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HOW I DO IT - PITUITARIES

Supraorbital keyhole approach for suprasellar arachnoid cyst: how I do it

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Abstract

Background Keyhole approaches have lately sparked strong interest because these approaches address skull base pathologies as reported by Eroglu et al. (World Neurosurg, 2019); Hickmann, Gaida, and Reisch (Acta Neurochir (Wien) 159:881–887, 2017); Jallo and Bognar (Neurosurgery, 2006); and Poblete et al. (J Neurosurg 122:1274–1282, 2015), minimizing brain retraction and improving cosmetic results. We describe the step-by-step surgical technique to drain a suprasellar arachnoid cyst by a supraorbital approach.

Method The eyebrow incision is a direct route to expose the supraorbital corridor and even if it is smaller than a pterional approach, it permits to open the cisterns and to visualize neurovascular structures. The arachnoid cyst could be safely drained and a T-tube is placed.

Conclusion This technique represents a suitable option for suprasellar arachnoid cyst, avoiding more extended and invasive approaches.

Keywords Supraorbital approach · Eyebrow incision · Minimally invasive technique · Suprasellar cyst

Relevant surgical anatomy

As far as this approach is now rather standardized, the essential anatomical landmarks to know in order to perform an optimal craniotomy are represented by neurovascular, muscular, and osseous structures [4, 8].

Neurovascular structures medial to the mid-pupillary line:

- supraorbital foramen, arches transversely the supraorbital ridge and it is crossed by the following structures;
- supraorbital artery, springs from the ophthalmic artery and divides in a superficial and a deep branch, anastomosing with branches of the supratrochlear artery and superficial temporal arteries (Fig. 1a);
- supraorbital vein, communicates with the ophthalmic vein and receives the frontal diploic vein (Fig. 1b);
- supraorbital nerve, gives off a medial and a lateral branch perforating the frontalis muscle and the galea aponeurotica (Fig. 1c).

Neurovascular structures lateral to the mid-pupillary line:

- superficial temporal artery, splits from the external carotid artery, toward the zygomatic process of the temporal bone, where it gives off one posterior parietal branch and one anterior frontal branch which anastomoses with the supraorbital artery (Fig. 1d);
- fronto-temporal branches of the facial nerve which crosses the zygomatic arch to the frontal and temporal region (Fig. 1e).

It is important also to identify the temporal muscle and its superior temporal line (Fig. 1f), which gives attachment to the temporal fascia, the zygomatic arch, and its fronto-zygomatic suture. These landmarks permit to define correct craniotomy borders and to plan safely the eyebrow skin incision.

This article is part of the Topical Collection on *Pituitaries*

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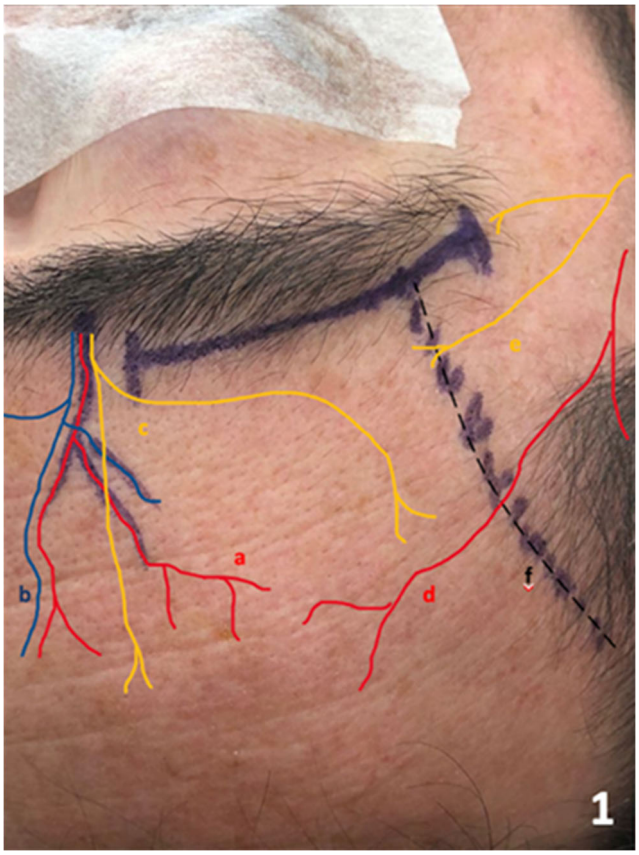

Fig. 1 Skin incision between the supraorbital foramen with its supraorbital artery (a), vein (b), and nerve (c) medially; the superficial temporal artery (d), the fronto-temporal branches of the facial nerve (e), and the superior temporal line (f) laterally

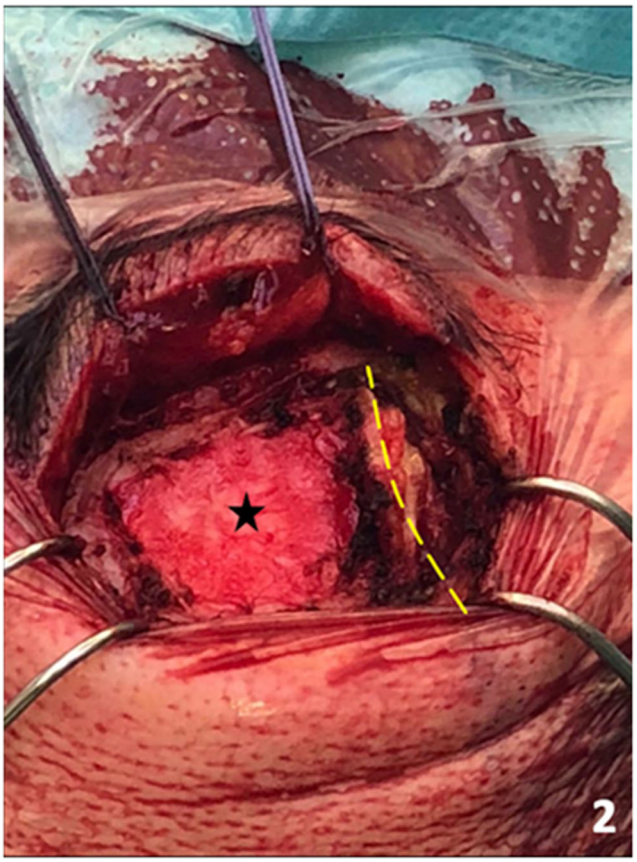

Fig. 2 Fronto-lateral supraorbital area exposure (black star) and superior temporal line identification (dotted yellow line)

Description of the technique

Positioning

The patient is placed in a supine position with the head secured in a three-pin Mayfield head holder. The head should be elevated above the heart level to reduce intracranial pressure, extended (30°) and turned (30°) to the contralateral side to allow gravity retraction of the frontal lobes.

Skin incision

The skin incision is started medially to laterally, from the supraorbital foramen to the end of the eyebrow, following the orbital rim and avoiding hair follicles, in order to achieve a better cosmetic result (Fig. 1). Subcutaneous tissues are then dissected to expose the fronto-lateral supraorbital area and the frontal muscle is cut with a monopolar instrument following the orbital rim, from medially to laterally. After having identified the superior temporal line, the temporal muscle is cut perpendicularly toward the frontal zygomatic process preserving its insertion to approximate it during closure (Figs. 2 and 3). The cutaneous flap, the temporal muscle, and the frontal muscle are therefore retracted with hooks and sutures (Fig. 2). The important anatomic points you have to identify before the craniotomy are the zygomatic process of the frontal bone and the fronto-zygomatic suture.

Craniotomy and durotomy

A single 5-mm burr hole with a high-speed drill is placed just below the superior temporal line, approximately 10 mm behind the fronto-zygomatic suture (Fig. 3). With a high-speed craniotome, a D-shaped bone flap is made (Fig. 4). The first cut should be along the orbital roof in an oblique fashion to avoid excessive bone loss. The second cut is arciforme in the cranial part. After dura detachment, the orbital roof and the lesser sphenoid wing are thinned with a diamond high-speed

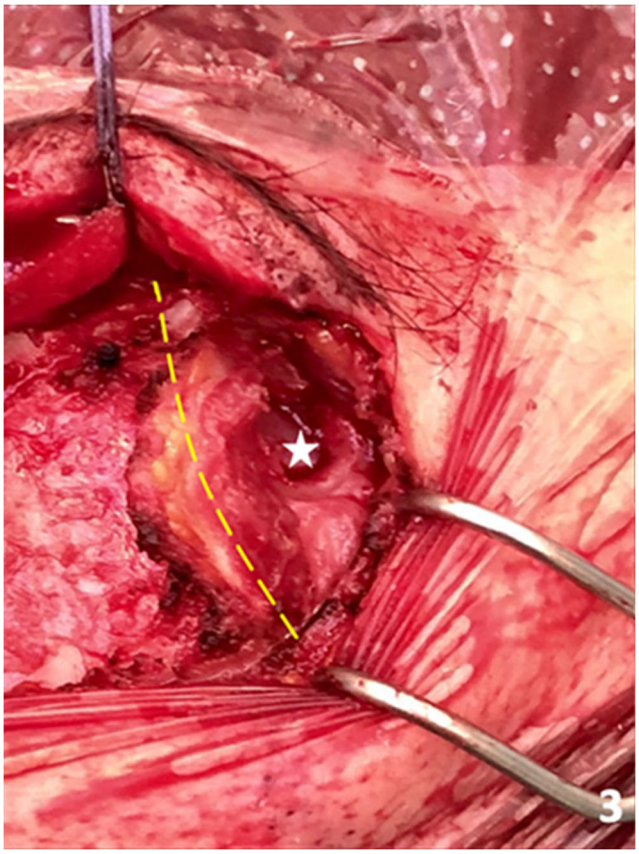

Fig. 3 Keyhole (white star) below the superior temporal line (dotted yellow line)

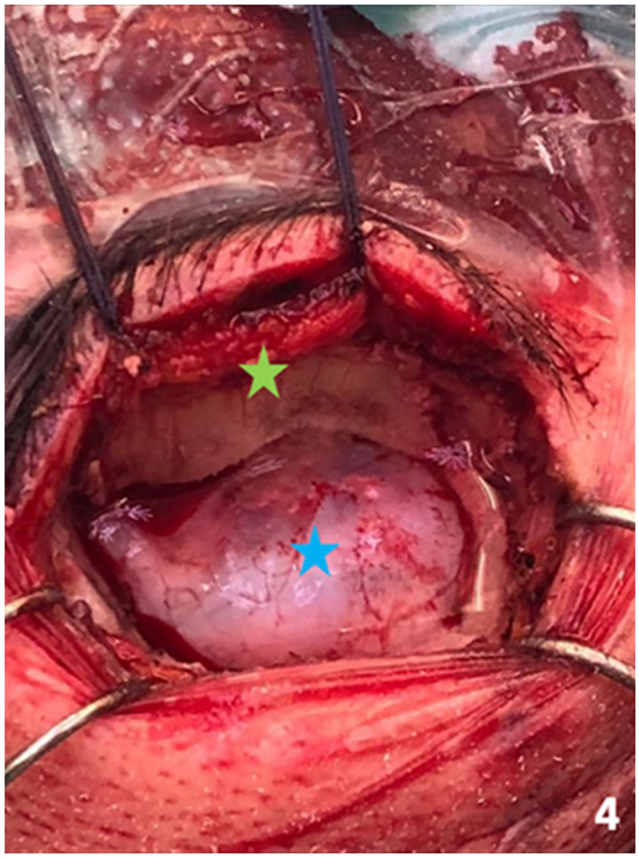

Fig. 4 Muscle flap (green star) with dural exposure (blue star)

drill and Kerrison rongeur. The dura is therefore opened in a C-shaped fashion and reflected over the orbital rim with sutures.

Intradural dissection

Due to the narrow corridor, identifying the optic nerves at the beginning could be difficult; that is why we first open the Sylvian cistern, in order to make room, and only after, we open the carotid and chiasmatic cisterns as well as the lateral membrane of the lamina terminalis. Before opening the arachnoid cyst, the optic nerves, the anterior part of the chiasm, and the internal carotid artery have to be visualized. The suprasellar arachnoid cyst is then opened and a T-tube is positioned inside it to avoid any relapse and fixed to the anterior skull base to prevent any displacement.

Closure

The dura is closed with a watertight running suture to avoid cerebrospinal fluid (CSF) leak. The bone flap is therefore replaced and secured with titanium plates. The periosteum and muscles are re-approximated, then subcutaneous suture with buried, interrupted, and absorbable stiches is performed while cuticular suture with a running absorbable stich is performed (Fig. 5). The wound is then strengthened with Opsite spray® and Steri Strip® plasters.

Indications

The supraorbital approach might be used for different kinds of pathologies, intra and extra-axial, of the anterior and middle cranial fossa and of the sellar region [1–3, 6, 7, 9], e.g., tuberculum sellae and olfactory groove meningiomas, craniopharyngiomas, anterior circulation aneurysms, and pituitary adenomas with a shorter hospital stay and a better cosmetic result if compared with standard approaches [5]. It represents a compelling option for suprasellar arachnoid cyst.

Limitations

Obviously, not every anterior and middle cranial fossa lesion can be treated with a gross total resection intent, especially the

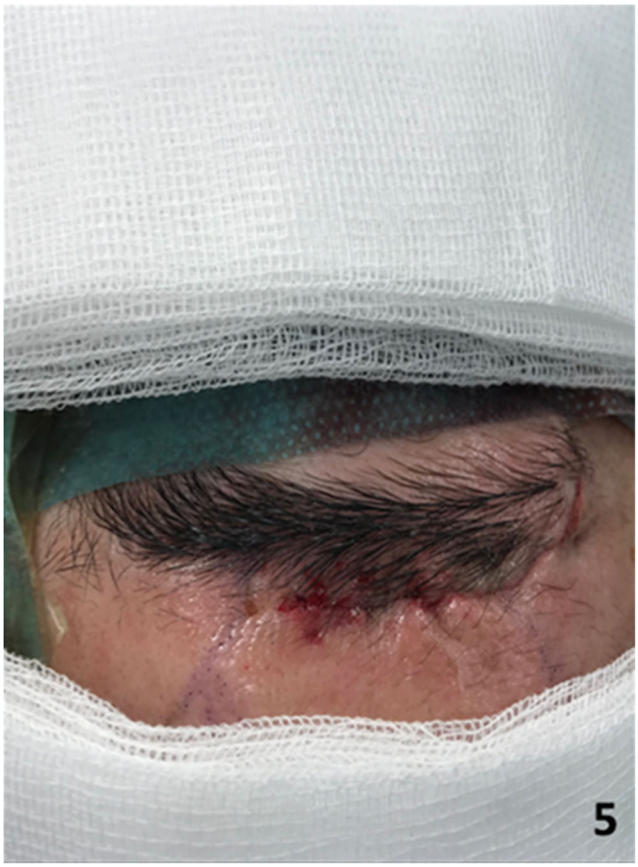

Fig. 5 Cosmetic result

deepest and the more distal ones (e.g., deep insular lesions, distal middle cerebral aneurysms) [9]. Furthermore, large laterally extended frontal sinuses may represent a relative contraindication to this approach, while slim eyebrow may be not suitable for cosmetic issues. The choice of this minimally invasive technique depends on the surgeon's experience and comfort with narrow corridors and limited workspace.

How to avoid complications

Anatomical knowledge is essential to correctly handle this approach, both to place an optimal craniotomy, respecting neurovascular structures and muscle thus avoiding supraorbital numbness, facial palsy, and temporal muscle atrophy and to be oriented in the small surgical space. The surgeon needs to carefully evaluate the preoperatively frontal sinus dimension in order to prevent CSF leak. The patient position should be cautiously evaluated, according to lesion location, to obtain a natural relaxation of the frontal lobe; mannitol bolus and early CSF release could also help in gaining extra workspace without retraction. Extended opening of the arachnoid spaces and cisterns is the key to securely work without brain retractors. Betadine-soaked gauzes are placed all over the craniotomy edge to prevent infections. Meticulous hemostasis and watertight closure of the dura are essential to avoid any hemorrhage and CSF leak. A precise replacement of the bone flap and suture of the skin are necessary to reach an optimal and pleasant cosmetic result.

Specific perioperative considerations (pre and postop workup, instructions for the postop care)

Preoperative requirements are represented to analyze lesion features and eloquent surrounding structures; computed tomography to assess dimension and lateralization of frontal sinuses; and careful evaluation of eyebrow shape and size. According to the lesion location, an ophthalmologic, olfactory, and/or endocrinological assessment would be required. Twenty-four-hour postoperative neurologic surveillance in intensive care is mandatory, as well as a postoperative magnetic resonance imaging within 48 h to rule out any complication and to estimate the resection extent. Discharge occurs generally between 3 and 5 days postoperatively, wound control after 7 days, and first clinical and radiological follow-up in the outpatient clinic at 6 weeks.

Specific information to give to the patient about surgery and potential risks

Beyond general potential complications depending on the lesion's nature and location, patients should be informed about specific risks linked to this approach: supraorbital numbness, facial palsy, CSF leak, periocular swelling and hematoma, poor cosmetic result.

Compliance with ethical standards

Conflict of interest The authors declare that they have no conflicts of interest.

Informed consent Informed consent was obtained from the individual participant included in the study.

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Key Points

1. Anatomical knowledge of superficial neurovascular structures is essential;
2. Only for expert surgeon with an appropriate learning curve to become familiar with narrow corridors and limited workspace;
3. Head extension is important to allow gravity retraction of the frontal lobes;
4. The keyhole location is crucial and should be placed only after fronto-zygomatic suture visualization;
5. The position and the oblique orientation of the craniotomy along the orbital roof have to be the most caudally possible;
6. The drilling of the orbital roof and the lesser sphenoid wing helps to open the supraorbital corridor;
7. Early extended opening of arachnoid cisterns to gain extra space is necessary;
8. Identification of optic nerves, chiasm, and internal carotid artery is critical;
9. Preoperative evaluation of frontal sinus and eyebrow is mandatory;
10. Shorter hospital stays and optimal cosmetic results.