



The extended eyebrow approach a cadaveric stepwise dissection

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Abstract

Background The eyebrow incision supraorbital approach is limited by the lack of exposure of the sylvian fissure exposure. By extending the skin incision 15 mm posteriorly and the supraorbital craniotomy beneath the superior temporal line, proximal sylvian dissection is achievable, and the surgical exposure is drastically improved.

Methods Throughout a cadaveric stepwise dissection and a pertinent anatomical analysis, we describe in detail the surgical technique of the extended eyebrow approach (xEBA). We additionally highlight main anatomical elements involved in this approach and provide technical nuances to avoid complications.

Conclusion xEBA is a versatile technique that uses the pretemporal, transylvian, and subfrontal corridor to enhance surgical exposure around the anterior cranial fossa.

Keywords Anterior fossa · Middle fossa · Tuberculum sellae · Meningioma · Cerebral aneurysms · Minimally invasive · Keyhole

Relevant surgical anatomy

Anatomically, we would like to highlight two aspects. First, the pterion is located at an average distance of 2 mm inferior to the sylvian fissure and approximately at the same level of the anterior sylvian point [6].

Second, the periosteal and visceral folds of the dura separate at the level of the superior orbital fissure (SOF). The periosteal dura creates a tent at this point that tethers the frontotemporal basal dura to the periorbita and constitutes the so-called meningo-orbital band (MOB) [2].

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Description of the technique

Positioning and skin incision

The position of the patient's head is the same as the one used in the standard pterional approach, with moderate extension to allow for gravity-based frontal lobe retraction and head elevation to reduce venous pressure [8]. Vertical rotation varies as regards to the surgical target (Fig. 1A). The skin is incised at the level of the superior one-third of the eyebrow lateral to the supraorbital notch and is directed laterally following the orbital rim up to the lateral epicanthus. Then, the incision is directed posteriorly over 1.5–2 cm in the direction of the tragus (Fig. 1B). We advise in this situation to follow a facial wrinkle in order to obtain better cosmetic results.

Temporalis muscle (TM) dissection

The subcutaneous tissue is sharply dissected to expose the galea and TM fascia. Then, the external layer of the TM and the galea are incised 1.5 cm behind the orbit rim, and the TM is dissected in an interfascial fashion [7] (Fig. 2). The TM is subperiosteally elevated to expose the anterior half of the pterion.

Craniotomy (Fig. 3)

This exposure is adequate to allow an aggressive flattening of the sphenoid wing and to access the proximal sylvian fissure directly. As such, a first burr hole, beneath the superior temporal line, is performed. A 3 to 4 cm craniotomy extending

from the supraorbital notch (medially) to the pterion (inferior and posteriorly) is thereafter completed.

Sphenoid wing drilling is then carried out until it is flattened, and the MOB is exposed at the level of the SOF.

Dural opening and intradural work (Fig. 4)

The dura is opened in a semilunar fashion with the base of the flap directed toward the orbital rim. The frontal and temporal operculum and the sylvian fissure anterior to the anterior sylvian point are then exposed.

The ipsilateral opticocarotid, chiasmatic, crural cisterns, and anterior stem of the sylvian fissure are exposed and opened to visualize the internal carotid artery, middle cerebral artery (MCA), anterior cerebral artery, anterior communicating artery, and posterior communicating artery.

Indications

Large tumors invading anterior cranial fossa are good candidates for the extended eyebrow approach (xEBA) given the straightforward trajectory along the greater sphenoid wing provided by this approach. Its versatility in using the subfrontal, transylvian, or pretemporal corridor provides a wide exposure of the tumor mass from different angles. Proximal sylvian dissection reduces traction in the frontal lobe, in comparison to the supraorbital approach.

xEBA is ideal for clipping anterior and posterior communicating aneurysms. Likewise, xEBA can also be used to access MCA aneurysms with a short M1 segment. Some

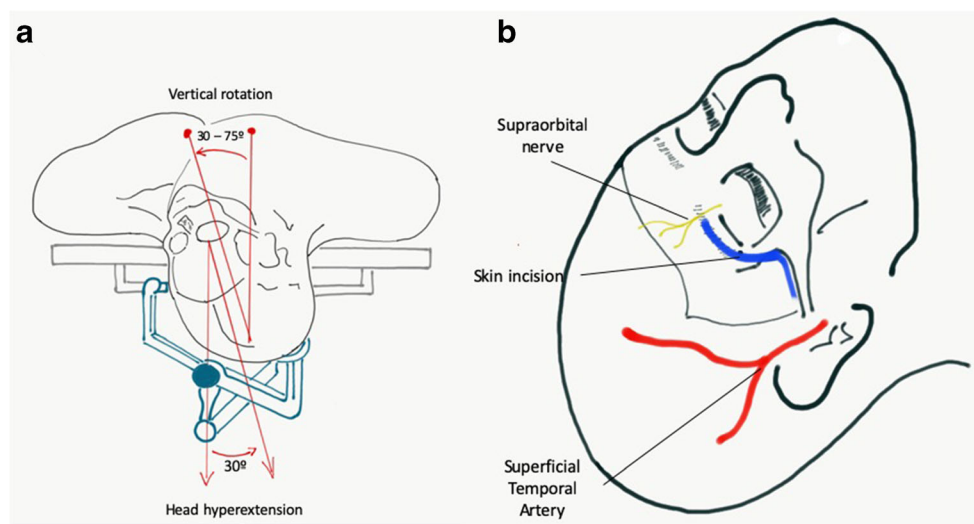
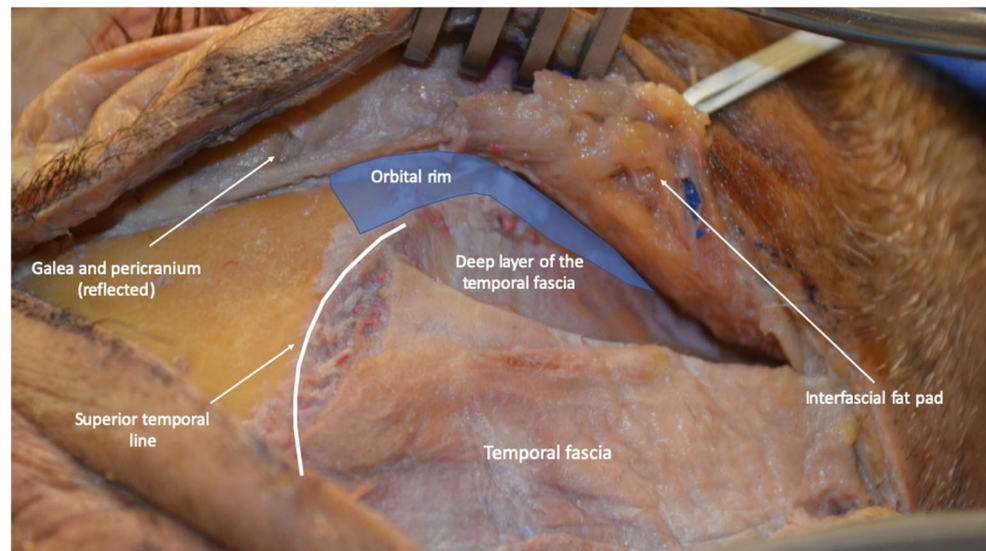


Fig. 1 A Positioning: the patient is positioned supine, with the head slightly posteriorly tilted and laterally rotated 30 to 75 degrees, as regards the surgical target. In the surgical scenario, the head rotation can be modified from its original position during some parts of the procedure, by changing the orientation of the rotating bet if needed. B

An arcuate skin incision is started lateral to the supraorbital notch at the level of the upper third of the eyebrow. The skin incision is followed over the contour of the eyebrow, and at the level of the external epicanthus, the incision is directed posteriorly extending up to 15 mm lateral to the orbital rim

Fig. 2 Interfascial dissection. The superficial layer of the temporal fascia and the interfascial fat, as well as the galea and periosteum over the frontal bone, are incised 15 to 20 mm behind the superior orbital rim and anteriorly reflected until exposure the orbital rim

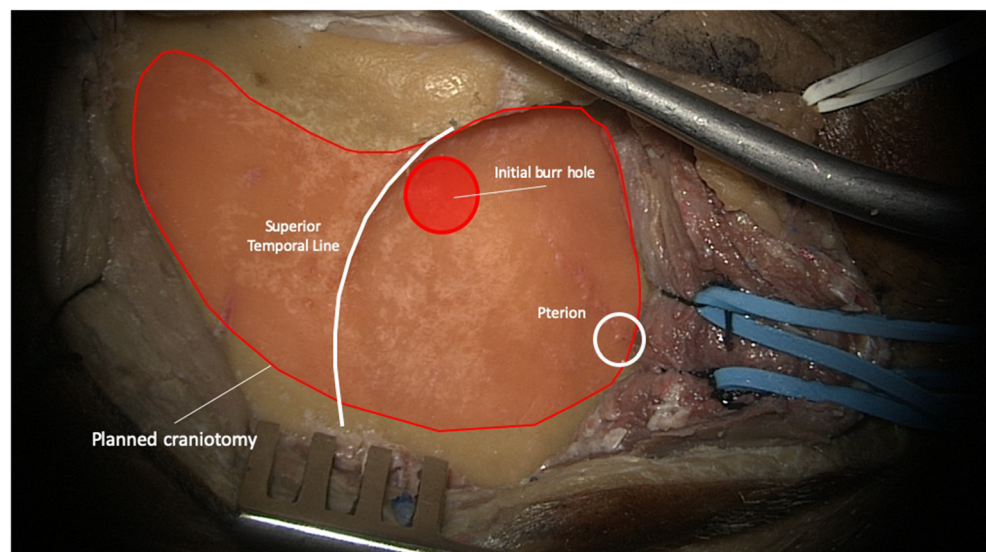


ophthalmic artery aneurysms can also be approached through a xEBA using a contralateral corridor, which would avoid the necessity to remove the anterior clinoid process.

Limitations

There are some relative contraindications to this technique. Patients with excessive pneumatization of the frontal sinus are poor candidates for the xEBA, given the risk of sinus violation and CSF leakage. Additionally, distal sylvian dissection is impeded in the xEBA. So then, cases in which a wide sylvian splitting is required (distal MCA aneurysms, insular tumors, distal MCA aneurysms, or when the brain lacks adequate relaxation) should not be considered suitable to this technique.

Fig. 3 Extended eyebrow approach craniotomy. First burr hole is placed underneath the superior temporal line. Limits of the craniotomy extend from the frontal bone lateral to the supraorbital notch up to the pterion. The pterion is selected as the inferior landmark given its relation to the sylvian fissure, being located at an average of 2 mm beneath the anterior sylvian point



Moreover, the xEBA is an anteromedial approach, and in spite of the exposure of the proximal sylvian fissure, reaching the floor of the temporal fossa is hindered by the interposition of the temporal lobe and the limit of the craniotomy. This drawback limits the suitability for approaching tumors mainly located in the temporal fossa.

How to avoid complications

Skin incision

The horizontal segment of the eyebrow incision extends up to 2 cm lateral to the external epicanthus, preventing injury to the superficial temporal artery and the frontalis branch of facial nerve. Conservation of the STA favors a fast healing process and reduces the risk of infectious complication [1].



Fig. 4 Subdural view provided by the extended eyebrow approach. **A** The subfrontal corridor allows to expose the prechiasmatic region and contralateral side. **B** Proximal sylvian dissection shows the adequate

exposure of the entire M1 segment of the middle cerebral artery and its bifurcation. **C** Pretemporal transylvian corridor enhances view of the posterior circulation and interpeduncular region

Muscle dissection

Subperiosteal and atraumatic dissection respect the innervation and vascularization of the TM, which, along with the minimal retraction, prevents from TM atrophy.

Interfascial dissection is recommended in order to prevent injury of the frontotemporal branches of the facial nerve while ensuring a good bone exposure for performing the craniotomy and sphenoid wing drilling. Alternatively, a subfascial dissection technique can be used as per surgeon's preferences.

Craniotomy

Two bony landmarks are considered key to ensure enough exposure and reduce potential complications. First, the medial limit of the craniotomy should be lateral to the supratrochlear notch to avoid supraorbital nerve injury [3]. Second, the inferior limit of the craniotomy should reach the pterion inferiorly to provide exposure of the sylvian fissure and reduce excessive brain retraction [6].

Preoperative planning of the craniotomy might avoid entering the frontal sinus. However, cases with large pneumatization in which entering the frontal sinus is expected, sinus cranialization is demanded in order to avoid CSF leakage.

Specific perioperative considerations

An appropriate preoperative radiological workup in regard to the pathology to treat is warranted. A multi-slice CT scan to preoperatively assess the frontal sinus extension is recommended.

Specific information to give the patient about surgery and potential risks

General information about benefits and risks of a neurosurgical intervention, including the shape and size of the incision, should be provided. Risk of CSF leak should be particularly discussed in patients with prominent pneumatized frontal sinus. Frontalis muscle palsy has been reported in up to 5% of

patients who undergo eyebrow-supraorbital approaches [5]. While further prospective studies are required, combining the eyebrow incision with a TM interfascial dissection will presumably reduce this rate [4]. Informed consent must be obtained from the patient prior to surgery.

Compliance with ethical standards

Patient consent No lived humans were included in the present study. Informed consent and ethical approval were not deemed necessary by the local ethics in view of the application of strict patient privacy regulations operating in our center (cadavers were unidentified).

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Key points

- As opposed to the frontotemporal incision, the skin incision in the xEBA is not visualized in bald patients or in those with a posteriorly located hairline.
- Eyebrow skin incision and minimal muscle dissection offer excellent cosmetic results and a fast and straightforward route for lesions located in the anterior and middle cranial fossae.
- Interfascial dissection reduces the risk of palsy of the frontotemporal branches of the facial nerve, while it enables the exposure of the orbital rim and facilitates sphenoid ridge drilling.
- Because the inferior limit of the craniotomy is the anterior limit of squamous suture at the pterion, exposure of the sylvian fissure and temporal operculum is ensured.
- There is an increased risk of CSF leakage and infection in cases with excessive frontal sinus pneumatization.
- Sinus cranialization should be performed whenever the frontal sinus is violated.
- Performing a retrograde dissection of the TM without monopolar coagulation prevents atrophy.
- In comparison to the standard eyebrow-supraorbital approach, the allowance for splitting the sylvian fissure reduces frontal lobe retraction.
- The xEBA is a versatile approach that takes advantage of the subfrontal and transylvian corridor to access large anterior cranial fossa lesions.