The EGYPTIAN SPINE Journal
Online ISSN : 2314-8969
Print ISSN: 2314-8950
www.esj.journals.ekb.eg
CLINICAL ARTICLE EgySpineJ 33:54-62, 2020 DOI: 10.21608/esj.2020.28217.1129

Applicability of the Conventional Suboccipital Approach for Resection of Foramen Magnum Meningiomas: Early Experience with a Case Series

Mohammed Adawi, MD., Mahmoud Wahdan, MD., Mohamed Elnokaly, MD.†

Neurosurgery Department, Faculty of Medicine, Benha University, Benha, Egypt.
†Neurosurgery Department, Faculty of Medicine, Helwan University, Cairo, Egypt.

ABSTRACT

Background Data: Foramen magnum (FM) meningiomas are always considered challenging cases for neurosurgeons. The challenge is even heftier with early experience with limited access to up-to-date neurosurgical gadgets. Besides the anatomical complexity of the region, FM meningiomas tend to grow in proximity to eloquent structures making the task even tougher. Multiple approaches have been advocated to manage these lesions; nevertheless, adopting an approach according to your experience and circumstances would be best.
Purpose: To present our experience with 16 cases of FM meningiomas operated via posterior suboccipital approach and discuss the validity of this approach.
Study Design: A retrospective cohort study.
Patients and Methods: We reviewed our hospital records for patients where the posterior suboccipital approach was performed for foramen magnum meningiomas in the period between November 2014 and January 2019 at our institution. Lesions with anterior location or limited posterolateral extension and those with vertebral artery encasement were excluded. We could trace 16 patients with FM meningiomas operated upon using the midline suboccipital approach. Patients' imaging included IV gadolinium-enhanced MRI brain and CT angiography including brain and neck for diagnostic and planning purposes. Recorded outcome variables were pre- and postoperative Japanese Orthopedic Association (JAO) scale, extent of tumor excision according to Simpson's grading, operative blood loss, duration of surgery, hospital stay, and perioperative complications. Follow-up data were recorded from our outpatient clinic chart records.
Results: Twelve patients were females and 4 were males with a mean age of 40.64±8.69 years (range, 29–56 years). The mean preoperative JOA score improved from 14.875±1.690 to 15.63±0.99 at the last postoperative follow-up. Total resection was achieved in 10 cases (6, grade I; 4, grade II), subtotal resection in 4 patients, and partial resection in 2 patients. Patients with residual lesions (N=6) were

Address correspondence and reprint requests: Mahmoud Wahdan, M.D.
Neurosurgery Department, Faculty of Medicine, Benha University, Benha, Egypt.
E-mail: drwahdan@hotmail.com

Submitted: November 2nd, 2019.
Accepted: December 29th, 2019.
Published: January, 2020.

The article does not contain information about medical device(s)/drug(s).
No funds were received in support of this work.
The authors report no conflict of interest.

managed with Gamma Knife. The mean operative time was 261.25±55.33; the mean blood loss was 682.5±84.19; the mean hospital stay was 7.25±2.05 days. Transient CSF leak was the most common recorded complication (N=9). The mean follow-up period was 13±7.186 months.

Conclusion: Our data suggest that the posterior midline suboccipital approach is a safe and effective option in the management of FM meningiomas that are mainly posterior or posterolateral. (2019ESJ203)

Keywords: Foramen magnum; Meningioma; Craniocervical junction; Suboccipital approach.

INTRODUCTION

Foramen magnum (FM) meningiomas are lesions arising within the confinements of the craniocervical junction. Generally, meningiomas are considered the most common intracranial tumor; however, those that tend to grow in this eloquent region constitute 1.8–3.2% of all intracranial meningiomas. On the contrary, meningiomas represent almost 70% of FM region tumors. This benign, slow-growing, and indolent tumor often develops into large-sized lesions before clinical presentation.[3,10] Total excision is always the main target for such lesions; however, their location makes them a surgical challenge for most neurosurgeons. The anatomical complexity of the area and the adjacency to the brainstem, vertebral arteries, and cranial nerves make complete surgical excision a hefty challenge and lower its odds.[16]

Posteriorly based FM meningiomas are usually approached via the conventional median suboccipital approach, whereas isolated laterally and anterolaterally situated lesions are approached via far-lateral approach and extreme-lateral approach. Such approaches carry technical challenges and are not mastered by many surgeons. On another scale, the region's complexity generates a debate as to which is the most propitious surgical approach.[15,18] Most advanced centers rely on neurophysiological monitoring facilities during the operation to ensure safe surgery especially with lesions extending down along the cervical cord increasing the possibility of neural injury.[9,11,17]

The purpose of this study is to present our experience with 16 cases of FM meningiomas operated via posterior suboccipital approach and discuss the validity of this approach.

PATIENTS AND METHODS

We retrospectively reviewed our hospital's medical records between November 2014 and January 2019 for patients where the posterior midline suboccipital approach was conducted for FM meningiomas. We excluded lesions anterior or anterolateral to the spinal cord and lesion encasing the vertebral artery, while we included lesions either posterior or mainly posterolateral to the spinal cord and with only contact data and complete perioperative data and images. According to our medical records, the full history of all the patients was reported and they were submitted to physical and neurological examinations. All were submitted to intravenous gadolinium-enhanced MRI of the craniocervical junction, 3D MSCT scan, when needed, CT angiography, and plain radiographs of the cervical spine in lateral and AP views.

We defined the FM meningiomas according to Cushing and Eisenhardt,[5] as spinocranial lesions arise from the area around the most rostral spinal cord encroaching into the FM. We classified the location of FM meningiomas based upon MRI into anterior (attached to the anterior rim of the FM, displacing the neuroaxis posteriorly), anterolateral (located at the ventrolateral rim of the FM, displacing the neuroaxis posterolateral), and posterolateral (located at the dorsolateral rim of the FM displacing the neuroaxis ventrolateral) in accordance with its location of the cord.[1]

Preoperative data included the following: age, sex, duration of symptoms, and clinical and functional status using the JOA scoring system.[23] Intraoperative parameters included operative duration, blood loss, extent of tumor resection, while postoperative data was comprised of hospital stay, JOA scoring, neurological status, complications, and histopathological typing of the tumor.

Surgical Technique

All patients had surgery through the posterior midline suboccipital approach. After inducing general anesthesia, patients were put into prone (Concorde) position. The head was positioned in neutral position. A midline skin incision was marked strictly in the midline and starting from the inion to the cervical spine according to the extent of the tumor. After that, the field was sterilized and draped. The skin incision was deepened through the subcutaneous fat and fascia and then between different muscle layers, with a subperiosteal muscle dissection exposing the upper four or five cervical laminae and the suboccipital bone. A small rim suboccipital craniectomy was performed to create some space for dural opening and to facilitate tumor removal. Full C1 laminectomy was conducted in all patients, while partial C2 laminectomy was only necessary for 2 patients to widen our surgical exposure.

The dura is opened in Y-shaped fashion and widened accordingly. After full tumor exposure, the microscope was introduced into the field at this point where the dentate ligaments were cut and a piecemeal tumor debulking was conducted. With adequate continuous homeostasis, we create a dissection plane around the lesion to dissect the tumor from the surrounding structures, thus facilitating removal of the remaining parts of the tumor. Hemostasis was ensured again using cottonoids and bipolar coagulation to clarify that the surgical field was clear and then the dura was repaired primarily or, if needed, a graft should be used to augment the dura and help its closure. The wound is closed in layers over a subfascial suction closed drain (Figures 1 and 2).

Postoperative Care

Immediately, after surgery, all patients were admitted to the surgical ICU for 24 hours for neurological and homeostasis monitoring and then discharged to the ward. In 4 patients, a Ryle nasogastric tube was used until the patient regained good bulbar function. Patients were discharged in a soft cervical orthosis for 6–8 weeks postoperatively and followed up routinely at the outpatient clinic.

RESULTS

Of the total 16 patients, 12 were females and 4 were males with a mean age of 40.64±8.69 (range, 29–56) years. The mean duration of symptoms at the time of presentation was 7.25±3.27 (4–12) months. Clinical presentation includes neck pain (N=14), shoulder pain (N=8), bilateral hand paresthesia (N=8), poor gait (N=6), urine incontinence (N=2), and cranial nerve palsy (N=7). (Table 1)

The preoperative JOA score improved from 14.88±1.69 to 15.63±0.99 at the last postoperative follow-up. The preoperative JOA score was mild in 9 patients, moderate in 5, and severe in 2, while the postoperative JOA score at the last follow-up was 12, 3, and 1, respectively (Figure 3).

Intraoperative Parameters. The mean operative time 261.25±55.33 (200–380) minutes. The mean blood loss was 682.5±84.19 (500–800) ml. According to Simpson's grading, total tumor resection was achieved in 10 patients (6, grades I; 4, grade II), subtotal tumor resection in 4 patients (grade III), and partial tumor resection in 2 patients (grade IV). The 10 out of 16 patients who has total tumor resection were followed up with no regrowth reported at a 2-year follow-up. Subtotal and partial tumor resection achieved in 6 out of 16 patients were managed with postoperative Gamma Knife (GK) with good tumor control for a 14-month follow-up. The mean hospital stay was 7.25±2.05 (6–13) days. The mean follow-up period of the study was 13±7.19 months (range, 9–32 months). Histopathological reports showed that all meningiomas were of WHO grade I including meningothelial type in 6 patients, psammomatous type in 6, and transitional type in 4 patients.

The most seen complication was CSF leaks. It was recorded in 9 patients (57%) of our cases. One of these patients presented with a large pseudomeningocele that required operative repair, while the remaining patients managed responded well to conservative measures. No mortalities were reported during the follow-up periods (Table 2). Other less common complications include deteriorated neurological state and muscle power (25%) and transient bulbar affection (12.5%).

Table 1. Characteristics of the patients.

Parameters		Results
Age/years		40.64±8.69 (range, 29–56)
Sex		12 females /4 males
Duration of symptoms/months		7.25±3.27(4–12)
Clinical presentation	Neck pain	14/16
	Shoulder pain	8/16
	Motor weakness	6/16
	Poor gait	6/16
	Bilateral hand paresthesia	8/16
	Urine incontinence	2/16
	Cranial nerve palsy	7/16

Table 2. Operative parameters of the patients in the study (N=16).

Parameters		Results
Operative time		261.25±55.3 (200–320)
Blood loss/ml		682.5±84.19 (500–800)
Tumor location	Posterior	8/16
	Posterolateral	8/16
Tumor resection	Total	10/16
	Subtotal	4/16
	Partial	2/16
Histopathology	Meningothelial	6/16
	Psammomatous	6/16
	Transitional	416
Hospital stay/days		7.25±2.05 (6–11)
Follow-up/months		13±7.19 (9-32)

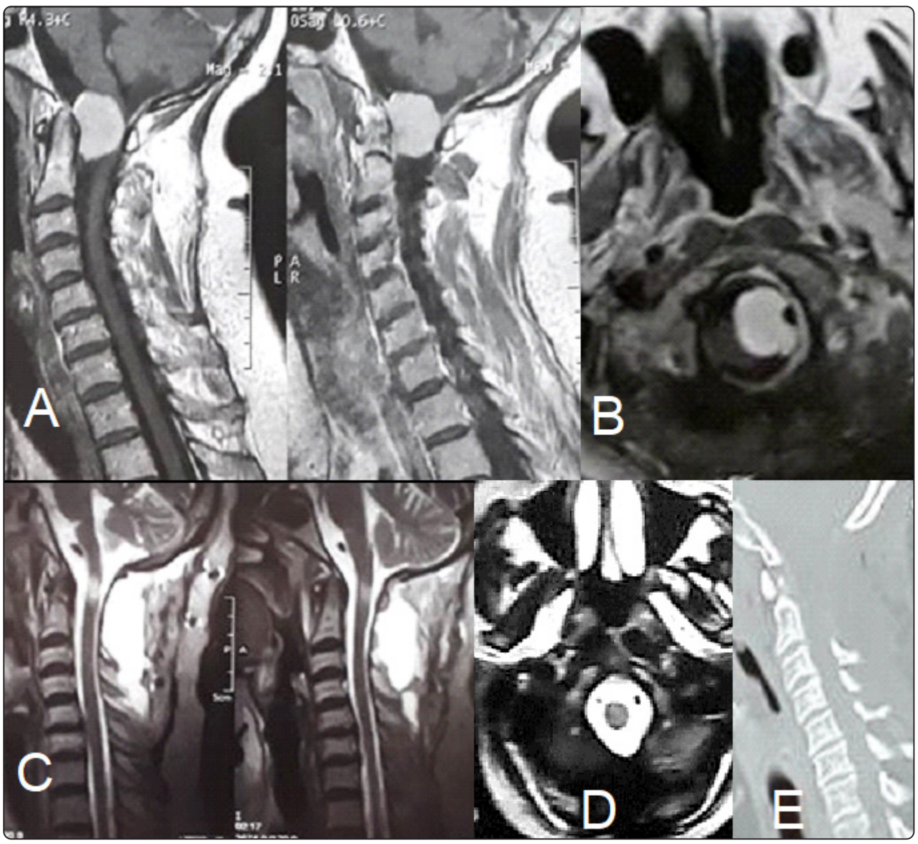

Figure 1. Images of a lateral foramen magnum meningioma; preoperative T1 post-intravenous gadolinium-enhanced MRI (A) sagittal and (B) axial images; postoperative T2 MRI (C) sagittal and (D) axial images showing complete total tumor resection with cord signal changes; (E) sagittal reformat MSCT scan showing the extent of bone removed during surgery.

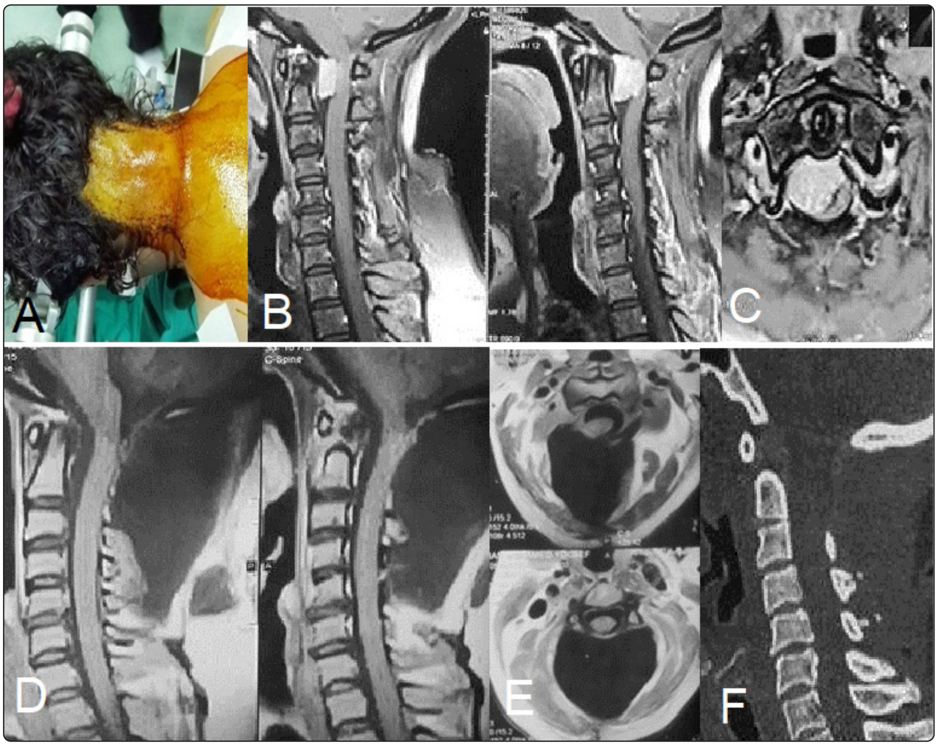

Figure 2. (A) Operative photo depicting surgical field preparation, preoperative T1 post-intravenous gadolinium-enhanced MRI (B) sagittal and (C) axial images showing FM meningioma; postoperative T1 MRI (D) sagittal and (E) axial images showing complete total tumor resection with large postoperative pseudomeningocele; (F) sagittal reformat MSCT scan showing the extent of bone removed during surgery.

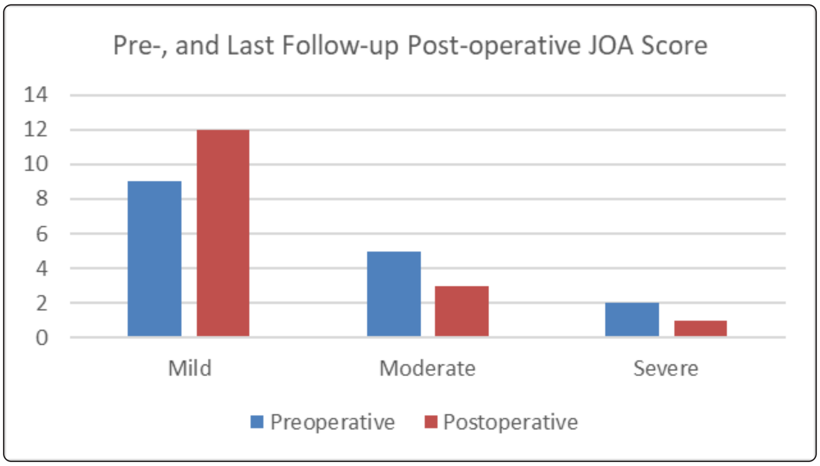

Figure 3. Pre- and postoperative JOA score

DISCUSSION

Foramen magnum meningiomas have been first described in 1939 by Bogorodinsky as meningiomas originating from the basilar groove projecting through the foramen magnum. On the other hand, Cushing and Eisenhardt[5] described them as spinocranial meningiomas from the area around the most rostral spinal cord encroaching into the FM. This kind of variation in defining FM meningioma has always defined how groups will include or exclude FM meningioma from their case series.

A wide variety of classifications have been presented to describe FM meningioma. Such classifications are important for implementing surgical strategies according to radiological findings and relations to the vital neurological structures. Bruneau and George introduced a classification for the primary FM meningioma based on the tumoral dural base insertion in the foramen magnum confinements, regardless of any aspect of tumor invasion. The classification was set based on compartment of development, dural insertion, and their relation to the vertebral artery. These aspects will alternate factors relied on in choosing the most appropriate surgical trajectory.[3]

The surgical difficulty of managing FM meningioma is mainly because of the site of attachment. A lot of articles anticipated FM meningioma attached to the lower-third of the clivus as the most challenging tumors when aiming for lower cranial nerve function preservation. On the other hand, meningiomas at the level of the foramen magnum, atlas, and axis have been less eventfully resected in recent literature. A large variety of surgical strategies are available to manage such lesions; however, they need to be selected and utilized in the right situation. Extreme far-lateral (transcondylar) and suboccipital approaches are the most common surgical approaches adopted for the excision of such lesions.[3,6,7,15]

When planning for surgical excision of a FM meningioma, a major consideration is the surgical corridor created by the meningioma itself. The corridor usually involves the space incorporated between the lateral limit of the cervicomedullary junction and the medial aspect of the occipital condyle. The operative corridor is considered narrow if it leads to a diameter of access to the lesion less than 1 cm; adequate if it is more than 1 cm but less than 2 cm; large if it is above 2 cm.[2]

The conventional suboccipital approach for FM meningioma accommodates several advantages, mainly the surgeon's familiarity with the approach. Furthermore, it avoids condyles or lateral mass drilling that induces cervical instability. Posterior cervical fusions reported in some literature with occipital condyle resection range between 0% and 66% in patients with the far-lateral approach.[18,19] Furthermore, postoperative recovery following the suboccipital approach is relatively faster and easier when compared to the transcondylar approaches. On the contrary, criticisms related to the approach are mainly attributed to encountering the brain stem, cranial nerves, and vessels when trying to reach the lesion. The midline suboccipital approach may encounter undue retraction on critical neurological structures if utilized for purely anterior lesions, rendering it impossible to pursue. Fortunately, these anteriorly located tumors are less common.

The complexity of both the far-lateral and extreme-lateral approaches accommodates a steep learning curve to master. Such approaches are better executed by expert well-trained neurosurgeons. Posterior FM meningioma has been reported to be safely resected via a midline suboccipital approach.[4] For that reason, in our early experience, we adopted the conventional suboccipital approach for patients with specific lesion criteria to enhance our experience and implement a surging learning curve. We first choose posterior situated lesions and limited anterolateral lateral ones, with sizes large enough to create a large surgical corridor. The surgical corridor is naturally widened by larger lesions, displacing normal structures away from the medulla oblongata in a confined space. Alternatively, for strictly anterior or smaller anterolateral lesions, the main surgical concept, such as with the transcondylar approach, would be to enlarge and create a wider surgical corridor.[2]

In our experience, we realized the cruciality of the preoperative MRI, studying the interface between the tumor and surrounding nervous structures and delineating a clear plane between the tumor and ventral surface of the brain stem and spinal cord. This is critical for the choice of the suboccipital route, especially when we decided to choose this approach in the later 4 cases of series; they had an anterior/lateral element. If a virtual plane of dissection can be appreciated, the choice of this approach requires removal of the posterior arch of C1 and C2 in some cases and was enough to create an adequate surgical working space.

Boulton and Cusimano[2] in their experience adopted the suboccipital approach in their cases. With posterior FM meningioma, patients were in a prone position. Regarding lateral or anterolateral lesions, patients were positioned in a lateral position. For all our cases, we utilized the

"Concorde" prone position. A lateral tilt of the operating table and extreme-lateral positioning of the surgical microscope were utilized to improve the surgeon's visualization and ergonomics as well as aiding tumor resection.

We used a narrow suboccipital craniectomy to create additional space for tumor dissection and removal and avoided unneeded traction and/or neural compression. The use of craniotomy was sometimes linked to a better outcome and less postoperative occipital pain by replacing a firm protective covering over the exposed dura. Atlas and axis posterior arch resections have been resected in all recent clinical papers.[1,8,13,20,21] To ensure wider exposure, subsequent wide opening of the dura mater allowed a large fenestration of cisterna magna and cerebrospinal fluid (CSF) removal and cerebellar relaxation.

For our 8 posterolateral lesions, we tried to create a wider surgical corridor by cutting the dentate ligament following dural opening. In this way, the medulla oblongata and spinal cord generously increase the space between the lesion and the surrounding structures. The lower cranial nerves are commonly encountered at the upper pole of the tumor, not encased within the lesion, rendering a safer excision after an initial debulking.

Della et al.[6,7] suggested a "clove" technique to excise the most proximal part of the tumor, splitting the lesion and disclosing the dural attachment of the meningioma, facilitating its coagulation and sectioning. Factors limiting completion of full surgical excision include adherence to cranial nerves and/or vertebral artery (VA) in addition to high tumor vascularity.

Total, subtotal, and partial tumor resections were 77, 16, and 7%, respectively, in some studies.[1,2,13] The study conducted by George et al.[10] shows gross total resection reaching about 94% of patients. Subtotal resection was encountered in recurrent cases or the cases of FM meningiomas with extradural extension. In our series, we had a total resection in 62.5% of our patients, while, in the rest of our patients, we achieved subtotal resections in 4 patients (25%) and partial resections in 2 patients (12.5%). In our study as well as in other studies[2,3,10,20], subtotal, and partial tumor resection were attributed to high tumor vascularity or tumor encasing an eloquent structure either.

It has been reported that some of the preoperative signs and symptoms were encountered in 57–100% of the patients with FM meningioma after surgery, 2.5–20% of the case series remained unchanged, and 7.5–17.4% of the patients deteriorated postoperatively.[2,3,6,7,14,22] In our experience, patients usually present to the clinic a bit late, and this affected the degree of improvement, especially when it comes to neurological deficits. Only 50% of patients that had preoperative neurological deficits showed improvement over the follow-up period. We noticed the deterioration of preoperative neurological state in 2 patients with transient dysphagia in one and transient tetraparesis in the other that has been fully recovered in a 2-year follow-up.

We reported complications following surgery ranging from mild dysphagia to complete bulbar palsy and motor weakness; however, the most common complication was CSF leakage. CSF leakage was reported in 57% of our patients, which is a high percentage when compared to other series[2,3,4,10,20] that reported lower percentages (7.5–41.6%) of CSF leaks. However, our result resembles the CSF leak seen in far-lateral approaches.[12,13] Other reported complications in our series are limited as a result of being less aggressive in our technique regarding the radicality of tumor resection and keeping in mind the safety and the use of Gamma Knife as a feasible and successful measure to control residual lesions.

Limitations of this study include the small number of the study series and the short period of follow-up. Moreover, some patients were excluded because of incomplete data and follow-up. These limitations suggest that we cannot generalize our study conclusions. We recommend a large series with a long-term follow-up study. A comparative study with anterior and anterolateral lesion is also recommended.

CONCLUSION

Our data suggest that the posterior midline suboccipital approach is a safe and effective option in the management of FM meningiomas that are mainly posterior or posterolateral.

REFERENCES

1. Borba LA, De Oliveira JG, Giudicissi FM, Colli BO: Surgical management of foramen magnum meningiomas. Neurosurg Rev 32:49–60, 2009
2. Boulton MR, Cusimano MD: Foramen magnum meningiomas: concepts, classifications, and nuances. Neurosurg Focus 14:1–7, 2003
3. Bruneau M, George B: Classification system of foramen magnum meningiomas. J Craniovertebr Junction Spine 1:10–17, 2010
4. Bruneau M, George B: Foramen magnum meningiomas: detailed surgical approaches and technical aspects at Lariboisière Hospital and review of the literature. Neurosurg Rev 31:19–32, 2008
5. Cushing H, Eisenhardt L: Meningiomas. Their classification, regional behaviour, life history and surgical end results. Springfield, IL: Charles C Thomas, 1938, P448
6. Della Puppa A, Rustemi O, Scienza R: The suboccipital midline approach to foramen magnum meningiomas. Acta Neurochir (Wien) 157:869–873, 2015
7. Della Puppa A, Rustemi O, Scienza R: The suboccipital midline approach to foramen magnum meningiomas: safety and efficacy in a series of 23 consecutive patients over a 5-year period. Acta Neurochir (Wien) 157:1275–1276, 2015
8. Flores BC, Boudreaux BP, Klinger DR, Mickey BE, Barnett SL: The far-lateral approach for foramen magnum meningiomas. Neurosurg Focus 35:12, 2013
9. Gazzeri R, Faiola A, Neroni M, Fiore C, Callovini G, Pischedda M, et al: Safety of intraoperative electrophysiological monitoring (TES and EMG) for spinal and cranial lesions. Surg Technol Int 23:296–306, 2013
10. George B, Lot G, Boissonnet H: Meningioma of the foramen magnum: a series of 40 cases. Surg Neuro 47:371–379, 1997
11. Ghadirpour R, Nasi D, Iaccarino C, Giraldi D, Sabadini R, Motti L, et al: Intraoperative neurophysiological monitoring for intradural extramedullary tumors: why not? Clin Neurol Neurosurg 130:140–149, 2015
12. Jung SH, Jung S, Moon KS, Park HW, Kang SS: Tailored surgical approaches for benign craniovertebral junction tumors. J Korean Neurosurg Soc 48:139–144, 2010
13. Kano T, Kawase T, Horiguchi T, Yoshida K: Meningiomas of the ventral foramen magnum and lower clivus: factors influencing surgical morbidity, the extent of tumour resection, and tumour recurrence. Acta Neurochir (Wien) 152:79–86, 2010
14. Kryzanski JT, Robertson JH, Heilman CB: A minimal access far-lateral approach to foramen magnum lesions. J Neurol Surg B Skull Base 75:236–242, 2014
15. Kumar CV, Satyanarayana S, Rao BR, Palur RS: Extreme Lateral Approach to Ventral and Ventrolaterally Situated Lesion of the Lower Brainstem and Upper Cervical Cord. Skull Base 11:265–275, 2001
16. Lynch JC, Temponi V, Emmerich JC, Pereira CE, Gonçalves MB: Foramen magnum meningiomas: To drill or not to drill the occipital condyle? A series of 12 patients. Surg Neurol Int 4:73, 2013

17. Macdonald DB, Skinner S, Shils J, Yingling C: Intraoperative motor evoked potential monitoring - a position statement by the American Society of Neurophysiological Monitoring. Clin Neurophysiol 124(12):2291–2316, 2013
18. Mostofi K: Foramen magnum meningioma: some anatomical and surgical remarks through five cases. Asian Spine J 9:54–58, 2015
19. Sohn S, Chung CK: Conventional posterior approach without far lateral approach for ventral foramen magnum meningiomas. J Korean Neurosurg Soc 54:373–378, 2013
20. Talacchi A, Biroli A, Soda C, Masotto B, Bricolo A: Surgical management of ventral and ventrolateral foramen magnum meningiomas: report on a 64-case series and review of the literature. Neurosurg Rev 35:359–367, 2012
21. Yamahata H, Yamaguchi S, Takayasu M, Takasaki K, Osuka K, Aoyama M, et al: Exploitation of simple classification and space created by the tumor for the treatment of foramen magnum meningiomas. World Neurosurg 87:1–7, 2016
22. Yoon SH, Chung CK, Jahng TA: Surgical outcome of spinal canal meningiomas. J Korean Neurosurg Soc 42:300–304, 2007
23. Yue WM, Tan SB, Tan MH, Koh DC, Tan CT: The Torg-Pavlov-ratio in cervical spondylotic myelopathy: a comparative study between patients with cervical spondylotic myelopathy and a nonspondylotic, nonmyelopathic population. Spine 26:1760–1764, 2001

العنوان العربي

تطبيق استخدام النهج تحت القذالي الأوسط لاستئصال الأورام السحائية بمنطقة الثُّقْبَةُ العُظْمَى : خبرة مبدئية في سلسله حالات

البيانات الخلفية: تعتبر أورام منطقة الثُّقْبَةُ العُظْمَى من الأورام التي تمثل صعوبة كبيرة لجراح الأعصاب في الوصول إليها لوجود الكثير من التراكيب ذات الاهميه العالية واللتي لا يمكن المساس بها اثناء الجراحه ، لهذا طرحت العديد من الطرق للوصول لهذه المنطقه والتعامل مع الاورام بها.

الغرض: عرض خبرة الباحثين في استخدام النهج تحت القذالي المتوسط لاستئصال الأورام السحائية بمنطقة الثُّقْبَةُ العُظْمَى , ومناقشة قابليته للتطبيق وامان استخدامه في مثل هذه الحالات.

تصميم الدراسة: دراسة وصفية

المرضي والطرق: تم مراجعه بيانات المرضى اللذين عانوا من اورام سحائيه في الفتره مابين نوفمبر 2014 وحتي يناير 2019 بمستشفى بنها الجامعي وتم تحديد ثمانية مرضى يعانون من ورم سحائي بمنطقة الثُّقْبَةُ العُظْمَى استوفوا الاشعات والفحوصات اللازمه للدراسه. تم في جميع الحالات التدخل عن طريق النهج الجراحي تحت القذالي الأوسط.و تمكن الباحثون في معظم الحالات من استئصال الاورم كاملا.

النتائج: لوحظ تحسن في الحاله المرضيه لمعظم الحالات وتم استئصال الورم بصورة كلية في خمس حالات , وبصورة شبه كلية في ثلاث حالات بسبب الدموية الشديدة للورم إضافة إلي مكانه العميق. لم تحث أي حالة وفاة أثناء استخدام هذا النهج الجراحي.

الاستنتاج: يعتبر استخدام النهج تحت القذالي الأوسط وسيلة آمنة لاستئصال الأورام السحائية بمنطقة الثُّقْبَةُ العُظْمَى , ويغني بدرجة كبيرة عن الجراحات المعقدة التي تستخدم في مثل هذه الحالات, كما ان الاختيار الجيد للحالات من حيث مكان الورم وحجمه هو من العوامل اللتي تدعم استخدام هذا النهج للتدخل.