Trigeminal neurinomas: operative approach in eight cases

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The authors report eight cases of trigeminal neurinoma managed over the past 13 years with radical resection at a single-stage operation. Three patients were male and five were female, ranging in age from 25 to 56 years (mean 41.5 years). One had von Recklinghausen's disease. The tumors were located mainly within the middle fossa in two cases and within the posterior fossa in two, and extended both supra- and infratentorially in four cases. Facial pain and hearing disturbance were the main symptoms, with various other symptoms such as focal seizures, hemiparesis, gait disturbance, increased intracranial pressure, and visual disturbance also being noted. All patients underwent radical tumor resection with either a transpetrosal transtentorial or orbitozygomatic infratemporal surgical approach; the approach depended on the topography of the tumor. Total removal was performed in all cases. Only one patient, treated early in the series, required a second operation to remove the tumor completely. In another case the tumor recurred 5 years after the operation. There has been no operative mortality, but injury or permanent damage to the trigeminal branches was inevitable in many cases. The surgical results were excellent in three patients and good in five.

Key Words • trigeminal nerve • neurinoma • von Recklinghausen's disease • brain neoplasm • operative approach

All trigeminal neurinomas are difficult to remove completely due to the close anatomical relationship between the trigeminal nerve and the elements of the cerebellopontine angle, the petrous apex, the cavernous sinus, and other important cranial nerves such as the oculomotor, facial, and acoustic nerves. Moreover, when the tumor extends into both the middle and posterior cranial fossae in a dumbbell configuration, it is usually removed by a two-stage operation involving suboccipital and subtemporal approaches. The authors have treated eight cases of trigeminal neurinoma with radical resection through a single-stage operation employing microsurgical techniques. A summary of the cases, with emphasis on the surgical techniques and operative results, is presented here.

Summary of Cases

Clinical Materials

During the past 13 years, eight histologically confirmed trigeminal neurinomas have been removed at our institution (Table 1). Three patients were male and five were female. The patients' ages ranged from 25 to 56 years (mean 41.5 years). The tumors were located mainly within the middle cranial fossa in two cases and within the posterior cranial fossa in two, and extended into both the supra- and infratentorial spaces with a dumbbell configuration in the other four. One patient (Case 5) had von Recklinghausen's disease, with a left trigeminal neurinoma and bilateral acoustic neurinomas. The main symptoms presented before surgery were facial pain in three patients and hearing disturbance in three. Various other symptoms such as focal seizures, hemiparesis, gait disturbance, symptoms of increased intracranial pressure, visual disturbance, and ptosis were also noted (Table 2). The duration of the symptoms ranged from 3 months to 2 years (average 9 months). Facial hypesthesia was found in seven patients, but weakness in mastication was noted in only one (Case 8). The oculomotor nerve was the other cranial nerve most likely to be involved by the tumor. The facial and acoustic nerves were also frequently invaded, and involvement of the other lower cranial nerves was sometimes found.

Computerized tomography (CT) was performed in six patients. The tumor was frequently isodense and rarely hypodense before contrast enhancement. Most were homogeneously enhanced by contrast medium. In Case 8, magnetic resonance (MR) imaging was also performed and offered anatomical detail of the area
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TABLE 1
Summary of total trigeminal neurinoma resection in eight cases

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Sex, Age (yrs)</th>
<th>Chief Tumor Location</th>
<th>Surgical Approach</th>
<th>Extent of Removal</th>
<th>Complications*</th>
<th>Results†</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M, 46</td>
<td>middle fossa</td>
<td>orbitozygomatic infratemporal</td>
<td>total</td>
<td>ophthalmoplegia</td>
<td>good</td>
</tr>
<tr>
<td>2</td>
<td>M, 46</td>
<td>middle &amp; posterior fossae</td>
<td>two-stage operation: suboccipital, &amp; fronto-pterional</td>
<td>total</td>
<td>V₁,₂,₃ injury, VI, VII palsy</td>
<td>good</td>
</tr>
<tr>
<td>3</td>
<td>F, 31</td>
<td>posterior fossa</td>
<td>transpetrosal transtentorial</td>
<td>total</td>
<td>V₁,₂,₃ injury, VI, VII palsy</td>
<td>good</td>
</tr>
<tr>
<td>4</td>
<td>F, 46</td>
<td>middle &amp; posterior fossae</td>
<td>transpetrosal transtentorial</td>
<td>total</td>
<td>V₁,₂,₃ injury, VII palsy</td>
<td>good</td>
</tr>
<tr>
<td>5</td>
<td>F, 25</td>
<td>middle &amp; posterior fossae</td>
<td>transpetrosal transtentorial</td>
<td>total</td>
<td>V₁,₂,₃ injury, VII palsy</td>
<td>good</td>
</tr>
<tr>
<td>6</td>
<td>M, 56</td>
<td>middle fossa</td>
<td>orbitozygomatic infratemporal</td>
<td>total</td>
<td>V₁,₂,₃ injury, VI palsy</td>
<td>excellent</td>
</tr>
<tr>
<td>7</td>
<td>F, 48</td>
<td>posterior fossa</td>
<td>transpetrosal transtentorial</td>
<td>total</td>
<td>V₁,₂,₃ injury, VI palsy</td>
<td>excellent</td>
</tr>
<tr>
<td>8</td>
<td>F, 34</td>
<td>middle &amp; posterior fossae</td>
<td>orbitozygomatic infratemporal</td>
<td>total</td>
<td>V₁,₂ injury</td>
<td>excellent</td>
</tr>
</tbody>
</table>

* V₁, V₂, V₃ = first, second, and third divisions of the trigeminal nerve; VI = abducens nerve; and VII = facial nerve.
† Good = good health with trigeminal nerve symptoms and other neurological deficits; excellent = good health with only trigeminal nerve symptoms.

Fig. 1. Drawings showing steps in the transpetrosal transtentorial approach. EA = external auditory meatus; S = sigmoid sinus; SPV = superior petrosal vein. A: Skin incision. B: Temporosuboccipital craniotomy and radical mastoidectomy with exposure of the full length of the sigmoid sinus. C: Petrosectomy within 1 cm of the petrosal ridge. D: Dural incision and tentoriotomy to the hiatus. Two Weck clips are applied to the superior petrosal sinus. E: Good exposure of the infratemporal region, posterior fossa, cerebellopontine angle, and cavernous sinus. III = oculomotor nerve; IV = trochlear nerve; and V = trigeminal nerve. The posterior communicating artery is indicated by an arrow.

around the tumor. The posterior fossa neurinomas and dumbbell-shaped neurinomas with large posterior fossa tumors were excised using a transpetrosal transtentorial approach, while the middle fossa neurinomas and dumbbell-shaped neurinomas with small posterior fossa tumors were excised by an orbitozygomatic infratemporal approach.

Operative Techniques

The details of the transpetrosal transtentorial approach and orbitozygomatic infratemporal approach have been described in detail in earlier reports. Only a brief description will be offered here.

Transpetrosal Transtentorial Approach. For the transpetrosal transtentorial approach (Fig. 1), the patient is placed in the "park-bench" or sitting position. After radical mastoidectomy with exposure of the full length of the sigmoid sinus, a temporosuboccipital bone flap is elevated (Fig. 1B). The petrosal bone is then drilled away to within 1 cm of the petrosal ridge (Fig. 1C). After the subtemporal and posterior petrosal dura mater has been opened, a tentoriotomy to the hiatus is
TABLE 2
Clinical features of eight cases with trigeminal neurinoma*

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Chief Complaint</th>
<th>Duration (mos)</th>
<th>Trigeminal Nerve Disorder</th>
<th>Involvement of Other Cranial Nerves</th>
<th>Pyramidal Sign</th>
<th>Cerebellar Sign</th>
</tr>
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<tr>
<td>1</td>
<td>focal seizure, hemiparesis</td>
<td>3</td>
<td>-</td>
<td>III, VII, IX, XII</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>hearing &amp; gait disorders</td>
<td>10</td>
<td>+</td>
<td>III, VII, VIII, IX</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>3</td>
<td>facial pain, hearing disorder</td>
<td>5</td>
<td>+</td>
<td>VI, VIII, IX</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>facial pain</td>
<td>12</td>
<td>+</td>
<td>VI</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5</td>
<td>hearing disorder</td>
<td>3</td>
<td>+</td>
<td>III, VII, VIII</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>6</td>
<td>headache, memory disorder</td>
<td>24</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>visual disorder</td>
<td>6</td>
<td>+</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>facial pain, eyelid ptosis</td>
<td>9</td>
<td>+</td>
<td>III</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* + = Factor present; - = factor absent; III = oculomotor nerve; VI = abducens nerve; VII = facial nerve; VIII = acoustic nerve; IX = glossopharyngeal nerve; XII = hypoglossal nerve.

performed by cutting the superior petrosal sinus (Fig. 1D). This approach provides good exposure of the infratemporal region, posterior fossa, cerebellopontine angle, and cavernous sinus with minimum retraction of the temporal lobe and cerebellum (Fig. 1E).

Orbitozygomatic Infratemporal Approach. For the orbitozygomatic infratemporal approach (Fig. 2), the patient is placed in the supine or sitting position. The skin flap is elevated (Fig. 2A) and multiple burr holes are made in the frontal and temporal regions (Fig. 2B). The bone is removed in three sections: first an orbitofrontotemporal bone flap, second a malar flap (Fig. 2C), and finally the posterolateral orbital roof and lateral wall of the orbit and anterior wall of the middle fossa lateral to the foramen ovale and foramen spinosum (Fig. 2D). This approach opens an internal route to the skull base; it offers a marked reduction in temporal lobe retraction and also provides the shortest access.

Operative Results

Total removal of the tumors was performed through single-stage surgery in seven of the eight cases. In the remaining patient (Case 2), the mass was completely removed through two-stage surgery, first using a suboccipital approach for the posterior fossa tumor and then a frontotemporal approach 2 months later for the portion of the tumor remaining in the middle fossa. This two-stage operation was performed early in the series. All of the lesions were dumbbell tumors. During surgery, it was found that a portion of supratentorial neurinomas were often below the tentorium, while tumors of the posterior cranial fossa were likely to come up into the middle cranial fossa without forming a true dumbbell configuration. The cavernous sinus was invaded to some extent in every case. In Case 3, the tumor recurrd 5 years postoperatively. There has been no mortality, but injury or permanent damage to the trigeminal branches was inevitable in many cases. Of the eight patients, the surgical results were excellent in three and good in five.

Illustrative Cases

Two representative cases are described: one (Case 7) in which the transpetrosal transtentorial approach was used and the other (Case 8) in which the orbitozygomatic infratemporal approach was used.

Case 7

This 48-year-old woman was hospitalized in March, 1985, for assessment of visual disturbance. Neurological examination revealed decreased corneal sensation on the right side and an awkward tandem gait. A CT scan showed an expanding lesion in the right cerebellopontine angle with a slight supratentorial extension. An enlarged Bernasconi's artery was visible on the right carotid angiogram. Vertebral angiography showed elevation of the first segment of the posterior cerebral and superior cerebellar arteries on the right side. Surgery was performed via a transpetrosal transtentorial approach in April, 1985, and the tumor was totally removed. The tumor originated from the root of the right trigeminal nerve and was well encapsulated. The pathological diagnosis was a schwannoma without any sign of malignancy. Postoperatively, there was anesthesia on the right side of the face without any trophic corneal disorder. Slight right abducens nerve palsy was also noted. At the patient's 2-year follow-up examination, the only sequelae still remaining were fifth nerve deficits.

Case 8

This 34-year-old woman was admitted in June, 1985, for evaluation of right facial pain and diplopia. Neurological examination revealed right-sided facial hypealgesia and ptosis of the right eyelid caused by oculomotor nerve palsy. Skull x-ray films showed erosion of the right petrous apex. A CT scan revealed a large dumbbell tumor in the internal middle fossa, extending into the ambient cistern and pushing the midbrain and fourth ventricle backward. Right carotid angiography showed the opening of the carotid siphon and a faint tumor stain supplied through Bernasconi's artery. Vertebral
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angiography revealed upward displacement of the right posterior cerebral and superior cerebellar arteries and downward displacement of the right anterior inferior cerebellar artery. Magnetic resonance imaging confirmed the dumbbell nature of the tumor (Fig. 3).

Surgery was performed via an orbitozygomatic infratemporal approach in June, 1985. The tumor was completely excised. It was well encapsulated and originated from the right gasserian ganglion with extension into the posterior fossa, forming a dumbbell configuration. The posterior fossa portion of the tumor was removed through a supratentorial route utilizing the space formed by erosion of the petrous apex. The pathological diagnosis was a benign schwannoma. Postoperatively, analgesia in the distribution of the first and second divisions of the trigeminal nerve and slight right oculomotor nerve palsy were noted. At follow-up examination 2 years later only hypalgesia in the area of the first and second divisions was found.

Discussion

Trigeminal neurinomas are relatively rare, their incidence among brain tumors being from 0.2% to 0.4%. The anatomical relationship of the trigeminal nerve along its intracranial route with the elements of the cerebellopontine angle, the petrous apex, the cavernous sinus, and the cranial nerves brings about various symptoms in cases of trigeminal neurinoma and makes it very difficult to remove these tumors completely. A review of the literature shows that total removal of the tumor has been achieved in only 50% of cases. Krayenbühl divided tumors of the trigeminal nerve into two types: neurinomas of the gasserian ganglion and neurinomas of the roots. In 1955, Jefferson identified three varieties: tumors of the gasserian ganglion in the middle cranial fossa, tumors of the roots of the trigeminal nerve in the posterior cranial fossa, and the so-called “hourglass” tumors occupying both of the cranial fossae at the same time. Based on plain skull x-ray films, tomograms of the petrous bone, CT scans, and especially MR images, a distinction can easily be made among these three types. Since a 5.0-tesla superconductive MR system was installed in our clinic, MR imaging has been found to be the most useful diagnostic tool for skull-base tumors. We have experience with MR imaging of trigeminal neurinomas in only one case, but the wealth of anatomical detail, the excellent sensitivity, the absence of bone artifacts, and the ease of imaging in multiple planes will undoubtedly make this the primary diagnostic modality for preoperative diagnosis in such cases.

Trigeminal neurinomas may arise in any segment of the nerve; however, the majority arise in the gasserian ganglion. Neurinomas of the gasserian ganglion develop primarily in the middle fossa and are usually approached by means of a temporal craniotomy. Neurinomas of the roots occupy mainly the posterior fossa and are commonly removed using a suboccipital cra-
When the tumor extends into both the middle and posterior cranial fossae forming a dumbbell configuration, it is frequently removed through a two-stage operation via suboccipital and subtemporal approaches. However, the present authors have been treating these tumors in accordance with the principles of radical resection through single-stage surgery even in cases of dumbbell tumors. A transpetrosal transtentorial approach was employed for tumors mainly located in the posterior fossa, and an orbitozygomatic infratemporal approach for tumors primarily located in the middle cranial fossa. It was also possible to resect dumbbell tumors via either the transpetrosal transtentorial or the orbitozygomatic infratemporal approach. The transpetrosal transtentorial approach provides good exposure of the infratemporal region, posterior fossa, cerebellopontine angle, and cavernous sinus with minimum retraction of the temporal lobe and cerebellum. An orbitozygomatic infratemporal approach opens up a route to the internal skull base with a marked reduction in temporal lobe retraction; the access is about 3 cm shorter than in a pterional approach. Review of the literature showed that total removal of trigeminal neurinomas was achieved in only 50% of cases. The relatively high incidence of incomplete removal may be explained by the fact that a significant number of cases were operated on before the era of microsurgery. Incomplete removal, as well as surgical complications, were undoubtedly the result of insufficient exposure of the lesion. Generally, when tumors extended into the cavernous sinus, a radical operation used to be difficult. The cavernous sinus was invaded to some extent in each of our cases, but radical excision was not difficult because the approach offered wide exposure of the lesion, and good visual control allowed safe dissection of the tumor from the surrounding blood vessels and adjacent nerve structures. If the venous pathway is lacerated in the cavernous sinus during dissection, bleeding is easily controlled by raising the head end of the operating table and by rapidly alternating insertion of fibrinogen-soaked Gelfoam and thrombin-soaked Gelfoam into the opening of the venous pathway of the cavernous sinus.

We realize that these approaches may be technically more demanding, because familiarity with the use of a chisel, sagittal saw, and air drill in addition to microsurgical techniques, is essential to their execution. We think that our surgical results have been satisfactory and we are encouraged by the results presented here. Whatever approach may be employed, however, excision of trigeminal neurinomas almost always results in aggravation of the trigeminal deficits. Rarely have convincing data been presented showing significant preservation or improvement of fifth nerve function. The only chance to reduce functional disability related to the trigeminal nerve is much earlier diagnosis which may allow complete tumor removal with preservation of some rootlets.

FIG. 3. Magnetic resonance image (T2-weighted inversion recovery technique) in Case 8. Coronal (A) and parasagittal (B) images better characterize the dumbbell nature of the tumor and offer anatomical details of the relationship of the tumor with the surrounding structures.
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References

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