Research article

Cranio-Cervical Meningiomas Surgical approaches and clinical outcome

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Introduction
Meningioma is one of the most common benign tumors in craniocervical junction , Each tumor has different growth pattern in relation to the neurovascular structures surrounding . So, required a specific surgical approach and technique. Especially in case of tumors at the anterior aspect of the craniocervical junction, we high lightened how much degree of condyle should be respected and whether the occipitocervical fusion should be performed or not. **Material & methods:** A total of ٩ Craniocervical Junction meningiomas were operated between (٢٠٠٦ -٢٠١٤). Male: Female = ١:٨, mean age: ٤٤.٥ years, mean follow up: ٢٧.٦٩ months. Most common symptom was headache and posterior neck pain followed by motor or sensory change, lower cranial nerve related symptoms. Mean symptom duration was ٢٤ months. We performed surgical treatment via Midline suboccipetal cranectomy in ٤ patients and Far-lateral approach in ٣ patients and Partial transcondylar approach in two patients, the degree of condyle resection was less than ١٠ percent. **Results:** Clinical results were estimated based on the karnofsky scale. In ٩ FM meningiomas, all cases except two cases were gross totally removed. One case showed hard consistency and vertebral artery encasement so some small portion was left the other one had cardio vascular instability during surgery so the procedure was aborted. Seven patients except two improved on the KPS karnofsky scale. One patient died two weeks following surgery due to cardiac problem. **Conclusion:** Despite challenging for the neurosurgeon in surgical treatment for meningiomas in craniocervical junction, a careful preoperative neuroradiological evaluation and the proper choice of approach and the extent of bone resection according to the location and size of the tumor could be helpful to the surgeon for better outcomes, In meningiomas of the craniocervical junction, a small amount of resection of occipital condyle provide adequate surgical view. Therefore occipitocervical fusion was not required. And gross total resection and excellent surgical outcome could be expected.
Key Words: CranioCervical, neuroradiological**,** clinical outcome

Introduction
Meningiomas are common neoplasms representing ١٤.٣ to ١٩٪ of all intracranial tumors[٦٣]. Among all the meningiomas, only ١.٨ to ٣.٢٪ arises at the foramen magnum (FM) level [٣]. Nevertheless, meningiomas are the most commonly observed FM tumors, representing ٧٠٪ of all benign tumors[١٣,١٥–١٩,٥٥,٦٤]. Most of the time, these are strictly intradural. Ten percent have an extradural extension: Most are intra- and extradural, and a few may be entirely extradural[٩, ١٣, ١٥–١٩, ٢٤, ٢٥, ٥٦, ٦٠, ٦١].

The lesion is often large when discovered because of their slow-growing rate, their indolent development, the difficulty of the diagnosis leading to a long interval since the first symptom, and the wide subarachnoid space at this level[٧].

Meningiomas are considered to be located in the FM area if their base of insertion is mainly located within the FM limits. This definition excludes tumors invading secondarily the FM region(١٢)

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 FMMs is not only the surgical approach but also the anticipation of modified vital structure position as this helps to decrease morbidity

and mortality associated with surgery for this lesions.[١٥]
FMMs can be classified according to their compartment of development, their dural insertion, and to their relation to the VA[١٨]. According to the compartment of development, FMMs can be subdivided in:Intadural, extradural and intra extradural

Burnard G et al., in has classified FMM into, posterior, lateral, and anterior According to their insertion in relation to the dentate ligament .posterior if their insertion is posterior to the dentate ligament, anterior if their insertion is anterior to the dentate ligament, and lateral if insertion is anterior to the dentate ligament with extension over the midline. This classification system helps to define the best surgical approach and the lateral extent of drilling needed and anticipate the relation with the lower cranial nerves.

Standard preoperative workup includes magnetic resonance imaging (MRI), computed tomography (CT) scan, and sometimes angiography.MRI, gadolinium-enhanced sequences help to precisely delimit the dural attachment zone, the tumor, and its relation to neural and vascular structures. Bone windows CT scan the need for fusion. Conventional angiography is generally useless in most of the cases.

Intraoperative neurophysiological monitorings have been used by several surgeons[٣,٧] and includes somatosensory-evoked potentials, brainstem auditory-evoked potentials and electromyographic monitoring of lower cranial nerves,

The surgical approaches to FMM depend on multiple factors, including position of the tumor and its relations to the neural structures passing through the FM, nature of the lesion according to the compartment extradural or intradural or combined ofamiliarity of the surgeon to the technique

Results

Meningiomas:

The present study included ١٥ cases of foramen magnum meningiomas, all were operated upon using the far lateral approach. Male to female ratio was ٢:٣, the age ranged from ٢٦ to ٦٤ years, with mean age of ٤٥.٦.

As shown in Table ١, the vertebral artery was encased in all patients but with different degrees. The vertebral artery was partially encased in ١٢ cases, and showed a good line of cleavage between it and the tumour. These were the cases in which total excision was achieved. Yet in the remaining ٣ cases the tumour was located more anterior to the brainstem with bilateral encasement of the vertebral arteries, thus rendering safe total excision impossible through this approach. Only subtotal excision was done for these ٣ patients, and subsequent foramen magnum decompressions.

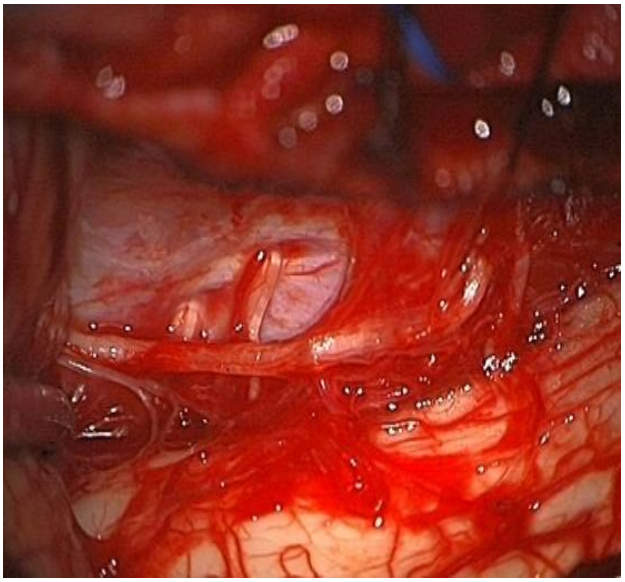
Dural attachment, as shown in Table ٢; ٨ patients had an anterolateral meningioma, whereas ٦ patients had a laterally based tumour, and only one patient showed a totally anterior based meningioma. The more laterally placed the meningioma and the more lateral its dural attachment was, the easier it is to devascularise the tumour extradurally and hindering the field less bloody and achieving total excision.

As regards tumour consistency; in only ٢ cases the tumour was soft, suckable and easy to remove from its dural base, whereas in the remaining ١٣ cases the tumour was tough and encasing the vertebral artery with a wide firm attachment to the dura.

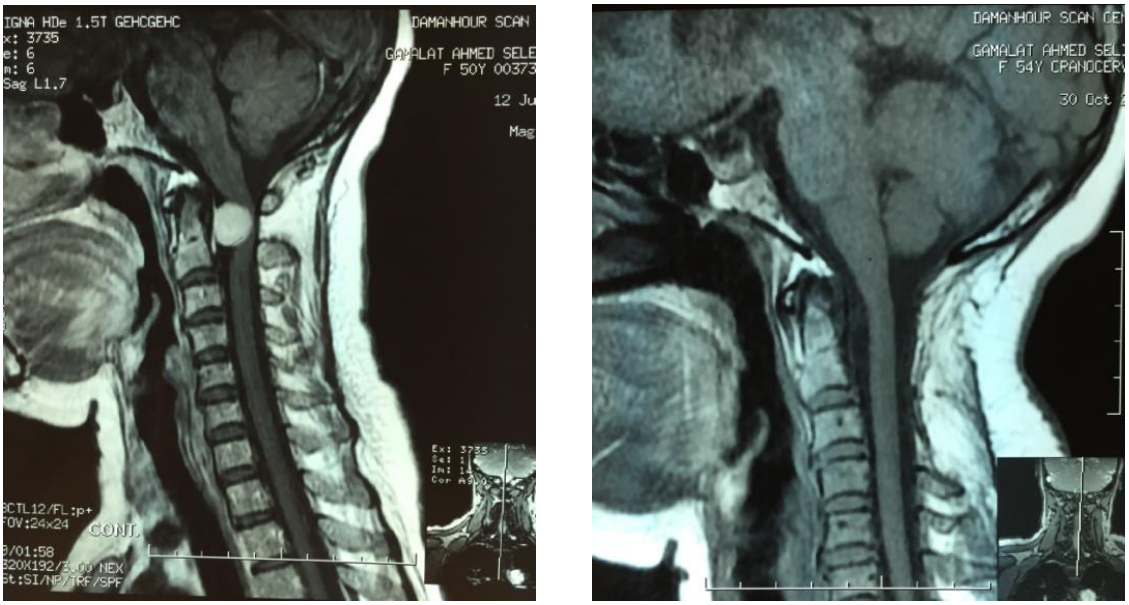
The extent of tumour removal depended on the consistency of the tumour and adherence to the VA. Total tumour removal was achieved in ١٢ cases. Subtotal removal leaving a sheet of the tumour on the VA was achieved in ٢ cases while in one case the tumour was located entirely anterior to the brainstem which necessitated more extradural bony work that was not achieved in this study (Table ٣).

Accessibility of approach; it is observed that for lateral and anterolateral based foramen magnum meningiomas the far lateral approach targeted the main goals of surgery. Yet, with for more anteriorly based meningioma involving the VA bilaterally

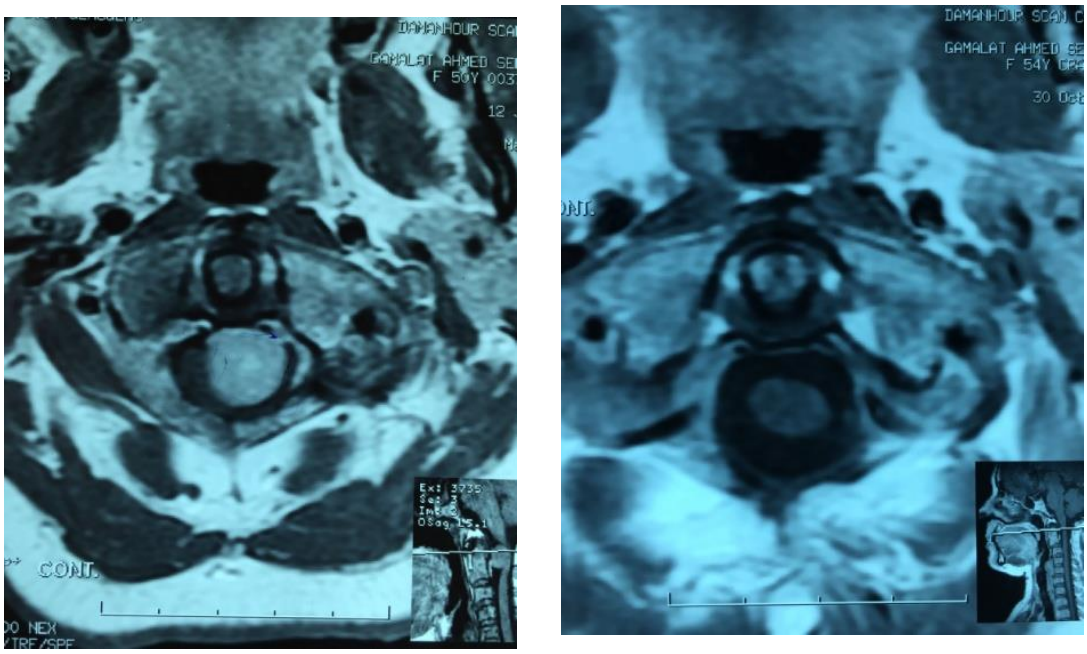
the angle of vision was obscured and limited.



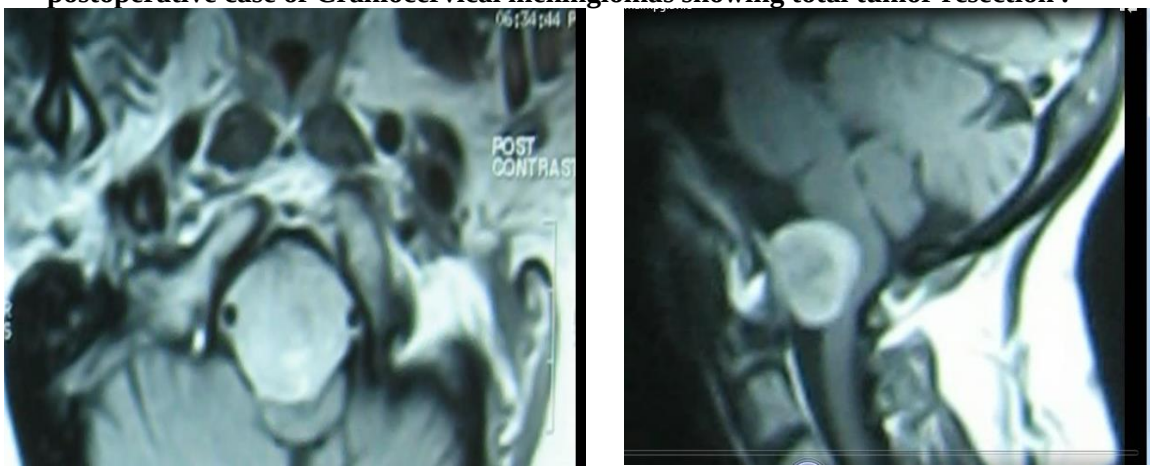
(Figure I) Intera operative photo of cranio cervical meningiomas showing the interphase between the tumour and the medullary -cervical junction



(Figure II) sagittal MRI T١ with contrast, pre and post contrast , both pre and postoperative case of Craniocervical meningiomas showing total tumor resection .



(Figure III) Axial MRI T١ with contrast, pre and post contrast , both pre and postoperative case of Craniocervical meningiomas showing total tumor resection .



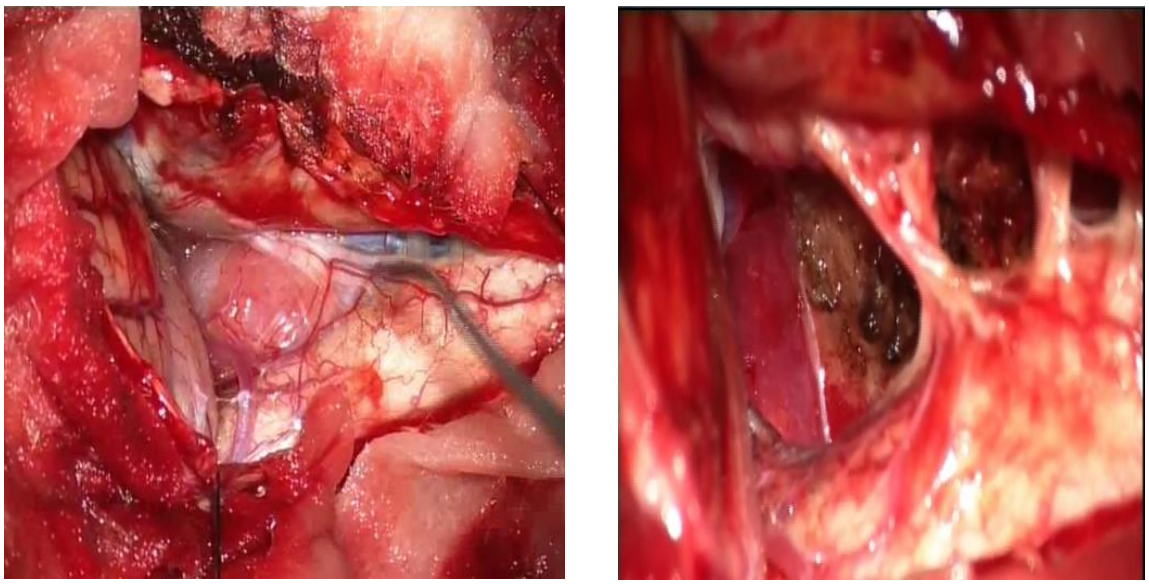


Figure IV post contrast axial and saggital MRI of a case with sizable foramen magnum meningiomas Intera operative picture of the same case pre and post gross total excision

Discussion

The surgical aspects to the foramen magnum have a unique consideration, due to its important neurovascular anatomy. Different intradural pathologies may present at the craniocervical junction. Various surgical approaches have been described to reach the anterolateral portion of the foramen magnum. The posterolateral transcondylar approach provides a good viewing access ventral to the brainstem and lower clivus. In addition, the far lateral approach does not affect the craniocervical stability when done with minimal removal of the occipital condyle.[٢٠,٢٦]

The far lateral approach provides an adequate exposure and viewing angle to the ventral brainstem with minimal retraction of important neurovascular structures in the region. The viewing angle is satisfactory even without mobilisation of the VA and its branches could be safely managed without jeopardizing the neurological status of the patient.[٣٢, ١٧,١٨,١٩,٢٢]

The far lateral approach is an extension of the standard suboccipital approach, designed to maximize exposure of the antero-lateral craniocervical junction.[١٨,٢٤,٣٤, ٣٨]

Bone removal involves C١ hemilaminectomy, a sub-occipital craniotomy and removing the posterior portion of the occipital condyle. Mobilization of the vertebral artery is not a mandatory step and only done if needed whenever the lesion is entirely anterior to the brainstem.[١٨,٢٤]

George, et al., classified foramen magnum meningiomas according to their zone of insertion and its relation to the midline and denticulate ligament into anterior, lateral, and posterior lesions.[١٨] It is very important to define the exact site and extent of the dural attachment of foramen magnum meningiomas, and the degree of encasement of the VA.[٧] These are the main factors regarding the extent of removal and the outcome. In the present work it is found that the far lateral approach offers a good working angle for lateral and antero-lateral meningiomas. Yet, with an entirely anterior meningioma this approach needs more extensive extradural bony work and to access the anterior foramen magnum dura.

There is continuing controversy in the literature concerning the necessity of resecting the occipital condyle.[٥,٧,١٩,٢٤] large lateral and anterolateral tumours could be exposed easily without extensively drilling the condyle. A different situation arises in anteriorly placed meningiomas or tumour portions located near the midline encasing the contralateral VA. In order to visualize such lesions from a lateral direction it is required not only to resect the medial rim of the foramen magnum which corresponds to the medial portion of the condyle but also of the jugular tubercle and, depending on the caudal extension of the tumour, of the medial portion of the lateral mass of the atlas.[٢,٧,٢٧]

It was found that most meningiomas included in the present study were tough in consistency and adherent to their dural attachment. The main target of surgical removal of meningiomas is attacking the vascular supply of the tumour first and this could only be achieved by disinsertion of the tumour from its dural attachment. Meningiomas have variable consistency and vascularity. Some tumours are fragile, of soft consistency but containing an abundant network of pathologic and fragile vessels. Such tumours cannot be cauterized adequately in their periphery.[٣,٢٣] An early devascularization of such tumours proved to be the best strategy, and this was possible only at the site of tumour insertion to the dura, requiring a so-called extreme lateral exposure.[٧,١١,٣٣]

The foramen magnum region concentrates many important neurovascular structures within a narrow field. Medulla and spinal cord, rootlets of the lower cranial and upper spinal nerves, VA, PICA, and small perforating branches of these arteries could not be seen in all instances at the beginning of surgery. Often these vital structures were hidden behind or inside a large tumour. When surgery of the tumour is performed in a fashion such that long-lasting bleeding, either from the tumour itself or from the extradural space, constantly obscures the surgical field the procedure becomes

hazardous because the aforementioned anatomic structures cannot be clearly identified.[١,٤,٨,١٠, and ١٢]

All patients included in this study were followed up for a period ranging between ٦ months to ٦ years. None of the patients showed any signs of instability of the craniocervical junction. Several reports in literature have assessed the stability pf the craniocervical junction both preoperatively and postoperatively.[١١,١٦ and ٢٨,٣١,٣٦,٣٩] these reports came to the conclusion that the far lateral approach can offer a good avenue to the anterolateral portion of the foramen magnum without jeopardizing the craniocervical stability. Most authors agree that far lateral approach could be carried out without the need of occipito-cervical stabilization.[٦, ٢٥, ٢٧, ٢٩, ٣٠]

The amount of occipital condyle removed is the main factor for doing craniocervical stabilization at the end of surgery. The more the surgeon has to remove from the occipital condyle the more the need for stabilization. The lateral approach of the foramen magnum offers a good surgical trajectory to the ventral brainstem and upper cervical cord. This approach can be modified whenever needed to reach lesions reaching the jugular tubercle or entirely anterior placed lesions.[٨, ١٣,١٥,١٩]

Conclusions

The far lateral approach could be done with great safety to reach antero-lateral foramen magnum lesions. Anteriorly based meningiomas require more drilling of the occipital condyle. The VA is a key stone during this approach and care must be given to preserve its main trunk and the branches. Removal of the posterior portion of the occipital condyle does not affect the craniocervical stability

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