Far lateral approach for foramen magnum meningioma

R. Dharmajaya
Department of neurosurgery, faculty medicine, Universitas Sumatera Utara

ABSTRACT: Among the meningioma of the posterior fossa, foramen magnum (FM) meningioma deserves special consideration because of their characteristics in symptomatology, intriguing surgical anatomy, unique operative requirements, and outcome. When all meningioma are considered, FM meningioma has the worst outcome in terms surgical results and operative morbidity. We report a 53 years old female who diagnosed had foramen magnum meningioma and had performed tumor removal surgery using far lateral approach. Finally, detailed technic operation and classification system from vary literature will also explained. Keywords: Foramen magnum meningioma, Far-lateral approach.

1 INTRODUCTION

Meningioma represented 20% of all primary intracranial tumors and 75% of benign tumors of the foramen magnum, however foramen magnum meningioma account for only 1.5 to 3.2% of all meningioma.\(^1\)\(^2\) Foramen Magnum meningioma categorized by their relative location to the medulla in the axial plane,\(^1\)\(^2\) interolateral is the most common, posterolateral is the second, purely posterior lesions are the third, and the least common are entirely anterior.\(^1\)\(^3\) Foramen magnum can be approach trough trans oral, sub occipital craniotomy, and far lateral approach.\(^4\) For anterior midline foramen magnum meningioma trans condylar approach preferred because it can gives better visibility anterior to the brainstem also decreases the need of brainstem, cerebellar, and upper cervical retraction.\(^4\)

2 CASE REPORT

A 53 years old female presented with chronic headache, numbness from the neck below, and weakness on both upper and lower extremities. Motor strength was 4 for all extremities and cape distribution of hypesthesia was found. MRI shows a solid enhancing mass attached to the midline, anterior foramen magnum, from the distal of clinoid to C1. Patient has performed microsurgical resection (Simpson grade I) through far lateral approach.

3 DISCUSSION

Foramen magnum meningioma arises from the arachnoid at the craniospinal junction. The borders of this zone, as defined by George and colleagues range anteriorly from the lower third of the clivus, to the upper margin of the body of C2, laterally from the jugular tubercle to the upper margin of the C2 laminae, and posteriorly from the anterior edge of the squamous occipital bone to the C2 spinous process.\(^5\)
3.1 Surgical Anatomy

When approximating FM menigioma, a precise affection of the normal anatomy is very important. Regional anatomy of the vertebral artery (VA) and the lower cranial nerves and their displacement by space-occupying lesions must be well recognized by the surgeon to ensure their protection.

The FM contains several critical neuroanatomical and vascular structures. The neural structures include the cerebellar tonsils, inferior vermis, fourth ventricle, caudal aspect of the medulla, lower cranial nerves (IX through XII), rostral aspect of the spinal cord, and upper cervical nerves (C1 and C2).6,7

Major arterial structures located within the FM include the VAs, posterior inferior cerebellar arteries (PICAs), anterior and posterior spinal arteries, and meningeal branches of the vertebral, external, and internal carotid arteries.6,7

For an anatomic description, the VA is divided into four segments.7 The first, “pretransverse” (ostial, proximal) segment extends from its origin to the transverse process of the C6 vertebra.

The second “transverse” segment runs inside the transverse processes of C6 through the axis.7 Of special interest for surgery around the FM are the third and fourth segments. The V3 segment is also called the “suboccipital segment” and extends from the transverse process of the axis to the dural penetration of the VA.7

Anatomical relations of the VA are modified by head movements of rotation, as well as during surgical positioning. In neutral position, the vertical and horizontal portions of the V3 segment are perpendicular. On the contrary, after head rotation, as required during an anterolateral approach, both segments are stretched and run parallel, only separated by the posterior arch of the atlas, because the C1 transverse process is pushed anteriorly by this movement, away from the C2 transverse process.7

3.2 Classification System

The definitive objective of a classification system is to define preoperatively the surgical strategy based on preoperative imaging characteristics of the lesion. The surgical strategy in cases of FM is the surgical approach but also the anticipation of modified vital structure position. In this classification system, FM can be classified according to their compartment of development, their dural insertion, and to their relation to the VA.8

According to the compartment of development, FMs can be subdivided into intradural, extradural, intra- and extradural. According to the insertion on the dura, FM can be defined in the antero-posterior plane as: anterior, if insertion is on both sides of the anterior midline, lateral, if insertion is between the midline and the dentate ligament, posterior, if insertion is posterior to the dentate ligament.1

Surgical strategies vary with the relation to the VA, FM having the possibility to develop above the VA, below the VA, or on both sides of the VA.9

Figure 2. Classification of FM according to its VA. FM location below VA, above VA, and both side. Based on the compartment of development intradural, extradural, intra-extra dura.

3.3 Key Step of Surgical Procedure

The goal of this approach is to allow a tangential view of lesions located ventrally and ventrolaterally to the brainstem and upper cervical cord. This approach along with control and mobilization of the vertebral artery (VA) allows better visibility anterior to the brainstem, thus influencing favorably the safety and completeness of the operation. The advantages are: provides exposure of the lower third of the clivus, the foramen magnum, and the upper cervical spine, decreases the need for brainstem, cerebellar, and upper cervical cord retraction required to visualize the lower clivus and anterior foramen magnum.10

The patient is placed in the lateral recumbent position on the operating table, with the head positioned in the Mayfield holder. The head is laterally flexed -30 degrees, contralateral to the lesion, and flexed anteriorly so that the chin is 1 cm from the sternum.

The incision starts at the mastoid process, descending in a curve dorsal to the sternocleidomastoid muscle and down to the level of C4. The dissection is carried through the subcutaneous tissues, the muscular fascia, and the fatty plane.9,10

Dissection through these anatomic layers, detaching each muscle from its lateral attachment, and displacing them medially and inferiorly, provides access to the transverse process of C1 and the lateral masses of the lower cervical vertebrae.9,10

By exposing the ipsilateral lamina of C2, and the posterior arch of C2, one can identify the VA with its venous plexus located in the sulcus arteriosus lat-
eral to the posterior arch of Cl, ventral to the C2 nerve root, and caudal to the inferior border of the inferior oblique muscle.\textsuperscript{9,10}

A small craniotomy is performed with a high-speed drill, removing 1 cm of suboccipital bone from the foramen magnum. It is important to take this bony exposure far lateral to the junction with the occipital condyle. The posterior portion of the occipital condyle is drilled, while protecting the VA. The amount of resection of the condyle depends on the actual location (ventral or ventrolateral), size, nature of the lesion, the shape of the foramen magnum and the relation of the VA to the lesion.\textsuperscript{9,10}

A high-speed drill or rongeurs are used to remove the posterior arch of Cl. The foramen transversarium of Cl is unroofed with a drill. Using a subperiosteal dissection of the lamina and lateral mass, the VA is freed from the sulcus arteriosus of Cl, and isolated to its entrance into the dura.\textsuperscript{9,10}

Following isolation of the VA and appropriate bone removal, the dura is opened in a curvilinear fashion. The dural edges are retracted with sutures and the neurovascular structures are identified. The artery can be mobilized posteriorly and dissected from the lesion.\textsuperscript{11} After resection of the lesion, the dura can rarely be closed in a watertight fashion: therefore, a dural graft may be used (pericranium or fascia) and the defect covered with oxidized cellulose (Surgicel) and fibrin glue.\textsuperscript{9,10}

3.4 Outcome And Postoperative complication

Yasargil and colleagues,\textsuperscript{11} in their review of the 114 cases in literature operated between 1924 and 1976, found an operative mortality of approximately 13%, a good outcome in 69%, fair outcome in 8%, and a poor outcome in 10%. A low preoperative Karnofsky Performance Score (KPS), progressive clinical course, and quadriplegia were associated with increased operative risk and poor prognosis.\textsuperscript{11} Recurrence is a major problem in skull base meningiomas.\textsuperscript{11}

The most common complications are vertebral artery injuries, vertebral venous plexus bleeding (source of potential complication during surgery), neurologic disability from retraction of the neurexus or arterial insult, delayed spinal cord and brainstem symptomatology from compromise of venous drainage, CSF leakage that leads to meningitis and pseudomeningocele, and C2 root neurapraxia from stretch injury.\textsuperscript{10}

3.5 Conclusion

The far-lateral approach has been used to approach for the majority of the lesions located ventrolateral to the brainstem and in the upper cervical spinal cord. This approach pursues to remove the occipital bone including the posterior aspect of the ipsilateral condyle and posterior arch of Cl. Anatomical landmarks may be recognized for the neurosurgeon to avoid neurovascular injuries, especially to the vertebral artery and hypoglossal nerve.

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