The One-Piece Orbitopterional Approach

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ABSTRACT

The orbitopterional approach is an anterior skull base extension of the pterional approach that provides greater exposure to the anterior cranial fossa, supra- and parasellar regions, and anterior communicating artery complex. We describe the surgical technique in a stepwise manner to create a one-piece orbitopterional craniotomy flap; keyholes for the bone cuts are the MacCarty burr-hole and the anterolateral portion of the inferior orbital fissure. This one-piece technique is less complicated than the two-piece orbitopterional craniotomy and eliminates the need for complex reconstruction of cosmetically important areas (i.e., the orbit and forehead).

KEYWORDS: Orbitopterional, anterior skull base, orbital osteotomy

Our experience with the one-piece orbitopterional approach evolved from our earlier experience with the two-piece approach. The two-piece flap consisted of a pterional craniotomy with the addition of an orbital osteotomy. Based on the excellent cosmetic results obtained in patients who underwent the one-piece frontotemporal orbitozygomatic osteotomy (FTOZ), we modified the orbitopterional approach into a one-piece craniotomy, the technical aspects of which are presented in this report.

SURGICAL TECHNIQUE

We have divided this surgical procedure into seven key steps.

Step 1: Patient Positioning and Skin Incision The patient is placed in the supine position with the head secured in a Mayfield headrest (Ohio Medical Instruments, Cincinnati, Ohio). The head is rotated ~45° to the contralateral side of the approach. A 30° cervical extension brings the zygoma

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to the highest point, allowing the frontal lobe to separate from the floor of the anterior cranial fossa. When possible, a hair-sparing incision is used. The incision starts 1 cm below the zygoma and follows the hairline ~3 cm beyond the midline on the contralateral side. After the scalp flap is reflected inferiorly with fishhooks, the pericranium, which is elevated as a separate layer, is also reflected inferiorly.

Step 2: Mobilization of the Temporalis Muscle A subfascial dissection of the temporalis muscle aponeurosis avoids injury to the frontalis branch of the facial nerve¹⁻³ and facilitates closure. A small myofascial cuff is left attached to the superior temporal line before dissection of the temporalis muscle.^{4,5} Inferior reflection of the flap is completed on exposure of the supraorbital ridge and lateral wall of the orbit and identification of the anterolateral portion of the inferior orbital fissure in the temporal fossa.

Step 3: Dissection of the Periorbita Using a Penfield No. 1 dissector, the periorbita is dissected off the orbital cavity laterally to medially to help preserve the periorbita. The medial extension of the periorbital dissection is the supraorbital notch; the supraorbital nerve is preserved. A Penfield No. 4 dissector is directed over the periorbita along the inner surface of the lateral wall of the orbit in a superior-to-inferior trajectory until the upper rim of the anterolateral portion of the inferior orbital fissure is palpated. Once this landmark is identified, the dissector is used to pierce the anterolateral portion of the inferior orbital fissure and to visualize or palpate in the temporal fossa. This maneuver is safe because the anterolateral portion of the inferior orbital fissure contains only fibroadipose tissue.

Step 4: MacCarty and Temporal Burr-Holes Using a high-speed pneumatic drill (Midas Rex, Fort Worth, Texas), a MacCarty burr hole is cut over the frontosphenoidal suture, ~1 cm behind the frontozygomatic junction (i.e., juncture of the frontal process of the zygomatic bone and zygomatic pro-

cess of the frontal bone).⁶ This burr-hole is usually located 5 to 10 mm below the standard pterional keyhole burr hole described by Dandy.^{7,8} To access the frontal fossa and orbital cavity, the MacCarty burr-hole opening diameter is about twice the size of a regular burr hole. When placed appropriately, the MacCarty burr-hole presents a posterosuperior half that exposes the basal frontal dura and an anteroinferior half that exposes the periorbita. Care should be taken to distinguish between the frontozygomatic and the frontosphenoidal sutures. Burr-hole placement at the frontozygomatic suture exposes only periorbita.⁷

A second burr-hole placed superior to the root of the zygoma exposes the temporal basal dura and serves as a temporal keyhole for the craniotomy. The dura is carefully dissected before proceeding with the bone cuts.

Step 5: Bony Cuts for the One-Piece Bone Flap Using a B1 footplate, the first cut is made at the temporal keyhole and carried toward the supraorbital notch in a curvilinear fashion until resistance from the orbital roof is encountered (Fig. 1A). Staying lateral to the supraorbital notch decreases the risk of frontal sinus penetration; however, penetration may be unavoidable in the presence of a developed frontal sinus. When the sinus is penetrated, the sinus mucosa is reflected inferiorly. The sinus cavity is plugged with muscle, sealed with a hydroxyapatite compound, and covered with a vascularized pericranium graft.

A second cut, again from the temporal keyhole, is directed anteriorly traversing the squama of the temporal bone projecting toward the inferior aspect of the MacCarty burr-hole until the sphenoid ridge is reached (Fig. 1A).

A third cut is made, again with the B1 footplate attachment, starting at the MacCarty keyhole along the lateral wall of the orbit until the anterolateral portion of the inferior orbital fissure is reached. This cut can be performed safely under direct visualization of the footplate from the orbital cavity by

Figure 1 The one-piece orbitopterional approach. (A) Lateral view of the skull shows the location of the burr holes and all the bony cuts in sequential order. 1 = starts at temporal keyhole toward the supraorbital notch. 2 = from the temporal keyhole to the sphenoid ridge. 3 = from the MacCarty keyhole to the anterolateral portion of the inferior orbital fissure (IOF). 4 = from the anterolateral portion of the IOF through the lateral wall of the orbit. 5 = from the first cut anteriorly into the orbital cavity and lateral to the supraorbital notch. 6 = from the infraorbital part of the fifth cut to the MacCarty keyhole along the orbital roof. (B) Shows in detail the orbit and all the bony cuts in sequential order (printed with permission from the Mayfield Clinic, Cincinnati, Ohio).

placing a brain spatula into the orbit to retract and protect its contents (Fig. 1A and B). The anesthesiologist should be warned about the possibility of bradycardia from the oculocardiac reflex as a result of retraction on the ocular globe. The fourth cut, continuous with the third, is made by changing the direction of the footplate 90 degrees anteriorly once into the anterolateral portion of the inferior orbital fissure. The lateral wall and lateral rim of the orbit are cut in a direction parallel to the superior edge of the zygomatic arch traversing the frontal process of the zygomatic bone (Fig. 1A and B).

The fifth cut, using either the B1 or the B5 attachment, extends from the first cut anteriorly into the orbital cavity, staying laterally to the supraorbital notch (Fig. 1B). The final drilling is made over the line of the second cut with the B1 or B5 drill bit over the sphenoid ridge, which is thinned to elevate the bone flap. This cut should continue the projected line between both keyholes.

The last cut extends from the intraorbital part of the fifth cut to the MacCarty keyhole along the

orbital roof (Fig. 1B). After gentle retraction of the orbital contents, an osteotomy is made ~2 cm posterior to the superior orbital rim with a small, straight chisel. To avoid damage to the optic nerve, this cut should not be extended more than 3 cm posterior to the orbital rim. This 2-cm distance has proven to avoid injury of the optic nerve and neurovascular structures of the orbital apex (superior quadrant, 38 mm; lateral quadrant, 36 mm).⁹

Step 6: Elevation of the One-Piece Flap After the cuts are completed, the flap is gently elevated. If resistance is met, the bony cuts are explored and completed. Areas that often require further work include the orbital roof and sphenoid wing. After elevation of the flap, the frontal sinus is immediately obliterated as described, if necessary. The sphenoid wing is drilled away with the B1 bit until the superior orbital fissure is reached.

The dura is opened in a semicircular fashion. Tenting sutures placed at the base of the dural flap achieve maximal exposure and obviate the need to

place retractors on the ocular globe. After the dura is reflected, the operative microscope is brought into the surgical field. Gentle application of a single retractor under the frontal lobe usually suffices to expose the ipsilateral optic nerve and optico-carotid cistern. Several lesions, including anterior communicating artery (ACoA) aneurysms and suprasellar or infrachiasmatic tumors, can be approached with minimal brain retraction and without dissection of the sylvian fissure.

Step 7: Closure After the procedure is completed, the dura is closed in a watertight fashion and the bone flap is reapplied and fixed with titanium miniplates. To ensure a cosmetic closure, the bone flap is positioned carefully to maintain the natural curves of the orbital rim and lateral wall. The myocutaneous flap is closed in a standard fashion. Insertion of a subgaleal drain prevents the collection of fluid under the flap and decreases palpebral swelling.

DISCUSSION

Following Jane's description of the supraorbital approach for suprasellar lesions and ACoA aneurysms in 1982,¹⁰ various authors have proposed several refinements of this procedure with considerable variation.¹¹⁻²² We have attempted to clarify this technique by presenting the key steps and describing the surgical anatomy.

Comparison of the Orbitopterional and Pterional Approaches

We recently reported on the results of a cadaveric study that quantified the increased exposure provided by orbitopterional versus standard pterional approaches.²³ Using frameless stereotaxy and taking the midpoint of the ACoA as the target, we determined that the axial angle of approach was substantially

greater in the orbitopterional (mean, 73 degrees) than in the pterional approach (mean, 50 degrees) ($p < 0.01$). This is a 46% increase in the circumferential visualization of the frontobasal interhemispheric fissure. The amount of bony resection provided by the orbital osteotomy improved the angle of visualization of the ACoA in the projection plane (halfway between the coronal and sagittal planes) by 11 degrees or 137.5% ($p < 0.01$).²³ Thus, the orbitopterional approach increases visualization of the midline structures of the anterior cranial fossa, allows multiple trajectories, and provides a larger working space to approach lesions in this region.

The orbitopterional approach differs from the FTOZ craniotomy.^{24,25} With use of the orbitopterional approach, resection of the zygomatic arch is not needed and extension of the temporal craniotomy is considerably less. Furthermore, the orbitopterional approach differs from the frontal variant of the FTOZ craniotomy in which most of the orbital roof remains intact.⁷

Advantages of a One-Piece Orbitopterional Osteotomy

Compared with a standard pterional approach, the orbitopterional approach offers the following advantages: (1) multidirectional viewing of midline structures of the anterior skull base allowing dissection from multiple routes (i.e., subfrontal, trans-sylvian); (2) basal exposure with minimal brain retraction; (3) minimal or no dissection of the sylvian fissure; and (4) shorter distance to the surgical target. Potential complications of both the orbitopterional and pterional craniotomies include cosmetic deformity, enophthalmos, oculomotor muscle damage, and blindness.

Although simple to understand, the two-piece orbitopterional approach can create undesirable cosmetic results by extensive drilling of the frontal bone at the level of the forehead and lateral wall of the orbit. Patients may develop enophthalmos or no-

ticeable bony defects in the forehead and temporal region after surgery when bone is removed during drilling of the lateral wall of the orbit. In some patients, fixation miniplates may be palpated and can cause irregularities and discomfort in the above-mentioned regions. With a one-piece orbitopterional approach, surgeons use the MacCarty burr-hole and the anterolateral portion of the inferior orbital fissure as keyholes that become relatively simple to understand and to achieve in a short time. Reconstruction is faster and less costly because fewer miniplates are used, and cosmetic results are better.

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