J Neurosurg 89:336–341, 1998

Orbitozygomatic craniotomy

Technical note

Joseph M. Zabramski, M.D., Talat Kiriş, M.D., Suresh K. Sankhla, M.D., Josep Cabiol, M.D., and Robert F. Spetzler, M.D.

Division of Neurological Surgery, Barrow Neurological Institute, Mercy Healthcare Arizona, Phoenix, Arizona

The orbitozygomatic approach provides wide, multidirectional access to the anterior and middle cranial fossae, as well as to the upper third of the posterior fossa and clivus. The authors describe technical details of the surgical approach as it has evolved over 3.5 years of experience in 83 consecutive cases. This modified technique eliminates the need for bone reconstruction of the orbital walls to prevent enophthalmos and minimizes the risk of injury to the frontal branch of the facial nerve. At a follow-up evaluation after a period averaging 14 months, all patients were pleased with the cosmetic results of this approach.

Key Words • **skull base surgery** • **surgical approach** • **surgical anatomy** • **orbitozygomatic approach**

Pellerin and colleagues[11] and Hakuba, et al.,[5] first described the orbitozygomatic approach to the anterior and middle cranial fossae as well as to the upper third of the clivus and posterior fossa. Since then, various authors have reported a variety of modifications to enhance the exposure offered by the orbitozygomatic approach.[2,4,6–9,14] The approach has been widely adopted by skull base centers for the management of neoplastic lesions, but has seen only limited use in vascular surgery.[13,15]

Over the last 3.5 years, we have used the orbitozygomatic approach to treat 83 patients with a variety of tumors and vascular lesions. In this report, we describe the technical aspects of this approach, emphasizing modifications that have evolved during this experience to maximize exposure and to minimize the risk of complications.

Clinical Material and Methods

We reviewed the hospital charts and office records for the period between July 1, 1992 and January 1, 1996 of 83 consecutive patients in whom an orbitozygomatic approach was used for lesions involving the skull base and brainstem. There were 34 males and 49 females (mean age 48 years). Intracranial vascular lesions accounted for 55 of these cases; 44 cases of aneurysm and 11 cases of cavernous malformations. The remaining 28 patients had tumors involving the petroclival and sphenoorbital areas. Follow-up evaluation by office visit or direct telephone contact was available for a mean of 14 months (range 8–45 months).

Surgical Technique

Patient Positioning and Incision. The patient is placed supine on the operating room table. The head is rotated between 30° and 60° to the side opposite to the surgical incision. Rotation is increased for tumors and vascular lesions of the anterior and middle fossae and decreased for those involving the clivus and posterior fossa. The neck is slightly extended to angle the head backward toward the floor so that the malar eminence is the most superior point in the operative field (Fig. 1). This position allows the frontal lobe to fall away from the orbital roof. The head is secured with skeletal fixation, and the position of the table or the angle of the microscope is changed if multidirectional views are needed.

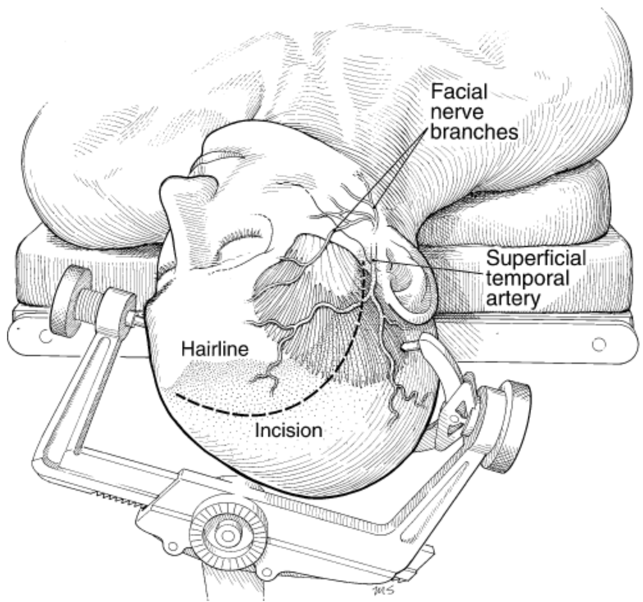

FIG. 1. Drawing depicting the position of the patient's head and the incision line for the orbitozygomatic skull base approach. Note that the scalp incision crosses to the opposite midpupillary line. This allows a wide exposure of the frontoorbital region on the side of the approach.

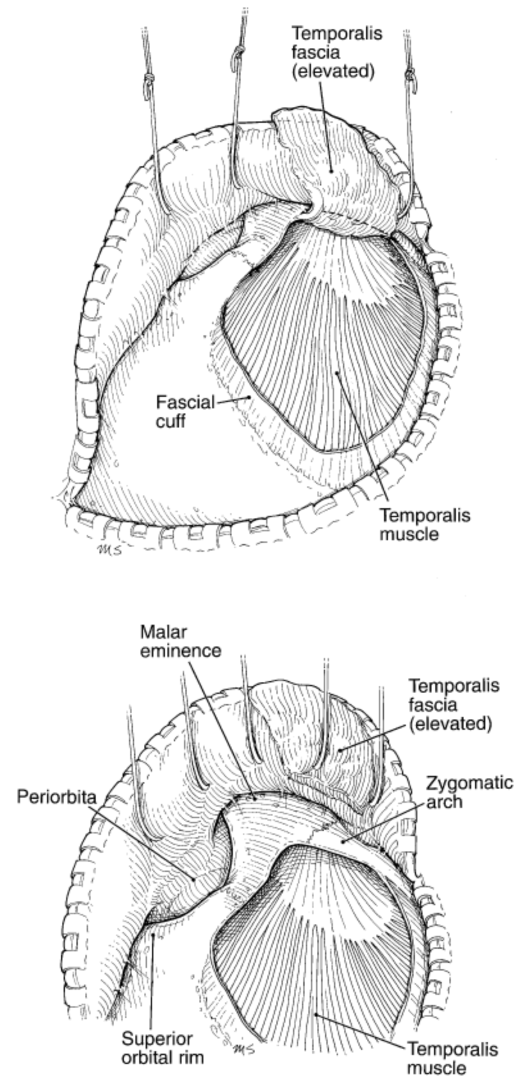

FIG. 2. *Upper:* Illustration depicting the dissection and elevation of the temporal fascia in the subfascial plane. The fascia and overlying scalp flap are elevated together to avoid injury to the frontal branch of the facial nerve which runs in the fat pad between these two layers. Note the narrow fascial cuff that remains along the insertion of the temporal fascia into the frontal bone. The cuff is used to reapproximate the muscle and fascia anatomically at closure. *Lower:* Illustration showing the exposure of the orbital rim and zygoma prior to elevation of the temporal muscle.

The scalp incision begins 1 cm anterior to the tragus, at the level of the inferior border of the zygomatic arch. It proceeds superiorly and forward in a gently curving arc to just behind the site where the hairline intersects the contralateral midpupillary line (Fig. 1). This incision allows a generous exposure of the frontotemporal area, the superior and lateral rims of the orbit, and the zygoma, with minimal stretching of the frontal branch of the facial nerve. The posterior limb of the superficial temporal artery should be spared if there is any possibility that a microvascular bypass will be needed. Extension of the incision inferiorly should be limited to avoid injuring the facial nerve, which lies approximately 1.7 cm below the zygomatic arch over the mandibular condyle.[12]

Scalp Flap Elevation and Preservation of the Frontal Branch of the Facial Nerve. The scalp flap is elevated to expose the underlying temporal fascia along the length of its frontotemporal insertion. The frontal branch of the facial nerve that supplies the frontal muscle lies in the subgaleal fat pad.[3] To minimize the risk of injury to this nerve, extensive exposure of the subgaleal fat pad should be avoided. The temporal fascia is incised sharply along the inferior margin of the incision. The fascial incision is made forward along the margin of the superior temporal line, leaving a narrow myofascial cuff attached to the bone for later reapproximation.[16] The temporal fascia is elevated in the plane between the muscle and deep fascia to expose the zygoma and superior orbital rim (Fig. 2 *upper*). The deep temporal fascia fuses with the periosteum of the zygomatic arch and is bluntly or sharply separated to complete the exposure. The intact temporal muscle is incised sharply along the fascial edges and elevated in the subperiosteal plane by using a retrograde dissection technique, as described by Oikawa and coworkers.[10] To minimize muscle atrophy, monopolar cauterization should not be used for hemostasis or dissection.

The access provided by elevation of the fascia over the zygomatic arch allows subperiosteal dissection along the orbital rim laterally and downward to the malar eminence (Fig. 2 *lower*). The skin flap is retracted inferiorly with fishhooks attached to the Leyla bar. Beginning at the lateral edge of the orbital rim, blunt dissection is used to free the periorbita gently from the lateral and superior aspects

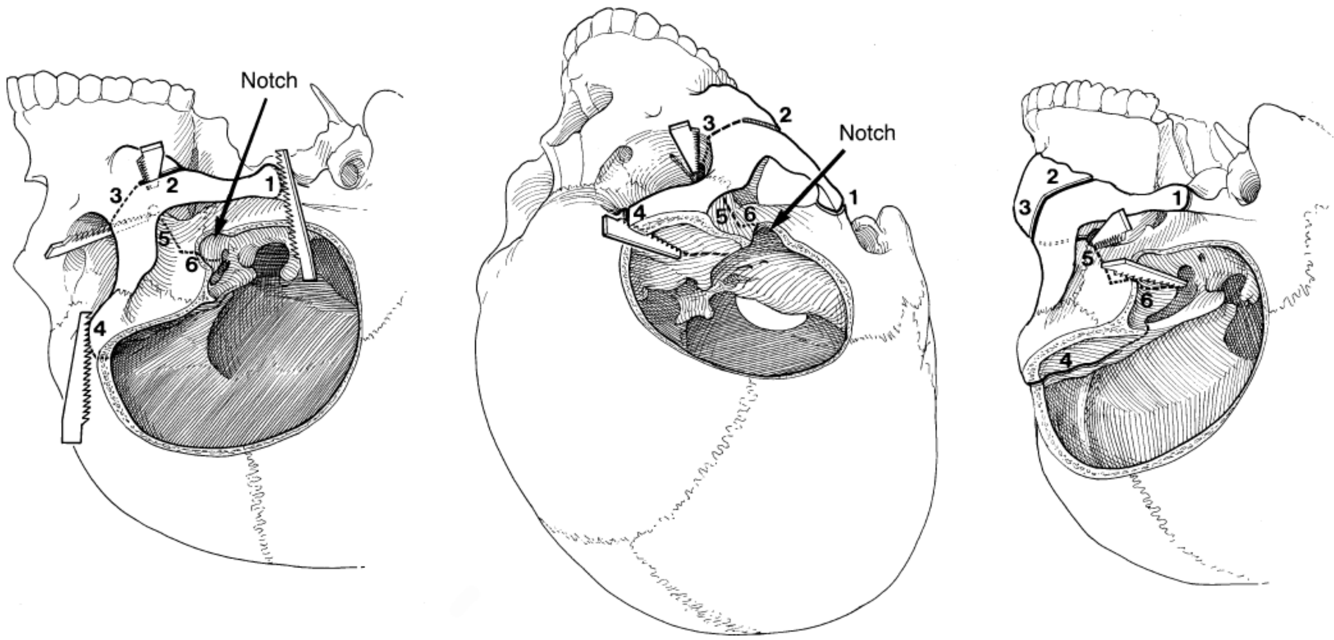

FIG. 3. Series of three drawings illustrating the location and angle of the six cuts (represented by Arabic numerals) used to complete the orbitozygomatic osteotomy. Prior to these cuts the temporal muscle is elevated and a generous frontotemporal craniotomy flap is turned.

of the orbital walls. The dissection is made medially to the supraorbital nerve. If additional medial exposure is needed, the supraorbital nerve can be freed from its bony canal with a small chisel or diamond drill. In this way, the zygoma and the entire orbital rim are completely exposed.

Craniotomy With Orbitozygomatic Removal. We use a high-speed drill (Midas Rex Pneumatic Tools, Inc., Fort Worth, Texas) with the B1 attachment to create a small burr hole in the temporal bone. The foot plate is attached and a standard pterional bone flap that encompasses the complete temporal muscle cuff is turned. The exact size and shape of this flap depend on the location of the lesion. It is extended farther forward for anterior fossa lesions and inferiorly into the temporal region for lesions of the middle and posterior fossae. The bone is elevated and the dura is tacked to the bone edges of the craniotomy for hemostasis. A small notch is drilled along the anterolateral wall of the temporal fossa (Fig. 3). This notch creates a space for placement of the saw blade when the lateral orbital wall is removed later in the procedure.

A reciprocating saw is used to complete the orbital and zygomatic osteotomies. Six bone cuts are used to free the orbitozygomatic bone flap in one piece. The first cut is made across the root of the zygomatic process (Fig. 3). This cut divides the zygoma obliquely; the oblique plane provides a stable base for fixation. The second and third cuts divide the zygomatic bone just above the level of the malar eminence (Fig. 3). These two cuts form a slightly obtuse angle when viewed from above. The second cut divides the zygomatic bone from its inferolateral margin halfway across to the lateral orbital rim (Fig. 3 *left*). The third cut, which begins intraorbitally with the tip of the saw in the inferior orbital fissure (Fig. 3 *center*) and extends posteriorly and laterally to join the second cut, completes the division of the zygomatic bone. During these and the remaining cuts, the previously freed periorbita is protected with thin-blade retractors or telfa strips.

Before the fourth cut is made, the dura must be elevated from the orbital roof and the anterior wall of the temporal fossa to expose the superior and lateral walls of the orbit. The fourth cut divides the superior orbital rim and roof. For most tumors and vascular lesions, we begin this cut 1 to 2 mm lateral to the supraorbital canal. If it is necessary to remove a greater portion of the medial orbital roof, the supraorbital nerve can be removed from its canal as described earlier. The thick supraorbital rim is divided using the saw blade, which is placed perpendicular to the orbital roof (Fig. 3 *left*). The cut is extended posteriorly by placing the saw parallel to the roof to take advantage of the full length of the saw blade (Fig. 3 *center*). The thin orbital roof bone is readily divided by the saw in this plane. This latter cut is extended 3 to 4 cm posteriorly and angled toward the medial edge of the superior orbital fissure (Figs. 3 *right* and 4 *left*).

The next two cuts free the lateral orbital wall by connecting the inferior and superior orbital fissures (Figs. 3 *right* and 4 *left*). The inferior orbital fissure is identified by direct vision or by palpating the infratemporal fossa with a No. 4 Penfield dissector. The reciprocating saw blade is engaged in the upper end of this fissure and a short cut is made to the edge of the notch made earlier in the temporal fossa (Fig. 3). The sixth and final cut extends from the lateral margin of the superior orbital fissure to join the fifth cut from the inferior orbital fissure (Figs. 3 *right* and

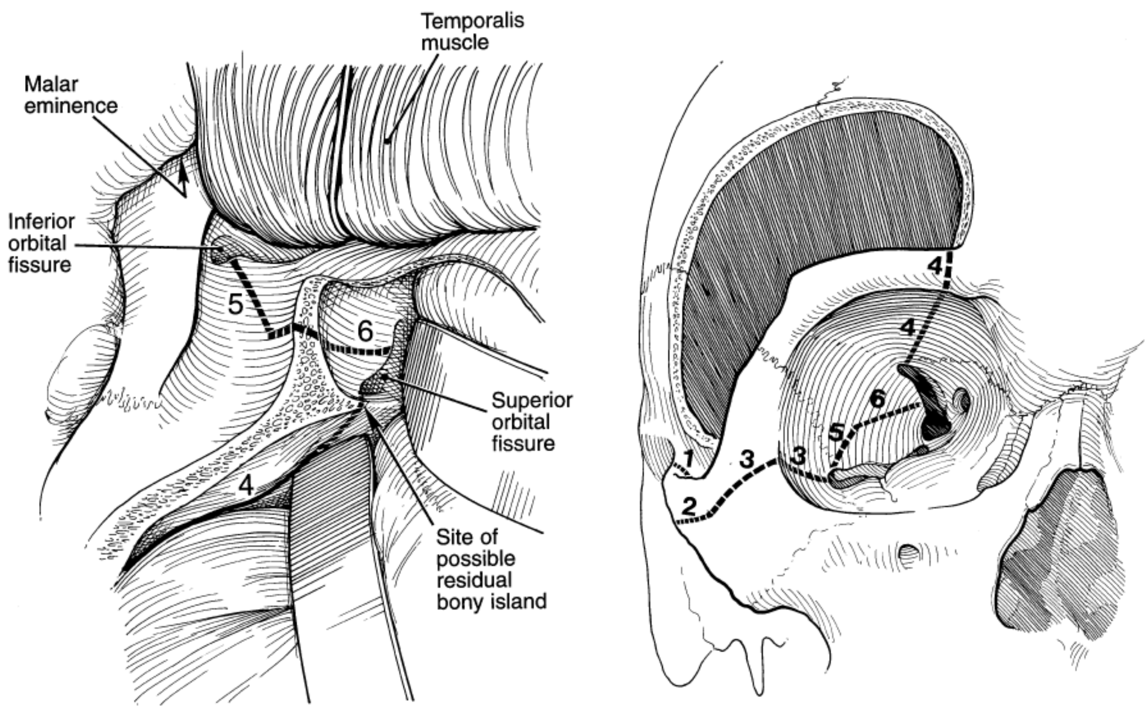

FIG. 4. *Left:* Illustration showing the location of the bone cuts in the orbital roof (Cut 4) and lateral orbital wall (Cuts 5 and 6). The superior and inferior orbital fissures serve as important landmarks for this series of cuts. *Right:* Drawing demonstrating the wide bone removal obtained in the orbit and zygoma by using this technique. Note the intersection of Cuts 3, 4, 5, and 6 with the superior and inferior orbital fissures.

4 *left*). Both of these cuts are made with the saw placed parallel to the walls of the orbit. The intraorbital contents are protected with telfa strips or thin-blade retractors.

At this point the entire orbitozygomatic bone flap should be free; however, a small island of bone may remain posteriorly between the medial edge of the superior orbital fissure and the orbital roof osteotomy (Fig. 4 *left*). This island can be thinned by using the drill and then fractured. Care should be taken to free all remaining periorbital and other soft-tissue attachments as the orbitozygomatic flap is removed. The extent of bone removal obtained by this combination of cuts can best be appreciated from the intraorbital view shown in Fig. 4 *right*. If required, the medial orbital roof and/or the anterior clinoid process can be removed using small rongeurs and a small diamond-tipped burr. Replacement of the orbitozygomatic flap provides excellent cosmetic results and eliminates the need for orbital reconstruction.

For access to the cavernous sinus and the posterior fossa, the lateral temporal fossa wall is drilled flush to the middle fossa floor. This is particularly important for high-lying aneurysms of the basilar bifurcation. A generous dural opening completes the exposure and is used to retract the orbital contents for a wide unrestricted view (Fig. 5).

Surgical Closure. After the intradural procedure has been completed, the dura is closed in a watertight fashion. The orbitozygomatic and pterional bone flaps are replaced and fixed in position with miniplates and screws (Fig. 6). Because this technique preserves the roof and lateral walls of the orbit, additional bone reconstruction is not required to prevent enophthalmus.

The muscle flap and temporal fascia are rotated backward and sutured to the myofascial cuff on the frontotemporal bone flap (Fig. 6). Care is taken to assure anatomical reapproximation of the bone flaps, muscle, and fascia in the frontal and anterior temporal regions. The scalp incision is closed in the usual multilayer fashion.

Discussion

Recent advances in neurological surgery include the adoption of a variety of skull base techniques that emphasize the removal of bone to improve the exposure of deep lesions while reducing brain retraction. The orbitozygomatic approach adheres to this skull base philosophy by removing the superior and lateral walls of the bony orbit and zygoma to provide a wide angle of exposure to lesions involving the cavernous sinus, upper clivus, and adjacent vascular structures.

Historically, the orbitozygomatic approach evolved from the pioneering work of a number of innovative neurosurgeons. In 1982, Jane and associates[8] reported a supraorbital approach for vascular lesions located at the anterior cranial base and orbit. In their description, a frontal bone flap, which incorporated the orbital roof and supraorbital ridge, was removed as a single piece. Al-Mefty[1] modified this approach by incorporating the superior and lateral orbital ridges with the pterional craniotomy and removing the entire complex as one flap.

Pellerin, et al.,[11] added removal of the zygoma, thus describing the orbitofrontomalar approach for sphenoor-

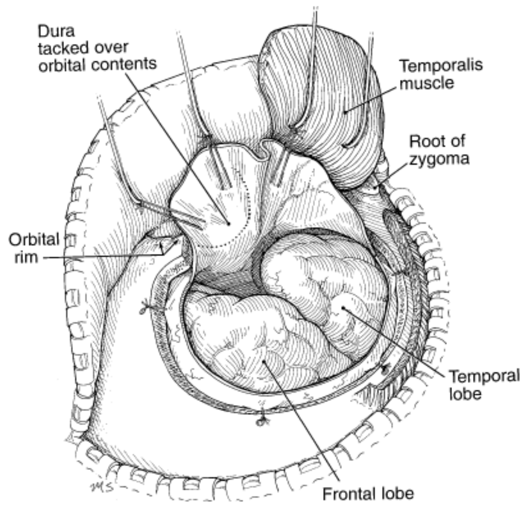

FIG. 5. Illustration showing the use of the dura to retract the orbital contents.

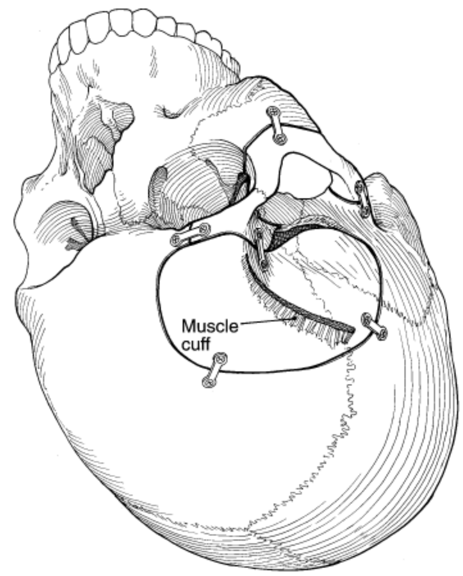

FIG. 6. Drawing showing that the frontotemporal and orbitozygomatic osteotomies have been repositioned and secured with miniplates and screws.

bital meningiomas, in which, again, a single craniotomy was used. Hakuba and coworkers[5,6] suggested using the orbitozygomatic approach for parasellar tumors, basilar tip aneurysms, and cavernous sinus lesions. They described a complicated technique involving three separate muscle-based bone flaps. Delashaw and colleagues[4] described an orbitozygomatic approach in which they used a frontotemporal bone flap that incorporated the frontal sinus and superior and lateral orbital ridges as one piece, with the zygomatic arch removed separately. Alaywan and Sindou[2] and McDermott, et al.,[9] reported removal of the frontotemporal and orbitozygomatic bone flaps separately as described here.

The technique described in this report has evolved from our experience in the last 3.5 years with 83 patients. The modifications offer a number of advantages that make the procedure safer and improve cosmetic results. Extension of the craniotomy scalp incision across the midline (Fig. 1) and dissection of the temporal fascia in the deep subfascial plane (Fig. 2 *upper*) reduce the risk of injury to the frontal branch of the facial nerve. Ten patients (12%) in this series experienced temporary paresis of the frontal muscle. All ten episodes occurred before the deep subfascial dissection for elevation of the temporal fascia was adopted. There were no episodes of frontal muscle paresis in the last 25 patients.

Subperiosteal elevation of the temporal muscle and avoidance of monopolar cauterization helps minimize muscle atrophy.[16] Use of a temporal fascia cuff ensures an anatomical approximation of the fascia and muscle at closure (Fig. 2 *upper*).

Using the technique described here, the removal of the orbitozygomatic bone flap assures maximum exposure with little or no loss of bone. The combination of cuts illustrated in Fig. 3 incorporates the superior and lateral orbital walls into the orbitozygomatic osteotomy and essentially eliminates the need for bone reconstruction. The use of miniplates rigidly fixes all bone flaps until normal bone healing is complete.

All patients in our series were pleased with the cosmetic results of their surgery; there was no evidence of enophthalmos, zygomatic separation, or excessive bone reabsorption during an average follow-up period of 14 months. All patients had some degree of orbital swelling related to this approach, which tended to resolve over 1 to 2 weeks. Two patients had severe orbital swelling that required temporary tarsorrhaphy; one case involved resection of an orbital cavernous malformation; whereas the other case followed clipping and reconstruction of a giant middle cerebral artery aneurysm. There were no complications involving changes in visual acuity.

Other complications included cerebrospinal fluid fistulas in five patients (6%). Three of these cases were related to extensive dissection into the paranasal sinuses for the resection of skull base tumors. Two of the five patients required open craniotomy for repair, whereas the remaining three were successfully treated with cerebrospinal fluid drainage procedures. There were no episodes of infection involving the cranial or orbital bone flaps.

Conclusions

The orbitozygomatic approach offers a wide angle of exposure for the management of lesions involving the cavernous sinus, parasellar region, upper clivus, and adjacent neurovascular structures. The modifications described in this paper reduce the risk of complications and improve cosmetic results, thus expanding the indications for this approach.

References

1. Al-Mefty O: Supraorbital-pterional approach to skull base lesions. **Neurosurgery 21:**474–477, 1987
2. Alaywan M, Sindou M: Fronto-temporal approach with orbito-zygomatic removal. Surgical anatomy. **Acta Neurochir 104:**

79–83, 1990
3. Ammirati M, Spallone A, Ma J, et al: An anatomicosurgical study of the temporal branch of the facial nerve. **Neurosurgery 33:**1038–1044, 1993
4. Delashaw JB Jr, Tedeschi H, Rhoton AL: Modified supraorbital craniotomy: technical note. **Neurosurgery 30:**954–956, 1992
5. Hakuba A, Liu S, Nishimura S: The orbitozygomatic infratemporal approach: a new surgical technique. **Surg Neurol 26:** 271–276, 1986
6. Hakuba A, Tanaka K, Suzuki T, et al: A combined orbitozygomatic infratemporal epidural and subdural approach for lesions involving the entire cavernous sinus. **J Neurosurg 71:**699–704, 1989
7. Ikeda K, Yamashita J, Hashimoto M, et al: Orbitozygomatic temporopolar approach for a high basilar tip aneurysm associated with a short intracranial internal carotid artery: a new surgical approach. **Neurosurgery 28:**105–110, 1991
8. Jane JA, Park TS, Pobereskin LH, et al: The supraorbital approach: technical note. **Neurosurgery 11:**537–542, 1982
9. McDermott MW, Durity FA, Rootman J, et al: Combined frontotemporal-orbitozygomatic approach for tumors of the sphenoid wing and orbit. **Neurosurgery 26:**107–116, 1990
10. Oikawa S, Mizuno M, Muraoka S, et al: Retrograde dissection of the temporalis muscle preventing muscle atrophy for pterional craniotomy. Technical note. **J Neurosurg 84:**297–299, 1996
11. Pellerin P, Lesoin F, Dhellemmes P, et al: Usefulness of the orbitofrontomalar approach associated with bone reconstruction for frontotemporosphenoid meningiomas. **Neurosurgery 15:**715–718, 1984
12. Pérez-Rull J, Brett MD, Levignac J, et al: [Surgical landmarks of the temporo-frontal branch of the facial nerve.] **Ann Chir Plast Esthet 37:**11–17, 1992 (Fr)
13. Sekhar LN, Kalia KK, Yonas H, et al: Cranial base approaches to intracranial aneurysms in the subarachnoid space. **Neurosurgery 35:**472–483, 1994
14. Sekhar LN, Pomeranz S, Janecka IP, et al: Temporal bone neoplasms. A report on 20 surgically treated cases. **J Neurosurg 76:**578–587, 1992
15. Smith RR, Al-Mefty O, Middleton TH: An orbitocranial approach to complex aneurysms of the anterior circulation. **Neurosurgery 24:**385–391, 1989
16. Spetzler RF, Lee KS: Reconstruction of the temporalis muscle for the pterional craniotomy. Technical note. **J Neurosurg 73:** 636–637, 1990

Manuscript received July 9, 1996.
Accepted in final form March 17, 1998.

Current address for Dr. Kırış: University of Istanbul, Istanbul, Turkey.
Current address for Dr. Sankhla: G. D. Ambekar Road, Wadala, Bombay, India.
Current address for Dr. Cabiol: Hospital de Bellvitge, University of Barcelona, Barcelona, Spain.
Address correspondence to: Joseph M. Zabramski, M.D., c/o Neuroscience Publications, Barrow Neurological Institute, 350