A modification of the preauricular skull-base approach is described. After sectioning and downward displacement of the zygomatic arch, the coronoid process of the mandible is dissected and sectioned at its base. The temporal muscle, with its coronoid insertion, is then retracted upward. This approach provides direct and unobstructed access to the temporal and infratemporal fossae. Adequate vascularity of the temporal muscle is maintained. The exposure encompasses the internal carotid artery in the neck for vascular control. Extensive reconstruction is eliminated. The described technique was used in seven patients with lesions of the skull base. There was no operative mortality, and morbidity consisted of temporary restriction of mandibular opening in two patients.

**KEY WORDS** - cavernous sinus • infratemporal fossa • temporal muscle • skull base • sphenopalatine fossa • zygomatic approach • operative approach

A VARIETY of tumors, such as angiofibromas, schwannomas, and carcinomas, occupy the infratemporal fossa and may involve the adjacent area: the skull base, intracranial cavity, cavernous sinus, orbit, and sphenopalatine fossa. Several approaches to the skull base have been developed to reach lesions in this location. Some of these approaches are hindered by the need for an extensive skull-base exposure and reconstruction, or by a need to transgress the contaminated flora of the maxillary sinus. Fisch, et al., have developed and perfected the infratemporal approach and applied it in the management of a variety of skull-base lesions, including tumors of the infratemporal fossa. This approach is posterior, however, and requires extensive temporal bone drilling to reach anteriorly located masses. Additional disadvantages are conductive hearing loss as a result of blind sac closure of the external auditory canal and the need to sacrifice the lower division of the trigeminal nerve.

Recently, a preauricular lateral approach with various modifications has been advocated as the route of choice to this area. In these latter approaches, the temporal muscle is totally detached from its insertion in the temporal fossa, rendering it devascularized and denervated, while the bulky muscle remains an obstacle to surgical exposure of the infratemporal and sphenopalatine fossae.

The following is a simple technique providing a wide and direct approach to the infratemporal, sphenopalatine, and temporal fossae, and the orbit and cavernous sinus. Adequate blood supply to the temporal muscle and all neural and vascular structures in the field are preserved. The internal carotid artery (ICA) is exposed for intraoperative control. Closure is simple and the site does not require reconstruction. After developing the technique in cadavers and suggesting it for surgical application, we have refined and utilized it in seven patients.

**Surgical Technique**

For surgery, the patient is placed supine with the ipsilateral shoulder elevated and the head turned to the side opposite to the lesion. A preauricular skin incision is made, extending behind the hairline, passing in front of the tragus, and extending along the mandible in a transverse skin crest. A subcutaneous dissection of the skin flap is carried out in a plane superficial to the parotid gland.

In the temporal fossa, an intrafascial dissection is performed to preserve the frontal branches of the facial nerve, as has been described previously. Meticulous attention is paid to preserving the superficial temporal artery with its posterior temporal branch. The ICA is exposed through the cervical extension of the incision and secured with umbilical tape to assure its proximal control (Fig. 1). The main trunk of the facial nerve is identified as it enters the parotid gland and is preserved.
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The superficial temporal fascia is incised, exposing the zygomatic arch. This arch is then dissected in subperiosteal fashion and sectioned with a fine drill* at its most anterior and posterior ends. The zygomatic cuts should be oblique for secure reattachment of the arch. The zygomatic arch is then displaced downward with its masseter muscle attachment or totally freed and removed. The temporal muscle is followed to its insertion on the coronoid process. The mandibular notch and the coronoid process are dissected in subperiosteal fashion. To bring the coronoid process into full view, the anesthesiologist is asked to close the patient’s mouth, pushing the mandible upward to a degree which does not affect the endotracheal tube in an orally intubated patient. The coronoid process is then sectioned at its base (Fig. 2). The temporal muscle is elevated upward, exposing the infratemporal and temporal fossae, but maintaining the large insertion of the muscle on the temporal squama (Fig. 3).

Depending on the tumor’s extension, one of three cranial exposures is used: 1) a single burr hole made at the floor of the temporal fossa, which is drilled away to expose the foramen rotundum, foramen ovale, and foramen spinosum extradurally; 2) a low temporal craniotomy for a wider intracranial exposure; or 3) a large single orbitocranial flap. If intradural and/or cavernous sinus dissection is required, the dura is opened. In any event, temporal lobe retraction is minimal because of the very low exposure.

At the completion of tumor resection, the coronoid process is reattached through a wire hole on the segment attached to the temporal muscle as well as the segment attached to the mandible. If the insertion of the masseter muscle was initially preserved by downward displacement of the zygomatic arch, then the zygomatic arch is repositioned in its place and secured with heavy sutures through wire holes. When the masseter muscle was totally separated from the segment of the zygomatic arch, we did not feel the need to reattach it to the sectioned segment of the zygomatic arch since the muscle had adequate anterior insertion. The soft tissues and skin are then closed in layers.

Summary of Cases

We have used this approach in seven cases of skull-base lesions: two schwannomas, one juvenile angiofibroma, one temporal fossa encephalocele, one he-
TABLE 1
Clinical findings and outcome in patients operated on via the zygomatic approach

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Type of Tumor</th>
<th>Tumor Origin &amp; Extension</th>
<th>Date of Surgery</th>
<th>Additional Exposure</th>
<th>Complications</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>7, M</td>
<td>juvenile angiofibroma</td>
<td>nasopharynx, pterygopalatine &amp; infratemporal fossae, cavernous sinus</td>
<td>4/88</td>
<td>partial hair loss from embolization; limited excursion of jaw for 6 mos</td>
<td>normal function</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>28, F</td>
<td>schwannoma</td>
<td>parapharyngeal &amp; infratemporal fossae, Meckel's cave</td>
<td>2/89</td>
<td>temporal craniotomy V₂ paresthesia; limited jaw opening for 6 wks</td>
<td>normal function</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>44, M</td>
<td>cavernous hemangioma</td>
<td>nasopharynx, infratemporal fossa, lateral orbit</td>
<td>12/87</td>
<td>lateral orbitotomy</td>
<td>none</td>
<td>no recurrence; complete resolution of preop visual loss</td>
</tr>
<tr>
<td>4</td>
<td>16, F</td>
<td>aggressive desmoplastic fibroma</td>
<td>maxilla, pterygomaxillary space, infratemporal fossa</td>
<td>2/90</td>
<td>floor of temporal fossa</td>
<td>none</td>
<td>normal function; residual tumor in maxillary bone</td>
</tr>
<tr>
<td>5</td>
<td>4, M</td>
<td>hypothalamic hamartoma</td>
<td>retrosellar, preptontine</td>
<td>8/85</td>
<td>temporal craniotomy</td>
<td>none</td>
<td>hormonal treatment for precocious puberty</td>
</tr>
<tr>
<td>6</td>
<td>73, F</td>
<td>encephalocele</td>
<td>temporal fossa, infratemporal</td>
<td>12/86</td>
<td>temporal craniotomy</td>
<td>none</td>
<td>death 2½ yrs postop of unknown cause; no autopsy</td>
</tr>
</tbody>
</table>

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mangioma, one hypothalamic hamartoma, and one aggressive desmoplastic fibroma. Table 1 lists the patients' age, sex, tumor extensions, complications, and outcome. Detailed preoperative computerized tomography (CT), with or without magnetic resonance (MR) imaging, assisted in selecting patients suitable for this approach by delineating the tumor's location and extensions, involvement of the cavernous sinus, and encasement of the carotid artery. Angiography was performed on all patients to delineate the anatomy of the cerebral circulation and to evaluate collateral vasculature.

Illustrative Cases

Case 1

This 7-year-old boy was referred to the University of Mississippi Medical Center in April, 1988, with an 8-month history of right facial bulge. Biopsy of the right buccal mass, performed at the referring hospital, revealed a juvenile angiofibroma. His clinical examination revealed a large nasopharyngeal vascular lesion surrounding the posterolateral wall of the nasopharynx, with evidence of extensions into the buccal and infratemporal regions. Multiplanar MR studies depicted a large, abnormal, soft-tissue mass in the infratemporal fossa, with predominantly low intensity on T₁-weighted images, and areas of both high and low intensity on T₂-weighted images (Fig. 4). A bone-window CT scan demonstrated anterior bowing of the posterior maxillary sinus wall, with destruction of the pterygoid plates. The mass invaded the middle cranial fossa floor through the foramen ovale and extended into the right cavernous sinus region through its inferior and lateral aspects. A selective internal and external carotid arteriogram revealed cross-filling to the opposite anterior cerebral artery. The predominant blood supply to the mass was from the internal maxillary artery on the right side and meningeal branches of the ICA.

FIG. 4. Case 1. Coronal T₁-weighted magnetic resonance image showing a large juvenile angiofibroma encroaching extradurally on the cavernous sinus. The described technique provided excellent exposure and results.
Zygomatic approach to skull-base lesions

Superselective catheterization of the external carotid artery was performed, with embolization of the branches supplying the tumor. The angiofibroma with its extension into the cavernous sinus was removed 4 days later via the described approach. The floor of the middle cranial fossa was dehiscent from the tumor's dense involvement of the inferior aspect of the cavernous sinus. The yttrium-aluminum-garnet (YAG) laser was helpful and the patient received five units of blood during surgery. He had limited excursion of his jaw for approximately 6 months postoperatively, with subsequent complete resolution (Fig. 5).

Case 2

This 28-year-old woman was referred with numbness and tingling along the maxillary division of the left trigeminal nerve. Following a biopsy of the mass, the patient was referred to the University of Mississippi Medical Center with a histopathological diagnosis of a benign schwannoma. The extensive neoplasm involved the pterygopalatine fossa, with marked displacement of the posterior left maxillary sinus wall, and eroded the floor of the middle cranial fossa, as documented on three-dimensional reconstructions of the CT scans. On MR imaging, extensions of the lesion into Meckel's cave as well as the lateral and inferior aspects of the cavernous sinus were evident (Fig. 6). Arteriographic examination revealed good collateral circulation on cross-compression studies. A temporal craniotomy was added to the zygomatic approach; successful removal of the tumor, including its origin in Meckel's cave, was accomplished with preservation of all cranial nerves.

The superior orbital fissure was opened and the tumor was debulked with an ultrasonic aspirator.† The dura of Meckel's cave was opened and the tumor was removed from the gasserian region. Dissection of the lateral wall of the cavernous sinus was performed after identification of the ophthalmic division of the fifth nerve. Dissection in the region of the cavernous sinus was performed extradurally. Postoperatively, the patient had dysesthesia and pain in the distribution of the fifth nerve, which resolved with Tegretol C (carbamazepine). Restriction of mouth-opening subsided 6 weeks after the initiation of appropriate exercises (Fig. 7).

Results

There was no operative mortality. One patient died in another hospital of cardiopulmonary arrest 2½ years later. Morbidity consisted of two patients with restricted jaw opening and pain in the temporomandibular joint, which resolved in 6 weeks in one and 6 months in the other after appropriate exercises. In the latter, the mandibular capsule was opened during surgery. None of the patients developed problems with mastication, which was probably a result of preserving the insertion of the masseter muscle on the maxillary wall and the reattachment of the temporal muscle to the coronoid process. Cosmetic problems were minor and related to

† Ultrasonic surgical aspirator manufactured by Cavitron, Stanford, California.
the visible lower end of the scar (Figs. 5 and 7). Temporal muscle atrophy was apparent in one patient, although to a much lesser degree than we have observed after using other approaches that require extensive detachment of this muscle. Limited hair loss, probably the result of embolization, was observed in one patient.

Discussion

The temporal muscle derives its rich anastomotic vascularity from the middle temporal artery, a branch of the superficial temporal artery, and branches of the anterior and posterior deep temporal arteries of the internal maxillary artery (Fig. 8). There exist extensive vertical and horizontal anastomotic channels between the anatomical layers of the temporal region. The middle meningeal artery forms an anastomosis with the deep temporal arteries in the temporal bone. In addition to the intradiploic anastomosis, there are multiple perforating branches entering the temporal muscle and anastomosing the middle meningeal artery with the superficial temporal artery.3,6 Furthermore, the middle temporal artery connects with the posterior and anterior deep temporal arteries. In addition to this “vertical” collateral blood supply to the temporal muscle, the superficial temporal, occipital, supraorbital, and supratrochlear vessels form an anastomosing network horizontally.6

Total detachment and downward folding of the temporal muscle frequently results in its total devascularization and denervation; elevating the muscle upward, while maintaining a larger area of attachment on the temporal squama in continuity with the pericranium, preserves adequate vascularity through the rich horizontal and vertical collateral blood supply. The merit of our technique, however, lies in the excellent exposure obtained by elevating the temporal muscle, obviating basal obstruction which occurs if the muscle is folded downward.

Discussing surgical approaches to tumors of the infratemporal fossa in 1964, Conley5 stated that “the simplest approach is through the temple, following the temporalis muscle underneath the zygomatic arch to the coronoid process.” This simple and direct approach, however, was overshadowed by more extensive and radical approaches, ranging from a posterior transtem- poral to an anterior transmaxillary approach. We encountered descriptions of similar exposures by Wetmore, et al.,6 and Obwegeser;12 however, Wetmore, et al., displaced the zygoma anteriorly while Obwegeser did not extend the incision to encompass a neck exposure. Wetmore, et al., also made no mention of a restriction of mandibular opening among their five patients.

References

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Address reprint requests to: Ossama Al-Mefty, M.D., Department of Neurosurgery, University of Mississippi Medical Center, 2500 North State Street, Jackson, Mississippi 39216-4505.