Technical Note

The transzygomatic approach

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ARTICLE INFO

Article history:
Received 16 January 2010
Accepted 1 March 2010

Keywords:
Anatomy
Intra-cranial surgery
Skull base
Transzygomatic approach
Zygomatic arch

ABSTRACT

We aim to describe the technical details of the transzygomatic approach to intracranial surgery. The incision begins at the level of the inferior border of the zygomatic arch, anterior to the tragus, and extends towards the contralateral pupillary line. A subgaleal and interfascial dissection is performed. Then, the zygomatic arch is vertically sectioned twice and mobilized downwards, together with the masseter muscle. Next, a fronto–temporo–sphenoidal craniotomy is performed and complete exposure of the anterior temporal dura achieved. Thus, the surgical possibilities are: (i) intradural access to the middle fossa; (ii) intradural pretemporal access to the basal cisterns; (iii) intradural transtemporal access to the insular region; and (iv) extradural access to the middle fossa. The transzygomatic approach offers excellent exposure to the floor of the middle fossa and the lateral wall of the cavernous sinus (both intradurally and extradurally). Also, combined with a pretemporal approach, it affords a good view of the interpeduncular cistern; and using a transtemporal approach, it provides good access to the insular region.

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1. Introduction

The pterional approach (fronto–temporo–sphenoidal craniotomy) 1–7 is one of the most commonly used approaches in neurosurgery, allowing for wide exposure of the anterior segment of the Sylvian fissure, as well as the frontal and temporal opercula. However, with this access it is difficult to expose the floor of the middle fossa, since the temporal muscle, leaning upon the zygomatic arch, acts as an anatomic obstacle. Over the last three decades, great advances in the surgical resection of lesions located at the skull base have been achieved due, among other technical details, to more extensive removal of bone, with the aim of minimizing cerebral retraction. Orbitozygomatic craniotomy 3–7 is a significantly extended example of this philosophy. With an orbitozygomatic craniotomy, a broader angle of vision for surgical work is achieved, in both the horizontal and vertical planes. 3 The section and displacement of the zygomatic arch, as the only accessory maneuver to the pterional approach, is an interesting variation to be taken into account, since it is simple to do and offers, in our opinion, the following advantages: (i) excellent access to the middle fossa floor, the lateral wall of the cavernous sinus and the medial portion of the petrous bone; (ii) an excellent working window through which to treat lesions located in the interpeduncular cistern; and (iii) a very good angle of vision for insular lesions, especially those located in the dominant hemisphere. The purpose of the present paper is to describe the technical details of the transzygomatic approach and demonstrate its effective use in 12 patients.

2. Patients and methods

From June 2006 to December 2008, the transzygomatic approach (Fig. 1) was used by the authors on 12 patients (four sphenoid wing meningiomas, one meningioma of the cavernous sinus, one sphenopetroclival meningioma, one epidermoid tumor of the basilar cistern, one aneurysm of the basilar bifurcation, one bone tumor involving the petrous bone, one pituitary adenoma with invasion to the cavernous sinus, and two temporoinsular gliomas) (Figs. 2–6) (Table 1).

3. Surgical technique

3.1. Position

The patient is placed in a supine position, with the head rotated to the contralateral side between 10° and 40°, depending upon the lesion being resected. Furthermore, the head is extended and separated from the ipsilateral shoulder.
3.2. Incision

The incision (Fig. 1A) starts at the level of the lower edge of the zygomatic arch, slightly anterior to the tragus, and extends behind the hairline towards the contralateral pupillary line. In patients with thick subcutaneous tissue, a preauricular incision can be extended downwards quite safely, up to 25 mm below the superior edge of the zygomatic arch. The anteroposterior position of the incision will depend upon the type and location of the lesion to be treated.

3.3. Dissection of the soft tissues

The dissection of soft tissues (Fig. 1B) starts with subgaleal dissection until the fatty tissue over the temporal aponeurosis is recognized. This sector roughly corresponds to the anterior fourth of the temporal muscle and is located immediately posterior to the frontal branch of the superficial temporal artery. From there, an incision is made on the external layer of the temporal fascia which, together with the interfascial fat, is dissected anteriorly in that plane to protect the frontal branch of the facial nerve. In this interfascial space runs a small vein, perpendicular to the incision, which must be coagulated and cut. Afterwards, the orbital rim is exposed at the top of the field, with the zygomatic arch lying below.

3.4. Sectioning of the zygomatic arch

The zygomatic arch is sectioned with two vertical cuts (Fig. 1C): a posterior cut immediately before the temporo-mandibular joint; and an anterior cut just behind the union of the zygomatic arch and zygomatic bone. Thus, the zygomatic arch is moved downwards, together with the masseter muscle.

3.5. Desinsertion of the temporal muscle

The temporal muscle is separated from the skull via retrograde dissection, so as to avoid post-operative muscular atrophy (Fig. 1D). A small cuff of muscle and fascia, at the level of the superior temporal line, is kept in place for reinsertion of this muscle at the end of surgery. Thus, the muscle is taken downwards, through the space left by the sectioned zygomatic arch. This procedure allows for complete exposure of the floor of the middle fossa.

Fig. 1. Step-by-step photographs of the transzygomatic approach showing: (A) incision, from the lower edge of the zygomatic arch to the contralateral pupillary line; (B) dissection of soft tissue, completely exposing the zygomatic arch; (C) section of the zygomatic arch; (D) desinsertion and downward displacement of the temporal muscle; (E) fronto–temporo–sphenoidal craniotomy, completely exposing the lateral temporal dura; and (F) dural opening.
3.6. Craniotomy

A pterional approach (fronto–temporo–sphenoidal craniotomy) (Fig. 1E) is performed in the usual way. The quantity of frontal and temporal bone to be removed depends upon the type and location of the lesion to be resected. The greater wing of the sphenoid bone and the squamous portion of the temporal bone are drilled out until complete exposure of the lateral aspect of the temporal dura is achieved. Once the craniotomy has been performed, the anatomical possibilities are numerous:

(i) Access to the middle fossa, useful for meningiomas of the sphenoid wing, especially when they are large and vascularized. Thus, first extradurally, the surgeon can advance to the

Fig. 2. Patient 1 – a 78-year-old male with a sphenoid wing meningioma on the left side, showing: (A) before surgery, coronal enhanced T1-weighted MRI; (B) before surgery, axial enhanced, T1-weighted MRI; (C) exposure of the dura mater after the craniotomy; (D) exposure of the tumor after dural and Sylvian fissure opening; (E) after surgery, coronal enhanced T1-weighted MRI; (F) after surgery, axial enhanced T1-weighted MRI.

Fig. 3. Patient 5 – a 57-year-old female with a meningioma of the cavernous sinus on the left side, showing: (A) before surgery, axial enhanced T1-weighted MRI; (B) before surgery, coronal enhanced T1-weighted MRI; (C) after craniotomy, exposure of dura; (D) after dural opening, exposure of the brain; (E) pretemporal view of the lateral wall of the cavernous sinus, after resection of the exophytic portion of the tumor; and (F) after surgery, coronal enhanced T1-weighted MRI.
floor of the middle fossa and behind the sphenoid wing, coagulate the meningeal vessels. Later, intradurally, the surgeon may proceed to resect the lesion.

(ii) Access to the inter-peduncular cistern, useful for aneurysms of the basilar bifurcation, as well as for tumors in that region. For this, a pretemporal intradural approach is used. It is important to adapt the dural opening to the edges of the craniotomy, especially at the temporal level (Fig. 1F). In this way, once the Sylvian fissure is exposed, it is opened widely from the lateral to medial side. The next step is to coagulate and cut the veins which extend from the tip of the temporal lobe to the sphenoparietal sinus, so as to move the temporal lobe backwards safely, without the risk of a venous hemorrhage. When this last procedure is completed, it is necessary to cut the arachnoid mater that is transversing from the medial part of the temporal uncus to the free edge of the tentorium. Finally, to have access to the interpeduncular cistern, it is necessary to open Liliequist’s membrane.

(iii) Access to the lateral wall of the cavernous sinus (extradurally), helpful for lesions located within the cavernous sinus, such as pituitary adenomas or trigeminal neuromas. After the craniotomy has been completed, the two dural sheets of the lateral wall of the cavernous sinus are separated (called “peeling”), starting at the level of the lateral extremity of the superior orbital fissure. Once the internal sheet of the lateral wall is exposed, the surgeon can enter the cavernous sinus from above and/or below the trochlear nerve.

(iv) Access to the lateral wall of the cavernous sinus (intradurally), which is useful for resection of the exophytic part of a cavernous sinus meningioma. A pretemporal intradural approach is used, for which the steps are similar to those described in (ii). The difference lies in that, in this instance, the surgeon’s vision is directed towards the cavernous sinus.

(v) Access to the medial portion of the petrous bone (extradurally), which is useful in the resection of bony and other lesions of the petrous apex. The surgeon starts by separating the temporal dura from the floor of the middle fossa. While doing this, it is necessary for the surgeon to identify three elements in the following order: the middle meningeal artery; the mandibular branch of the trigeminal nerve; and the greater petrosal nerve.

(vi) Access to the insular region, useful for intrinsic tumors of the temporopinsular region, especially when they are on the dominant side. After opening the dura, the immediate next step is to resect the temporal pole. Next, utilizing the angle of vision provided by displacement of the zygomatic arch and temporal muscle, one can resect the insular portion of the lesion, without retracting the frontal operculum.

3.7. Closure

With the transzygomatic approach, reconstruction is performed in the reverse order to that used to achieve intracranial surgical access. First, the sphenoid–temporo–frontal bone is replaced and fixated; then the temporal muscle is sutured to the soft tissue cuff that has been left attached to the superior temporal line; and, finally, the zygomatic arch is replaced and fixated.

4. Discussion

The section and displacement of the zygomatic arch as a complement to the pterional approach was first described in the 1980s. Fujitzu and Kuwabara, Pitteli et al., Neil-Dwyer et al., Ammirati et al., Deda and Ugur and Sindou et al. all suggested that this approach is useful as a means to better access the interpeduncular cistern. Al-Meftly and Anand, Uttley et al. and Terasaka et al. proposed that, to gain access to the infratemporal fossa, it is necessary to section the zygomatic arch. Honeybul et al. established that the transzygomatic approach provides access to multiple regions of the skull base. According to these authors, the main advantage of the transzygomatic approach, relative to
the pterional approach, is that it affords complete exposure of the lateral temporal dura and, therefore, provides major access to the floor and the anterior wall of the middle fossa, without the formal obstacle of the temporal muscle. This is useful for: (i) advancing topographically in an extradural/intradural way to the floor of the middle fossa (Fig. 2); (ii) minimal retraction of the tip of the temporal lobe backwards, thereby gaining access to the interpeduncular fossa (Figs. 4 and 5) and also to the lateral wall of the cavernous sinus (Fig. 3); and (iii) resection of the tip of the temporal lobe, then continuing in an inferior to superior direction to resect lesions located in the insular region.

From a technical point of view, the current authors suggest sectioning the zygomatic arch and then mobilizing it downwards, together with the masseter muscle; in this way, it is not necessary to separate the insertion of this muscle from the bone, thereby achieving both anatomical and time advantages. However, Ustun et al.22 and Terasaka et al.19 both proposed dissecting the masseter muscle first and then sectioning and removing the zygomatic arch.

Regarding division of the zygomatic arch, there are several possible approaches. We propose two osteotomies sectioning only the zygomatic arch; both are vertical and parallel, so as to achieve a space of approximately 3 cm through which the temporal muscle can be displaced downwards. However, other authors have

Fig. 5. Patient 8 – a 55-year-old female with a previously embolized aneurysm at the basilar bifurcation, showing: (A, B) presurgical angiography; (C) after craniotomy, exposure of the dura; (D) after dural opening, exposure of the brain; (E) pretemporal view before opening the roof of the oculomotor cistern; (F) the same view after opening the roof of the oculomotor cistern; this procedure allows for safer displacement of cranial nerve III during dissection; (G) view of the basilar artery and the neck of the aneurysm, through the space between the carotid artery and cranial nerve III; (H) final view of the pretemporal approach after clipping the aneurysm; and (I) after surgery, magnetic resonance angiogram.

Fig. 6. Post-surgical photos showing cosmetic results after the transzygomatic approach: (A, B) patient 9; and (C, D) patient 7.
suggested sectioning the zygomatic arch with “a bit” of zygomatic bone or the orbital edge. Moreover, Krisht and Kadri proposed drilling the upper segment of the zygomatic arch, thereby reducing its height without having to mobilize the arch. Admittedly, there is merit in all these different approaches. However, we feel that the technique we describe is simple to carry out, requires little extra time relative to thepterional approach, and yields a very good postoperative cosmetic result (Fig. 6).

5. Conclusions

The transzygomatic approach allows for excellent access to the floor of the middle fossa and the lateral wall of the cavernous sinus (both intra- and extra-durally). Furthermore, combined with a pre-temporal approach, it offers a very good surgical field for accessing the interpeduncular cistern. Finally, it is useful for the resection ofinsular lesions, especially those located within the dominant hemisphere.

References