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Case Report

Foramen magnum meningioma approached by the midline subtonsilar approach – Revisiting Cushing's classification of craniospinal meningiomas

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ABSTRACT

Background: The management of foramen magnum meningiomas (FMMs) has been a challenge for skull base neurosurgeons. Since the initial description of a FMM in 1872, various surgical approaches have been described. Posterior and posterolateral FMMs are safely removed through a standard midline suboccipital approach. Nevertheless, we still face controversy regarding the management of anterior or anterolateral lesions.

Case Description: A 47-year-old patient presented with progressive headaches, unsteadiness, and tremor. Magnetic resonance imaging showed an FMM that caused significant displacement of the brainstem.

Conclusion: This operative video highlights a safe and effective surgical technique for the resection of an anterior foramen magnum meningioma.

Keywords: Cushing, Foramen magnum, Meningioma, Subtonsilar approach

INTRODUCTION

Since the initial description of a foramen magnum meningiomas (FMMs) in 1872, various surgical approaches have been described. The management of FMM has been a challenge for skull base neurosurgeons. Posterior and posterolateral FMMs are safely removed through a standard midline suboccipital approach.[2,3] Nevertheless, we still face controversy regarding the management of anterior or anterolateral lesions.

The foramen magnum is located in the occipital bone, which has three parts: a squamosal part located behind the foramen magnum; a basal (clival) portion located anterior to the foramen magnum; and a condylar part that connects the squamosal and clival parts.[6] The suboccipital approaches are directed through the squamosal part and the condylar part, which includes the occipital condyle, posterior margin of the jugular foramen, and hypoglossal canal, is exposed in the far-lateral approach.[4] Structures involved in foramen magnum lesions include the lower cranial and upper spinal nerves, the caudal brainstem and rostral spinal cord, the vertebral artery and its branches, the veins and dural sinuses at the craniovertebral junction, and the ligaments and muscles uniting the atlas, axis, and occipital bone.[6]

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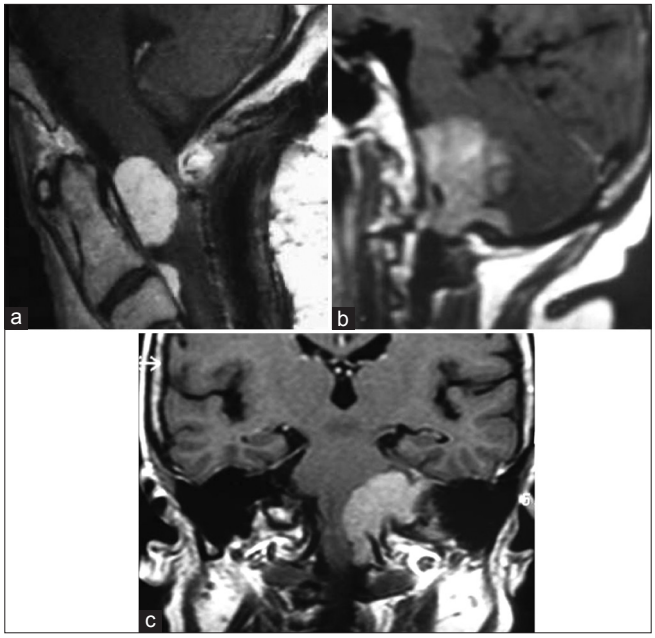


Figure 1: Example of the last cases seen by the authors. Sagittal view of head magnetic resonance imaging showing a meningioma arising below the foramen magnum, the *Spinocranial* type (a). A *craniospinal* type *2* foramen magnum meningioma, reaching above the pontomedullary sulcus on sagittal and coronal views (b and c).

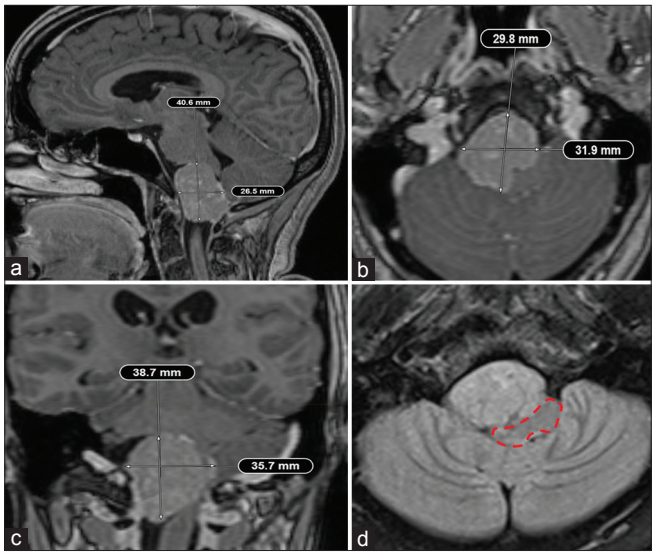


Figure 2: Head magnetic resonance imaging evidence large anterolateral foramen magnum mass with homogeneous enhancement of contrast in (a) sagittal, (b) axial, and (c) coronal views. (d) Note the important posterolateral displacement of brainstem (red traced lines).

The foramen magnum is most commonly approached from posteriorly through the suboccipital and upper cervical region. Tumors arising in the region of the foramen magnum

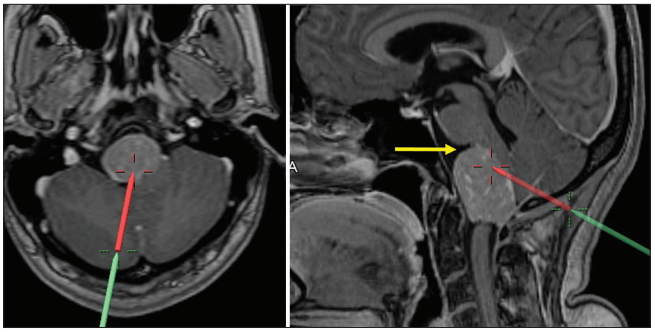


Figure 3: Neuronavigation in magnetic resonance imaging showing the direction to the mass allowed for the suboccipital midline approach. Note that the tumor was at the level of the pontomedullary sulcus (yellow arrow), and almost completely anterior to the tonsil. Red and green line represents the operative trajectory, shown with neuronavigation.

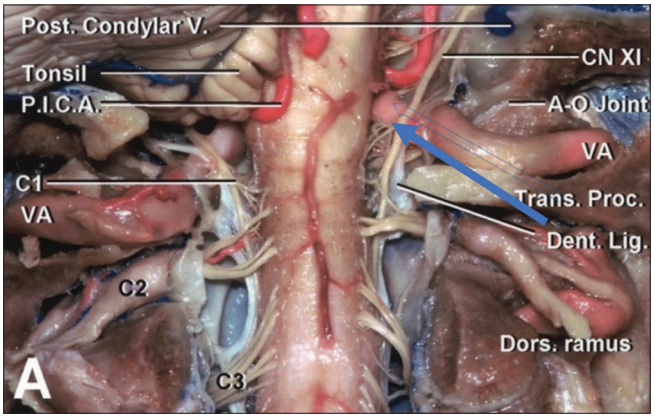


Figure 4: Courtesy of the Rhoton Collection, American Association of Neurological Surgeons/Neurosurgical Research, and Education Foundation. The complex craniocervical junction anatomy from a posterior view from foramen magnum opening. The blue arrow indicates the surgery approach view in our case. P.I.C.A = posterior inferior cerebellar artery, VA = vertebral artery, CN XI = cranial nerve XI (accesory nerve), AO joint = atlanto-occipital joint, Dent. lig. = dentate ligament, Dors. ramus = Dorsal ramus, Trans. proc. = transverse process, Post. condylar V. = posterior condylar vein.

are divided by Cushing and Eisenhardt into a craniospinal group that arises above and grows downward toward the foramen magnum, and a spinocranial group that arises below and grows upward toward the foramen magnum.[1]

CASE DESCRIPTION

A 47-year-old female patient was referred to a neurosurgery consultation due to headaches that failed to improve with standard medical treatment. Her headaches had been progressively worse for the past 3 years. She also complained of tremors involving the upper limbs and being constantly unable to maintain balance, in which she described as an "unsteadiness." She denied any issues with swallowing and reported to other deficits.

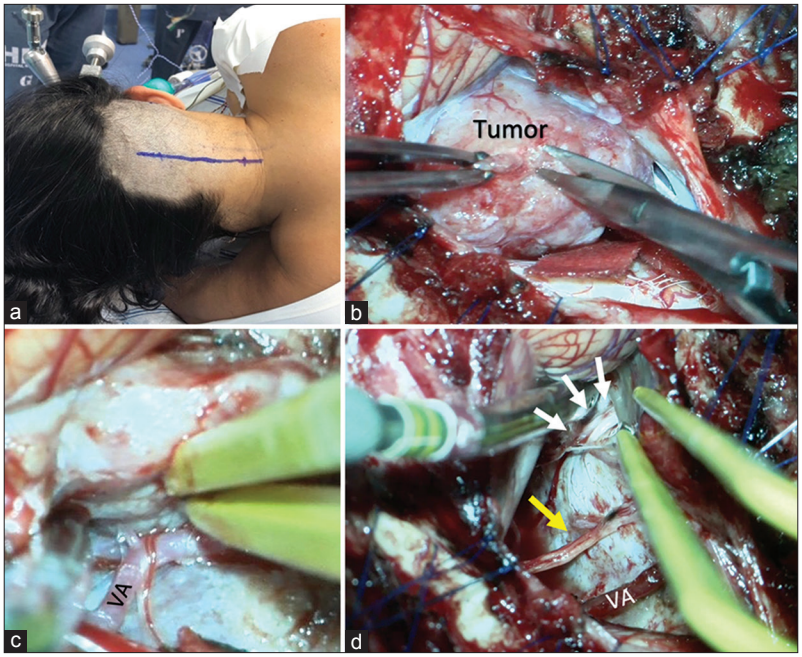


Figure 5: Steps from the suboccipital midline approach. Programmed skin incision (a); Intraoperative view, tumor exposition and beginning of debulking (b); dissection and exposure of right vertebral artery (VA), arterial branches for the mass (c); complete resection and view of IX, X, XI complex (white arrows) and XII cranial nerve (yellow arrow) and VA intact (d).

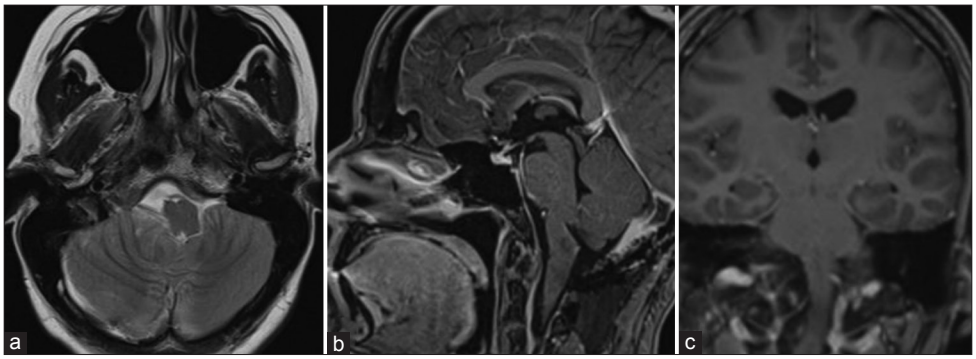
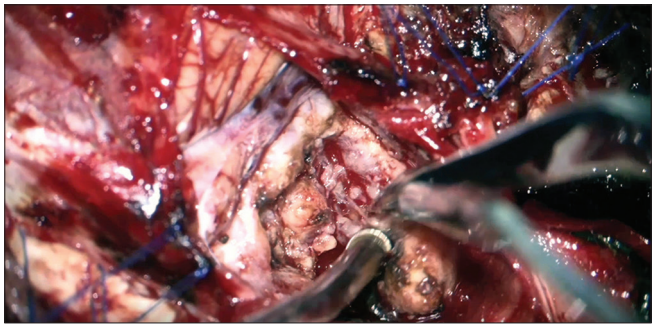


Figure 6: Postoperative magnetic resonance imaging showing complete removal of the tumor and the brainstem getting back to the normal position. T2 axial reconstruction (a); T1 + Gadolinium contrast sagittal and coronal reconstruction without contrast enhancement (b and c).



Video 1: Surgical video.

Magnetic resonance imaging (MRI) showed a mass-occupying lesion originating from the anterior aspect of the foramen magnum that caused significant displacement of the brainstem and extends from the pontomedullary sulcus to the cervical spinal cord [Figures 1 and 2]. The lesion presented homogeneous enhancement with gadolinium contrasting, raising suspicion of a meningioma. Due to the patient significant disability, surgical treatment was imperative. A midline suboccipital-subtonsilar approach was deemed appropriate for the case due to the significant posterolateral displacement of the brainstem [Figure 3]. The

anatomy of this approach it's seen in Figure 4. Operative position and images can be seen in Figure 5 and at Video 1. The patient recovered well without complications. Post operative images [Figure 6] showed complete ressection of the lesion.

Postoperative CT scan and MRI showed no hemorrhages, significant improvement of mass effect, and complete removal of the tumor. The patient was discharged after 10 days. She returned to the outpatient clinic after 16 and 30 days having recovered fully from all previous symptoms. The histopathological results confirmed a grade 1 (the World Health Organization classification) meningioma.

CONCLUSION

We, hereby, endorse that the midline suboccipital subtonsillar approach allowed safe and effective treatment of this anterior FMM.[2,3] This approach was deemed safer and less invasive than other alternatives, such as the Far Lateral and transcondylar approaches.[4,5,7] Because the tumor was at the level of the pontomedullary sulcus, covered by the tonsils and due to the brainstem displacement, this approach was made possible. We believe that by tailoring our approaches to the specific needs of each patient is key for safer, faster, and less invasive surgeries when appropriate.[3,5,7]

Cushing divided these FMMs into a variety arising above the foramen magnum – craniospinal – and those arising below the foramen magnum – spinocranial.[1] Revisiting this historical classification, we propose a new classification by subdividing the craniospinal type into two sub-types: A and B as described as follows:

- The craniospinal type 1 meningiomas may be reached by a posterolateral subtonsillar approach without removing the condyle mainly if they dislocate the brain stem to the opposite side, as we have done in this present case

The craniospinal type 2 meningiomas are those reaching above the pontomedullary sulcus. Herein, the cerebellar hemisphere is wider laterally, above the upper part the tonsils are located, needing more cerebellar retraction, so it is better to use a far-lateral and/or transcondylar approaches to a safer exposure. Indications for each approach can be found on Table 1.

Declaration of patient consent

Patient's consent not required as patient's identity is not disclosed or compromised.

Table 1: Proposed foramen magnum meningiomas modified classification based on the level of the brain stem reached by the upper extension of the different types of foramen magnum meningiomas, based on a retrospective analysis of the last cases.

Leal – Landeiro classification for foramen magnum meningiomas	
Spinocranial	Up to the foramen magnum
Craniospinal type 1	Up to the pontomedullary sulcus
Craniospinal type 2	Above the pontomedullary sulcus

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Conflicts of interest

There are no conflicts of interest.

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