8 The Fronto-Temporo-Orbito-Zygomatic Approach

Roberto Delfini, Andrea Gennaro Ruggeri, and Sara Iavarone

8.1 Introduction

Evolution toward the current concept of the frontal-temporo-orbit-zygomatic approach has been progressive. In 1982, Jane et al. described the "supraorbital approach" which allowed access to the floor of the anterior cranial fossa and the superior portion of the orbit with minimal retraction through a craniotomic operculum incorporating the superior orbital rim and part of the roof of the orbit [1]. Al-Mefty [2, 3] modified this approach by incorporating the superior and lateral margins of the orbit with a pterional craniotomy and then removing them in one piece. In 1984, Pellerin et al. [4] described an orbitofrontal craniotomy with removal of the lateral wall of the orbit, malar eminence, and zygomatic arch in surgical treatment of meningiomas of the sphenoid wing. Hakuba et al. [5] described the infratemporal orbitozygomatic approach as a useful technique for lesions located in the parasellar region and interpeduncular fossa, including meningiomas of the medial third of the sphenoid wing, petroclival meningiomas, trigeminal neuromas, and aneurysms of the basilar top. Their method involved preserving a large part of the skull base with three separate bone fragments. Alaywan and Sindou [6], and McDermott et al. [7] described a two-piece orbitozygomatic approach with fronto-temporal and orbitozygomatic bone opercula removal. In 1998, J. Zabramski et al. reported a variant of the orbitozygomatic approach in two pieces according to a technique that is currently the most widely used [8].

8.2 Surgical Technique

8.2.1 Patient Position and Skin Incision

The patient is positioned supine on the operating table with the head locked in the Mayfield head holder and rotated 30° (to a maximum of 60°) toward the side contralateral to the surgical incision. Rotation is greater for tumors and vascular lesions of the anterior and middle cranial fossae and less for those involving the clivus and posterior cranial fossa. The neck is slightly extended so that the malar eminence is positioned at the highest point of the operating field, thus allowing a spontaneous retraction of the frontal lobe with respect to the roof of the orbit [8].

The skin incision begins 1 cm anterior to the tragus, at the level of the lower edge of the zygomatic arch. It then proceeds upward and forward in a slightly curved arc to reach just behind the point where the hairline intersects the contralateral midpupillary line (Fig. 8.1). The inferior portion of the incision must be limited to avoid

R. Delfini (✉) · A. G. Ruggeri · S. Iavarone
Division of Neurosurgery, Department of Neurological Sciences, University of Rome Sapienza, Rome, Italy

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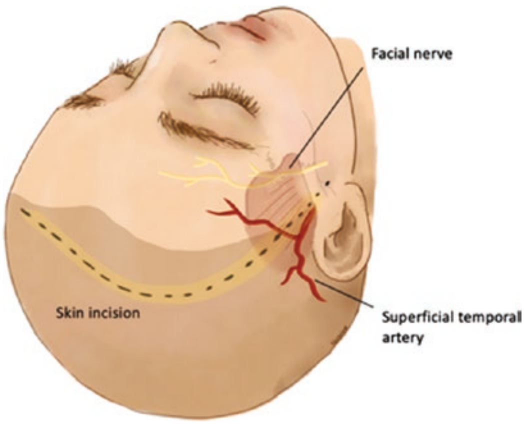

Fig. 8.1 The skin incision extends from the lower edge of the zygomatic arch to the contralateral midpupillary line. (Illustration by Sara Iavarone)

injury to the frontotemporal branch of the facial nerve. The division of the frontotemporal branch into the zygomatic and temporal branches occurs within the parotid gland and the point where the anterior and middle branches diverge from the frontotemporal branch of the facial nerve is approximately 1.1 cm below the tragus [9].

8.2.2 Elevation and Preservation of the Skin Flap and Frontal Branch of the Facial Nerve

The skin flap is mobilized anteriorly to expose the underlying superficial temporal fascia. The frontal periosteum is preserved. The frontotemporal branch of the facial nerve is located in the subgaleal fat pad. To avoid injuring this branch, the subgaleal dissection must be interrupted 2.5–3 cm posterior to the superior margin of the orbit in its lateral portion. Subfascial dissection is then performed via an incision of the superficial temporal fascia. The subfascial dissection begins posteriorly and extends forward along the margin of the superior temporal line. This technique offers the possibility of protecting the branches of the facial nerve located in the superficial portion of this fascial plane (Fig. 8.2). The frontotemporal branch of the facial nerve emerges from the parotid gland in multiple branches located in the subgaleal space, in the same plane as the superficial fat pad. In the study described by Ammirati et al. [10], it was found that in 30% of the cases examined, some branches of the middle division of the frontotemporal branch of the facial nerve run within the interfascial space and enter the temporal muscle. This finding may explain why interfascial dissection, conventionally used for pterional craniotomy, carries a 30% risk of injury to these branches.

In order to obtain a better approximation of the temporal muscle in the reconstructive phase, it is useful to leave a myofascial cuff along the superior temporal line.

Dissection proceeds by raising the temporal fascia in the plane between the deep layer and the muscle to anteriorly expose the cheekbone and superior orbital margin. The deep layer of the temporal fascia (fused with the periosteum of the zygomatic process of the frontal bone and the cheekbone) is separated subperiosteally to obtain full exposure of the upper margin of the orbit, the zygomatic process, and the malar eminence as far as the zygomatic-facial foramen and zygomatic arch.

The temporal muscle is incised near the posterior portion of the skin incision and elevated subperiosteally using the retrograde technique described by Oikawa et al. [11], i.e., proceeding from the bottom upward with a dissector, maintaining the integrity of the periosteum and thus protecting the deep vessels as well as nerve and muscle fibers (Fig. 8.3). The prevention of temporal muscle atrophy is an important aspect in the orbitozygomatic approach.

Kadri and Al-Mefty [12] recommended six steps useful for temporal muscle preservation: (1) preservation of the superficial temporal artery; (2) preservation of facial nerve branches by subfascial dissection; (3) zygomatic osteotomy to increase exposure and avoid compression or retraction injuries of the temporal muscle; (4) dissection of the muscle via the retrograde subperiosteal route to preserve the deep vessels and nerves; (5) disengagement of the muscle along the superior temporal line without cutting the fascia; (6) reattachment of the muscle directly to the bone. Alternatively, the muscular cuff can be used to bring the fascia and the temporal muscle

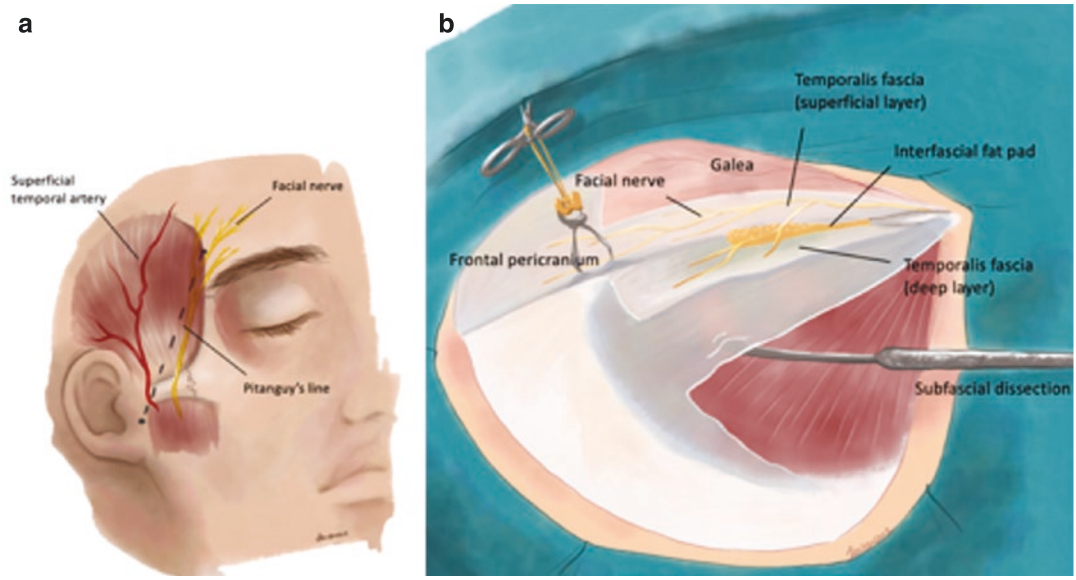

Fig. 8.2 (**a**) The frontal branch of the facial nerve runs posterior to the Pitanguy line: a line passing 0.5 cm below the tragus and 1.5 cm above the lateral end of the eyebrow. (**b**) Illustration of the subfascial dissection of the temporal muscle and the distribution of the fibers of the facial nerve with respect to the anatomical planes. (Illustration by Sara Iavarone)

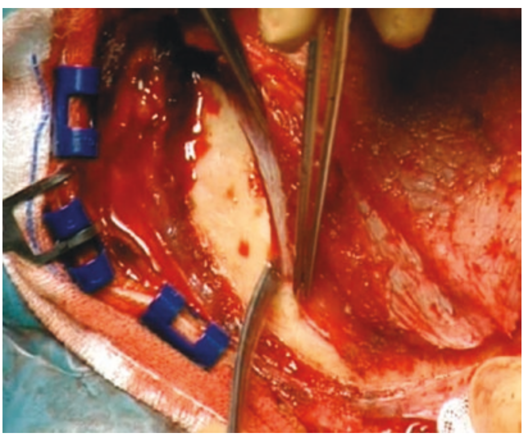

Fig. 8.3 Dissection of the temporal muscle according to the retrograde technique described by Oikawa while preserving the integrity of the periosteum

together according to the technique originally described by Spetzler and Lee [13].

At this point, we proceed medially by blunt dissection to separate the periorbit from the upper and lateral margins of the orbit up to the supraorbital notch (Fig. 8.4). If further medial exposure is required, the supraorbital nerve can be freed from the notch or supraorbital foramen using a small chisel or a burr [9].

8.2.3 Single Piece Orbito-Zygomatic (OZ) Craniotomy

In the single-piece OZ approach, the frontotemporal craniotomy is combined with a series of osteotomies through the orbit and the cheekbone to remove a single craniotomic operculum that includes the roof and lateral wall of the orbit, the lateral surface of the cheekbone, and the zygomatic process of the temporal bone.

Positioning of the keyhole at the MacCarty point (Fig. 8.5) is a fundamental step in order to proceed with the one-piece OZ craniotomy. The keyhole, as described by MacCarty [14, 15], should expose in its upper half the dura mater that lines the frontal lobe and in its lower half the periorbit: the roof of the orbit constitutes the bony bridge that divides the two halves. The drill hole in the MacCarty point is made over the frontosphenoid suture, approximately 1 cm behind

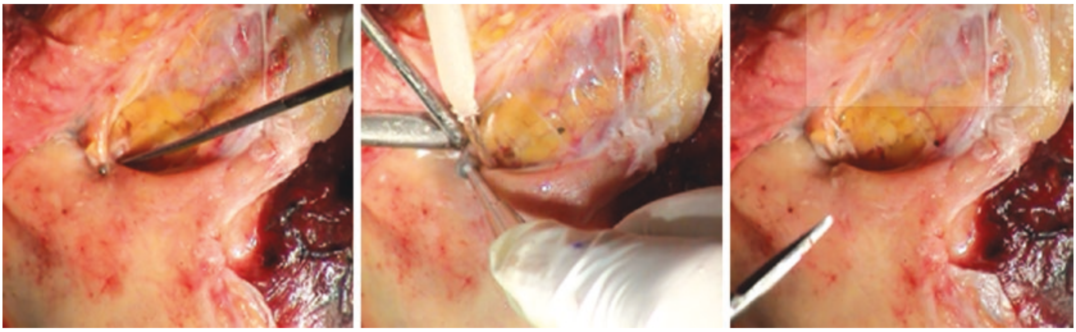

Fig. 8.4 Intraoperative photo showing the supraorbital notch that represents the medial margin of the craniotomy. With the aid of a burr, the supraorbital nerve is freed from the supraorbital notch

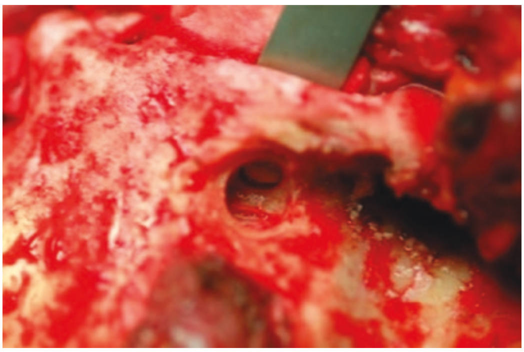

Fig. 8.5 MacCarty point: a bony bridge consisting of the roof of the orbit divides the periorbit from the dura mater that covers the frontal lobe

the frontozygomatic junction. Its diameter is about twice the size of a normal drill hole in order to allow access to the anterior cranial fossa and the orbital cavity.

The six osteotomies are then performed using the craniotome. The first osteotomy extends from the orbital portion of the MacCarty keyhole to the inferior orbital fissure. The second osteotomy crosses the zygomatic body and extends to the inferior orbital fissure: this section is made 1 cm below the angle of junction of the frontal and temporal processes of the zygomatic bone (Fig. 8.6). The osteotomy through the cheekbone meets the cut along the lateral wall of the orbit at the anterolateral edge of the inferior orbital fissure.

The third osteotomy is performed through the anterior root of the zygomatic process of the temporal bone, just in front of the articular tubercle of the zygomatic bone. The zygomatic process is dissected in an oblique direction, providing a stable base for reconstruction.

The fourth and most critical osteotomy of the one-piece OZ craniotomy involves a cut through the upper edge of the orbit and an intraorbital cut along the roof of the orbit (Fig. 8.7).

The fifth osteotomy extends along the frontal and parietal bones and connects the craniotomy holes. The final osteotomy of the single-piece OZ craniotomy connects a temporal craniotomy hole and the frontal compartment of the MacCarty keyhole (Fig. 8.8) [16].

8.2.4 Two-Piece OZ Craniotomy

The two-piece OZ craniotomy combines the pterional craniotomy with a supraorbital osteotomy and removal of a portion of the zygomatic bone (Fig. 8.9).

First, a classic frontotemporal craniotomy is performed. Subsequently, before proceeding with bone cuts, the dura mater must be separated from the frontal bone, from the small wing of the sphenoid and from the middle cranial fossa.

The small wing of the sphenoid is drilled until it reaches the lateral margin of the superior orbital fissure.

During the initial part of the two-piece OZ craniotomy, the osteotomies of the skull base through the anterior root of the zygomatic process of the temporal bone and the zygomatic body are similar to those described in the one-piece OZ craniotomy. The remaining osteotomies

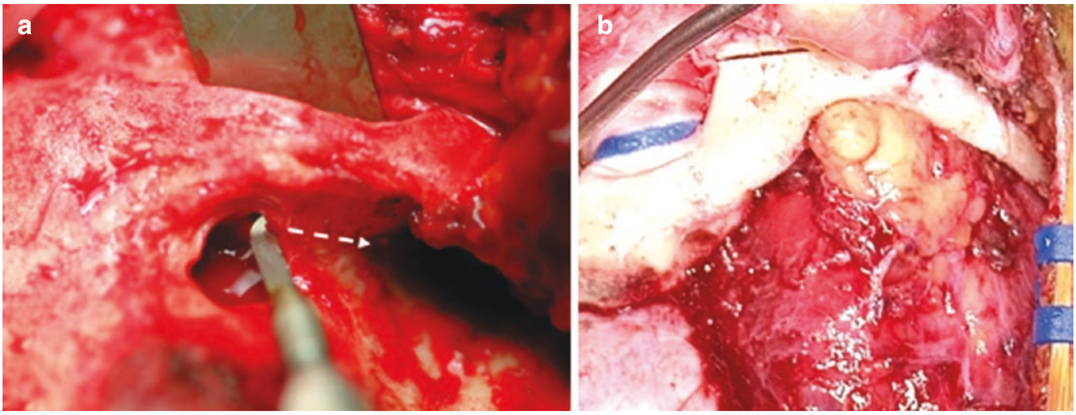

Fig. 8.6 The first cut extends from the orbital portion of the MacCarty keyhole to the inferior orbital fissure (**a**). The second cut crosses the body of the zygomatic bone and reconnects to the first cut at the level of the inferior orbital fissure. The third cut crosses the zygomatic process of the temporal bone just in front of the articular tubercle (**b**)

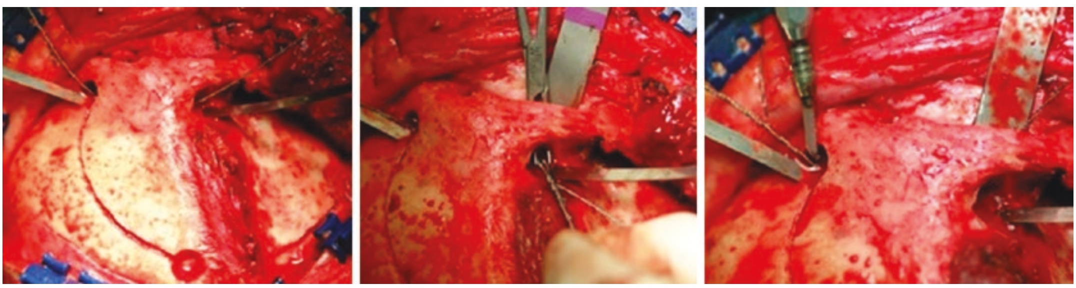

Fig. 8.7 The cut along the roof of the orbit is made using the Gigli saw, connecting the medial margin of the craniotomy at the level of the supraorbital notch to the orbital portion of the MacCarty keyhole

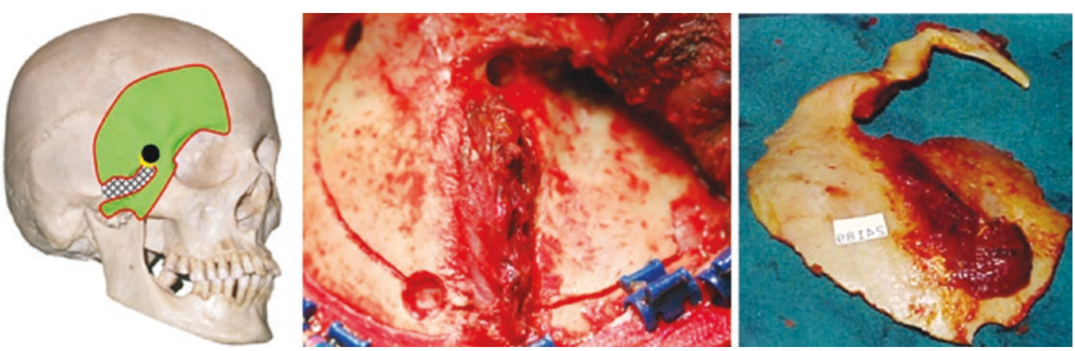

Fig. 8.8 Final craniotomy connecting the individual craniotomy holes and final appearance of the single piece bone operculum

are specific for the two-piece OZ craniotomy. As described by Zabramski et al. [8], a small craniotomy is made using a burr hole along the antero-lateral wall of the temporal fossa, thus creating a space for the craniotome used to perform the osteotomy along the lateral wall of the orbit. The

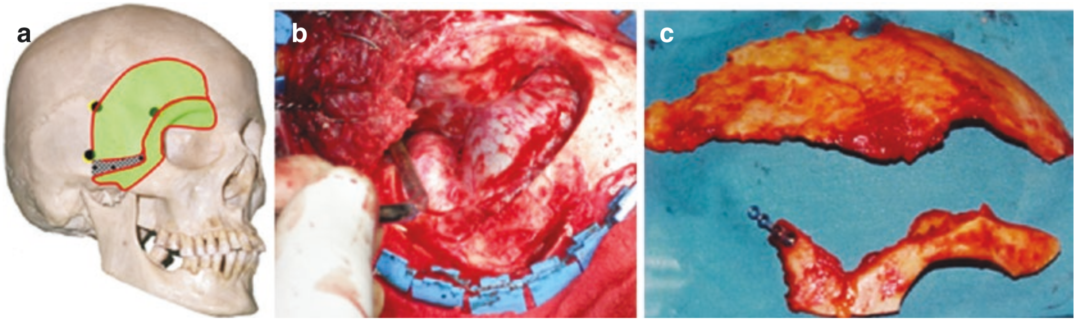

Fig. 8.9 The two-piece orbitozygomatic approach essentially consists of the combination of a pterional craniotomy with an orbitozygomatic osteotomy (**a**). Figure (**b**) shows the intraoperative view after completing the craniotomy with the two removed pieces next to it (**c**)

first osteotomy begins along the roof of the orbit lateral to the supraorbital notch and is directed toward the superolateral margin of the superior orbital fissure. The subsequent osteotomy frees the lateral wall of the orbit by connecting the posterolateral end of the first osteotomy and the anterolateral part of the inferior orbital fissure (Fig. 8.9). The inferior orbital fissure can be visualized in most craniotomies, and this portion of the osteotomy passes through the craniotomy hole previously made on the anterolateral part of the temporal bone [16].

8.2.5 Modified Supraorbital Orbitozygomatic Craniotomy

The periorbit is separated by blunt dissection from the upper and lateral margins of the orbit and medially up to the level of the supraorbital notch. The depth of the dissection rarely exceeds 2–3 cm. If further medial exposure is required, the supraorbital nerve is freed from the supraorbital notch or foramen with a small chisel or diamond burr. Typically, the limits of exposure include the supraorbital notch medially and the frontozygomatic suture laterally (Fig. 8.7). The first osteotomy is performed at the upper edge of the orbit, lateral to the supraorbital nerve (Fig. 8.7a). This cut can be extended medially if more medial frontal exposure is desired. The second osteotomy is made in the lateral wall of the orbit toward the inferior orbital fissure. The third osteotomy is made to connect these two osteotomies in the roof of the orbit. Modified supraorbital orbitozygomatic craniotomy can be performed using a 1- or 2-piece method [9].

8.2.6 Reconstruction

The galea can be used as an autologous patch graft in the event of duroplasty or for a possible cranialization of the frontal sinus. To obtain a better osteosynthesis, it is also possible to perform a pre-plating before proceeding with the zygomatic osteotomy in order to reduce the risk of postoperative facial asymmetry. Care must also be taken in the reconstruction of the roof of the orbit to limit the risk of enophthalmos. Titanium plates and 4 or 5 mm self-tapping screws are used for osteosynthesis of the craniotomic operculum. The temporal muscle is brought back to the myofascial cuff at the level of the superior temporal line. An interrupted suture with 3/0 vicryl stitches can be used for the superficial temporal fascia and galea. Subcutaneous drainage is left in place for 2 days to prevent blood collection. The skin suture can be performed using either resorbable sutures or metallic staples [16].

8.3 Clinical Use

The OZ approach makes it possible to follow four different surgical corridors: (1) subfrontal, (2) trans-Sylvian, (3) pretemporal, and (4) subtemporal. The trans-Sylvian and pretemporal corridors allow access to deep regions, including (1) optic-carotid; (2) carotid-oculomotor; (3) supracarotid; (4) oculomotor-tentorial [16] .

The orbitozygomatic craniotomies in either one and two pieces both have the advantage of providing a wider exposure of the anterior skull base than the frontotemporal approach (Figs. 8.9 and 8.10), thus minimizing the need for retraction of the brain parenchyma. By removing the upper and lateral walls of the orbit and cheekbone, a wide angle of exposure is obtained for lesions involving the apex of the orbit, the paraclinoid and parasellar regions, the apex of the basilar artery, the cavernous sinus, and the floor of the anterior and middle fossa [8].

In the one-piece OZ approach, the zygomatic osteotomy is generally less extensive and mainly involves the frontal process. Therefore, the one-piece OZ approach is theoretically more suitable for tumors of the parasellar and orbital regions (Figs. 8.11 and 8.12), in which greater mobilization of the zygomatic arch does not really improve lesion exposure.

In contrast, the one-piece OZ approach is less indicated for ruptured aneurysms [17], hyperostotic spheno-orbital and sphenoid meningiomas, and for large intraorbital tumors with increased intraocular pressure. In ruptured aneurysms, coexisting cerebral edema increases the risk of damage to the parenchyma during extracranial osteotomy of the roof of the orbit. In tumors characterized by severe hyperostosis of the roof and lateral wall of the orbit, accidental fracture of the single block bone flap may give rise to force vectors involving the optic canal and the sphenoid sinus with consequent risk of damaging the optic nerve and the CSF fistula. In the case of intraocular hypertension, the greater manipulation of the eyeball necessary to dissect the roof of the orbit from the extracranial intraorbital side increases the risk of blindness as well as the risk of dangerous bradyarrhythmias resulting from the elicitation of the Aschner-Dagnini oculocardiac reflex [18].

Supraorbital craniotomy is usually used for injuries of the anterior, middle, and sella turcica cranial fossae. The major fields of application are aneurysms of the anterior communicating artery and supraclinoid ICA aneurysms. Lemole et al.

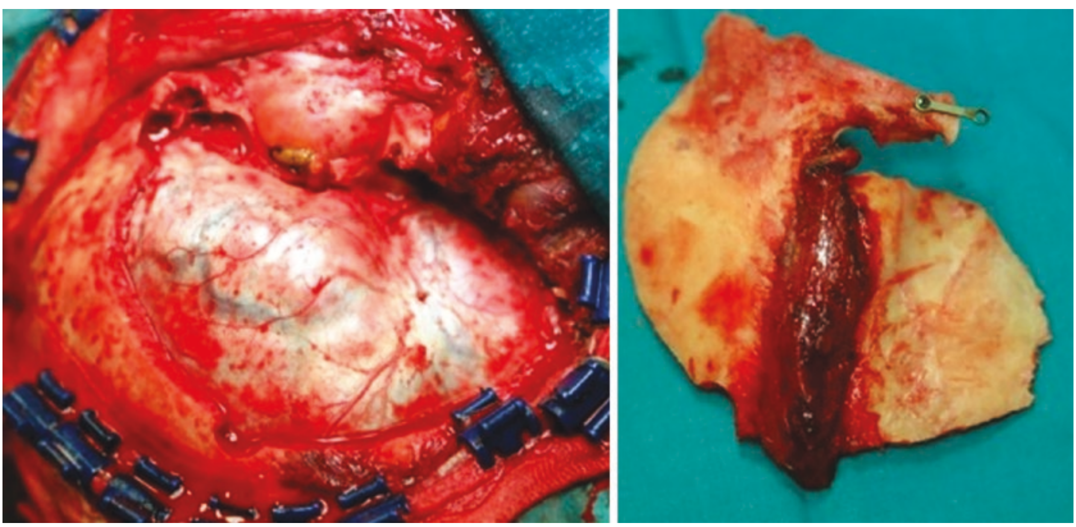

Fig. 8.10 Intraoperative photo of the supraorbital orbitozygomatic craniotomy and the removed craniotomic operculum

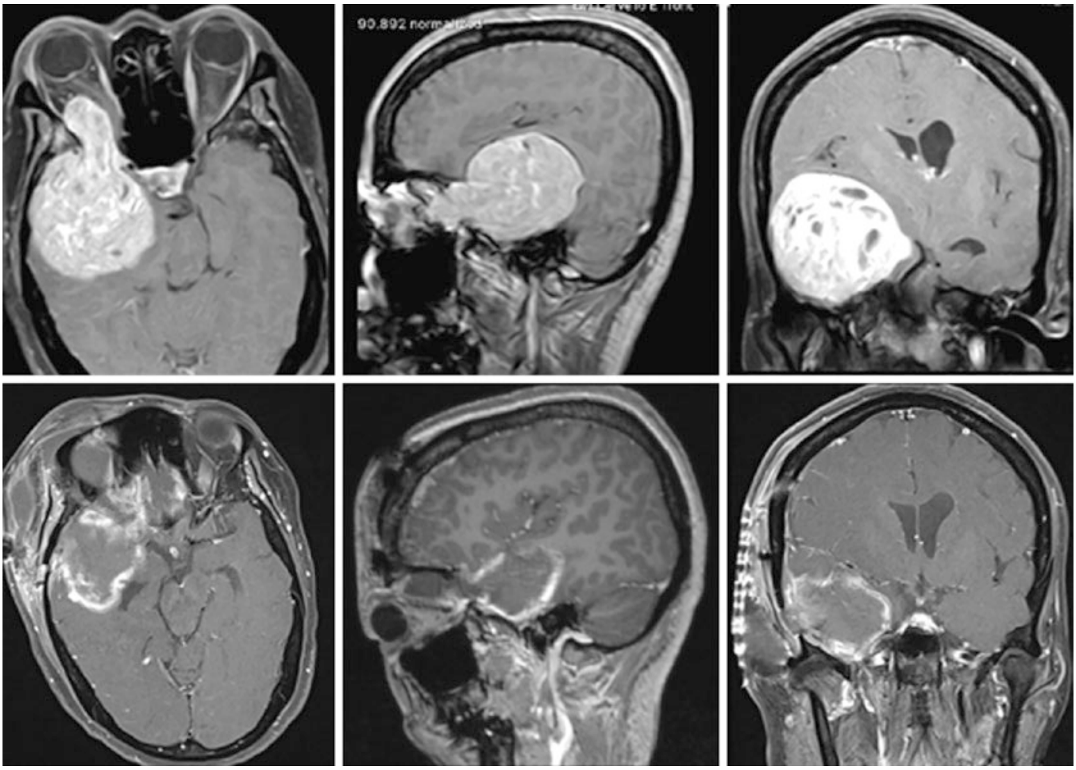

Fig. 8.11 Clinical case of voluminous spheno-orbital wing meningioma removed using a fronto-temporo-orbito-zygomatic approach, obtaining a complete removal

[19] also proposed the use of this approach for the treatment of sellar lesions.

The increased exposure offered by OZ craniotomy comes at the expense of an increased risk of cosmetic deformity, CSF leakage, enophthalmos, pulsating exophthalmos, and blindness [18].

As emerges in the study described by Tanriover et al., the two-piece OZ allows for significantly greater orbital roof removal than the one-piece variety. However, permanent removal of the roof of the orbit carries an inherent risk of inadequate reconstruction and consequent cosmetic defect, meaning that at least 2.5–3 cm of the anterior-posterior length of the roof of the orbit must be preserved with the osteotomy to prevent enophthalmos [17]. In the two-piece OZ, the frontotemporal bone operculum is lifted as the initial step and the orbitozygomatic osteotomy is performed as a second separate step. The roof of the orbit and the side wall are then removed under direct vision, achieving a more precise orbitotomy than in the single-piece OZ.

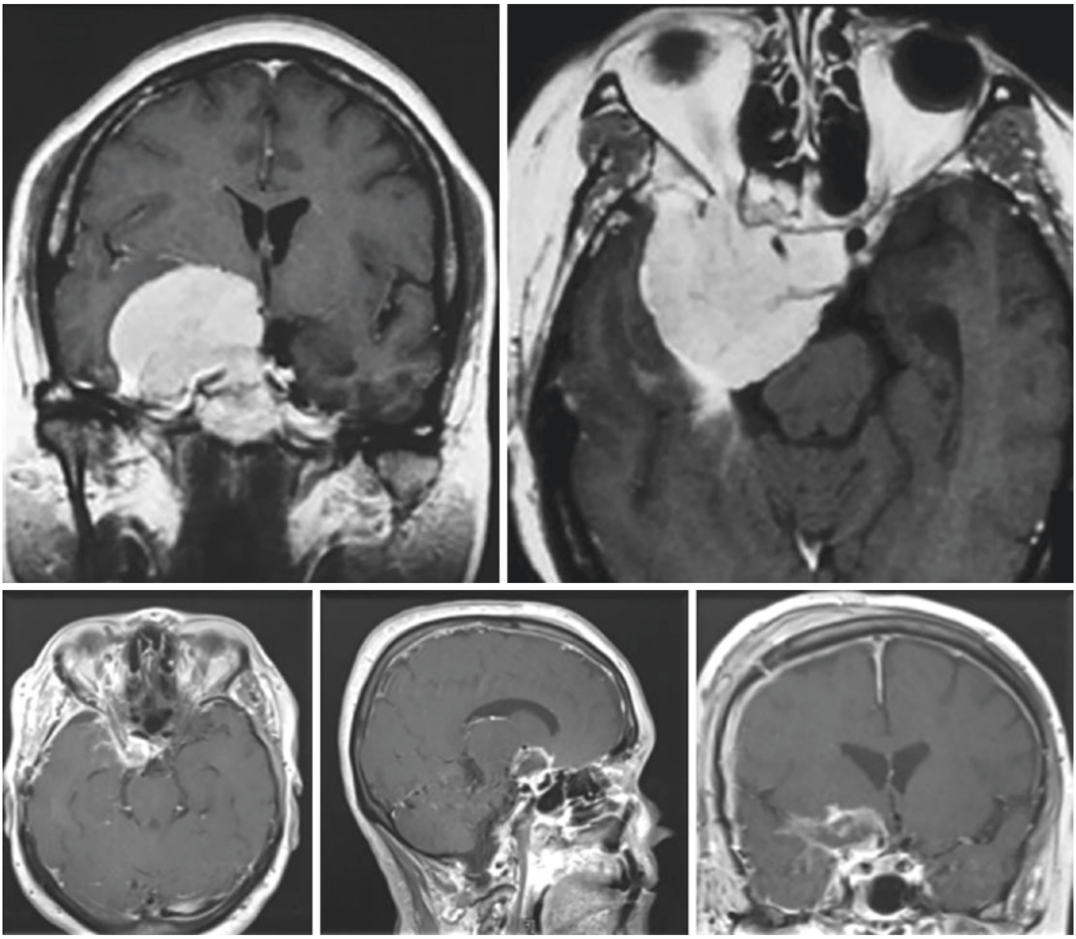

Fig. 8.12 Clinical case of spheno-petro-clival meningioma removed using a fronto-temporo-orbito-zygomatic approach

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