Experiences with a translabyrinthine-transtentorial approach to the cerebellopontine angle

Technical note


The technique, results, advantages, and complications of a combined translabyrinthine-transtentorial approach to the cerebellopontine angle are discussed. The method has been associated with a low morbidity and no operative mortality in 23 cases of acoustic nerve tumor and six with miscellaneous lesions.

KEY WORDS cerebellopontine angle tumors translabyrinthine-transtentorial approach

SINCE Dandy's early descriptions, the usual neurosurgical approach to the cerebellopontine angle for removal of acoustic nerve tumors has been through a unilateral suboccipital craniotomy. Because acoustic nerve tumors are the commonest lesion in this area, they have afforded the principal opportunity for standardization of technique; Northfield provided one of several excellent accounts of this operation.

Although excellent results have been obtained by certain surgeons, the operation is one that most neurosurgeons and referring neurologists regard with a certain amount of apprehension, for the mortality and morbidity rates remain high.

In the last 10 years, alternative approaches through the labyrinth and middle fossa have been advocated by Hitselberger and House, who use microsurgical techniques for the removal of portions of the petrous temporal bone and have brought the lesions into the field of interest of the otologist. The middle fossa approach is only useful for the removal of small tumors confined to the internal auditory canal; the purely translabyrinthine exposure of the internal auditory canal offers an adequate exposure for larger tumors but does not provide access to the largest tumors. Improved access has been obtained by division of the sigmoid sinus, so that the operative field can be extended into the posterior fossa as originally suggested by Quix. The possibility of approaching this difficult area through the middle fossa by incision of the tentorium seems first to have been suggested by Gerster in 1896, but his attempt failed because of high intracranial pressure. It was subsequently advocated by Naffziger, Fay, and more recently by Bonnal, et al., and Rosomoff.

In 1965 Henderson described a combined approach to the cerebellopontine angle in which a drill dissection of the petrous temporal bone exposed the superior petrosal
Translabyrinthine-transtentorial approach to cerebellopontine angle

Operative Procedure

Anesthesia and Position of Patient

The operation is performed in one stage under endotracheal anesthesia with controlled ventilation. In the earlier cases a spinal drain was used, but this collapses the cisterns of the posterior fossa and makes division of the arachnoid around the margins of the tumors difficult. The patient is supine with the head rotated toward the nontumor side. The head of the table is elevated but the patient's head is somewhat extended to lessen the necessity for retraction of the temporal lobe (Fig. 1). Mannitol is given toward the end of the labyrinthine dissection and before the opening of the dura.

Incision

The ear is stitched forward and the scalp marked out for a small lateral scalp flap, centered on the ear (Fig. 2). The posterior limb of this is carried down over the mastoid process. A frontal burr hole is made, and when dealing with large tumors a catheter is inserted in the frontal horn to decompress the ventricles. We have thought it wise in all cases to leave access to the ventricles available, to cope with postoperative swelling or hemorrhage in the posterior fossa. The scalp flap is turned down and the mastoid process and upper margin of the external auditory canal exposed. A small bone flap is then cut, so that its lower margin exposes the sigmoid sinus. Division of this structure and the tentorium extended the exposure upward through the middle fossa. He used this method successfully for acoustic nerve tumors and a meningioma of the clivus. We are reporting our experience with a modification of this technique.

The operative procedure described is that used with acoustic nerve tumors; the specific details for removal of other types of tumors are not dealt with.

Fig. 1. Position of head on operating table.

Fig. 2. Outline of scalp incision and bone flap.

Fig. 3. The bone flap elevated, showing the exposure of the sigmoid sinus.
FIG. 4. The extent of the dural exposure after elevation of the bone flap and completion of the labyrinthine dissection. The position of the dural incisions is shown.

A. W. Morrison and T. T. King

sinus (Fig. 3). It has proved helpful for the otologist if elevation of the bone flap is left until he has finished the labyrinthine dissection, as the dura is thereby protected from injury during this part of the procedure.

OtoIogical Exposure

The otologist now clears the soft tissues from the mastoid cortex and opens the mastoid cells and antrum. The dissection continues with the aid of the operating microscope and drill. The incus is removed to facilitate subsequent sealing of the aditus and middle ear from the operative site. Cells and bone are removed with a cutting burr and continuous suction-irrigation. The labyrinthine removal includes all of the lateral and superior semicircular canals and most of the posterior canal together with the aqueduct of the vestibule and the bone medial and inferior to the vestibule. The ampullated end of the posterior canal, which lies medial and a few millimetres from the descending portion of the facial nerve, is not removed. The posterior meatal wall is left intact, and the middle ear, apart from the attic, is not seen. Having thinned the bone, diamond burrs are used to expose the whole length of the sigmoid sinus down to the jugular bulb and to uncover the posterior fossa dura, the superior petrosal sinus, and the middle fossa dura. Finally, with small cutting and diamond burrs, the whole length of the internal meatus is exposed. This dissection removes the superior, posterior, and inferior bony margins of the meatus. In large tumors it is helpful to drill out bone above the meatus toward the petrous apex. In this final stage of the exposure the intrapetrous portion of the facial nerve is identified. The dura of the internal meatus is opened for its whole length posteriorly, the incision being carried into the posterior fossa. The tumor is dissected from the facial nerve and from the dural lining to the porus medially. Patties are placed between tumor and nerve. The otoIogical dissection is now considered complete, unless the tumor is entirely intracana-
Translabyrinthine-transtentorial approach to cerebellopontine angle

The size, of course, is assessed preoperatively.

Neurosurgical Exposure

The neurosurgeon now elevates the bone flap to expose the dura over the middle fossa. It is necessary to remove bone from the lower margin of the craniotomy exposure in order to extend it into the area of the petrosal dissection. When this has been done the dura over the lateral surface of the temporal lobe, the sigmoid sinus at the junction with the superior petrosal sinus, and the dura of the base of the skull exposed by the labyrinthe dissection are accessible (Fig. 4). The linear dural incision is started well forward over the temporal lobe to avoid veins draining from the temporal lobe into the sigmoid and petrosal sinuses. The incision runs vertically downward, turns inferiorly around the lateral margin of the temporal lobe, and runs across the exposed dura of the middle fossa to the superior petrosal sinus. Another dural incision is made below the superior petrosal sinus and into the posterior fossa; this incision is extended upward as far as the superior petrosal sinus, which can then be clipped and divided between the two incisions (Fig. 5). Thus the incision extends from the middle fossa into the posterior fossa and across the base of the tentorium. The last part can then be extended inward by elevation of the temporal lobe, until the tentorial notch is reached. The tentorial incision should run approximately parallel to and about 1 cm behind the superior petrosal sinus. The incision in the posterior fossa dura is then extended in a radiating fashion; one cut must run into the internal auditory canal to join with the dural incision made earlier by the otologist (Fig. 4). The ends of the superior petrosal sinus may be retracted by stitches (Fig. 5), and the flaps of dura in the posterior fossa shrunk by endothermy.

The exposure is now complete and a little retraction of the temporal lobe upward will expose the midbrain and fourth nerve, while the fifth nerve may appear stretched over the upper pole of the tumor (Fig. 6) or remain concealed on its medial side. Further inferiorly and laterally the superior petrosal vein will be seen stretched over the lateral side of the cerebellum.

Fig. 5. The dura over the temporal lobe and posterior fossa has been opened, the superior petrosal sinus divided and retracted and the tentorial incision has commenced.
A. W. Morrison and T. T. King

Fig. 6. Completion of tentorial incision. Note the exposure of the upper pole of the tumor, the midbrain, and the fourth and fifth cranial nerves, with the petrosal vein lateral to these structures.

Tumor Removal

Magnification is essential and in all our recent cases we have used the operating microscope. Mobilization of the tumor from the internal auditory canal and porus is accomplished by working around the inferior margin of the porus with bipolar diathermy and sharp dissection, freeing the tumor from the dural margin of the porus. Usually the internal auditory artery is encountered here and is coagulated; however, it appears again more proximally as the surgeon dissects across the anterior surface of the tumor toward the brain stem. The facial nerve is identified again in the anterosuperior part of the meatus and is carefully preserved during the completion of the meatal dissection. When the tumor is free from the meatus, it is usually possible to dissect across in front of it and recognize the cistern in front of the pons.

In both medium and large tumors the next step is to incise the arachnoid around the periphery of the tumor. It is usually convenient to start this superiorly, coagulating and dividing the petrosal vein at the same time. The arachnoid incision continues around the upper pole of the tumor and extends laterally, so that the tumor is separated from the cerebellum. It then passes around the lower pole, which can be retracted upward to re-
Reveal the ninth, tenth, and eleventh nerves, and it is completed as it runs into the lower margin of the porus.

When the arachnoid covering the tumor has been completely divided, one may then coagulate the exposed surface, incise it and carry out a thorough gutting with sucker, rongeurs and curettes. Further mobilization of the tumor is carried out as in the conventional approach. It is usually easiest to work from the top and bottom poles alternately in the beginning. When the tumor has been gutted, the lower pole can be lifted up and one can start working the tumor away from the brain stem inferiorly, until the choroid plexus of the lateral recess is encountered. In medium-sized tumors the central end of the facial nerve will be found here and the dissection of the nerve may be completed from medial to lateral end. In large tumors the considerable adherence of the tumor to the brain stem at this point makes it wise to turn to the upper pole and retract it downward away from the fifth nerve and the pons. At this point some retraction of the temporal lobe is usually necessary; it is rarely necessary to have a retractor in the wound at any other stage. When the upper and lower poles have been mobilized, the posterolateral part of the tumor may be turned forward away from the cerebellum. Progressive reduction in the size of the tumor is then achieved by cutting pieces off the mobilized tumor and by further gutting, until the last portion of the tumor to be removed is that over the pons and facial nerve, where the tumor is particularly adherent to the brain stem. Hemostasis is obtained in the usual careful fashion, avoiding diathermy on the brain stem itself; large venous bleeders can usually be stopped by the application of gelatine sponge. If the facial nerve has not been preserved, we have usually applied diathermy to the internal auditory canal, both for hemostasis and to destroy any fragment of tumor that may remain.

**Closure**

The superior petrosal sinus is roughly approximated by tying together the two retracting sutures. The dura over the temporal lobe is left open or closed according to the surgeon's inclinations. The middle ear attic is packed with fat, and covered with a sheet of fascia lata previously cut from the thigh. It is wise to have a generous supply of fascia lata; a portion of this may be used to patch the hole in the tentorium and thus discourage CSF from tracking up from the operative cavity and collecting in the subdural space over the cerebral hemisphere.

The bone flap is replaced; any spare fascia lata can be used to provide an extra covering over the mastoid cavity. The scalp is sutured in two layers without a drain. The ventricular catheter is clipped off and left in place as a safety valve for 24 to 48 hours. The patient is given antibiotics in view of the length of the procedure and the opening of the mastoid cavity. Steroids are used in the usual doses to prevent edema of the temporal lobe and minimize swelling of the facial nerve.

**Results**

The following are specific comments on the tumors summarized in Table 1.

**Miscellaneous Tumors**

Extensive partial removal was accomplished in the patient with a chordoma; he returned to work but showed evidence of re-

<table>
<thead>
<tr>
<th>Tumor</th>
<th>No. of Cases</th>
<th>Removal</th>
<th>Deaths</th>
</tr>
</thead>
<tbody>
<tr>
<td>meningioma of cerebellopontine angle</td>
<td>1</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>trigeminal neurinoma in cerebellopontine angle</td>
<td>1</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>neuroinoma of jugular foramen</td>
<td>1</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>cholesteatoma of cerebellopontine angle</td>
<td>1</td>
<td>+</td>
<td>0</td>
</tr>
<tr>
<td>chordoma of clivus</td>
<td>1</td>
<td>Biopsy</td>
<td>0</td>
</tr>
<tr>
<td>pontine glioma</td>
<td>23</td>
<td>+</td>
<td>0</td>
</tr>
</tbody>
</table>

**Summary of cases treated by the translabyrinthine-transtentorial approach to the cerebellopontine angle**
occurrence after 11 months and died 2 years after the original operation.

In another patient the meningioma presented as a large mass in the cerebellopontine angle adherent to the apex of the petrous temporal bone and lateral part of the clivus and perforated the tentorium to present as a mass in the middle fossa. Total removal of the intradural portion was achieved but there was a carpet of tumor lying extradurally in the middle fossa that proved impossible to excise. A postoperative course of irradiation was, therefore, given. The patient has survived 4 years and is working, although a recent onset of facial hemispasm on the operated side and some alteration in personality suggest the possibility of further tumor growth.

Total removal of the trigeminal neurinoma and the jugular neurinoma was accomplished. The first patient made an excellent recovery, except for a persistent sixth nerve palsy, and, of course, trigeminal anesthesia. The jugular foramen neurinoma is of interest because it might be thought that the superior approach to the cerebellopontine angle would lead to difficulties in dealing with the lower pole of this inferiorly placed tumor. The area of tumor attachment was subsequently explored through a posterior fossa approach, since we were concerned that the jugular foramen, which had been coagulated from above using a small laryngeal mirror to obtain a view of the area, might contain residual tumor; none was found. Actually, if the diagnosis can be made preoperatively we do not advise this approach for such a lesion; the posterior fossa approach is better. We merely point out that even in this unfavorable case, it proved possible to cope with the tumor. Bonnal, et al., cautioned against the transtentorial approach for cerebellopontine angle tumors extending toward the foramen magnum; in our experience, if an adequate labyrinthine dissection is added to a tentorial incision, one can quite easily expose the region of the lower pole of a large acoustic nerve tumor.

The cholesteatoma was a small lesion and was removed totally, except for two small fragments of capsule adherent to the brain stem and trigeminal nerve, which it was considered safer to leave. Only a biopsy of the pontine glioma was obtained, and the patient was readmitted for terminal care a few months later.

With some of these tumors it was only necessary to expose the lateral part of the superior sagittal sinus, and a more limited bone removal was therefore used.

There was no operative mortality in this group of miscellaneous angle tumors and no permanent facial nerve palsy; in the case of the jugular foramen neurinoma, a facial palsy persisted for some months but subsequently cleared up almost completely.

**Acoustic Nerve Tumors**

The risks of acoustic nerve surgery are very closely related to the size of the tumor and the extent to which it is adherent to and distorts the brain stem. It is not always easy to express in precise measurements the size of these tumors, as judged at operation. Removal is piecemeal, much of the tumor being lost up the sucker, so that accurate weights are difficult to obtain. The whole of the tumor is not usually visible at the beginning of the operation, and its medial extent, in particular, often becomes apparent only during the latter stages of the procedure. Thus, estimates as to the portion of acoustic neuroma left behind in partial removal tend to be inaccurate. We have used the following classification of size based on preoperative radiological as well as operative findings:

1. **Small.** The tumor is confined to the internal auditory canal, or only just protrudes through the porus acusticus into the subarachnoid space. Their small size is easily recognized during positive contrast cisternography and at operation. We have only two such cases and they were satisfactorily removed by a purely translabyrinthine approach, with preservation of facial nerve function.

2. **Medium.** These extend into the cerebellopontine angle and come in contact with the brain stem which they may indent but do not distort. There are few clinical signs except those due to eighth and more rarely fifth and seventh nerve dysfunction. Radiologically they are associated with a small well-marked filling defect in the cerebellopontine angle cistern but
Translabyrinthine-transtentorial approach to cerebellopontine angle

without distortion of the fourth ventricle. At operation, they are found to be between 2 and 4 cm in diameter. We removed six of these tumors by the combined approach and one by the translabyrinthine route.

3. Large. These are usually, although not universally, associated with clear-cut signs of involvement of structures in the cerebellopontine angle, with brain-stem signs and often with elevated intracranial pressure. The tumors are larger than 4 cm in diameter and are recognizable on a gamma scan. They produce recognizable distortion of the fourth ventricle in an air study, and at operation they reach from the tentorium and fifth nerve above to the ninth, tenth, and eleventh nerves below. They deeply indent and may be adherent to the pons. They are the commonest variety of tumor diagnosed primarily by neurologists or neurosurgeons. We have removed 17 such tumors by the translabyrinthine transtentorial operation.

There has been no death in the series, and total removal has been done in all 23 cases. In only one case, a second stage procedure through the posterior fossa, was it necessary to remove a residual nodule of tumor embedded in the cerebellum. The morbidity has been surprisingly low. Only two cases have sufficient disability to limit their activities. One of these patients, in whom follow-up has not been possible, had useful vision in only one eye preoperatively, the other having been affected by an injury in childhood. In spite of immediate tarsorrhaphy postoperatively, he developed a keratitis, and vision on discharge was 6/12 in the good eye, we doubt that he will continue his previous occupation as a clerk although he is otherwise in good condition. In the other case, a considerable degree of ataxia exists; although this patient can get about by herself, her activities are limited but improving.

The remaining 21 cases have little or no disability other than deafness and in some cases facial nerve palsy. They are able to work and lead normal lives. It has been noteworthy that in spite of the apparently formidable list of potential postoperative complications described below, the postoperative course has been surprisingly benign. There has been little evidence of bulbar disorders, so that very early oral feedings have been possible, usually within a day or two of operation. One tracheostomy has been necessary because of marked swelling of the tongue as a consequence of pressure from a displaced endotracheal tube. The reasons for the smoothness of the postoperative course are probably the excellent view the approach offers of the brain stem at the upper pole of the tumor from the very beginning of the procedure, and the use of technical advances such as magnified vision. In early cases the neurosurgical part of the procedure was done with a 3.5 loupe, while all recent cases have been done with the operating microscope. The avoidance of interference with the cerebellum, which is protected during the greater part of the operation, is also a factor. Facial nerve function was preserved in four of the six medium-sized tumors and in one of the 17 large tumors. Although we have always made total removal of the tumor our principal aim, we have also always attempted to preserve the facial nerve.

Special Complications of the Technique

Dysphasia. Dysphasia is presumably due to interference with the posterior pedicle of veins draining from the temporal lobe into the lateral and superior petrosal sinus, and perhaps to traction on the temporal lobe, although the latter is usually only light and required for the exposure of the upper pole of the tumor only. The risk is reduced by placing the dural incision over the temporal lobe well forward so as to avoid exposure of temporal veins. In all our cases speech returned to normal in a few days to weeks.

Epilepsy. Epilepsy is an obvious hazard of a supratentorial operation and, as with dysphasia, is a reflection of vascular or physical damage to the temporal lobe. Three of our cases had early epilepsy. In one this consisted of a single fit, in another a series of minor attacks, and in the third the patient had had epilepsy preoperatively and an EEG showed photosensitivity. One patient has continued to have infrequent fits.

CSF Leak. CSF leak occurred in several early cases, usually via the mastoid cavity.
With the use of a large fascia lata graft over the raw petrous temporal bone, this complication has become infrequent. Two cases developed a temporary leak through the wound, which cleared with CSF drainage.

**Meningitis.** A sterile pleocytosis in the CSF occurred in three of the acoustic nerve tumors and also in the jugular neurinoma. In only one case was there any difficulty in treating it and on this occasion exploration of the operative cavity revealed a piece of infected gelfoam, which was removed and thereafter the infection subsided rapidly. The length of the operation and the opening into the mastoid cavity, of course, increases the risk of this complication.

**Subdural Collection of CSF.** In two cases a subdural collection of CSF manifested itself by the development of drowsiness. The CSF had tracked up from the cerebellopontine angle and spread over the ipsilateral cerebral hemisphere. It responded to aspiration. This complication might be avoided by putting a piece of fascia lata over the opening in the tentorium.

**Diplopia.** A temporary fourth nerve palsy developed in two cases of acoustic nerve tumor. This nerve is exposed, of course, when the incision in the tentorium is carried into the tentorial hiatus and it may be damaged at this point.

**Cerebellar Swelling.** An obvious objection to this approach is that no decompression of the posterior fossa is afforded except that due to division of the tentorium. Only one case was reopened; this was because of drowsiness on the first postoperative day, but no cerebellar swelling or clot was found. The cerebellum is rarely manipulated by this approach and seems to have little tendency to swell postoperatively.

**References**

2. Bonnal J, Louis R, Combalbert A: L'abord temporal transtentoriel de l'angle ponto-céré-