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Eyelid approach to the anterior cranial base

Technical note

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Skull base approaches play a fundamental role in modern neurosurgery by reducing surgical morbidity. Increasing experience has allowed surgeons to perform minimally invasive approaches without straying from the premises of skull base surgery. The eyelid approach has evolved from the orbitopterional osteotomy into a more effective and targeted approach to disease of the anterior cranial fossa. In this technique, after an incision is made on the supratarsal fold, the orbicularis oculi muscle is incised, and a myocutaneous flap composed of the elements of the anterior lamella is elevated. Subperiosteal dissection is used to expose the superior and lateral walls of the orbit, the superior and lateral orbital rim, and the frontosphenoidal suture. A MacCarty bur hole is drilled, and a frontal osteotomy is fashioned medial to the supraorbital notch and extending through the orbital roof back toward the orbital half of the MacCarty bur hole, exposing the frontobasal brain. A conventional microsurgical technique is used to treat tumors and aneurysms of the anterior cranial fossa under the operative microscope.

Five patients were treated for unruptured aneurysms of the anterior circulation (3 anterior communicating artery aneurysms, 1 ophthalmic artery aneurysm, and 1 posterior communicating artery aneurysm) using the eyelid approach. The mean aneurysm size was 5 mm, and all aneurysms were approached from the right side. Three tumors in the anterior fossa (2 suprasellar pituitary adenomas and 1 craniopharyngioma) were also excised using this approach. There was no surgical morbidity. Three months after surgery all patients presented excellent cosmetic results. The eyelid approach may be considered as an effective, cosmetically beneficial, and minimally invasive skull base approach to selected aneurysms and tumors of the anterior circulation. *(DOI: 10.3171/JNS/2008/109/8/0341)*

Key Words • anterior skull base • eyelid approach • orbital osteotomy

The addition of an orbital osteotomy has become a very popular and useful resource in anterior cranial base surgery. Several anatomical and clinical reports document its benefits in terms of increased exposure, decreased brain retraction leading to a lower incidence of frontobasal retraction injury, and obviation of sylvian fissure dissection, another potential cause of surgery-induced brain injury.[2,3,6,7,12,13,14,19,33–35,44]

A critical analysis of these approaches shows that a large part of the structures (bone, dura mater, and brain) exposed during a standard cranioorbital craniotomy is in many cases far from the area of interest of the surgical procedure.[14] Therefore, exposure of those structures does not add any significant advantage to the procedure itself. Based on this observation, and on the increasing experience of keyhole neurosurgery, several minimally invasive approaches that reach the anterior fossa through a small craniotomy in the frontoorbital region have been reported in the literature.[4,6,7,11–13,18–20,27,29,30,33–35,37,38,40,41,43] A mini supra- or transorbital roof craniotomy and its variations have been described in which the procedure is performed through an incision in the eyebrow[4,6,11,13,18,19,29,33,35,37,38,40] or through the standard frontotemporal incision behind the hairline.[20,30,34,43] Cosmetic outcomes after either incision, however, may not be optimal. Based on the vast experience from ocular plastic surgery, we describe a transeyelid, supratarsal, transorbital roof minicraniotomy. We also report on clinical data from our initial series of 8 patients in whom the eyelid approach was performed.

Methods

A key anatomical element in surgical upper eyelid reconstruction is the orbital septum, which represents the anatomical boundary between the lid tissue and the orbital tissue, and divides the eyelid into 2 lamellae: 1) an anterior lamella, which includes the skin and the orbicularis muscle, and 2) a posterior lamella, which includes

Abbreviation used in this paper: ACoA = anterior communicating artery.

the tarsal plate, the conjunctiva, and the eyelid retractors (levator muscle, aponeurosis, and the Müller muscle; Fig. 1). The orbital septum is a connective tissue structure that attaches peripherally at the periosteum of the orbital margin and fuses centrally with the lid retractor structures near the lid margins, thus acting as a diaphragm to retain orbital contents. Details on the anatomy of the eyelid can be found elsewhere.[8–10,16,21–24,31,32,36,39,45]

The patient is placed in the supine position with the head secured in a 3-pin headrest. The head is rotated ~ 45° to the contralateral side of the approach. A 30° cervical extension brings the zygoma to the highest point, allowing the frontal lobe to separate from the floor of the anterior cranial fossa.

Initially, a temporary tarsorrhaphy is performed to protect the cornea, which is covered with a bland antibiotic ointment. A 2.5–3.5-cm upper eyelid incision is marked on the eyelid crease. If no crease is detectable, a curvilinear incision line along the supratarsal fold extending over the lateral orbital rim is marked (Fig. 2). The incision may be extended laterally as necessary. The incision should begin at least 10 mm superior to the upper lid margin and 6 mm above the lateral canthus at its lateral extension. After marking the skin incision, a local anesthetic with a vasoconstrictor is injected along the planned incision line. An additional vasoconstrictor may be injected supraperiosteally in the superolateral orbital rim. The incision is made through the skin and sharp dissection is carried through the orbicularis muscle. The vasculature of the muscle maintains the viability of the skin when they are elevated together, leading to excellent healing.

Sharp dissection is performed in a superior and lateral dissection to create a myocutaneous flap composed of the elements of the anterior lamella (eyelid skin, orbicularis muscle, and aponeurosis), which is elevated from the orbital septum. The dissection then continues above the septum to the superior and lateral aspect of the orbital rim. The area exposed extends medially to the supraorbital notch and nerve superomedially to a point approximately 1–2 cm below the frontozygomatic junction inferolaterally (Fig. 3). The supraorbital nerve is preserved and dissected off the supraorbital notch.

The myocutaneous flap is retracted and a periosteal incision is made on the anterior aspect of the orbital rim. Blunt subperiosteal dissection is performed toward the orbital roof, making every effort to preserve the periorbita in continuity with the reflection of the orbital septum anteriorly, to avoid herniation of the orbital contents (Fig. 4). When reflecting the periosteum from the lateral orbital rim into the orbit, care must be exerted to preserve the periorbita at the lacrimal fossa, a deep concavity in the superolateral orbit. If the periorbita is violated, the lacrimal gland may herniate into the surgical field. This can usually be avoided by turning the periosteal elevator almost directly laterally inside the orbital rim.

Once the orbital roof and lateral wall are exposed, the temporalis muscle covering the lateral wall of the orbit is posteriorly mobilized using subperiosteal dissection, leaving a small cuff attached to the superior temporal line for a cosmetic closure. The frontosphenoidal

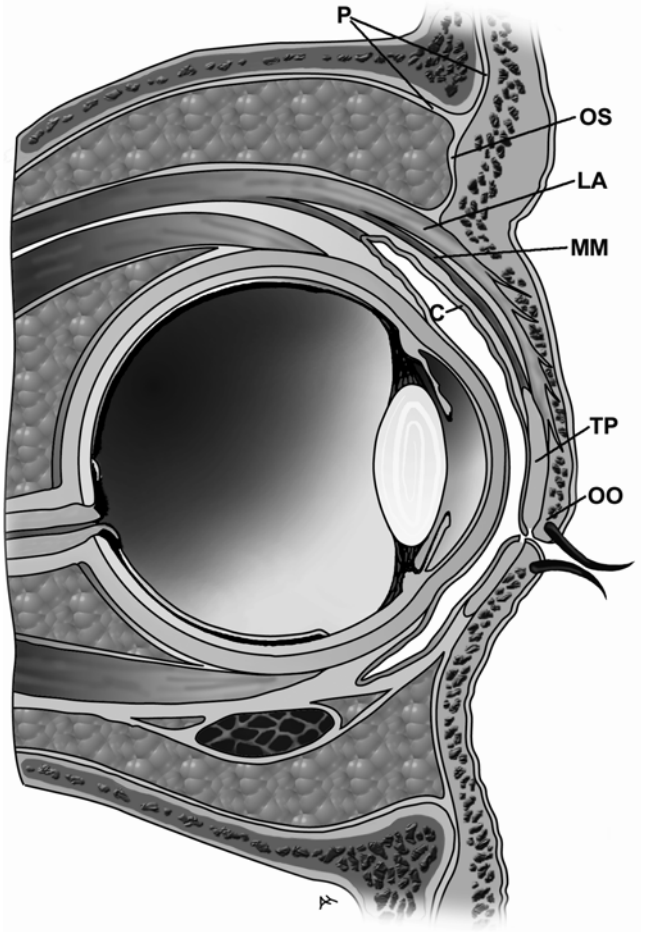

FIG. 1. Illustration of a sagittal section through the orbit and globe. C = palpebral conjunctiva; LA = levator palpebrae superioris aponeurosis; MM = Müller muscle; OO= orbicularis oculi muscle; OS = orbital septum; P = periosteum/periorbita; TP = tarsal plate.

junction is exposed, and a MacCarty bur hole is made using a high-speed pneumatic drill to provide access to the anterior fossa and the orbital cavity (Fig. 5).[3,4,25] Using a B1 footplate and a bone chisel, a 1-piece transorbital roof supraorbital minicraniotomy incorporating the lateral wall of the orbit is fashioned, as depicted in Fig. 6 and described in other studies.[2,4, 6,11,13,17–19,28,29,33,35,37,38,40]

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 field to proceed with the surgical procedure. Gentle application of a single retractor under the frontal lobe usually suffices to expose the ipsilateral optic nerve and opticocarotid cistern. After the procedure is completed, the dura is closed in a watertight fashion and the bone flap reapplied and fixed with titanium miniplates. Care is taken in positioning the bone flap to maintain the natural curves of the orbital rim and lateral wall, ensuring a cosmetic closure. The wound is closed in 3 layers: the periosteum, the muscle, and the

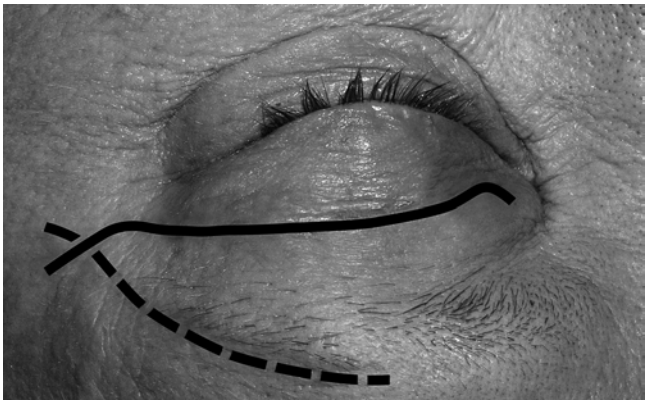

FIG. 2. Cadaveric dissection photograph depicting the location of the skin incision on the supratarsal fold for the eyelid approach *(solid line)* in comparison with the eyebrow incision *(dotted line)*. Reprinted from *Neurosurgical Approaches: A Dissection Guide for Residents*, Mayfield Clinic, Cincinnati OH, 2007, with permission from the Mayfield Clinic.

skin. It is especially important to close the orbicularis muscle laterally, over the orbital rim, to prevent thinning of the soft tissues covering the bone.

Results

A total of 5 patients (3 men and 2 women, mean age 52 years) were treated for unruptured aneurysms of the anterior circulation (3 ACoAs, 1 ophthalmic artery aneurysm, and 1 posterior communicating artery aneurysm) using the eyelid approach. Mean aneurysm size was 5 mm. All aneurysms were approached from the right side. The mean hospital stay for the patients was 2.2 days. There was no surgical morbidity. Three months after surgery all patients presented with excellent cosmetic results (Fig. 7).

Three tumors in the anterior fossa (2 suprasellar pituitary adenomas and 1 craniopharyngioma) were resected

FIG. 3. Cadaveric dissection photograph shows the myocutaneous flap sharply dissected. Notice the preservation of the orbital septum. Reprinted from *Neurosurgical Approaches: A Dissection Guide for Residents*, Mayfield Clinic, Cincinnati OH, 2007, with permission from the Mayfield Clinic.

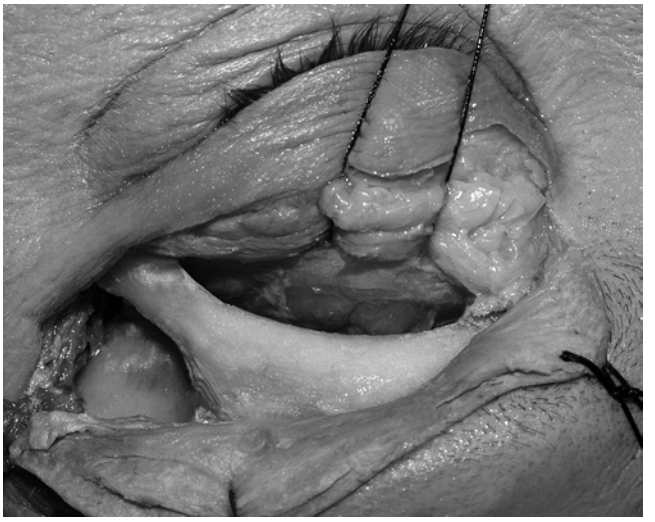

FIG. 4. Photograph of a subperiosteal dissection in a cadaveric specimen. The orbital contents contained by the intact periorbita and orbital septum are retracted inferiorly from the superolateral orbital cavity. Reprinted from *Neurosurgical Approaches: A Dissection Guide for Residents*, Mayfield Clinic, Cincinnati OH, 2007, with permission from the Mayfield Clinic.

FIG. 5. Photograph from a cadaveric specimen showing the MacCarty bur hole. A bur hole is placed in the frontosphenoidal suture, exposing the orbital roof, the anterior fossa dura in its posterosuperior half (1), and the periorbita in its anteroinferior half (2). Notice the dissector through the anteroinferior half of the bur hole from the orbital side. Reprinted from *Neurosurgical Approaches: A Dissection Guide for Residents*, Mayfield Clinic, Cincinnati, OH, 2007, with permission from the Mayfield Clinic.

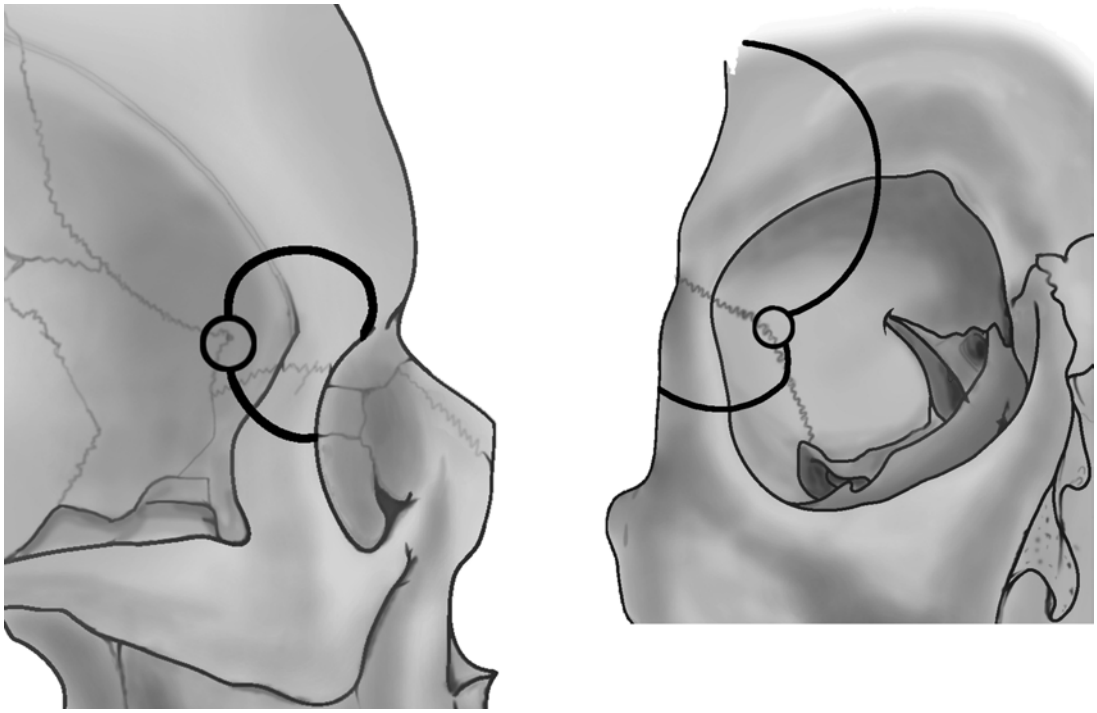

FIG. 6. Lateral skull *(left)* and anteroposterior orbital *(right)* views depicting cuts for a transsupraorbitral minicraniotomy. An initial, semicircular cut is carried through the frontal bone originating from the MacCarty bur hole toward the lateral aspect of the supraorbital notch. A second cut extends through the lateral wall of the orbit with an inferior and anterior trajectory originating from the MacCarty bur hole. A third cut extends the first one through the roof of the orbit in the sagittal plane. A final, fourth cut connects the latter with the MacCarty bur hole through the orbital roof.

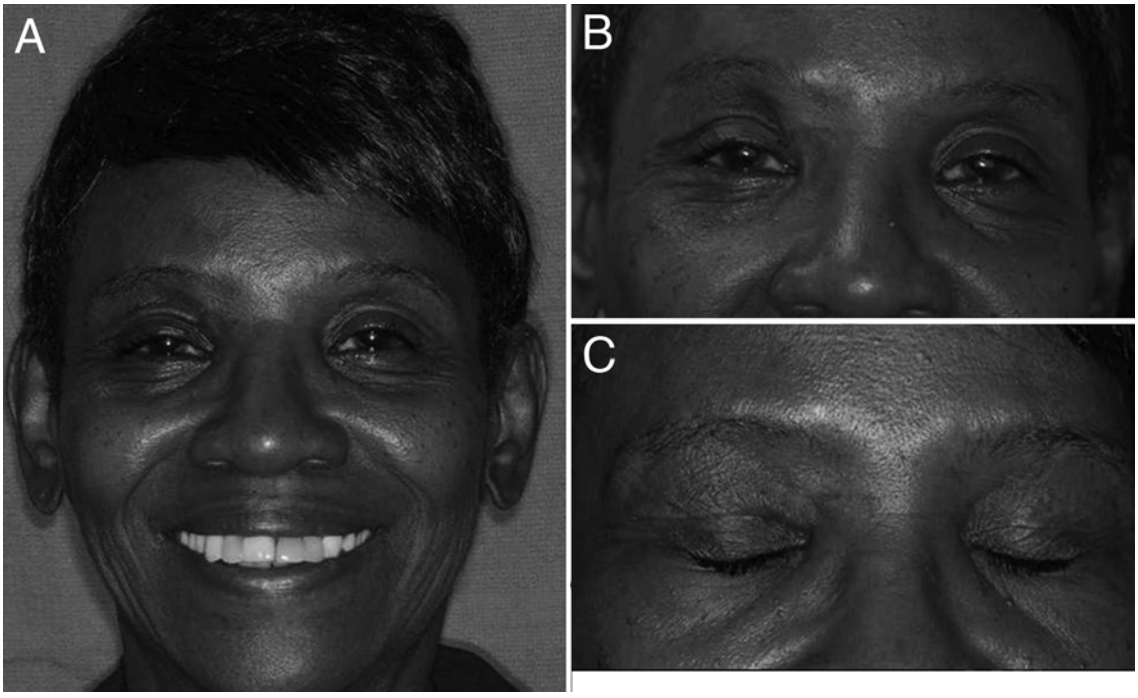

FIG. 7. Photographs showing excellent cosmetic results in a woman 12 weeks after clipping of an unruptured ACoA aneurysm using the eyelid approach.

in 3 women (mean age 33 years) using this approach. The hospital stay averaged 3 days, there was no surgical morbidity, and all patients showed excellent cosmetic results at 3 months (Fig. 7).

Discussion

Using an orbital roof craniotomy to approach lesions of the anterior cranial fossa was described by Jho in 1997[19] as a modification of a procedure performed by Frazier in 1913.[15] In recent years, many authors have described similar approaches with minor variations to treat aneurysms of the anterior circulation, particularly of the ACoA, and tumors of the floor of the anterior fossa and sellar region.[4,6,11,13,18–20,29,30,33–35,37,38,40,43] The benefits of adding an orbital osteotomy to the pterional approach when treating aneurysms of the ACoA complex have been previously reported in cadaveric and clinical studies.[1,2,13,14]

A number of approaches that involve a supraorbital and/or transorbital roof craniotomy via a supraciliary or standard frontotemporal incision have been described.[3,6,11,13,18–20,29,30,33–35,37,38,40,43] Although the potential benefits of a transorbital roof approach remain the same using any particular incision, cosmesis takes a more significant role in minimally invasive surgery outcome. A frontotemporal incision behind the hairline generates an excessively large flap for a small craniotomy and may involve the optional use of subgaleal drains, shaving (although hair-sparing is an alternative), or incising the forehead in patients with alopecia or a receding hairline. The cosmetic results of a supraciliary incision may be affected by unsightly scar tissue formation, eyebrow alopecia, scarring leading to asymmetric eyebrows, and unsightly scars due to an extension of the eyebrow incision through the forehead, among others.

The most direct and cosmetically appealing approach to the superolateral orbital rim is the upper eyelid approach, also called upper blepharoplasty, upper eyelid crease, and supratarsal fold approach. A natural skin crease in the upper eyelid is used to make the incision. Based on the substantial experience in ocular plastic surgery with blepharoplasty,[8,23,26] the superior eyelid incision has been described to treat lesions of the orbit.[9,16,17,22,24,31] By extending its application to the surgical approach of the anterior cranial base, we found that it allows for a good exposure in select cases, with a cosmetic result that is superior to that obtained with an eyebrow incision. The risk of temporalis muscle atrophy that may occur in association with the extensive dissection required for a standard pterional approach is avoided, and the temporomandibular joint pain frequently reported by patients who undergo a pterional craniotomy and its variants is eliminated. The minimal dissection of soft tissue required also reduces the risk of injury to the frontalis branch of the facial nerve; cosmetic results are superior.

There has been criticism of the variety of transorbital approaches to the anterior fossa, based on the premise that traditional approaches carry the advantage of familiarity, especially for less experienced neurosurgeons, and because of the risks involved with potential damage to the orbital contents.[5,42,44] As implied, it is imperative to possess an excellent understanding of the anatomy and the so-called classic approaches (the pterional approach) prior to undertaking the eyelid approach, which may appear simple, but may become very problematic for those less-experienced surgeons. We have only used this approach for unruptured aneurysms of the anterior circulation that presented a favorable angiographic configuration (such as smaller size and clear anatomical delineation of the vessels in the proposed surgical trajectory). We have also used this technique for tumors of the anterior fossa that were believed to be amenable to the approach (craniopharyngiomas and suprasellar pituitary tumors). As Figueiredo and colleagues[13] have stated, selection for this approach should not be based upon the anatomical structures to be exposed, but rather on the vector or working angles anticipated to be required.

When appropriately selected, the eyelid approach provides satisfactory access to the anterior cranial fossa and sellar region, decreasing the need for brain retraction and minimizing the dissection of soft tissues. The final result is the exposure of an adequate effective working space in a shorter surgical duration. Decreased surgical trauma and postoperative pain, shorter hospital stays, and excellent cosmetic results add to the fulfillment of the premises of minimally invasive surgery in a select patient population.

Conclusions

The eyelid approach may be considered as an effective, cosmetically beneficial, and minimally invasive skull base approach alternative to select tumors and aneurysms of the anterior circulation.

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