Translabyrinthine and transtentorial removal of acoustic nerve tumors

Results in 150 cases

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The translabyrinthine route or an extension of it was used to remove 150 acoustic nerve tumors. The mortality was 2% and the morbidity low. Preservation of the facial nerve was achieved in 100% of the small and 80% of the medium-sized tumors, but in only 20% of the large growths. The complications encountered are discussed.

KEY WORDS acoustic nerve tumor petrous temporal bone facial nerve trigeminal neurinoma

It is now about 15 years since the appearance in 1964 of House’s monograph on acoustic nerve tumors, an event that led to a revival of interest in an old subject and, indeed, revolutionized the treatment of the condition. Yet, although its importance can hardly be denied, of its three messages—that early diagnosis is possible; that the operating microscope is an important aid to surgery; and that the translabyrinthine approach has advantages over the suboccipital—only the first two have been generally accepted by neurosurgeons. Rather, they have been hostile to House’s operation and have turned to refining the traditional neurosurgical method, with great success, as the results reported by Yaşargil and Fox, Hullay, et al., and DiTullio, et al., show. Among neurosurgeons, Griffith is almost alone in speaking with enthusiasm of an approach entirely in front of the sigmoid sinus; others trying this route have fallen back on a two-stage posterior fossa operation for completing the removal of large tumors. Meanwhile, the otological literature has continued to carry reports of quite large series of cases operated on by the translabyrinthine method.

There is clearly a division of opinion between the two specialities on the matter, and this leads us to put forward our experience with the translabyrinthine operation, modified when necessary, and carried out by an otologist and a neurosurgeon working together.

Surgical Techniques

Between January, 1968, and May, 1978, 165 acoustic nerve tumors were operated on by one or both of the authors. Of these, 150 were performed by a translabyrinthine route, or a modification of it, and 15 cases by the suboccipital method. The reasons for use of the latter were as follows. Early on, the neurosurgeon was uncertain of the value of the unorthodox way and continued to use the conventional method in the cases to him, until it looked as if these patients were having a less satisfactory convalescence than the translabyrinthine group. One combined suboccipital-petrosal operation was done in this period but we were worried by the risk of deliberately dividing such a large venous channel as the sigmoid sinus, and never used the technique again. This case is the only one in the series in which partial removal was done other than by choice, a small piece of tumor having been left adherent to the pons. Suboccipital removal has, since then, been used when, because of the patient’s age or debility, a subtotal removal has been decided upon preoperatively. This approach was also used for one patient with large bilateral tumors when a bilateral decompression seemed a wise precaution at the time of the first operation. We have recently used this method to try to preserve hearing in four patients, while totally remov-
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ing small or medium-sized tumors. There have been no operative deaths in any of these cases, although five of the removals were incomplete.

The only other element of selection in this series is that we have not operated on the smaller grades of tumor in patients over the age of 70 years, or if there were a general medical condition present, such as chronic lung disease, which would make it hazardous. Only three patients have been kept under observation for these reasons. In addition, one patient with very slowly growing bilateral tumor is under observation. With these exceptions, a translabyrinthine approach has been used for all acoustic nerve tumors regardless of size, and has been extended, as will be described, for larger ones.

General anesthesia, controlled ventilation, intravenous mannitol, and direct monitoring of the blood pressure are routinely used. The patients are placed in the supine position. A ventricular drain is introduced to reduce intracranial pressure during surgery in the largest lesions. The translabyrinthine dissection is by the method described by House. When the tumor is of more than 3 cm in diameter, and occasionally when smaller, an extension of the exposure is obtained in an upward direction by dividing the superior petrosal sinus. To do this, we remove the bone covering the dura of the middle fossa above the ear dissection, the superior petrosal sinus, and dura over the lower lateral surface of the temporal lobe above the mastoid opening. A short incision in the dura of the middle fossa in front of the petrosal sinus exposes a small area of temporal lobe cortex, which is carefully protected; the petrosal sinus is isolated between this incision and that in the posterior fossa dura below, and can now be clipped, or ligated, and divided. This cut is carried a short distance into the tentorium and can, as in our original technique, be extended right through it into the tentorial notch, although we now avoid doing this where possible.

We have described these techniques in detail elsewhere. The first of these techniques we have called "translabyrinthine with division of the petrosal sinus," and the second "translabyrinthine transtentorial" (Table 1).

**Clinical Material**

The size of the tumor is the most important factor in the difficulty of the operation and in the morbidity and mortality rates. We categorize the tumor as small, medium, or large, using criteria from clinical observation, as well as from investigations. We try to do this preoperatively, because in large tumors it is difficult to get an accurate measurement of size during the operation, when the mass is removed piecemeal. Small and medium tumors are often removed in toto and an exact measure is then possible. The most accurate preoperative estimate is obtained from the computerized tomography (CT) scan, but this has only been available in the last few years. The scan will very occasionally fail to show a large tumor, and cannot be expected to show anything smaller than about 1.5 to 2 cm. Pneumoencephalography with tomography provided a very good estimate of the size of medium-sized tumors in the earlier part of the series.

Small tumors are confined to the internal auditory meatus or protrude just into the cerebellopontine angle; clinically, they cause no symptoms other than those due to eighth and seventh nerve involvement, and they produce, on Myodil cisternography, nonfilling of the internal auditory canal. Medium-sized tumors also have signs confined to the nerves in the meatus, but they extend out into the angle for up to 2.5 cm, may be in contact with the brain stem, indenting it slightly, and usually measure between 1 and 2.5 cm in diameter (Fig. 1 left). Large tumors often, but not always, have brain-stem and cranial nerve signs, and may cause raised intracranial pressure; but there may only be trigeminal disturbance, and quite a number show no more signs than the other two groups. There is rather a wide range encompassed by this category, from just over 2.5 cm (Fig. 1 center) to massive growths, such as that illustrated in Fig. 1 right. Probably the mean size of large tumors is smaller in this series than in previous neurosurgical series, as most patients were first referred to an otologist. The low incidence of papilledema, 21% in large growths, and 10% overall, would suggest this.

There were 88 women and 62 men in the whole series, and a similar proportion in each tumor-size group. The ages ranged from 19 to 69 years, with a mean of 47 years. The average age in each category of tumor was about the same as that of the whole considered together, unless each group was divided into men and women. Then it was apparent that the average age of men with large tumors was 42 years, and of women 50 years.

Table 1 shows an analysis of the techniques used on each of the three groups in this series. The extensive exposure obtained by dividing the tentorium was used with decreasing frequency, and not at all in the last 30 cases; this was partly because, with increasing experience, bigger tumors have been manageable through the translabyrinthine approach alone, and partly because there was a rather high incidence of

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**Table 1**

<table>
<thead>
<tr>
<th>Size of Tumor</th>
<th>Translabyrinthine Translabyrinthine with Division of Sup Pet Sinus</th>
<th>Translabyrinthine</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>small</td>
<td></td>
<td></td>
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</tr>
<tr>
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<td>13</td>
<td>4</td>
<td>46</td>
</tr>
<tr>
<td>large</td>
<td>44</td>
<td>17</td>
<td>10</td>
</tr>
<tr>
<td>total</td>
<td>57</td>
<td>21</td>
<td>72</td>
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</table>

*Sup Pet Sinus = superior petrosal sinus.*
epilepsy after exposing and retracting the temporal lobe earlier in the series. These results forced us to try to minimize trauma to the temporal cortex. Division of the petrosal sinus usually affords adequate access to the cerebellopontine angle but exposes only a very small area on the inferior temporal cortex.

Results

Removal of Tumor

When the facial nerve is preserved, especially in large tumors, it is sometimes difficult to ensure that small fragments of tumor have not been left on the nerve. This is likely to occur if the plane between the nerve and tumor is lost at any time. With this proviso, all the removals have been considered total. In three cases a two-stage operation was necessary because operative difficulties (mainly excessive hemorrhage) so prolonged the procedure that it seemed wise to desist for the time being and come back later. The second operation in each case was carried out through the posterior fossa, it being thought easier to reoperate through a clean field. Although all three tumors were large, we do not think that size alone is a barrier to the use of the extended translabyrinthine approach, for we have removed very large tumors in this way.

Mortality

Mortality for each of the three groups is shown in Table 2. Three patients died as a result of surgery; two had large tumors and one a medium-sized growth. The first death occurred in a patient who had developed hydrocephalus and meningitis postoperatively, and had been totally disabled as a consequence for 18 months before she died in an institution, probably of status epilepticus. The other patient with a large tumor died of brain-stem infarction. The patient with a medium-sized tumor died on the night of the operation from a hemorrhage into the operative cavity. The operative mortality for the whole translabyrinthine series is, therefore, 2%; that for large tumors is 2.8%, for medium-sized tumors 1.6%, and for small tumors, nil. In all the patients who died, the facial nerve had been destroyed. There have been three late deaths, more than 1 year after surgery, in patients who had good functional results and died of unrelated causes.

Functional Results

A patient was judged to have had a “good” result if he could return to his normal occupation or lead the same type of life as preoperatively, whether or not he had some neurological disability, such as trigeminal anesthesia or a facial palsy. A “fair” result was one in which the patient was independent, but had significant neurological disability, sufficient to limit his activities. In a “bad” result, the patient was totally disabled. Table 2 shows the results in the three groups of tumors.

Facial nerve function has not been considered in this classification, nor has depression, which occurred rather commonly as a temporary state postoperatively. The one bad result was due to an infarct in the contralateral hemisphere occurring 10 days postoperatively in a woman 68 years old. The fair results in the large group were due mainly to ataxia, and, in one, to neuroparalytic keratitis in the only seeing eye. The fair result in the small group was due to unsteadiness in a man in his sixties, which we thought...
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due to an inability to compensate for loss of one labyrinth. He was not badly disabled by this but decided to take an early retirement.

**Facial Nerve Preservation**

The facial nerve was counted as preserved only if some function returned to the facial muscles. Anatomical preservation alone has not been included in the figures shown in Table 3. We have used three grades in judging the quality of the final result. An "excellent" result meant that the face was normal. In a "good" result, there was only very slight weakness or asymmetry on spontaneous movement. In a "fair" result, there was marked weakness and asymmetry, and synkinesis was apparent during spontaneous movements. In this last group the deviation from normal function was very marked, and in two or three of the worst cases the amount of recovery was minimal. It is true that anything less than normal function is very noticeable, and the whole of this last group may, to some extent, be regarded as having an unsatisfactory result. Table 4 summarizes the functional results in all cases in which the nerve recovered.

All 16 patients with small tumors had preservation of their nerves; in 11 the function was normal, and in the remaining five, fair. The high proportion of incomplete recoveries in this favorable group is surprising, and we can only attribute it to the fact that these five cases were treated early in the surgical experience. In the long term, 51 (80%) of the 63 patients with medium-sized tumors had some facial function. In 33 of these patients the face was normal, in six a good result was obtained, and in 12 the result was only fair. Of 71 patients with large tumors, facial nerves were preserved in only 14 (20%). This is a low figure compared with that reported in the other recent series already cited. The possible reasons for these results are suggested in the discussion, but success with the nerve was only obtained in the smaller tumors in this group. We do not think we are likely to improve our figures for very large growths. Indeed, when confronted with a tumor of the size illustrated in Fig. 1 right, we think it is probably not worth the extra time and risk involved in trying to preserve the nerve. This attitude may seem a counsel of despair, but even if the nerve can be preserved in large tumors, it has already been extensively dissected, and will rarely function immediately after the operation. A wait of 6 months or more follows, during which the patient has the disadvantages of a complete facial palsy. If recovery then takes place, it is likely to be of such poor quality that one might question whether it is better than that of faciohypoglossal anastomosis. If recovery fails to occur, then the result of the anastomosis that is necessary may have been jeopardized by the long delay. Thus, there has been little gain for the patient and what there is has been at the cost of considerably adding to the duration and difficulty of the original operation.

When preserved, the facial nerve was variable after the operation. There might be slight weakness apparent when the patient woke from the anesthetic or none at all. These cases all did well and provided most of the excellent results. Those without any weakness did sometimes develop it over the next few days. The more delayed and the milder this was, the more likely the end result was to be satisfactory. Virtually all such cases ended in the excellent group. At the other extreme, the patients might wake with a complete paralysis, and few of these cases ever reached the category of "good." If, however, the surgeon is certain that the nerve is anatomically intact, it is worth waiting at least 6 months for signs of recovery. Most of the nerves that recovered function did so within this time, although two took between 9 and 12 months. Between these two extremes lay those cases that
showed a little facial movement when the patient woke, but lost this rapidly within the first 24 hours. This group also usually failed to recover completely, although the earlier the movement returned, the better the result tended to be. Most took almost as long to recover as the preceding group.

Recurrence

It is reasonable to suppose that attempts to preserve the facial nerve may increase the risk of recurrence from small fragments of tumor left on the nerve. We have kept in contact with all but a few of these patients, the follow-up period varying from 10 years to 6 months, with a mean of 4 years. No recurrences have been noted so far, but this is clearly a point of importance and it must be watched carefully in the future.

Complications

There are a number of complications common to any method of removal, of which hemorrhage and infection are the most important. The translabyrinthine route is, however, peculiarly liable to be followed by a CSF leak through the middle ear and eustachian tube to the nasopharynx. While this is not unknown with the posterior fossa approach (indeed, in our small series involving the posterior fossa approach we have had one very persistent leak via cells in the lips of the opened meatus), it has been a recurring and irritating feature of the translabyrinthine series. Table 5 shows that rhinorrhea occurred in 21 cases (14%). In an attempt to overcome this complication, we routinely cut a piece of fascia lata and a large piece of fat from the thigh at the start of the procedure in order to have plenty of tissue to cover the petrous bone and pack the petrous cavity; despite the fact that the middle ear is exposed. It resolved rapidly, and has not occurred since.

This was necessary in three cases.

TABLE 5

<table>
<thead>
<tr>
<th>Complications*</th>
<th>Cases</th>
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<tr>
<td></td>
<td>No.</td>
</tr>
<tr>
<td>CSF rhinorrhea</td>
<td>21</td>
</tr>
<tr>
<td>CSF wound leak</td>
<td>11</td>
</tr>
<tr>
<td>epilepsy</td>
<td>13</td>
</tr>
<tr>
<td>subdural CSF collection</td>
<td>2</td>
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<tr>
<td>meningitis</td>
<td>7</td>
</tr>
<tr>
<td>dysphasia</td>
<td>4</td>
</tr>
<tr>
<td>postoperative hematoma</td>
<td>2</td>
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</tbody>
</table>

*CSF = cerebrospinal fluid.

Before the patient is discharged, he should be questioned about discharge from the nose, and tested in a head-down position. Reoperation consists of carefully exploring the petrous cavity and replacing the graft. Care is necessary to avoid damaging the facial nerve if this is still intact. If the leak recurs after this, it is better to go back through the posterior fossa and put a large sheet of fascia over the back of the petrous bone, although again the facial nerve is at risk. This was necessary in three cases.

Leaks of CSF through the scalp wound have not proved a serious problem. Although they have occurred from time to time, they have been transitory, and cleared spontaneously or with the aid of a spinal drain.

Most of the ills which may befall a patient who has had an acoustic nerve tumor removed, even CSF rhinorrhea, are common to any of the approaches. Epilepsy is an exception; it is peculiar to a method that exposes the temporal lobe. Although in this series it has occurred 13 times (7%), its incidence was as high as 22% of those cases in which the tentorium had been completely divided.1 It has not occurred in any of the purely translabyrinthine cases. Since the previous report on our material,1 we have so far succeeded in avoiding this complication by limiting the exposure of the temporal lobe as already described, and by using anticonvulsant drugs for at least 1 year postoperatively. Apart from the one patient who eventually died of status epilepticus, no patient has suffered from severe epilepsy, either in terms of the seizures themselves, or their frequency. Onset of epilepsy has varied from the early postoperative period to 4 years later. Dysphasia, another manifestation of temporal lobe damage, was seen in four out of 29 cases (14%) in which the dominant temporal lobe was exposed. It resolved rapidly, and has not occurred with the modified approach in which the superior petrosal sinus only is cut.

In seven patients, a sterile meningitis was seen, which we regarded as infective in origin and treated accordingly. In two cases, it grumbled on in spite of antibiotic therapy, until exploration of the cerebello-pontine angle revealed a nidus. In one, this was a bit of infected gelatin sponge, and in the other, a patty which had lost its string. Removal of these objects was accordingly. In two others, there was a collection of CSF over the cerebral hemisphere of the operated side. Probably this was due to a mild degree of hydrocephalus driving fluid from the cerebello-pontine angle through the hole in the tentorium. Although it produced drowsiness, it was treated by simple aspiration in each case.

Hydrocephalus was severe enough to require a shunt in three patients. In two others, there was a collection of CSF over the cerebral hemisphere of the operated side. Probably this was due to a mild degree of hydrocephalus driving fluid from the cerebello-pontine angle through the hole in the tentorium. Although it produced drowsiness, it was treated by simple aspiration in each case.

Two patients suffered postoperative hematomas, one of which was fatal. In the other patient, the hematoma was quickly evacuated, and the patient eventually finished with a good result. Two other
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Patients have been reoperated on suspicion of postoperative compression, but nothing abnormal was found. It is interesting that, in spite of the lack of an external decompression, there have been no difficulties from cerebellar swelling.

Discussion

No useful comparison can be made between the two groups of cases, with the posterior fossa approach and the translabyrinthine approach, since with few exceptions the choice of operation was not random. These translabyrinthine cases should be compared with other series operated on through the posterior fossa using a microsurgical technique.

In mortality and morbidity this material compares well with the best posterior fossa reports. The criticism which, in tone if not in words, suggests that the translabyrinthine route is incapable of being used for total removal of large tumors is, in our opinion, without foundation. Indeed, we think that the gain from an approach that provides exposure at the expense of bone rather than brain has not been sufficiently regarded by neurosurgeons. The advantage of keeping away from brain or nerve, and the risk of damage by exposure or manipulation have been widely accepted by neurosurgeons in the case of a transsphenoidal operation for pituitary tumors, but have been scorned in the present condition. We believe in House’s assertions that ataxia after the posterior fossa operation is in many cases due to retraction of the cerebellum and damage to it, and that the main advantage of the translabyrinthine technique over the orthodox neurosurgical exposure is its avoidance of the cerebellum and of damage to it.

With smaller tumors, the brain is scarcely exposed at all. It is to this that we attribute the remarkable smoothness of the postoperative course in the majority of cases. The patients were usually able to get up on the 1st or 2nd postoperative day and to take oral feedings. There has been a very low incidence of bulbar palsy. Tracheostomy or tube feeding have been necessary in only a handful of cases. That there are disadvantages is true. The first is the extra time involved in carrying out the bone removal, 1 to 1½ hours being added, in most cases, at the beginning of an already lengthy operation. To this may be added the narrowness of the exposure and the angle of approach unfamiliar to the average neurosurgeon. We do not suggest that the translabyrinthine route is an easier technique than the suboccipital approach.

The problems of postoperative CSF leaks and epilepsy have been sufficiently discussed above.

An important point is whether the temporal bone route is capable of coping with tumors other than acoustic neuromas. Mistaken diagnoses are not common when modern diagnostic tools are available, but we have been surprised by three jugular neurinomas. They were all managed through this exposure, which one might imagine to be unfavorable. In two cases, we subsequently opened the posterior fossa to ascertain that no tumor had, in fact, been left in that less accessible area below the internal auditory meatus; no residual tumor was found in either case. The neural portion of the jugular foramen is difficult to expose and examine by any route, and although we could not see it directly through the translabyrinthine opening, it proved possible to evacuate the residual tumor there blindly, in rather the same way as the internal auditory meatus used to be dealt with through the posterior fossa before it became the practice to open it microsurgically with a drill.

A small meningioma and a hemangioma in the internal auditory meatus have each been met with once, and there have been no problems about their removal while preserving the facial nerve.

Three trigeminal neurinomas have been diagnosed preoperatively, and have been operated on through the tentorium. These tumors are unsuitable, in our opinion, for a posterior fossa operation, and the possibility of extending the translabyrinthine exposure into the middle fossa makes it better able to deal with a surprise finding of this sort.

Nine large meningiomas arising from the posterior face of the petrous bone have been diagnosed preoperatively, and have not taken us by surprise. If lateral to the porus, they are best dealt with through the posterior fossa, but if medial, especially if they perforate the tentorium, a transtentorial approach offers the best exposure and has, on occasions, been combined with a temporal bone dissection.

Three cases of neurinomas arising from the seventh rather than the eighth nerve have been encountered in this material. It has not as yet been possible to preserve the facial nerve in such cases.

It is in the preservation of the facial nerve that we have not achieved the degree of success reported by other surgeons. This is largely due to our marked lack of success with large tumors. There are three possible reasons for this that spring to mind. It may be a matter merely of technical skill; it may be due to the fact that there is a difference in the size of the tumors in different reports; or it may be that there is some inherent reason why the translabyrinthine operation is less likely to be successful in this rather difficult feat. The first two reasons are not readily accessible to examination. So far as the third is concerned, we have noticed that the point at which the nerve is most likely to be damaged, and indeed the point where the plane between nerve and tumor is usually lost, is just medial to the porus where the bulk of a large tumor, as it expands out of the meatus, displaces the nerve sharply anteromedially. In the translabyrinthine dissection, one is following the nerve along the anterior wall of the meatus and is working almost parallel to its axis. There is a marked tendency, however, on reaching the point at which the nerve suddenly deviates, to lose the plane and pass straight into the tumor; when this occurs it is difficult to recover the correct plane. The
angle of approach to the meatus through the posterior fossa is further posteriorly, and it is therefore somewhat easier to follow the nerve around the medial lip of the porus. This may be one explanation, although we are bound to say that we have damaged the facial nerve at other points, and do not think we were likely to save it by any method in the largest tumors. Furthermore, we have thought that the primary aim of treatment, total removal of large tumors with a low morbidity and mortality, is better achieved by the translabyrinthine approach in our hands.

Conclusion

The translabyrinthine approach, or an extension of it, has proved a satisfactory method of achieving total removal of acoustic nerve tumors of all sizes, with a low morbidity and mortality. We have had a satisfactory percentage of facial nerve preservations in small and medium-sized tumors, but the percentage of facial nerves preserved in large tumors has not been high.

Acknowledgment

We wish to express our great indebtedness to Dr. J. V. I. Young, who anesthetized almost all of these patients.

References
