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HOW I DO IT - TUMOR - OTHER

Extra-intradural extracavernous subtemporal approach for chondrosarcomas: technical note and case report

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Abstract

Background Skull base chondrosarcomas are rare tumors often invading the petrous apex and cavernous sinus, and many surgical approaches have been described. For most of them, these tumors grow slowly and their partial removal can be a first option before complementary radiotherapy. We described herein a minimally invasive approach that could be useful for soft non-calcified chondrosarcomas.

Method and results We report a case of right parasellar chondrosarcoma, for which an extra-intradural extracavernous subtemporal approach allowed a safe effective partial removal.

Conclusion This surgical approach is indicated in selected cases to obtain good decompression or partial removal of lesions involving the parasellar space and the petrous apex.

Keywords Skull base surgery · Cavernous sinus surgery · Chondrosarcomas · Subtemporal approach · Extradural approach · Extracavernous approach

Abbreviations

GG	Gasser ganglion
GeG	Geniculate ganglion
FO	Foramen ovale
FR	Foramen rotundum
FS	Foramen spinosum
GSPN	Greater superficial petrosal nerves
ICA	Internal carotid artery

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Relevant surgical anatomy

The anatomy of the middle skull base fossa, mainly composed of the temporal bone, must be perfectly known for such a surgery. Its relevant limits are the greater wing of the sphenoid bone anteriorly, the squamous portion of the temporal bone laterally, and the petrous pyramid and its contents posteriorly.

The relevant anatomical landmarks at the middle temporal fossa floors have to be identified: from lateral to medial, the *foramen spinosum* (FS) with the middle meningeal artery, the *foramen rotondum* (FR) with the V2 branch, the *foramen ovale* (FO) with the V3 branch, and the carotid canal carrying the horizontal intra-petrous segment of the internal carotid artery (ICA). Extradural peeling of the V2, V3 trigeminal branches lead to the Gasser ganglion (GG). Postero-medial to the V3 lies the petrous apex. Furthermore, the greater superficial petrosal nerves (GSPN) lies parallel and between the carotid canal and the FO-FS line locating posteriorly the geniculate ganglion (GeG). (Fig. 1) [1].

Description of the technique

We report the case of a 45-year-old patient who presented with a 2-year history of seizures and a cerebral MRI showing a right parasellar hyperintense T2 lesion

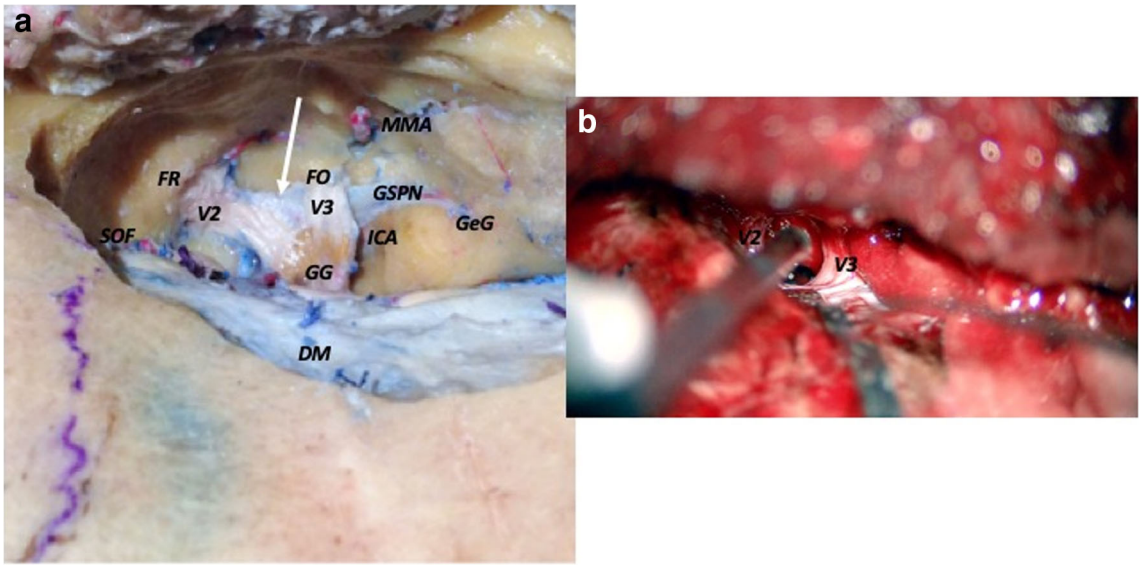

Fig. 1 **a** Anatomical view: subtemporal craniotomy with a pure extradural sub-temporal approach is performed. Craniotomy is delimited superiorly by the superior temporal line and posteriorly it passed the external acoustic meatus for 1.5 cm. Bone flap was extended till the skull base. Following the medial meningeal artery, both the ovale and rotondum foramens are exposed with an extradural peeling of the V3 and V2 till the Meckel's cave. Posteriorly on the petrous bone, the petrosal nerves and the geniculate ganglion are tracked and for the first, detached from the dura-mater. In this case, the parasellar chondrosarcoma has been approached working in between V2 and V3 (arrow). A more posterior approach pushing away anteriorly the V3 can be used to get access to the petrous apex. **b** Operative view. (*SOF* superior orbital fissure, *FR* foramen rotondum, *FO* foramen ovale, *MMA* middle meningeal artery, *ICA* internal carotid artery, *GSPN* great superficial petrosal nerve, *GeG* geniculate ganglion, *GG* ganglion of Gasser, *DM* dura mater)

extending to the petrous bone (Fig. 2). The patient underwent a percutaneous biopsy that confirmed the diagnosis of a soft, low-grade chondrosarcoma [4]. After 12 months, the patient developed a trigeminal neuralgia and the cerebral MRI showed a significant increase of its intra-cavernous portion. Therefore, surgical treatment was decided in order to reduce the volume of the lesion before considering radiotherapy.

The patient was positioned in the supine position, with the head turned 60° to the contralateral side and fixed by a Mayfield head-holder. The right trigeminal and facial nerves were monitored.

A right fronto-temporal incision was used and the cutaneous flap was reflected anteriorly, while the temporal muscle was retracted inferiorly. A craniotomy, bounded by the pterion, the superior temporal line, and the external acoustic

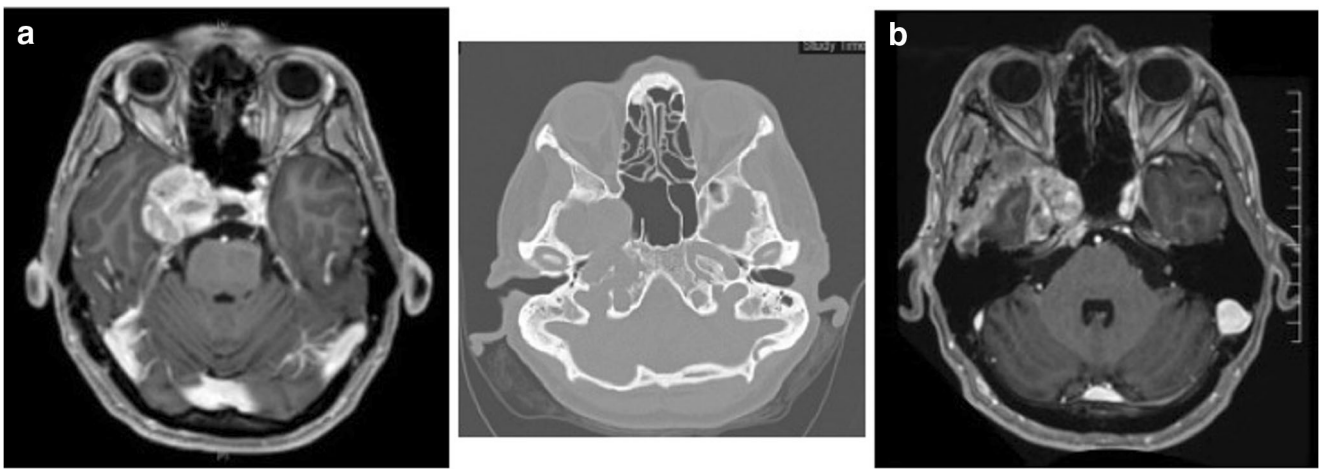

Fig. 2 Pre- and postoperative imaging: **a** Axial T1-MRI and CT-scan images showing a right parasellar lesion extending to the petrous bone and the Meckel's cave. The bone CT scan clearly shown the right petrous apex lysis and the relationship with the sphenoid sinus; **b** axial T1-MRI sequence showing a postoperative decompression with the cavernous part kept in place

meatus bone, was performed extending till the skull base by drilling.

A pure extradural subtemporal approach was first used. Following the medial meningeal artery (MMA), the FS, FR, and FO were identified. The GSPN and the GeG were also tracked, as well as the posterior edge of the petrous pyramid. The location of the GeG was confirmed through micro electric stimulation (100 microV, 0.03 mA, Nimbus, Ynnopsis®). The MMA was coagulated and sectioned. The GSPN were detached from the dura to avoid damage to the geniculate ganglion and a facial palsy. An extradural peeling of the lateral wall of the Meckel's cave was done and the V3 trigeminal branch exposed.

The motor component of the V3 branch of the trigeminal nerve, anteriorly to its sensitive counterpart, was identified using micro electric stimulation. Finally, the lesion was accessed extradurally in between the V2, V3 branches.

Tumor resection was started by extradural intra-tumoral aspiration. ICA in its intrapetrous segment was visualized within the tumor cavity. The surgical corridor reached the medial limit of the tumor, crossing around the ICA through a narrow surgical window. Intra-durally, gentle dissection led to exposing the lateral wall of the Meckel's cave blowed by the tumor and resection was completed by repeated compressions on it to expulse tumor fragments in the extradural window. All of these maneuvers were useful to evacuate the crumbliest portion of the tumor and to considerably reduce its total volume. Using this approach, the cavernous sinus and the oculomotor and trigeminal nerves were perfectly preserved.

Surgery led to a partial removal and a relief of all clinical symptoms. The tumor remains stable till after 2 years of follow-up.

Indications

Either chondrosarcomas or other tumors, whose friable consistency can be suspected or histologically proved, represent best indications for extradural resection by this extra-intradural extracavernous subtemporal approach [3, 5].

This approach can also be used to perform tumor biopsies and decompressions of the parasellar space when visual impairment (with diplopia being the most common presenting symptom) or trigeminal neuralgia occurs. Indeed, with a slight opening of the dura mater, the lateral wall of the cavernous sinus—Meckel's cave can be reached and pressure on it will improve extradural tumor removal without endangering its content. Working in between the V2 and V3 gives access to the Meckel's cave and behind the V3 to the petrous apex [2].

This approach finds its best application in partial or subtotal removal of tumors before complementary radiotherapy or a "wait and see" attitude according to grade, histological analysis, and clinical context.

Limitations

- Indirect access to the cavernous sinus
- Difficult access to the superior and medial compartment of cavernous sinus
- Risk of facial nerve palsy, due to traction to the GSPN and the geniculate ganglion
- Risk for the trigeminal branches damage, even if drilling of the FO can increase the safety of the V3 mobilization
- Petrous ICA management, in particular when it is displaced laterally by the tumor

How to avoid complications

- Comprehensive preoperative imaging (MRI, angio MRI, DTI, CT scan) is mandatory to anticipate surgical difficulties (ICA position, intracranial anastomosis, bone lysis, and communication with the sphenoid sinus, cranial nerve position)
- Intraoperative monitoring of the facial nerve to be warned of excessive traction
- Dissecting (sometimes cutting) the GSPN to avoid any traction to the geniculate ganglion
- Using suction, gentle moves and avoiding any sharp dissection with curettes inside the tumor;
- Careful retraction of the temporal lobe paying attention to posterior temporal veins.

Specific perioperative considerations

Preoperatively, a cerebral MRI and bone skull base CT scan is used for pre-surgical planning and neuro-navigation during the surgical procedure. A detailed neurological examination and a visual assessment are mandatory.

Postoperative, intensive care is suitable after surgery, a CT scan is performed at day 1 and the patient is discharged from the hospital around day 5. MRI is also performed within 2–3 months to evaluate the evolution of the residual tumor and to plan further strategy or treatments.

Specific information to give to the patient

Patients have to be informed of potential cranial nerves injuries (facial numbness, dysesthesia, pain, facial palsy) and vascular risks. Postoperative discomfort rate is minimal.

Key points

- Intraoperative monitoring of the facial nerve and intraoperative stimulation is highly recommended
- The ICA position determines the feasibility and risks of this approach (transcranial vs. endonasal)

- The patient is placed in the supine position, with the head turned 60° to the contralateral side and fixed by a Mayfield head-holder
- A wide craniotomy, extended posteriorly to the external acoustic meatus, is mandatory to expose the surgical field
- The middle meningeal artery serves as a key marker to follow in order to visualize V3 and it can be coagulated
- The GSPN and the geniculate ganglion must be precisely located and for the first cut if necessary to avoid any traction
- The extradural step is followed by an intradural one, which gives access to the lateral wall of cavernous sinus—Meckel's cave
- Retraction of temporal lobe must be minimal
- Resection can be helped by compression on the lateral wall of cavernous sinus to expulse the lesion through the extradural corridor (indirect strategy)
- For slowly growing chondrosarcoma, a "wait and see" strategy and repeated surgeries can be a reasonable option.

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Compliance with ethical standards

Patient consent The patient has consented to the submission of this "How I Do It" for submission to the journal.

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