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HOW I DO IT - TUMOR - MENINGIOMA

Extreme lateral supracerebellar infratentorial approach: how I do it

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Abstract

Background The extreme lateral supracerebellar infratentorial (ELSI) approach was initially proposed to treat lesions of the posterolateral surface of the pons principally cavernomas. The versatility of the approach allowed its use for other pathologies like gliomas, aneurysms, epidermoids, and meningiomas.

Method We describe here the ELSI approach along with its advantages and limits in comparison with other surgical approaches for the treatment of meningiomas of the petroclival region.

Conclusion ELSI is a versatile approach that allows access to the anterolateral brainstem surface including extensions to the midbrain diencephalic junction when needed. ELSI compares favorably to other surgical alternatives with respect to the approach-related morbidity, while allowing adequate access to treat the pathology.

Keywords Supracerebellar infratentorial approach · Petroclival meningiomas · Tentorial meningiomas tentorial incisura

Relevant surgical anatomy

The tentorium divides the cranial cavity into supra- and infratentorial compartment spaces. The extreme lateral supracerebellar infratentorial (ELSI) approach is primarily related to the middle incisural space that is located lateral to the midbrain and upper pons and medial to the parahippocampal gyrus of the temporal lobe. This space is bounded superiorly by the posterior part of the optic tract and by the inferior surface of the thalamus and continues inferiorly with the cerebellomesencephalic fissure. This space contains the crural and ambient cisterns and it is traversed by the trochlear and trigeminal nerves, posterior cerebral artery (PCA), superior cerebellar artery (SCA), and the basal vein of Rosenthal [1, 5].

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Description of the technique

The patient is placed in a lateral park-bench position with the head fixed with a three-point fixation system. The head is kept in minimal flexion and tilted towards the floor. Intraoperative neuromonitoring is used to identify and preserve cranial nerves. A curvilinear retroauricular incision is performed extending from the level of the mastoid to the posterior temporal region. A craniotomy that allows complete exposure of the lateral part of the transverse sinus, transverse-sigmoid junction, and the upper part of the sigmoid sinus allows adequate access for this approach (Fig. 1). Sinus bleeding is controlled with hemostatic agents and gentle compression. Adequate repair of any opened mastoid air cells is essential. The durotomy is performed 5–8 mm parallel to the sinus border (Fig. 1). The lateral cerebellomedullary cistern is opened to relax the cerebellum. Dural suspension stitches adjacent to the sinus border allows the mobilization of the sinuses for improved vision.

Arachnoidal attachments of the tentorial surface of the cerebellum are separated along with the division of bridging veins (if any) that hinder the access. When the patient's positioning and craniotomy are properly performed, there is seldom the necessity for cerebellar retraction. The superior petrosal vein, the facial-vestibulocochlear nerve complex, AICA, and trigeminal nerve are identified early during the approach. The fourth nerve and SCA are always identified early at the tentorial edge (Fig. 2). The tentorial and petrous

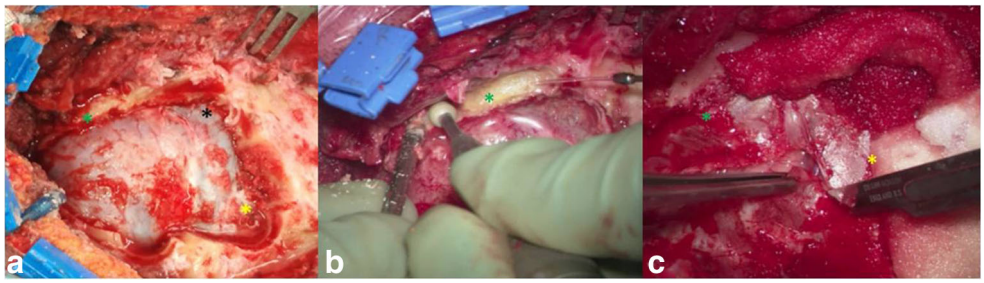

Fig. 1 **a** The craniotomy is performed with the placement of three burr holes that are placed at the level of the transverse sinus (yellow asterisk), transverse-sigmoid junction (black asterisk), and the inferior part of the suboccipital region. **b** The sigmoid, transverse-sigmoid junction, and transverse sinus are skeletonized using a diamond burr. **c** The dura mater is incised 5–8 mm parallel to the sigmoid (green asterisk) and transverse sinus (yellow asterisk)

attachments of the meningioma are then divided to achieve a devascularization of the meningioma. The tumor is progressively reduced in size and the capsule is removed after dissection from the cerebellar and the brainstem surfaces (Fig. 2). The tumor extending towards the Meckel's cave and the lateral clival edge is removed after ensuring that the other oculomotor nerves are identified and dissected off aided by direct nerve stimulation at 0.1–0.5 mA (Fig. 2). The dura is closed in a watertight fashion. A sealing hemostatic with glue is employed for reinforcement. The bone flap is repositioned and fixed with plates and screws.

Though this surgery is often performed by many surgical groups in the semi-sitting position to enable gravity-aided cerebellar retraction, our experience shows that cisternal opening and maintaining the table position in a minimal anti-Trendelenburg position allow adequate cerebellar relaxation thus avoiding air embolism that is a known complication of the semi-sitting position [7].

Indications

ELSI could be used to access lesions in relation to posterolateral midbrain and anteriorly towards middle incisura (Fig. 3) [1, 3]. When superior access is indicated, the tentorium can be incised to access lesions extending up to the level of the thalamus to treat a variety of lesions like gliomas, aneurysms, and meningiomas [6–10]. Petrosal approaches (anterior or posterior petrosal approaches), traditionally favored for petroclival meningiomas, are often time-consuming and could imply hearing sacrifice and possible facial nerve impairment [2]. The classical retrosigmoid approach implies increased manipulation of VII/VIII cranial nerves. The subtemporal approach has an increased incidence of temporal lobe damage in relation to the vein of Labbé injury. The ELSI, in comparison, is an attractive alternative that is actually an extension of the retrosigmoid craniotomy that makes access to the petroclival region easier and less morbid.

Limitations

The ELSI approach implies a long working distance when compared with petrosal approaches that necessitate microsurgical skills with the use of long microinstruments. The approach needs expertise in dealing with venous sinuses and harbors a risk of sinus thrombosis. Based on the clival extent of the tumor, this approach may not be enough for midline clival extensions. In this situation, petrosal approaches or

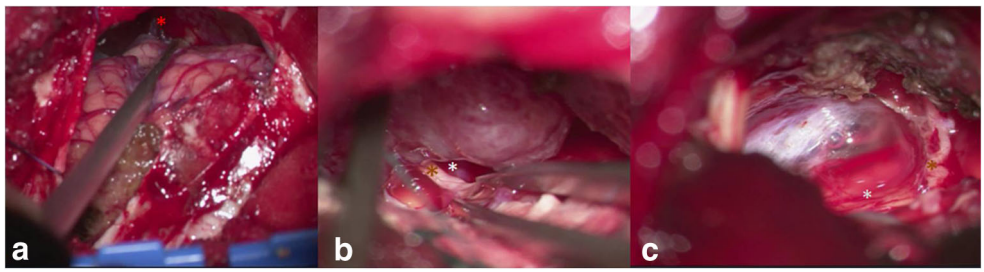

Fig. 2 **a** The tentorial attachment of the tumor is seen adjacent to the superior petrosal vein (red asterisk). **b** Mobilization of the most medial part of the tumor is achieved by dissecting away the trochlear nerve (brown asterisk) and superior cerebellar artery (white asterisk). **c** Surgical field at the end of tumor resection. Note the long length of the trochlear nerve (brown asterisk) that was dissected off the tumor, lateral surface of the brainstem (gray asterisk), and the part of the dural attachment adjacent to the Meckel's cave and the lateral part of the clivus that has been coagulated

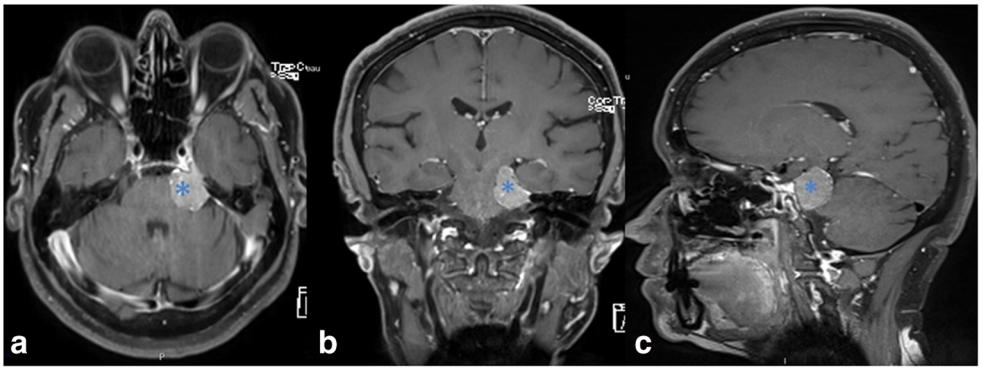

Fig. 3 **a** Axial, **b** coronal, and **c** sagittal gadolinium-enhanced T1-weighted MRI showing a petroclival meningioma (blue asterisk) with attachment to the dura of the anterior petrous bone, lateral part of the clivus, and inferior part of the tentorium. Note the significant brainstem compression

ventral endoscopic approaches may be needed either as an add-on or instead of the ELSI.

How to avoid complications

Sinuses skeletonization should be carefully performed to minimize sinus injury. Excessive traction of the transverse and sigmoid sinus should be avoided, and they should at all times be covered by wet Gelfoam to protect them from thermal/mechanical injury.

Specific perioperative considerations

Preoperative workup

Preoperative brain MRI and CT scan with bone windows are performed to study the tumor anatomy with adjoining structures. Vascular sequences (MRI or CT) are useful to evaluate the size/predominance of the transverse-sigmoid sinuses. A complete oto-neurological examination is performed for auditory status and to see if a petrosal approach can be used as an add-on if necessary.

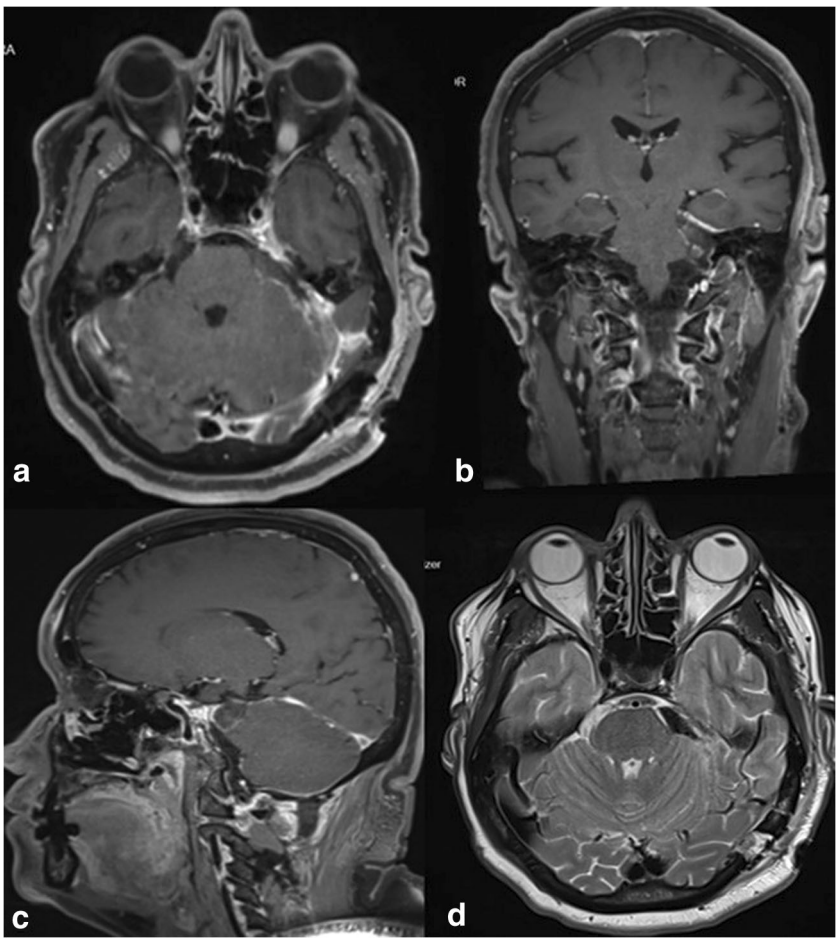

Fig. 4 Postoperative. **a** Axial, **b** coronal, and **c** sagittal gadolinium-enhanced T1-weighted MRI showing a subtotal resection (Simpson grade IV) of the petroclival meningioma. Please note the tentorium still thickened by tumor remnants and residual tumor within the Meckel's cave. Tumor resection at the level of the porus trigeminus and Meckel's cave is not attempted in order to avoid trigeminal neuropathy and also due to technical limitations of the ELSI. **d** T2-weighted MRI does not show any contusions or edema of the brainstem/cerebellum in relation to the approach or dissection

Postoperative workup

Postoperative MRI of the brain is obtained (Fig. 4) 3 months after surgery and repeated at intervals of 1–2 years for meningiomas. We favor, like other authors [8], the use of upfront radiosurgery in case of incomplete tumor resection. If the residue is very small or doubtful, serial MRI images can be obtained at a yearly interval.

Instructions for the postoperative care

Accurate clinical examination should be performed in the immediate postoperative course to detect neurological complications related to surgery. Attention should be given to avoiding and treating sinuses thrombosis, if present.

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

Surgery of petroclival meningiomas is associated with not insignificant morbidity [4, 10]. The most frequent complications are CSF leakage, hydrocephalus, hemorrhages, wound infections, brainstem or cerebellar ischemia, and new cranial nerve deficits. The rate of reported gross total resection widely varies upon the published surgical series (20–86%) with a trend towards a less aggressive surgical resection in most recent series [11]. For this reason, patients should be informed about serial follow-up MR imaging and supplementary surgical procedures or radiosurgery.

Compliance with ethical standards

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

Patient consent The patient/next of kin/guardian has consented to the submission of this "How I Do It" to the journal.

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Key points

1. ELSI is a versatile approach that can be used to resect lesions within the posterior and middle tentorial incisura.

2. ELSI is rapid and, when compared with petrosal approaches, could prove to be useful in reducing the approach-related morbidity. The global morbidity of this pathology still remains mostly dependent on the relationship with vital neurovascular structures

3. Compared with the subtemporal approach, ELSI avoids the need for temporal lobe retraction and possible venous complications.

4. Compared with retrosigmoid approach, ELSI reduces the manipulation of VII/VIII cranial nerves.

5. A careful analysis of the anatomy of the transverse and sigmoid sinuses, and pneumatization of the mastoid bone is important for a safe craniotomy.

6. Surgery in a park-bench position reduces the incidence of air embolism that is associated with the semi-sitting position.

7. Opening of the lateral cerebellomedullary cistern allows early relaxation of the cerebellum.

8. Dissection of the external surface of the tumor should only be attempted after adequate internal debulking.

9. A tentorial incision is only performed if the visualization of the superior part of the tumor is limited.

10. Tumor remnants left in place due to critical adherence to neurovascular structures can be later treated with radiosurgery.