Original Article
Suboccipital Partial Transcondylar Approach in Management of Antrolateral and Anterior Foramen Magnum Meningiomas, Surgical Experience

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ABSTRACT

Background: Antrolateral and anterior foramen magnum meningiomas remain one of the most challenging pathologies in neurosurgery because they are in close contact with nervous, vascular and articular structures that can not be scarified or retracted. Objective: This is a retrospective case series study that analyzes the postoperative clinical and radiological outcome of nine patients with antrolateral and anterior foramen magnum meningiomas operated upon in the Neurosurgery Department, Cairo University Hospital. Patients and Methods: Patient selection: seven patients with antrolateral and two patients with anterior foramen magnum meningiomas were operated upon and followed up clinically and radiologically for one year. Operation: Microsurgical excision of the tumor using suboccipital partial transcondylar approach. Results: Between Jan 2009 and December 2013, nine patients underwent operation for foramen magnum meningiomas using suboccipital partial transcondylar approach and followed up clinically and radiologically for twelve months. The tumor attachment was antrolateral in seven patients (77.8%) and anterior in two patients (22.2%). Total tumor removal was accomplished in 100% of the patients. Transient morbidity rate was 66.7% which all recovered by six months follow up interval. No permanent surgical morbidity or mortality were encountered. Eight patients (88.9%) had regained full daily activity. No recurrence was observed after a follow up period of one year. Conclusion: Antrolateral and anterior foramen magnum meningiomas can be removed gross totally using the suboccipital partial transcondylar approach. It allows adequate exposure of the important neurovascular structures in this region with no or minimal retraction.

INTRODUCTION

Foramen magnum meningiomas are relatively rare, and they account for 1.8 to 3% of all intracranial meningiomas.1,2 Meningiomas comprise 70% of benign tumors that arise at the foramen magnum.3,4 Foramen magnum meningiomas are subdivided into antrolateral meningiomas with an antrolateral dural insertion (52.5 to 84%), pure anterior meningiomas with an almost symmetric dural attachment on both sides of midline (4 to 45%) and posterior or postrolateral meningiomas with dural attachment located behind the dentate ligament (2.5 to 20%).5,6,7,8 Similar to meningiomas at other locations, the patients with foramen magnum meningiomas demonstrate a predilection for female, with an estimated female-to-male ratio 2:1.9 The clinical course is slowly progressive leading to dysesthesia, asymmetric motor weakness, gait ataxia, and less common lower cranial nerve affection.10

Magnetic resonance imaging (MRI) has provided a significant advancement in diagnosis as it delineate the exact tumor size, location, site of dural attachment and relation to vascular and neural structure.11

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PATIENTS AND METHODS

This study was approved by the ethical committee of the Neurosurgery Department, Faculty of Medicine,
Cairo University and performed in accordance with institutional ethics committee guidelines.

Between January 2009 and December 2013, nine patients with antrolateral and anterior foramen magnum meningiomas were admitted and managed in the Neurosurgery Department, Cairo University Hospital. All patients underwent proper history taking including age, sex, presenting symptoms, duration of symptoms and proper neurological assessment. All patients were examined preoperatively by magnetic resonance imaging (MRI) of the craniocervical junction without and with gadolinium to delineate the tumor attachment, extension and tumor relationship with the blood vessels and neuraxis. Computed tomography (CT) of the foramen magnum region was done in all cases to detect any calcifications.

Anterior meningiomas were attached to the anterior rim of the foramen magnum and displacing the medulla in a pure posterior direction. Antrolateral meningiomas were situated in the ventrolateral rim of the foramen magnum and displacing the medulla postrolateral. Both subgroups were located ventral to the dentate ligament. The surgical approach:

All patients were operated in the sitting position with standard anesthetic monitoring to detect and treat air embolism. An inverted hockey-stick skin incision initiated at the mastoid process then carried on superiorly to the superior nuchal line, curving towards the inion and proceeding to the spinous process of C4 was performed. After dissecting the suboccipital muscles. The vertebral artery was identified in its sulcus arteriosus on the posterior arch of C1 but was neither dissected nor transpositioned. A unilateral suboccipital craniectomy was then performed from the midline to the edge of the sigmoid sinus and down through the midline of the foramen magnum. The posteromedial third of the occipital condyle was removed extradurally using power drills so that a flat angle is obtained after opening the dura which offers satisfactory exposure. A laminectomy of C1 or C1 and C2 was tailored according to the caudal extent of the tumor in the upper cervical spinal canal. The dura was opened microsurgically behind the enter of the vertebral artery. The processes of dentate ligament were sectioned before initiating tumor removal to release tension on the neuraxis and to widen the surgical access of the tumor. The spinal portion of the accessory nerve and the posterior root of C2 lying posterior to the tumor were identified and dissected away. The intrathecal segment of the vertebral artery and its branches should not be dissected except after partial removal of the tumor to facilitates their dissection.

A self retaining retractor was routinely used to gently elevate the cerebellar hemisphere and tonsil. Internal debulking was achieved by piecemeal resection using microscissor and cupped forceps. After removal of the tumor, proper hemostasis and coagulation of dural attachment of the tumor were done. Water tight dural closure either primarily or with duraplasty using fascia lata graft was performed. The dural closure was augmented with fat to avoid post operative cerebrospinal fluid (CSF) leakage.

The operative notes were analyzed to evaluate the surgical approach together with the extent of resection which was evaluated and classified according to Simpson Grading Scale.14 (Table 1)

Table 1: Simpson grading system for removal of meningiomas

<table>
<thead>
<tr>
<th>Grade</th>
<th>Degree of removal</th>
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<tbody>
<tr>
<td>I</td>
<td>Macroscopically complete removal with excision of dural attachment and abnormal bone.</td>
</tr>
<tr>
<td>II</td>
<td>Macroscopically complete removal with endothermy coagulation of dural attachment.</td>
</tr>
<tr>
<td>III</td>
<td>Macroscopically complete removal without coagulation of dural attachment or of its extradural extension (e.g. hyperostotic bone).</td>
</tr>
<tr>
<td>IV</td>
<td>Partial removal leaving tumor in situ</td>
</tr>
<tr>
<td>V</td>
<td>Simple decompression.</td>
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</table>

Proper postoperative monitoring was performed in the intensive care unit for 24 hours. The Karnofsky Performance Scale (KPS) was used to evaluate the clinical outcome immediately postoperative, during the hospital stay, and at 2 and 6 months intervals.15

Postoperative CT scan of the brain was done within the first 24 hours of surgery to exclude postoperative hematoma or edema. MRI studies were done at 3 and 12 months intervals to delineate the extent of tumor removal.

RESULTS

From January 2009 to December 2013, eight female patients (88.9%) and one male patient (11.1%) with a mean age 47.7 years (range, from 25-63 years) were admitted to Cairo University Hospitals with foramen magnum meningiomas. All patients underwent microsurgical resection using the suboccipital partial transcndylar approach.

The main presenting symptoms were occipital pain in seven patients (77.8%), gait disturbance in six patients (66.7), paraesthesia in five patients (55.6%), and the main presenting signs were gait ataxia in six patients (66.7%), weakness in six patients (66.7%) as summarized in (Table 2).
Table 2: Clinical presentation of patients.

<table>
<thead>
<tr>
<th>Clinical Presentation</th>
<th>No of patients (%)</th>
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<tbody>
<tr>
<td><strong>Symptoms:</strong></td>
<td></td>
</tr>
<tr>
<td>Occipital pain</td>
<td>7 (77.8%)</td>
</tr>
<tr>
<td>Parasthesia</td>
<td>5 (55.6%)</td>
</tr>
<tr>
<td>Gait disturbance</td>
<td>6 (66.7%)</td>
</tr>
<tr>
<td>Hand clumsiness</td>
<td>1 (11.1%)</td>
</tr>
<tr>
<td>Difficulty in swallowing</td>
<td>1 (11.1%)</td>
</tr>
<tr>
<td><strong>Signs:</strong></td>
<td></td>
</tr>
<tr>
<td>Gait ataxia</td>
<td>6 (66.7%)</td>
</tr>
<tr>
<td>Hemihypotthesia</td>
<td>4 (44.4%)</td>
</tr>
<tr>
<td>Hemiparesis</td>
<td>4 (44.4%)</td>
</tr>
<tr>
<td>Paraparesis</td>
<td>2 (22.2%)</td>
</tr>
<tr>
<td>Cranial nerve deficit IX,X</td>
<td>1 (11.1%)</td>
</tr>
</tbody>
</table>

The mean duration of symptoms was 7 months (range, 3-24 months).

Seven patients (77.8%) had antrolateral foramen magnum meningiomas (five tumors on the right and two on the left side) and two patients (22.2%) had anterior foramen magnum meningiomas.

The caudal extension of the tumor was to C1 in five patients (55.6%) and to C2 in four patients (44.4%). Mean maximum dimension of the tumor on MRI was 3.6 cm (range, 3-4.1 cm).

Tight adherence of the tumor to the antrolateral aspect of medulla was encountered in one patient (11.1%) who developed transient postoperative cranial nerve IX, X paresis which improved within 6 weeks. In two cases (22.2%), the vertebral artery was encased by the tumor but there was an arachnoid plane that facilitated its dissection.

The consistency was firm in seven patients (77.8%), and soft in two patients (22.2%). The tumor was moderately vascular in eight patients (88.9%), and highly vascular in one patient (11.1%).

Total excision (Simpson grade II) was achieved in all patients (100%). (Fig. 1, 2&3)

Repair of the dura was done using fascia lata graft and fat in all cases to prevent postoperative CSF leakage.

A postoperative cerebrospinal fluid leakage occurred in one case and managed by continuous lumbar drain placement for 4 days. Partial accessory nerve affection occurred in one patient (11.1%) and showed complete recovery on follow up at 6 months interval. There were two patients (22.2%) with postoperative bulbar palsy, one of them had preoperative partial IX, X paresis and increased postoperatively, one patient managed by Ryle feeding for 6 weeks and the other necessitated tracheostomy procedure for two months postoperatively. Overall, the surgical complications were observed in six patients (66.7%) all of them were transient and resolved within 6 months interval. (Table 3)

Table 3: Post operative complications.

<table>
<thead>
<tr>
<th>Postoperative Complications</th>
<th>No of patients (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gait ataxia</td>
<td>2 patients (22.2%)</td>
</tr>
<tr>
<td>Accessory l nerve palsy</td>
<td>1 patients (11.1%)</td>
</tr>
<tr>
<td>XI,X cranial nerve palsy</td>
<td>2 patients (22.2%)</td>
</tr>
<tr>
<td>CSF leakage</td>
<td>1 patients (11.1%)</td>
</tr>
</tbody>
</table>

The mean KPS score improved from 70 (range 50-90) before surgery to 86.6 after surgery (range, 70-100). Eight patients (88.9%) regained full activity with nuchal pain persisting in one of them (KPS score 80-100). One patient (11.1%) with preoperative KPS score 50 presenting with hemiparesis and bulbar affection improved to reach KPS score 70 with 6 months follow up interval.

No mortality or recurrence were encountered in this study.

Histological examination revealed World Health Organization grade I meningioma in all cases, 4 patients (44.5%) meningothelial, 3 patients (33.3%) fibroblastic and two patients (22.2%) transitional.

Fig. 1a-c: a: Axial, b: Sagittal and c: Coronal preoperative MRI showing anterolateral foramen magnum meningioma
DISCUSSION

Foramen magnum meningiomas are highly challenging tumors because they are situated in the vicinity of the medulla and spinal cord and are surrounded by vital and sensitive structures like vertebral artery and lower cranial nerves. The aim of surgical management is radical removal of the tumor without morbidity to improve the long term clinical outcome and decrease the recurrence rate. Dorsally situated foramen magnum meningiomas are clearly approached through a posterior approach while the ventral tumors have been considered to require other complex approaches to ensure adequate surgical corridor such as far lateral and extreme far lateral approaches.

Several modifications and classifications have been done over the past decade. Spetzler et al subdivided the far lateral approach based on the extent of bone removal into condylar approach (far lateral approach with condylar resection) and transcondylar approach (far lateral approach with resection of posteromedial one third of the occipital condyle. Sekar et al also subdivided the extreme lateral approach into six variants based on the extent of the bone resection: (1) retrocondylar approach, (2) partial transcondylar approach, (3) complete transcondylar approach, (4) transtubercular approach, (5) transjugular approach, (6) transfacetal approach. The retrocondylar approach is considered the same as condylar variant of far lateral and the partial transcondylar approach is also the same as the transcondylar variant described by Spetzler.

In this study, nine patients with antrolateral and anterior foramen magnum meningiomas were operated using suboccipital partial transcondylar approach and followed up clinically and radiologically for 12 months. During the follow up period, the mean KPS score improved from 70 before surgery to 86.6 after surgery (range, 70-100). Eight patients (88.9%) regained full activity. Overall, transient surgical complications were observed in six patients (66.7%) all resolved by within 6 months interval, with no permanent surgical morbidity noted in any case. Total excision (Simpson grade II) was achieved in all patients (100%). The mortality rate was 0% and no recurrence was encountered.
Bassiouni et al studied 25 patients with anterior and antrolateral foramen magnum meningiomas operated upon by suboccipital retrocondylar approach during a 14 year period. The most common symptoms were cervico-occipital pain (72%) and gait disturbance (32%). Clinical examination revealed ataxic gait in 48% of the patients. As depicted from preoperative magnetic resonance imaging (MRI), dural attachment of the meningioma at the foramen magnum rim was anterior in 36% and anterolateral in 64% of cases. A Simpson Grade 2 resection was achieved in 96% of the patients. Permanent surgical morbidity and mortality rates were 8 and 4%, respectively. No tumor recurrence was observed after a mean follow-up period of 6.1 years (range, 1-14 yr) with clinical and MRI examination, and 80% of the patients have regained full daily activity. There are differences in results between their study and our study as they have higher morbidity and mortality rates than in our study and lower total resection rate. They attributed it to poor dissection plane to the brain stem in two patients, one received radiotherapy and the other was being treated for her second tumor recurrence. We also attribute the differences in the results to the approach they used because partial condyle resection provide adequate corridor to the tumor without any retraction or manipulation on the brain stem.

Pamir et al. surgically treated 20 patients with anterior and antrolateral foramen magnum meningiomas using transcondylar approach with resection of one third of the condyle. Total tumor resection was achieved in 100% of patients, the permanent morbidity rate was 5% and vertebral artery was encased in 40% of the patients. The median follow up period was 40 months, no tumor recurrence was encountered during the follow up period. The mortality rate was 0%.

Pamir et al. had near similar results to the current study except in their higher permanent morbidity rate and this is attributed to the number of patients with encased vertebral artery in their study ,eight patients (40%) which necessitated its dissection while we encountered only two patients with encased vertebral artery (22%).

There is a debate about how much of the condyle needed to be drilled. For tumors of the ventrolateral and anterior to medulla, only posteromedial one third is enough as it will be added to the corridor already created by the tumor , displacing the neurovascular structure giving large avenue to work through without manipulation on the brain stem. The patient can tolerate about 25-50% drilling of the condyle without affecting the stability of craniocervical junction and with no need for fusion and stabilization.

Although in the previous descriptions of this approach, there was stress on the importance of exposure and skeletonization of the vertebral artery but in recent studies, this maneuver is no longer necessary. In this study, localization and identification the vertebral artery itself along with its surrounding venous plexus were performed so that the artery could be easily protected during drilling of the posterior portion of the occipital condyle.

**CONCLUSION**

Antrolateral and anterior foramen magnum meningiomas can be removed gross totally using the suboccipital partial transcondylar approach. It allows adequate exposure of the important neurovascular structures in this region with no or minimal retraction. This approach is easier and faster with less morbidity and mortality than other variants of the lateral approach and allows better lateral view of the foramen magnum region than the conventional posterior suboccipital approach without any manipulation on the brain stem.

**Disclosure:**

The authors have no personal, financial or institutional interest in any of the drugs, materials, or devices described in this article.

**REFERENCES**


