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HOW I DO IT - TUMOR - SCHWANNOMA

How I do it: retrosigmoid suprajugular approach to the jugular foramen

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Abstract

Background The retrosigmoid suprajugular approach provides a less-aggressive approach for a subset of tumors of the jugular foramen.

Method We described the retrosigmoid suprajugular approach with its advantages, caveats, and indications. A Samii-B2 glossopharyngeal nerve schwannoma is shown to exemplify the procedure.

Conclusion The retrosigmoid suprajugular approach provides an excellent option for tumors with a variable extension into the cerebellopontine cistern and limited extension into the jugular foramen. It is less destructive than the other approaches and allows a good exposure to the posterior part of the jugular foramen.

Keywords Schwannoma · Glossopharyngeal nerve · Jugular foramen

Abbreviations

CSF	Cerebrospinal fluid
3D-CISS	3-dimensional constructive interference steady state

Relevant surgical anatomy

The jugular foramen is an extremely complex region on the inferior portion of the petrous bone. It contains the jugular bulb, inferior petrosal sinus, meningeal branches of the ascending pharyngeal and occipital arteries, glossopharyngeal, vagus, accessory, Jacobson's and Arnold's nerve, and cochlear aqueduct. On its intracranial surface, the foramen is roofed by the jugular notch, intrajugular process and pyramidal fossa (from lateral to medial), and covered in several dural layers [1, 6]. In the cerebellopontine angle cistern, the bulbar nerves are identified entering the jugular foramen, with the glossopharyngeal nerve having the most superomedial course at the level of the pyramidal fossa, and a dural septum separating it from the other nerves, though this is not usually seen in vivo due to the angle of view [3, 4, 6].

Description of the technique

The procedure for a left Samii-B2 [5] glossopharyngeal schwannoma is shown in Video 1 and Figs. 1, 2, and 3. Surgery is performed under continuous electrophysiological monitoring of the facial, glossopharyngeal, vagus, accessory, and cochlear nerves. The patient is positioned in dorsal decubitus with the head elevated and rotated to the contralateral side, leaving the maxilla as the highest point of the field and the mastoid surface parallel to the floor. After the head is fixed, the projection of the transverse sinus is identified by creating a line from the zygomatic process to the inion. The projection of the sigmoid sinus is identified by the tip of the mastoid. A Straight line, two fingerwidths from the external auditory canal are marked, extending from the level of the lobule of the ear to about 2 cm superior to the root of the pinna. The incision must allow exposition of the posterior surface of

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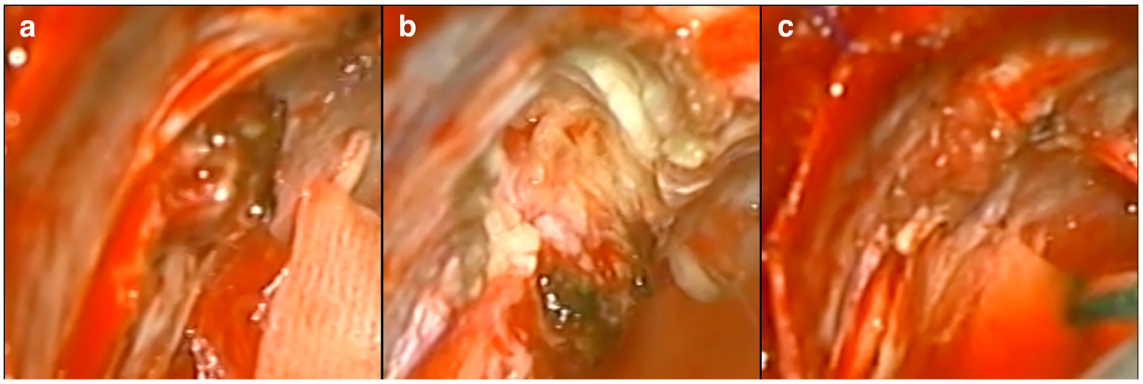

Fig. 1 Retrosigmoid suprajugular approach for glossopharyngeal nerve schwannoma. **a** Residual tumor inside the jugular foramen. **b** Exposure of the intraforaminal tumor after bone resection. **c** Reconstruction of the jugular foramen with muscle graft

the mastoid up to the digastric notch and anterior part of the nuchal plane of the occipital bone. C1 should be palpated, but not exposed. A burr hole is created at the transition of the transverse and sigmoid sinus, as identified by the perpendicular crossing of the projection of the zygoma and the digastric notch. A second burr hole is drilled at the most anteroinferior point allowed by the exposure. The craniotomy is completed by joining the 2 burr holes posteriorly using a craniotome and anteriorly by drilling the mastoid bone over the projection of the sigmoid sinus. To expose the jugular foramen, the border of the sigmoid sinus must be identified throughout the entire anterior border of the craniotomy, especially in the anteroinferior part. The dura is opened parallel to the sigmoid sinus, followed by opening of the lateral cerebellomedullary cistern to allow drainage of cerebrospinal fluid (CSF). After arachnoidal dissection, the lesion and/or bulbar nerves should be visible. According to the size of the lesion, internal debulking may be necessary before approaching the jugular foramen. A curved incision is made right above the jugular notch, limited by the endolymphatic sac, and extending to the pyramidal process. Using a high-speed drill with coarse diamond and diamond bits, the jugular notch and intrajugular process are carefully resected until identification of the pars nervosa and exposure of the intrajugular tumor is achieved. The lesion is then resected in a piecemeal fashion. In some cases, an endoscope may be used to assure complete resection. The jugular foramen is inspected for mastoid cell openings and then closed with muscle patch and fibrin glue. After hemostasis, dura mater is closed in a watertight fashion, the bone flap is repositioned, and the wound is closed.

Indications

The suprajugular approach is indicated for lesions in the cerebellopontine angle cistern with a small projection into the jugular foramen, or for small intrajugular tumors [6]. In our experience, lesions with extension up to 10 mm into the jugular foramen are suitable for this approach—in particular, schwannomas and meningiomas—whereas paragangliomas, chordomas, chondrosarcomas, and endolymphatic sac tumors would often need more aggressive approaches.

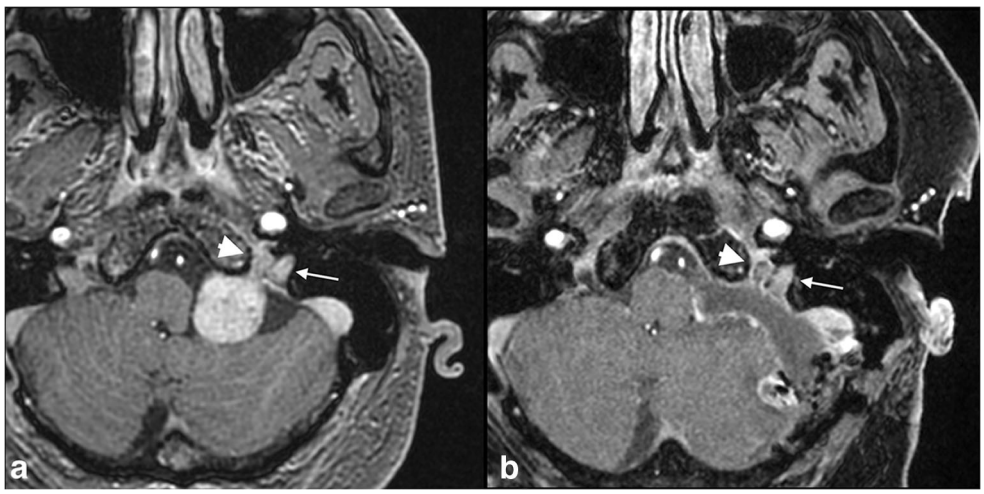

Fig. 2 **a** Preoperative MRI showing a mainly cranial lesion with extension to the pars nervosa of the jugular foramen. **b** Postoperative MRI showing gross total resection of the lesion including its intrajugular portion. Arrow: jugular bulb. Arrowhead: pars nervosa of the jugular foramen with (**a**) and without (**b**) tumor

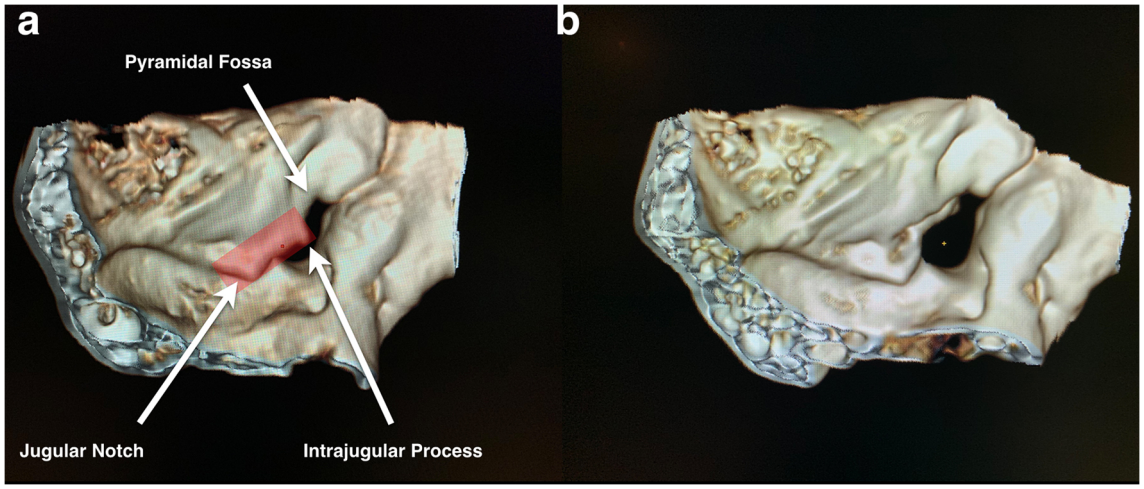

Fig. 3 Preoperative (**a**) and postoperative (**b**) CT reconstruction showing the extent of resection of the roof of jugular foramen. Note the drilling on the jugular notch and intrajugular process, with almost complete preservation of the pyramidal fossa

Limitations

Lack of cervical control of carotid artery and jugular vein, and a high-riding jugular bulb pose an added difficulty and should be carefully taken into consideration when choosing the best approach. The tumor must not extend to the anterior half of the jugular foramen; otherwise, the extent of bone resection would favor other approaches.

How to avoid complications

In tumors without venous invasion, handling the jugular bulb requires careful dissection, then pushing it inferiorly with a cotton patty to reach the anteromedial foramen. Lacerations are usually controlled with a muscle graft fixed with fibrin glue. In cases of normal hearing, exposing the cisternal aperture of the cochlear aqueduct should be avoided. We have found that for most cases, opening the roof of the pyramidal fossa is not necessary, thus avoiding unintentional damage.

Preoperative workup

Gadolinium-enhanced T1-weighted and 3-dimensional T2 MRI sequences are used to evaluate tumor extension, endolymphatic sac position, nerve displacement, and the presence of high-riding jugular bulb. MR venography or angiography should be considered to evaluate jugular infiltration. CT is used to evaluate jugular enlargement and pneumatization of the petrous bone, as well as to estimate the degree of bone drilling that will be required. Audiometry must be performed in all cases to determine hearing status.

Postoperative workup

Postoperative MRI and CT of the brain are obtained on the first postoperative day to evidence extent of bone and tumor resection.

Instruction for postoperative care

Patient may be extubated immediately after surgery if manipulation of the cranial nerves was deemed not significant; otherwise, it should be delayed until there is evidence of normal airway protection mechanisms. Oral ingest may be considered if there are no signs of swallowing alterations.

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

There are several approaches to the jugular foramen [2, 5], most carrying high morbidity and extensive operating times. The retrosigmoid suprajugular approach is a significantly less aggressive approach, albeit suitable for a small subset of patients. Risk of CSF leak, hemorrhage, jugular thrombosis, hearing loss, nerve deficits, stroke, and infection are explained to the patient. Even though no direct comparison exists, we consider that this approach has lower morbidity than others.

Key points

- The retrosigmoid suprajugular approach provides a simpler, less invasive option to access the jugular foramen and CPA.

- Tumors suitable for this approach should be limited to the posterior part of the jugular foramen, regardless of intracranial extension.
- Presumed tumor histology should be considered in choosing this approach: schwannomas and meningiomas are the best indications.
- Invasion of the venous system is a relative contraindication for this approach, as there is no cervical vascular control.
- During craniotomy, exposition of the entire border of the sigmoid sinus is key to obtain intradural exposure of the jugular foramen.
- In patients with preserved hearing, the endolymphatic sac and aperture of the cochlear aqueduct must be identified and preserved.
- In most cases, drilling of the pyramidal fossa is not necessary for adequate exposition of the intrajugular tumor.
- The jugular bulb may be dissected from the lesion and pushed downwards to improve visualization of the anteromedial foramen.
- The foramen should be thoroughly checked to close any inadvertently opened air cells to avoid CSF leaks.
- Complications are similar to the other approaches to the jugular foramen, though they are probably less frequent.

Compliance with ethical standards

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

Ethical approval All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

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

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