The work horse of skull base surgery: orbitozygomatic approach. Technique, modifications, and applications

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Object. The aim of this study was to describe the microsurgical anatomy of the orbitozygomatic craniotomy and its modifications, and detail the stepwise dissection of the temporalis fascia and muscle and explain the craniotomy techniques involved in these approaches.

Methods. Nine cadaveric embalmed heads injected with colored silicone were used to demonstrate a stepwise dissection of the 3 variations of orbitozygomatic craniotomy. The craniotomies and dissections were performed with standard surgical instruments, and the microsurgical anatomy was studied under microscopic magnification and illumination.

Results. The authors performed 2-piece, 1-piece, and supraorbital orbitozygomatic craniotomies in 3 cadaveric heads each. Stepwise dissection of the temporalis fascia and muscle, and osteotomy cuts were shown and the relevant microsurgical anatomy of the anterior and middle fossae was demonstrated in cadaveric heads. Surgical case examples were also presented to demonstrate the application of and indications for the orbitozygomatic approach.

Conclusions. The orbitozygomatic approach provides access to the anterior and middle cranial fossae as well as the deep sellar and basilar apex regions. Increased bone removal from the skull base obviates the need for vigorous brain retraction and offers an improved multiangled trajectory and shallower operative field. Modifications to the orbitozygomatic approach provide alternatives that can be tailored to particular lesions, enabling the surgeon to use the best technique in each individual case rather than a “one size fits all” approach. (DOI: 10.3171/FOC.2008.25.12.E4)

KEY WORDS • orbitozygomatic approach • pterional craniotomy • skull base approach • supraorbital craniotomy • surgical anatomy

THE orbitozygomatic approach to craniotomy facilitates access to lesions involving the orbital apex, paraclinoid and parasellar regions, basilar apex, cavernous sinus, and anterior and middle fossa floor, either without or with only minimal brain retraction. Since the method for a supraorbital craniotomy was redefined by Jane et al.,¹⁹ the orbitozygomatic approach has been the “work horse” of skull base surgery. Al-Mefty^{1,2} modified this approach by incorporating the superior and lateral orbital ridges with the pterional craniotomy and removal as a 1-piece bone flap. Pellerin and associates²⁶ described an orbitofrontal craniotomy with extensive removal of the lateral orbit, malar eminence, and malar arch in surgery for sphenoid wing meningiomas, again in a 1-piece bone flap. Hakuba et al.^{14,15} described a similar craniotomy technique for approaching parasellar tumors, basilar tip aneurysms, and cavernous sinus lesions,

which they called the orbitozygomatic approach. Their method involved the preservation of much of the skull base with 3 separate muscle-based bone flaps. Delashaw and coworkers^{8,9} modified this approach in their description of a 1-piece craniotomy including the superior and lateral orbital walls with separate removal of the zygomatic arch. Alaywan and Sindou³ and McDermott et al.²⁴ described a 2-piece orbitozygomatic approach with separate removal of the frontotemporal and orbitozygomatic bone flaps. Many variations on 1- and 2-piece orbitozygomatic craniotomy techniques have been proposed.^{1–3,8,10,11,13,17,18,24,29,30,32}

Orbitozygomatic craniotomy is essentially the expansion of the classic pterional approach. The superior and lateral orbital rims are mobilized with additional removal of part of the lateral wall along the zygoma and orbital roof, which provides access to the floor of the anterior and middle cranial fossae with minimal brain retraction. The variations that are typically used clinically are 1- and 2-piece orbitozygomatic craniotomies and orbital osteotomy. Although there are numerous reports in the

Abbreviations used in this paper: ICA = internal carotid artery; GTR = gross-total resection.

FIG. 1. A: Cadaveric dissection photograph showing that the subgaleal dissection ends 2.5–3 cm posterior to the upper lateral orbital rim. B: Photograph showing preoperative positioning of a patient who underwent surgery with the orbiatzygomatic approach. C: Cadaveric dissection photograph showing head position and location of the skin incision for orbiatzygomatic craniotomy.

neurosurgical literature concerning the indications for, techniques, and variations on the orbiatzygomatic craniotomy, a report is needed to demonstrate the stepwise dissection and offer a detailed description of the anatomy of the orbiatzygomatic approach and its modifications. In this report we consolidate the 3 main variations with advanced techniques demonstrated in stepwise cadaveric dissections. Surgical case examples are discussed, and the relevant microsurgical anatomy is presented.

Methods

Nine cadaveric embalmed heads injected with colored silicone were used to demonstrate a stepwise dissection of the 3 variations of the orbiatzygomatic approach. Before dissection, the heads were rigidly fixed in a Mayfield headholder (Codman, Inc.). The craniotomies and dissections were performed with standard surgical instruments. Microsurgical anatomy was studied under microscopic magnification and illumination (Leica, Wild M 695, Leica Microsystems, Inc.).

Two-Piece Orbiatzygomatic Craniotomy

Surgical Technique

The heads are rotated 30–60° to the side opposite the surgical incision, and the neck is slightly extended so that the malar eminence is the most superior point in the operative field (Fig. 1A and B). We begin a curvilinear skin incision 5–10 mm anterior to the tragus and 5 mm below the inferior border of the zygomatic arch. The inferior limb of the incision should be limited to avoid injury to the frontotemporal branch of the facial nerve. The division of the frontotemporal branch into the zygomatic and

temporal branches takes place inside the parotid gland, and the point at which the anterior and middle rami diverge from the frontotemporal branch of the facial nerve is about 1.1 cm below the tragus.⁴ The posterior limb of the superficial temporal artery should be spared if a microvascular bypass is planned or may be necessary.

The scalp incision is extended superiorly across the contralateral forehead, gently curving anteriorly, and terminating at the hairline superior to the contralateral mid-pupillary line (Fig. 1A and B). The scalp flap is mobilized anteriorly to expose the underlying temporalis fascia and the frontal periosteum is preserved. The frontotemporal branch of the facial nerve lies in the subgaleal fat pad.⁴ To avoid injury to this branch, subgaleal dissection must be stopped 2.5–3 cm posterior to the upper lateral orbital rim (Fig. 1C). The subfascial dissection then proceeds following the incision of the temporalis fascia, starting posteriorly and extending forward along the margin of the superior temporal line. A narrow myofascial cuff should be left superiorly along the superior temporal line for later reapproximation (Fig. 2A).³³ The temporalis fascia is elevated separately in a subfascial dissection to protect the nerve located in the superficial surface of this fascial plane (Fig. 2B).⁷ The temporalis fascia is elevated in the plane between the muscle and deep fascia to expose the zygoma and superior orbital rim. The deep layer of the temporalis fascia (fused with the periosteum of the zygomatic process of the frontal and the zygomatic bones) is separated subperiosteally to achieve full exposure of the superior orbital rim, zygomatic process, malar eminence inferior to the zygomaticofacial foramen, and the zygomatic arch (Fig. 2C and D). The temporalis muscle is incised sharply along the scalp incision and elevated in the subperiosteal plane using a retrograde technique, as described by Oikawa et al.²⁵

The skin flap is retracted inferiorly with fish hooks

Orbitozygomatic approach

FIG. 2. A: Cadaveric dissection photograph showing the fascial layer over the temporalis muscle and continuous with the frontal periosteal layer. B: Cadaveric dissection photograph showing the fascia over the temporal muscle subfascially dissected to preserve the twigs of the frontotemporal branch of the facial nerve. C: The frontal bone and its zygomatic process and the zygomatic bone with malar eminence are exposed after dissection of the temporal fascia and the frontal periosteum (MB = myofascial band). D: Intraoperative photograph showing the exposed bone structures after the dissection of the temporalis fascia and frontal periosteum. E: Cadaveric dissection photograph showing the supraorbital nerve dissected away from its foramen by drilling the inferior rim of the supraorbital foramen. F: Surgical photograph showing the supraorbital nerve after it is dissected from its foramen.

FIG. 3. Cadaveric dissection photograph showing the borders of the frontotemporal craniotomy, the first step in the 2-piece orbitozygomatic approach (A). Frontotemporal craniotomy as seen in a cadaveric specimen (B) and intraoperatively (C).

attached to the retractor. Blunt dissection is used to free the periorbital from the superior and lateral aspects of the orbital rims medial to the supraorbital notch. If additional medial exposure is needed, the supraorbital nerve can be freed from the supraorbital notch or foramen with a small chisel or drill (Fig. 2E and F).

Craniotomy With Orbitozygomatic Removal

A Midas Rex drill is used to place 2 bur holes, 1 in the temporal bone over the root of the zygoma, and another on the keyhole, and a frontotemporal craniotomy is made (Fig. 3). A small notch is drilled along the anterolateral wall of the temporal fossa, creating space for the drill used in cutting through the lateral orbital wall. Zabramski et al.³⁶ noted that the exact size and shape of the bone flap depends on the location of the lesion. The bone flap should be extended farther forward for anterior fossa lesions, and inferiorly into the temporal region for lesions of the middle and posterior fossae. A series of small holes is then created along the superior and posterior edges of the craniotomy and the dura is tacked to the bone edges of the craniotomy for hemostasis. The sphenoid wing is drilled down until it is flush with the frontotemporal dural fold. We find that drilling the sphenoid wing prior to making the osteotomy cuts facilitates a wider exposure and minimizes retraction.

A reciprocating saw is used to complete the orbital and zygomatic osteotomies. We use the 2-piece orbitozygomatic technique as described by Zabramski et al.³⁶ with modifications. The technique involves making 6 bone cuts to free the orbitozygomatic bone flap in 1 piece. The first cut is made across the root of the zygomatic process (Fig. 4A). We make this cut in 2 steps, 1 medial-to-lateral cut in an oblique direction, and the other lateral-to-medial in a vertical direction, to provide a stable base for fixation. Special care must be taken to avoid injury to the temporomandibular joint during these cuts. The second and third cuts divide the zygomatic bone just above the level of the malar eminence. The second cut divides the zygomatic bone from its inferolateral margin halfway across to the lateral orbital rim (Fig. 4B), and the third cut starts intraorbitally from the inferior orbital fissure and extends posteriorly to join the second cut (Fig. 4C).

The dura mater is then 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 is directed in an superior-inferior fashion, and made through the superior orbital rim and roof (Fig. 4D). The cut is made 1–2 mm lateral to the supraorbital nerve, but for lesions extending into the midline, it may be made medially after freeing the nerve from its bone canal. This cut was extended 2.5–3 cm posteriorly by placing the saw parallel to the roof and angled toward the medial edge of the superior orbital fissure (Fig. 4E).

The fifth and sixth cuts connect the inferior and superior orbital fissures. The inferior orbital fissure is identified by direct vision or by palpating the infratemporal fossa with a thin dissector (Fig. 4F). The fifth cut connects the inferior orbital fissure and the frontotemporal bur hole (Fig. 4G). The last cut is from the lateral margin of the superior orbital fissure and directed to join the fifth cut from the inferior orbital fissure (Fig. 4H). The intraorbital contents are protected by thin blades. The summary of the bone cuts is shown in Fig. 4I and J. The periorbital and soft tissue attachments are then dissected to free the orbitozygomatic bone flap completely (Fig. 4K).

The medial orbital roof, the anterior clinoid process, and the roof of the optic canal are removed by cutting or using diamond drill tips (Fig. 5A). Removal of the lateral wall of the temporal bone provides a wider view of the cavernous sinus and middle fossa (Fig. 5B and C). During closure, the orbitozygomatic and frontotemporal bone flaps are replaced and fixed with miniplates. If the frontal sinus is opened with a craniotomy or medial supraorbital osteotomy, it should be repaired by removing the mucosa, packing with antibiotic-soaked Gelfoam and muscle, and covering with the pedicled frontal periosteal flap. Because the 2-piece orbitozygomatic approach allows an osteotomy at least 2.5–3-cm in the orbital roof, there is usually no need for additional reconstruction to prevent enophthalmos.

One-Piece Orbitozygomatic Craniotomy

The 1-piece orbitozygomatic approach combines frontotemporal craniotomy with orbitotomy. In the pres-

Orbitozygomatic approach

FIG. 4. Cadaveric dissection photographs. The first cut is made at the root of the zygomatic bone. Note that the reciprocating saw is angled anteriorly to avoid injury to the temporomandibular joint (A). The second and third cuts (B and C) are made to divide the zygomatic bone just above the level of the malar eminence. There is an obtuse angle between these 2 cuts. The fourth cut can be done in 2 ways: either by placing the saw over the medial edge of the supraorbital nerve at an acute angle while the globe is protected by malleable retractors (D), or by placing the saw parallel to the roof and angled toward the medial edge of the superior orbital fissure (E). The inferior orbital fissure is identified by direct vision or palpating the infratemporal fossa with a thin dissector (F). The fifth cut connects the inferior orbital fissure and the frontotemporal bur hole (G). The fourth, fifth, and the sixth cuts are shown in an anteroposterior direction (H). The sixth cut is done from the lateral margin of the superior orbital fissure and directed to join the fifth cut from the inferior orbital fissure. Final overview of the bone cuts for 2-piece orbitozygomatic craniotomy (I, J, and K).

ent study we used a combined technique for 1-piece orbitozygomatic craniotomy which has been described previously by Pieper and Al-Mefty²⁷ and Aziz et al.,⁶ with small modifications. Preparation is similar to that described earlier. A MacCarty bur hole²³ is made near the

anatomical keyhole to span the intracranial and orbital compartments (Fig. 6A). A pterional craniotomy is then made with a high-speed pneumatic drill and footplate attachment. A free pterional flap is avoided with this method, and so drilling stops at the orbital rim just lateral to

FIG. 5. Cadaveric dissection photographs showing additional bone removal after orbitozygomatic craniotomy. The medial orbital roof, the anterior clinoid process, and the roof of the optic canal can be removed using cutting or diamond drill tips to expose the contents of the orbita (A). Removal of the lateral wall of the temporal bone provides additional exposure of the cavernous sinus and middle fossa (B and C). *Star* indicates the motor branch of the trigeminal nerve. ACP = anterior clinoid process; CN = cranial nerve; GSPN = greater superficial petrosal nerve; MMA = middle meningeal artery.

the supraorbital notch and at the pterion from below. The orbitotomy cuts are made from within the orbit. The first cut extends through the orbital rim just lateral or medial to the supraorbital notch to connect with the pterional craniotomy (Fig. 6B). Care must be taken to avoid cutting past the orbital roof and into the brain. The second cut extends from the inferior orbital fissure to the anatomical keyhole; this cut should be made over the lateral orbital wall, and should remain extracranial. In both cuts, the osteotome can be used to extend fractures along the osteotomy lines to connect the cuts. The third cut across the zygomatic body also extends into the inferior orbital fissure. This cut joins with the cut along the lateral orbital wall at the anterolateral margin of the inferior orbital fissure. The fourth cut is made across the anterior root of the zygomatic process of the temporal bone, just anterior to the articular tubercle of the zygoma.

Once the cuts are completed and the surrounding tissue is dissected, the 1-piece bone flap can be mobilized (Fig. 6C). The flap is elevated from the dura in a medial-to-lateral direction to avoid driving the orbital roof into the frontal lobe.

Supraorbital Modified Orbitozygomatic Craniotomy

We used the supraorbital modified orbitozygomatic craniotomy technique described by Lemole et al.,²² which uses essentially the same head position as the conventional orbitozygomatic craniotomy. The same curvilinear skin incision begins 5–10 mm anterior to the tragus at 5 mm below the inferior border of the zygomatic arch. Elevation of the frontal periosteum and the subfascial dissection of the temporalis muscle are also done in a manner similar to that in the complete orbitozygomatic approach.

The periorbita are freed from the superior and lateral aspects of the orbital rims medial to the supraorbital notch with blunt dissection. The depth of dissection is seldom > 2–3 cm. If additional medial exposure is needed, the supraorbital nerve is freed from the supraorbital notch or the foramen with a small chisel or diamond drill. The limits of the exposure typically include the supraorbital notch medially and the frontozygomatic suture laterally (Fig. 7). The first osteotomy is made in the supraorbital rim lateral to the supraorbital nerve (Fig. 7A). This cut can be extended more medially if more medial frontal exposure is desired. The second cut is made in the lateral orbital wall toward

FIG. 6. Cadaveric dissection shows the MacCarty bur hole near the anatomical keyhole and the first osteotomy cut extending through the orbital rim just lateral or medial to the supraorbital notch to connect to the pterional craniotomy (A). Consecutive cuts, shown in red and blue, connect the bony cuts necessary to free the bone flap from the surrounding cranium (B). Once the cuts are completed and the surrounding tissue is dissected, the 1-piece bone flap was mobilized (C). MB = myofascial band.

Orbitozygomatic approach

FIG. 7. A: Cadaveric dissection shows steps in the supraorbital modified osteotomy. Cadaveric dissection (B) and intraoperative photograph (C) show bone removal and dural exposure after supraorbital osteotomy is completed.

the inferior orbital fissure (Fig. 7A). The third cut is made to connect these 2 cuts in the orbital roof (Fig. 7A). The supraorbital modified orbitozygomatic craniotomy can be performed using a 1- or 2-piece method.^{8,36}

Discussion

The orbitozygomatic craniotomy has greatly affected the practice of skull base surgery by providing improved exposure and less need for brain retraction by increasing bone resection. By removing the superior and lateral walls of the orbit and zygoma, a wide angle of exposure is obtained for lesions involving the orbital apex, paraclinoid and parasellar regions, basilar apex, cavernous sinus, and anterior and middle fossa floor. In this study, we demonstrated the anatomical stepwise dissections and microsurgical anatomy of the orbitozygomatic craniotomy and its clinical applications.

In our dissections with the 2-piece orbitozygomatic craniotomy we used a technique originally described by

Zabramski et al.³⁶ These authors made modifications on the 2-piece method to increase the safety of the procedure and improve cosmetic results. Their modifications included the extension of the craniotomy scalp incision across the midline, and dissection of the temporalis fascia in the deep subfascial plane to reduce the risk of injury to the frontotemporal branch of the facial nerve. There are 3 fat pads over the anterior one-fourth of the temporalis muscle.⁴ The first fat pad is located in the subgaleal space, the second is between the duplication (or laminae²¹) of the superficial temporalis fascia, and the third is beneath the superficial temporalis fascia (Fig. 8A and B). The frontotemporal branch of the facial nerve emerges from the parotid gland as multiple twigs (Fig. 8C), and is located in the subgaleal space, in the same plane as the superficial fat pad. However Ammirati et al.⁴ reported that there are sizable twigs from the middle division of the frontotemporal branch of the facial nerve that course within the interfascial space and then enter the frontalis muscle in 30% of specimens. This variation in anatomy may ex-

FIG. 8. Cadaveric dissection photographs showing the 3 fat pads over the temporal muscle. The facial nerve and its branches are seen coursing over the first fat pad (in the subgaleal space). The second fat pad is located between the duplication of the superficial temporal fascia, and the third is located beneath the superficial temporalis fascia (A and B). The frontotemporal branch of the facial nerve emerges from the parotid gland as multiple twigs (C). STA = superior cerebellar artery.

FIG. 9. Oblique (upper) and axial (lower) views in a cadaveric dissection show the angles of exposure to the anterior and middle fossae gained through the orbitozygomatic craniotomy. Star indicates the motor branch of the trigeminal nerve. MCA = middle cerebral artery; PCA = posterior cerebral artery; SCA = superior cerebellar artery.

plain why the conventionally used interfascial dissection for pterional craniotomy carries a 30% risk of injury to these twigs.³⁵ In our dissections, we performed subfascial dissection over the temporalis muscle to preserve the twigs of the frontotemporal branch of the facial nerve.

Prevention of temporalis muscle atrophy is also an important step in orbitozygomatic craniotomy. Zabramski et al.³⁶ stressed the importance of subperiosteal elevation of the temporalis muscle and avoidance of monopolar cauterization to minimize atrophy. Kadri and Al-Mefty²⁰ recommended 6 steps to preserve the temporalis muscle: 1) preservation of the superficial temporal artery; 2) preservation of the facial nerve branches by using subfascial dissection; 3) zygomatic osteotomy for greater exposure and avoidance of compression or retraction injuries to the temporalis muscle; 4) dissection of the muscle in subperiosteal retrograde fashion to preserve the deep vessels and nerves; 5) deinsertion of the muscle to the superior temporal line without cutting the fascia; and 6) reattachment of the muscle directly to the bone. In our dissections, we used the myofascial band to help anatomically reap-

FIG. 10. Preoperative T1-weighted, contrast-enhanced axial (A), sagittal (B), and coronal (C) MR images demonstrating a giant cranio-pharyngioma with extension into multiple compartments. A right orbitozygomatic approach provided excellent exposure of interpeduncular and prepontine cisterns. A combined transcallosal approach was not needed for resection of the part that extended into the third ventricle. Postoperative T1-weighted, contrast-enhanced axial MR image (D) demonstrates GTR without recurrence at the 6-month follow-up examination.

proximate the fascia and temporalis muscle at closure, a technique originally described by Spetzler and Lee.³³

In our study we used a combination of techniques for 1-piece orbitozygomatic craniotomy, which were described by Pieper and Al-Mefty²⁷ and Aziz et al.,⁶ with small modifications. Both techniques involve the placement of frontal bur holes, which we did not use in the present study. However, we agree with the idea that frontal bur holes may be useful in pediatric and elderly patients in whom the dura is firmly attached to the bone. The MacCarty bur hole is cut over the frontosphenoidal suture, ~ 1 cm behind the frontozygomatic junction.²² Shimizu et al.³¹ noted the importance of the correct placement of this keyhole to maximize the amount of orbit removed. When placed appropriately, the MacCarty bur hole creates a posterosuperior half that exposes the basal frontal dura and an anteroinferior half that exposes the periorbital (Fig. 6A). Its diameter is about twice the size of a regular bur hole so that the frontal fossa and orbital cavity can be accessed.

One- and two-piece orbitozygomatic craniotomies both provide wider exposure to the anterior cranial base than frontotemporal and pterional approaches (Fig. 9).^{8,12,13,16,28} These approaches are used to access anterior and middle cranial fossae lesions (Fig. 10). Honeybul and colleagues¹⁶ found that the surgical window increased up to 300% for basilar apex lesions when the orbitozygomatic infratentorial approach was used. Schwartz et al.²⁸

FIG. 11. Axial (A), sagittal (B) and reconstruction (C) CT angiograms showing a large, complex and partially calcified, unruptured anterior communicating artery aneurysm projecting anteriorly. A left supraorbital modified orbitozygomatic approach was performed, which permitted wide exposure and clipping of the aneurysm without any brain retraction. Postoperative angiogram (D) shows complete obliteration of the aneurysm at the 1-year follow up.

used a frameless stereotactic system to measure the area of exposure associated with removal of the orbital roof compared with removal of the zygomatic arch. They targeted a lesion on the posterior clinoid process and found that the exposure increased 26% after resection of the superolateral orbital rim. Inclusion of the zygomatic arch in osteotomies did not improve the surgical exposure. Alaywan and Sindou³ found a 75% gain in sagittal exposure of the opticocarotid complex after resection of the superolateral orbital rim. They also found that the bone resection increased the angle of exposure from 11 to 19°. Gonzalez et al.¹³ have shown that increments in bone removal open a wider angle of attack to the lesion more than they increase the working area. In their quantitative anatomic study comparing the 3 surgical approaches (orbitozygomatic, orbitopterional, and pterional) to the anterior communicating artery complex, Figueiredo et al.¹² found that the vertical and horizontal angles of approach were significantly larger with the orbitopterional and orbitozygomatic than the pterional approach. The wider angle of attack and extended areas of exposure provided by the orbitozygomatic craniotomy decreases the need for frontal lobe retraction and resection of the gyrus rectus.

The advantages and disadvantages of 1- and 2-piece orbitozygomatic craniotomy have been described by several authors. Lemole et al.²² reported that the 1-piece method was less predictable in terms of osteotomy placement and preservation of the orbital wall and roof. They did not advocate using the 1-piece method in patients with

FIG. 12. Coronal CT angiogram (A) and T1-weighted MR image (B) showing a giant thrombosed aneurysm of the left supraclinoid ICA with a surrounding vasogenic edema. Reconstruction 3D angiogram (C) confirms the diagnosis and demonstrates a patent aneurysm neck originating from the anterior wall of the supraclinoid ICA. A left supraorbital modified orbitozygomatic approach with drilling of the anterior clinoid process and optic roof was performed, which provided wide exposure and minimized the brain retraction during thrombectomy. Postoperative angiogram (D) demonstrating complete obliteration of the aneurysm neck.

tumors of the sphenoid ridge, elderly patients in whom the dura is very adherent to the bone, or patients with thickened orbital roofs and walls. They recommend conversion of the 1-piece to a 2-piece procedure if mobilization of the bone flap is difficult. From a technical standpoint, Tanriover and colleagues³⁴ criticized the difficulty of performing the intraorbital cut. In their study they quantitatively compared 1- and 2-piece orbitozygomatic craniotomies, concluding that the surgical access achieved with removal of the orbital roof in a 2-piece orbitozygomatic craniotomy significantly exceeds that with the 1-piece method, leading to a better visualization of the basal frontal lobe and a lower incidence of enophthalmos and poor cosmetic outcomes.

The supraorbital (orbitopterional) craniotomy modification is usually applied to lesions of the anterior fossa, middle fossa, and sella.²² This method is best used in anterior communicating artery aneurysms (Fig. 11) and supraclinoid ICA aneurysms (Fig. 12). In our surgical practice, modified supraorbital craniotomy often provided sufficient exposure in tumors of the orbit (Fig. 13), parasellar region (Fig. 14), and anterior and middle fossae (Fig. 15). It reduces the need for brain retraction. Andaluz et al.⁵ found that this approach improved the observation of the anterior communicating artery complex significantly, compared with the classical pterional approach. They reported that orbitopterional craniotomy permits

FIG. 13. Preoperative axial (A) and sagittal (B) T1-weighted, contrast-enhanced MR images, and a sagittal MR angiogram (C) demonstrating a large and extremely vascular fibrous tumor of the orbit. A left extradural supraorbital modified orbitozygomatic approach with optic roof drilling was performed to access this tumor transcranially. Postoperative, T1-weighted, contrast-enhanced axial MR image (D) demonstrating GTR at the 3-month follow up.

rapid identification and isolation of the ipsilateral A_1 segment, and also adhesions between the aneurysm and the contralateral A_2 segment, which are often obscured with a pterional approach, can be better observed and treated with this approach. Lemole et al.²² reported the use of this modification to treat sellar lesions, including ICA segment aneurysms and sellar tumors.

Conclusions

In providing access to the anterior and middle cranial fossae as well as the deep sellar and basilar apex regions,

the orbitozygomatic approach has revolutionized skull base surgery. The increased bone removal from the skull base with this technique has obviated the need for vigorous brain retraction and offered an improved multiangled trajectory and shallower surgical field. Modifications to the orbitozygomatic technique provide alternatives that can be tailored to particular lesions, enabling the surgeon to choose the best technique for each individual case rather than using a “one size fits all” approach.

Disclaimer

The authors do not report any conflict of interest concerning the materials and methods used in this study or the findings specified in this paper.

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FIG. 14. Axial (A) and sagittal (B) T1-weighted, contrast-enhanced MR images demonstrating a large tuberculum sella meningioma. A right supraorbital modified orbitozygomatic approach was performed. The exposure allowed extradural drilling of the anterior clinoid process and optic roof, which provided removal of the portion within the optic canal. This approach also significantly reduces the risk of optic nerve injury during intradural dissection. Sagittal T1-weighted contrast-enhanced MR image (C) demonstrating GTR without recurrence 1 year postoperatively.

FIG. 15. Axial T1-weighted (A), axial T2-weighted (B), and sagittal T1-weighted, contrast-enhanced (C) MR images show a large planum sphenoidale meningioma. Three-dimensional (D) and conventional (E) angiograms reveal a highly vascular tumor and compression of the regional vasculature. In this case, a left supraorbital modified orbitozygomatic approach was performed. Postoperative, contrast-enhanced, T1-weighted axial (F) and coronal (G) MR images demonstrating GTR without recurrence 1 year postoperatively.

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