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HOW I DO IT - VASCULAR NEUROSURGERY - ANEURYSM

Transpalpebral approach in skull base surgery: how I do it

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Abstract

Background Keyhole surgery has been actively developing in the last two decades. Modern neuroimaging, preoperative individual planning, and innovative neurosurgical equipment allow us to operate through mini craniotomy with minimization of approach-related complications.

Method Preoperative planning is very critical. After the patient positioning, skin incision, craniotomy, and dura incision are performed. Intradural lesion is reached with standard microneurosurgical technique. A watertight dura closure is important.

Conclusion Transpalpebral approach can be good alternative to traditional, extended fronto-lateral craniotomies with excellent cosmetic and functional outcomes. Adequate selection of patients is important.

Keywords Keyhole · Transpalpebral approach · Cerebral aneurysms · Skull base surgery · Minimally invasive neurosurgery

Relevant surgical anatomy

Keyhole surgery has been actively developing for the last two decades. Minimally invasive approaches reduce iatrogenic trauma and provide a focused surgical route. Excellent cosmetic and functional outcomes with rapid recovery of patients are the main advantages of keyhole surgery [4–6].

The surgical corridor, formed by transpalpebral approach, provides visualization to the anterior cranial fossa, parasellar space, orbit, and frontal sinus [3–6].

The most important anatomical landmarks used for transpalpebral approach are the supraorbital notch (foramen), the frontal sinus topography, the supraorbital artery and nerve, and the fold of the upper eyelid. Dissection of subcutaneous tissues, orbicularis oculi muscle, orbital septum, and periosteum must be performed very carefully. Other anatomical structures that should be considered are the temporal muscle, lateral canthal ligament, zygomatic process of the frontal bone, and the frontozygomatic suture (Fig. 1).

Description of the technique

- Preoperative planning

We use individualized preoperative planning that includes CT-angiography, MRI, and virtual craniotomy with a special software. Critical assessment includes facial and bone anatomy, frontal sinus sizes, their relationship with the planned craniotomy, and localization of the supraorbital artery and nerve (Figs. 1 and 2).

- Positioning

The patient is placed on the operating table similar as for pterional craniotomy. The patient should lie supine with the head fixed in a three-pin Mayfield holder, with the elevation of

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the head above the heart level, tipping the head downwards and turning in the opposite side from 15 to 60° depending on the pathology. Before the skin incision, we use an ophthalmic gel subconjunctivally. Temporary tarsoraphia is performed with a 5–0 nylon suture. The area of the planned incision is infiltrated with an anesthetic solution and vasoconstrictor.

- Skin incision

The skin incision of 3.5–4 cm in length is made along the natural fold of the upper eyelid from the level of the supraorbital foramen (Fig. 1). If necessary, the incision can be continued laterally by several millimeters within the fold. The incision should begin at least 10 mm higher than the upper edge of the eyelid and not less than 5–6 mm above the projection of the lateral canthal ligament. Thus, the incision is planned below the supraorbital and facial nerve branches, which excludes the negative cosmetic effects associated with nerves damage.

- Soft tissue dissection

After skin incision, careful soft tissues dissection is performed. The dissection of the orbicularis oculi muscle is performed with preservation of the orbital septum and lateral canthal ligament. A single musculo-cutaneous flap is formed and retracted with stitches. The main direction of dissection is laterally and upward. It is necessary to constantly palpate the upper edge of the orbit to control the degree of dissection of the underlying bone. Subperiosteal dissection of the supraorbital region occurs from the lateral margin of the supraorbital notch to the frontozygomatic suture. Attention during dissection should be made to the preservation of the periosteum and periorbital fat. The temporal muscle is cut off by monopolar coagulation from the place of its attachment at the level of the anterior temporal line and is mobilized laterally to visualize the area of burr hole placement (Fig. 2).

Craniotomy

The one burr hole is formed in the key point with the high-speed diamond drill. After applying the burr hole, a mini-orbitofrontal craniotomy is performed, including the roof of the orbit, the portion of the frontal bone about 1–1.5 cm of the frontal process of the zygomatic bone. The diameter of the bone window does not exceed 2.0–2.5 cm. It is important to protect the contents of the orbit continuously with a spatula when the orbital roof is removed. After the osteotomy is done, the roof of the orbit is broken with a chisel. An important step is resection of the inner edge of the bone. The degree of bone resection is determined by the underlying pathology (Fig. 3).

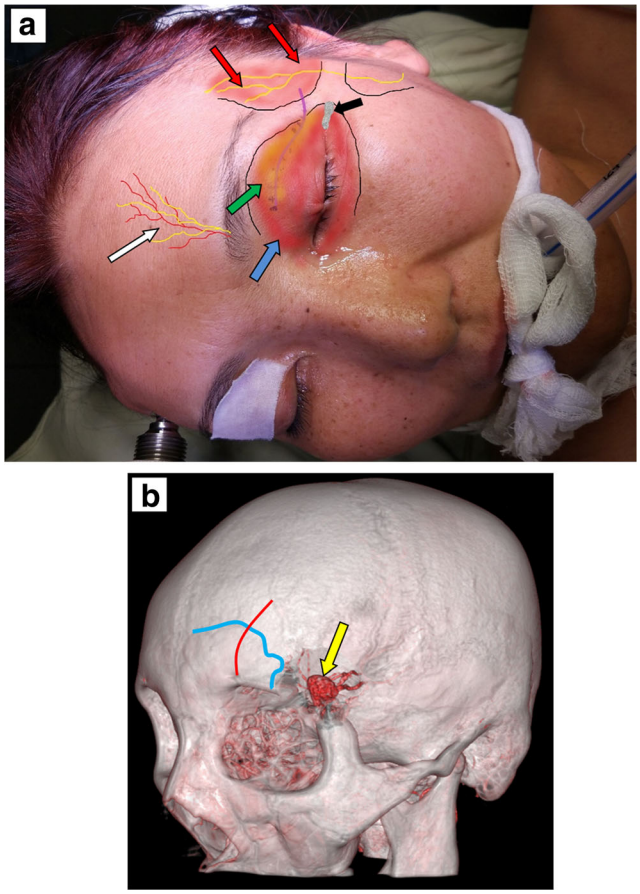

Fig. 1 **a** Relevant surgical anatomy landmarks for transpalpebral approach. Patient's head position. Black lines – bones margins. Arrows: white – supraorbital artery and nerve, blue with red area – musculus orbicularis oculi, green arrow with yellow area – subcutaneous tissue, black – lateral canthal ligament, red – temporalis muscle (red area) and branches of facial nerve, violet line – projection of skin incision. **b** Preoperative CT angiography for approach planning. Red line – projection of supraorbital artery and nerve, blue line – border of frontal sinus, and yellow arrow – left internal carotid artery aneurysm

This approach allows for an extradural anterior clinoid process and sphenoid bone removal.

- Dural incision, intradural dissection

The dura mater (DM) is opened by a C-shaped incision. After opening of the DM, the traditional microneurosurgical technique is used. It includes early brain relaxation, dissection of the proximal Sylvian fissure, approach to the parasellar region, and opening of basal cisterns with retractorless technique.

Closure

The DM is tightly sutured. The bone flap is fixed with mini plates. Bone cement is optionally used for additional fixation and better cosmetic results. The wound is sutured layer by layer, and intradermal 6–0 absorbable suture is applied to the

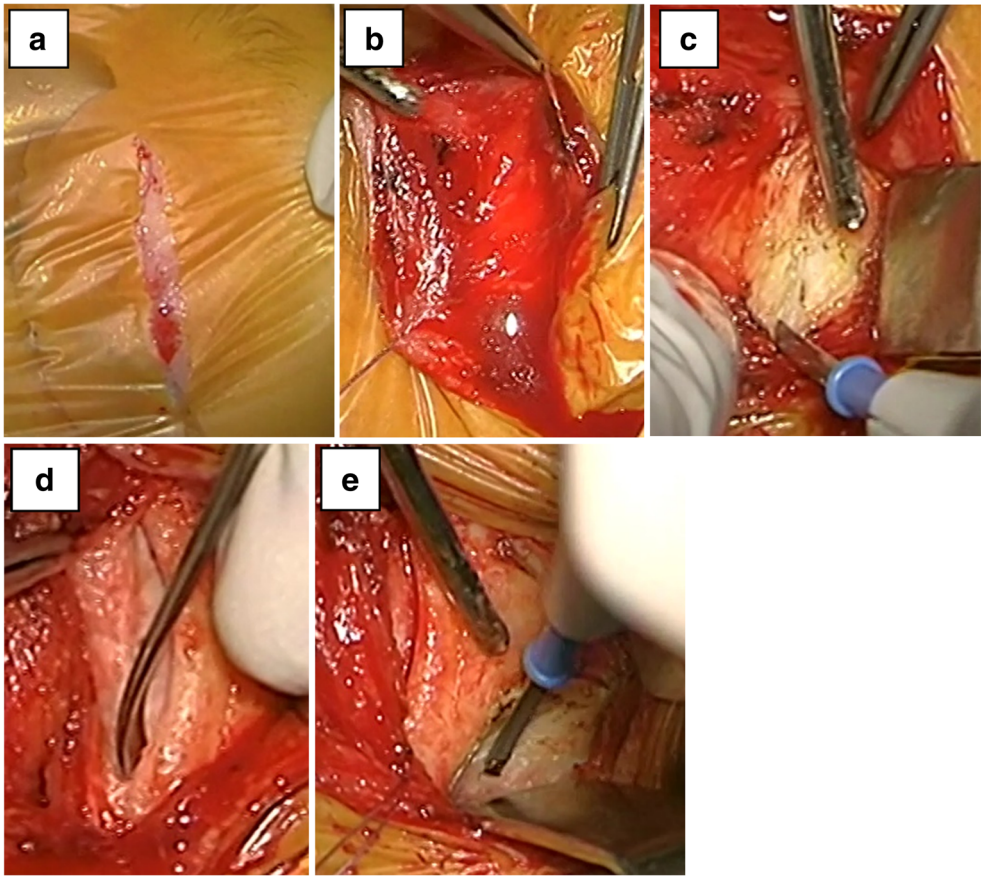

Fig. 2 Steps of soft tissue dissection. **a** Skin incision. **b** Preparation of subcutaneous tissue and musculus orbicularis oculi. **c**, **d** Subperiosteal dissection and exposure of orbital rim. **e** Temporal muscle dissection

skin. In the first 1 h after the operation, cubes of ice are placed on the area of the postoperative wound to reduce periorbital edema. The result is visible on postoperative CT angiography (Fig. 4). Cosmetic outcomes are presented on Fig. 5.

Indications

We use this approach mainly for unruptured anterior circulation aneurysms less than 10 mm in size, tumors

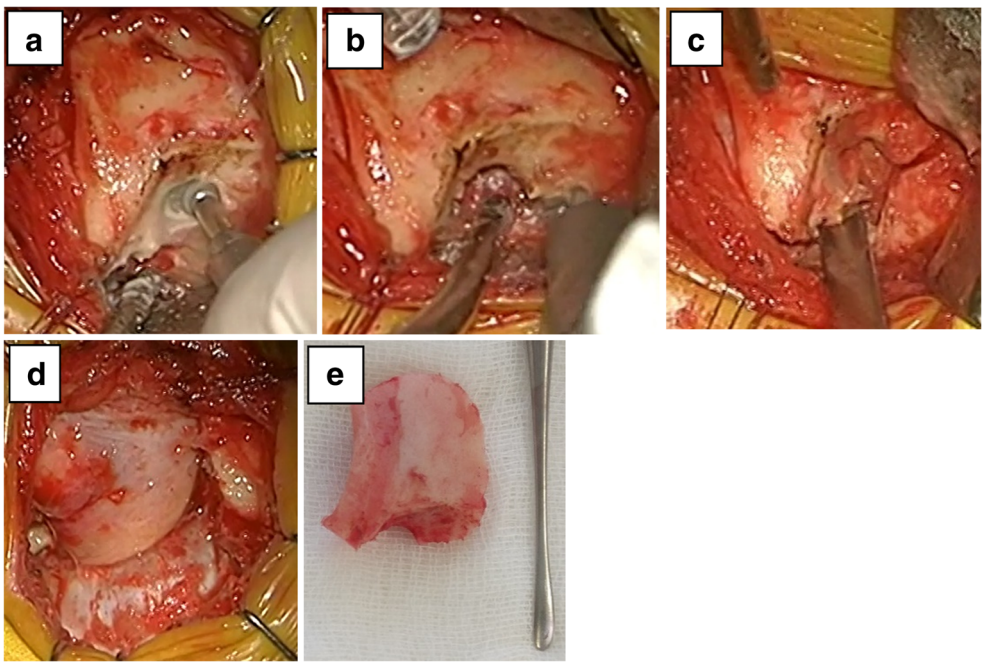

Fig. 3 Steps of the craniotomy. **a** Forming of the burr hole at the key point. **b** Mini-orbitofrontal craniotomy with high-speed craniotome. **c** Broking roof of the orbit. **d** General view after bone removing. **e** Bone flap view

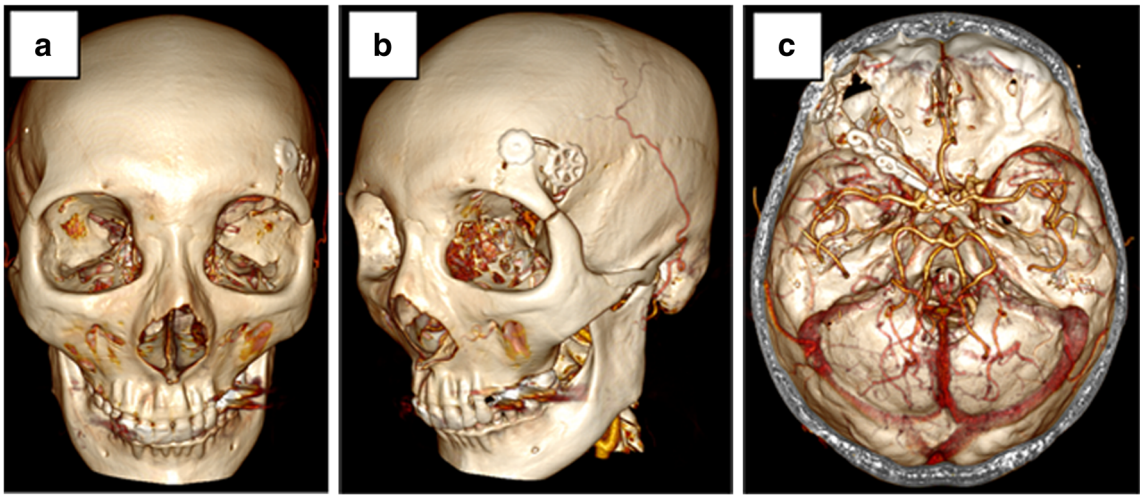

Fig. 4 **a**, **b** Postoperative CT with 3D-reconstruction. **c** CT angiography, aneurysm clipped

of the anterior cranial fossa less than 4 cm in size, and orbital cavernomas.

Limitations

Transpalpebral approach has certain limitations: insufficient illumination, restriction of angles of attack and trajectories, and limitation in the freedom of work by microsurgical instruments.

Some other contraindications include large frontal sinuses, large complex and giant aneurysms, acute period of subarachnoid hemorrhage, cerebral edema and signs of intracranial hypertension, large tumors of the anterior cranial fossa (>4 cm), and cosmetic contraindications (not expressed fold of upper eyelid, tendency to form of keloid scars).

Avoiding complications

To avoid frontal sinus penetration, it is important to perform an individualized preoperative planning, with an evaluation of the frontal sinuses and their borders.

Accurate determination of the location of the supraorbital notch (foramen) will reduce the risk of damage to the supraorbital artery and nerve and minimize the complications associated with their damage.

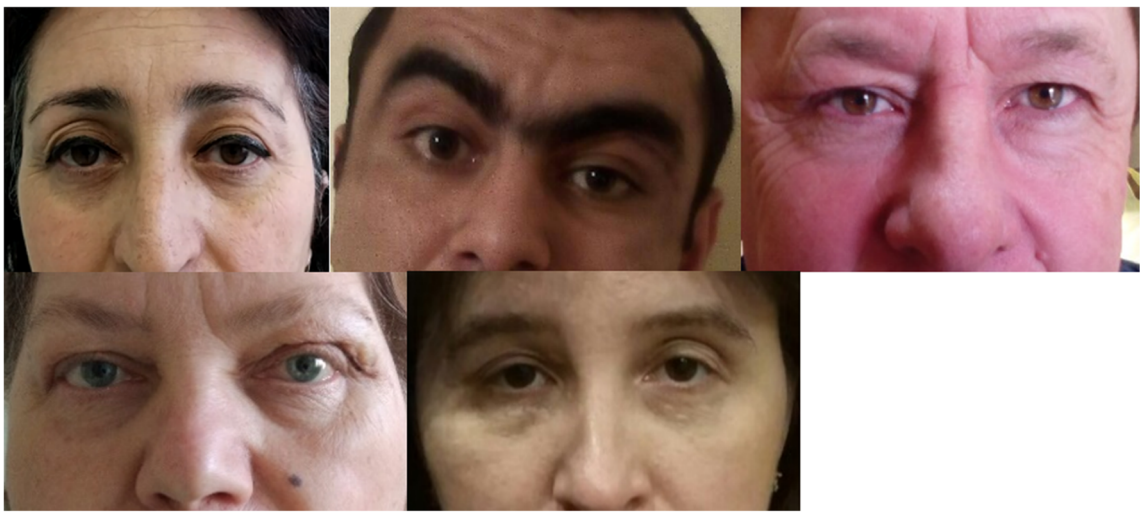

Fig. 5 Cosmetic outcomes after transpalpebral approach

Due to the minimal dissection of the temporalis muscle, patients did not present complaints related dysfunction of the temporomandibular joint.

Using of a retractorless technique minimizes the risk of brain damage and enlarges the working space [1, 2, 7].

Specific perioperative considerations

Preoperative individual planning with virtual craniotomy (CT angiography, MRI with contrast enhancement) is one of the main factors for successful use of transpalpebral approach.

If fat extrusion is coming from the orbit, we use low-volume coagulation, and if periorbital fat is significantly prolapsed, another option is suture to the orbital septum.

The frontal sinuses should be carefully assessed on preoperative computed tomography (CT) images, as well as the shape and size of the eyelids.

If frontal sinus is opening, there are two solutions: (1) when the frontal sinus is opened without damaging the mucous membrane, the defect is waxed and (2) when the mucous membrane of the frontal sinus is damaged, cranialization is performed, then packing with fat and vancomycin is performed in sinus cavity with additional fibrin glue sealing.

Postoperative evaluation in the intensive care unit is mandatory. An early postoperative CT should be performed within 24–48 h to exclude complications. Three to five days after aneurysm clipping, the control CT angiography is performed. The MRI with contrast enhancement is critically to control the degree tumor removal.

To reduce the periorbital edema, we place ice cubes on the area of the postoperative wound.

Sutures are removed on the 4th–5th day after surgery, the thin skin of the upper eyelid provides early healing and excellent cosmetic outcome.

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

In addition to the general risks of aneurysm and tumor surgery, patients are informed for possible cosmetic outcomes: periorbital edema (regression for 3–5 days) and hypoesthesia of the supraorbital region in 1–3 months.

A summary of key points

1. Preoperative individualized planning and neuronavigation are necessary for the successful use of transpalpebral approach.
2. Adequate selection of patients is necessary.
3. It is important to have a lot of experience with traditional approaches.
4. Perfect knowledge of anatomy is necessary.
5. Use of early brain relaxation, traditional microsurgical technique, and retractorless technique is mandatory.
6. Intradermal suture contributes rapid healing of the operating wound and its camouflage in the natural fold of the upper eyelid.
7. You can modify and extend this approach by resecting a part of the orbital roof, anterior clinoid process, and sphenoid bone.
8. Temporal muscle dissection should be minimal to decrease the risk of its atrophy and formation of a temporal hollow.
9. Transpalpebral approach is a safe and effective surgical route with excellent functional and cosmetic outcome.
10. The approach provides early recovery of patients, reduction of hospital stay, and financial costs of treatment.

Compliance with ethical standards

Conflict of interests The authors declare that they have no conflict of interest.

All patient consent The patients have consented to the submission of this How I Do It for submission to the journal.

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