendoscopy has the advantages of providing the following: documentation of complete tumor excision; a lateral view of facial and cochlear nerves; a better view of the mastoid air cells that need obliteration; and excision of all vestibular neurons in patients with neurofibromatosis Type 2. The advantages of the endoscopes are summarized in Table 1.

To obtain a view of the lateral aspect of the IAC via the posterior fossa approach, excessive drilling of the IAC is necessary, which is not possible in procedures in which hearing preservation is attempted because of the limitation of the posterior semicircular canal. In the past, we used

TABLE 1

Advantages of using endoscopes in posterior fossa acoustic neuroma removal

1) drilling less bone in posterior portion of IAC (<4–5 mm)
2) inspection of neurovascular contents of IAC & their relation w/ tumor
3) inspection of proximity of jugular bulb to IAC
4) inspection of fundus for residual tumor following resection
5) inspection of IAC for integrity of cochlear & facial nerves after tumor removal
6) inspection of drilled-out portion of the petrous bone for open air cells that might need sealing

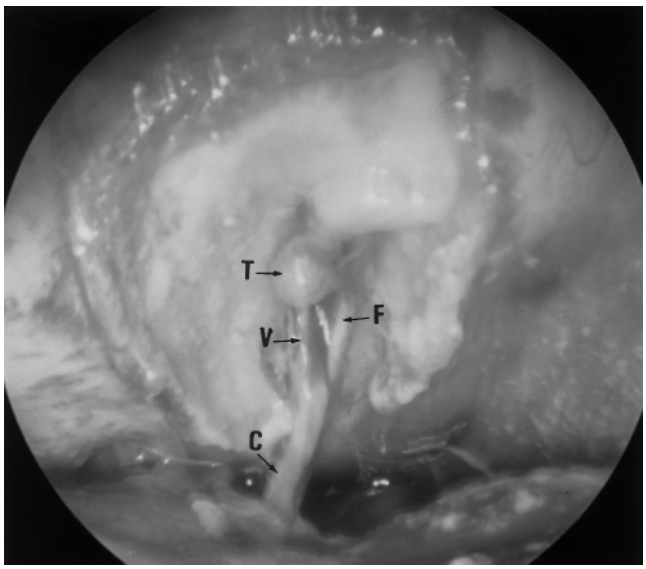


FIG. 3. View through a 30˚ endoscope during endoscopically guided tumor (T) dissection with its superior vestibular nerve (V) attachment. The facial nerve (F) is clearly observed, and the meatal portion of the cochlear nerve (C) is masked by the tumor.

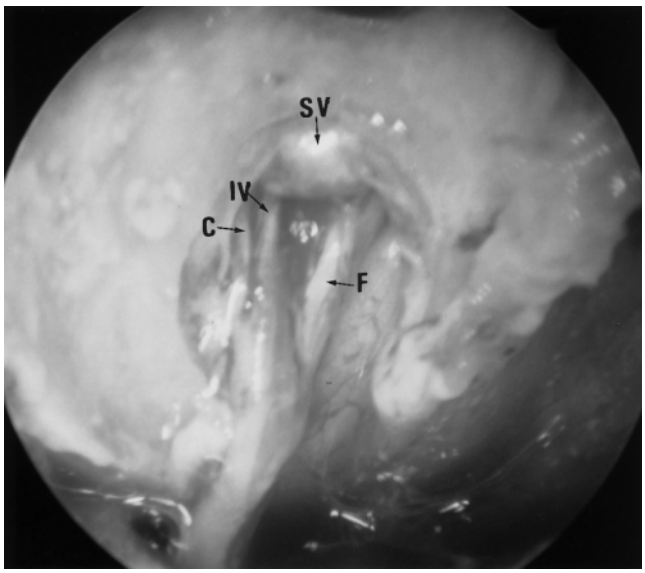


FIG. 4. View through a 70˚ endoscope after completion of tumor removal. Note the remnant of the superior vestibular nerve (SV). The facial (F), inferior vestibular (IV), and cochlear (C) nerves are intact. The fundus is free of tumor.

mirrors to inspect the lateral aspect of the IAC for residual tumor in the posterior fossa approach. In addition, we drilled the posterior portion of the IAC when a tumor was encountered within it so that we could remove the tumor completely; such drilling is not desirable when hearing preservation is attempted. However, excessive drilling of bone is not necessary when endoscopes are used. Only 4 to 5 mm of drilling is required at the posterior IAC. Rosenberg, et al.,[9] also pointed out that the endoscope obviates the need for excessive drilling. Briefly, the surgeon does not need a microscope and can see the whole IAC directly through the endoscope after standard posterior fossa exposure; a tumor within the IAC can be subsequently dissected under direct endoscopic view (Fig. 3). Moreover, after completion of tumor removal the endoscope can be used to inspect the IAC for residual tumor (Fig. 4).

We performed endoscopically guided tumor dissection within the IAC and observed that tumors in this site can be removed safely in a controlled manner with direct endoscopic visualization of the cochlear and facial nerves and their relationship with the tumor. The results of other studies support our contention that the use of endoscopy makes the operation safer and facilitates the inspection of the fundus.[6] However, they do not address endoscopically guided tumor dissection. To the best of our knowledge, ours is the first report in the literature in which this method of AN resection is discussed.

Endoscopically guided dissection of the tumor within the IAC can be performed either under direct view or by viewing on a monitor. However, endoscopically guided tumor dissection has some drawbacks. These include the problems associated with the difficulty in manipulation of the instrument under endoscopic view if the surgeon is not skilled in their use. In particular, this difficulty is seen when the surgeon uses 30˚ or 70˚ endoscopes so that the direction of the endoscope and the site of vision are different. That is, the surgeon cannot see in the direction of the endoscope. In addition, during dissection performed while watching the endoscopic view on a monitor, the surgeon cannot obtain a three-dimensional view of the operative field, which may lead to a misperception of depth. The surgeon needs to place the endoscope adjacent to the lesion and that can detract from the concomitant overview of the operative field. It is necessary to navigate the endoscope around the neurovascular structures during neuroendoscopy; therefore meticulous care should be taken not to injure these structures. Finally, the surgeon holds the endoscope in one hand and operates with the other, which does not allow for bimanual maneuvers. However, this problem can be overcome if another surgeon holds the endoscope during tumor dissection.

Conclusions

Use of endoscopes in otoneurosurgical procedures is a new concept with promising results. Endoscopy can make the operation safer and eliminate the disadvantages inherent in the posterior fossa approach, which are lack of visualization of the fundus and gaining access to the lateral IAC under direct vision. Standard sinus endoscopes of 0˚, 30˚, and 70˚ are useful for the evaluation of the relationship between the AN and neighboring neurovascular structures even in the early stages of the operation. However, neuroendoscopy also has some drawbacks that will be overcome by improvements in neuroendoscopic instrumentation and technology.

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