Efficiency of Posterior Approach for Ventral and Ventrolateral Foramen Magnum Meningiomas

Mohamed H. El-Sissy*
Neurosurgery Department, Cairo University Egypt

ARTICLE INFO

ABSTRACT
Background: Foramen magnum (FM) meningiomas are uncommon lesions, considered challenging because of the vicinity of the medulla oblongata, the lower cranial nerves, and the vertebral artery. Surgery for meningiomas located in the region of the foramen magnum anterior or anterolateral to the brainstem constitutes a formidable challenge and has been studied by various authors for many years through various approaches.

Objective: To evaluate the efficacy of conventional posterior approach for ventral FM meningioma.

Patients and Methods: From September 2002 to June 2008, eight patients with foramen magnum meningiomas arising from the anterior or anterolateral rim of the foramen magnum underwent operations in the Department of Neurosurgery at Kasr Alainy Hospital, Cairo University, Egypt. All patients were operated on in a semi-sitting position by use of a conventional suboccipital approach with a midline incision and extension of the craniectomy laterally toward the side of the tumor up to the occipital condyle.

Results: Total tumor resection was achieved in six patients, and a subtotal resection of the tumor was performed in the other two patients due to inability to free vascular territories; in one of them, part of the tumor in relation to the vertebral artery (VA) and in the other, part in relation to posterior inferior cerebellar artery (PICA) was left behind. After surgery, one patient developed exaggerated lower cranial nerve weakness and two patient developed pseudomeningocele. The follow-up period was 24 months; there has been no recurrence of the tumor or growth of the residual tumor.

Conclusion: Ventral and ventrolateral FM meningiomas can be removed gross totally and safely using a posterior suboccipital approach without the need for far lateral approach.

INTRODUCTION

Meningiomas represent 25–30% of all hospital-based primary intracranial neoplasms. The foramen magnum meningiomas constitute 1–3% of all cranial meningiomas. The female to male ratio is 2.6:1. The mean age at presentation is 55.9 years for female and 56.4 years for male. The clinical signs and symptoms are variable and depend on the involved structures. The patient may present with headache, cervical pain, occipital pain and other symptoms; like lower cranial nerve palsies, long tract deficits, sensory and motor deficits starting in one arm and spreading to the other extremities, Lhermitte’s sign cerebellar dysfunction. They may have slow athetosic-like movements on their arms and hands. Magnetic resonance imaging (MRI) is the radiological investigation of choice for detecting tumors of the foramen magnum, computed tomography (CT) scan and magnetic resonance angiography (MRA) are also useful. In T2- weighted images meningiomas appears as isointense to slightly hypointense in comparison with normal brain. T1-Gd enhanced contrast imaging delineate the lesion and can define the dural attachment site of the tumor. MRA defines the vascular anatomy and the relations between vascular structures and the tumor. CT scanning demonstrates the osseous anatomy, the presence of calcifications and hyperostosis. The tumor appears as a hemispherical or round mass isodense to hyperdense in comparison with normal brain. FM meningiomas are challenging lesions because of the vicinity of the medulla oblongata, the lower cranial nerves, and the vertebral artery. The first successful removal was accomplished by Elsberg and Strauss in 1927 via a suboccipital craniotomy and C1–C3 laminectomy. Although their patient had several intraoperative episodes of respiratory arrest, she eventually experienced a full postoperative recovery. In addition to the standard midline suboccipital craniotomy and upper cervical laminectomy, several surgical approaches have been proposed for the removal...
of these tumors. Such approaches include the anterior transoral, lateral transcervical, and posterolateral suboccipital approaches. Particular controversy exists regarding the optimal treatment of FM meningiomas located on the ventral and ventrolateral aspect of the medulla and upper cervical cord. To accomplish a complete and safe removal of these tumors, approaches that include partial resection of the occipital condyle, usually in combination with transposition of the vertebral artery (VA), have been increasingly advocated in recent years.

**PATIENTS AND METHODS**

In the period from September 2002 to June 2008, eight patients: six females and two males with age range from 31-69 years having FM meningiomas arising from the anterior or anterolateral rim of the foramen magnum underwent surgical resection in the department of Neurosurgery at Kasr Alainy Hospital, Cairo University, Egypt. We defined a ventral tumor as its dural origin was anterior to the dentate ligament that displaced the brain stem and spinal cord dorsally or dorsolaterally. The duration of symptoms ranged from 6 to 72 months. The principal presenting symptoms and clinical features of the patients illustrated in table (1). The maximum diameter of the tumors ranged from 2.4 to 4.2 cm. In all patients, the tumor arose either anteriorly or anterolaterally and the brainstem was pushed predominantly posterolaterally. In all patients, the tumor “pointed” to one side, from which at least a small corridor was available to approach the tumor. The intradural VA was partially encased on one side in four patients and the PICA in two patients. Gross total resection was performed in six cases (Simpson grade II) and subtotal in two cases (Simpson grade III) where the intradural VA was partially encased in one patient and the posterior inferior cerebellar artery in another one that could not be freed. Postoperative complications were pseudomeningocele at the surgical site in two cases and exaggerated lower cranial nerve palsy in single case. No tumor recurrence was observed during the follow up period which was two years. Regarding the clinical outcome, all cases with motor deficits were improved with variable degrees postoperative while only two cases out of five with sensory deficits had mild and delayed improvement and single case with partial lower cranial nerve palsy had increased deficit.
Table (1): Summary of patients

<table>
<thead>
<tr>
<th>No.</th>
<th>Sex</th>
<th>Age (years)</th>
<th>Symptoms</th>
<th>Duration of symptoms</th>
<th>Max. tumor diameter &amp; location</th>
<th>Subtype</th>
<th>Removal extent</th>
<th>Compactions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>M</td>
<td>48y</td>
<td>Paraesthesia UL</td>
<td>18m</td>
<td>3.2cm Ventrolateral</td>
<td>Meningiothelial</td>
<td>Total</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Neck pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Quadraparesis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>F</td>
<td>42y</td>
<td>Paraesthesia UL</td>
<td>6m</td>
<td>3.8cm Ventrolateral</td>
<td>Meningiothelial</td>
<td>Total</td>
<td>Pseudo meningocoe</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Neck pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Quadraparesis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>F</td>
<td>38y</td>
<td>Headache</td>
<td>9m</td>
<td>2.4cm Ventral</td>
<td>Meningiothelial</td>
<td>Total</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Neck pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Quadraparesis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>F</td>
<td>54y</td>
<td>Hand wasting</td>
<td>30m</td>
<td>2.8 cm Ventrolateral</td>
<td>Meningiothelial</td>
<td>Total</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Neck pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Quadraparesis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>M</td>
<td>53</td>
<td>Paraesthesia UL</td>
<td>72m</td>
<td>4cm Ventrolateral</td>
<td>Thelial</td>
<td>Total</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Quadraparesis</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>F</td>
<td>31y</td>
<td>Hemihypoesthsia</td>
<td>30m</td>
<td>4.2 Ventrolateral</td>
<td>Meningiothelial</td>
<td>Total</td>
<td>++ Low cranial in palsy</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Lower cranial n. partial palsy</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>F</td>
<td>57y</td>
<td>Trunkal ataxia</td>
<td>54m</td>
<td>3.8cm Ventrolateral</td>
<td>Transitional</td>
<td>Incompl. removal</td>
<td>--</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Hand wasting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>F</td>
<td>69y</td>
<td>Paraesthesia UL</td>
<td>30m</td>
<td>3.8cm Ventrolateral</td>
<td>Transitional</td>
<td>Incompl. removal</td>
<td>Pseudo meningocoe</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Cervico-occipital pain</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Fig. 1a-d: (case 1). a: Preoperative T1 weighted axial MR image with gadolinium enhancement for a ventrolateral FM meningioma. b: Preoperative T1 weighted sagittal MR image with enhancement. c: Postoperative T1 weighted axial MR image with enhancement showing no residual mass. d: Postoperative T1 weighted sagittal MR image with enhancement showing no residual mass.

DISCUSSION

Castellano and Ruggieri, in 1953, proposed a classification of meningiomas of the posterior cranial fossa according to site of dural attachment: posterior surface of the petrous bone (42%), tentorium (30%), cerebellar convexity (10%), clivus (11%), and foramen magnum (4%). Meningiomas comprise about 70% of all benign tumors arising in the FM region. These tumors were formerly subdivided into craniospinal (supraforaminal) and spinocranial (subforaminal) types according to their location, that is, anterior or posterior to the spinal cord/medulla oblongata, respectively. The clivus is derived embryologically from the fourth occipital “proatlas”. The anterior landmarks for foramen magnum have been the lower third of the clivus and upper edge of the body of C2. We can infer that FM is an extension of the spinal canal. Hence, FM meningiomas are more similar to spinal cord meningiomas than to skull base meningiomas. Through our experience, ventral intradural extramedullary spinal cord tumors including meningiomas could be removed gross totally through conventional posterior approach. Therefore, it is quite natural to use a conventional posterior approach for removing FM meningiomas like ventral intradural - extramedullary spinal cord tumors. Similar to meningiomas at other locations, meningiomas of the foramen magnum demonstrate a predilection for females, with an estimated female-to-male ratio ranging from 2:1 to 3.6:1, coinciding with our series; six females and two males. A large proportion of
foramen magnum meningiomas are located anterior to the brainstem in close relation to vital neural, vascular, and bone structures. Meningiomas with en plaque extension and extradural growth have been reported, but were not in our study. The clinical course is slowly progressive, leading to dysesthesia, asymmetric motor weakness, gait ataxia, and relatively less common lower cranial nerves affection. The most common symptoms were paraesthesia and neck pain (four cases), followed by quadraparesis (three cases) and wasting of the small muscles of the hand (two cases). Misdiagnosis that results from uncommon symptoms, leading to wrong decisions and inappropriate treatment, has been observed frequently with these lesions. MRI has provided a significant advancement in diagnosis. It clearly delineates the exact tumor size, location, site of dural attachment, and relation to vascular and neural structures; It also provided an opportunity to assess the vascularity of the tumor. Surgery for meningiomas located in the region of the foramen magnum anterior or anterolateral to the brainstem constitutes a formidable challenge and have been studied by various authors for many years. Anterior transoral, anterolateral transcervical, extreme lateral, far lateral, and lateral approaches have been advocated and preferred over the conventional posterior approach. According to others, the suboccipital approach that uses a midline skin incision is not outdated and continues to find favor with some authors. The midline skin incision and exposure of the region of the foramen magnum, occipital bone, arch of atlas, and axis was far easier, safer, quicker, and can be enhanced with partial condylar resection as compared with any anterior or lateral approach. Extensive drilling of the occipital condyle, lateral mass of the atlas, or anterior spinal elements should not involved, so the possibility of injury to the hypoglossal nerve, the vertebral artery and spinal instability was avoided. The VA was exposed easily in the region of the arch of atlas at the site of its entry into the dura by a midline approach, and proximal control was possible. Exposure of the extradural vertebral artery and its manipulation and mobilization among large venous plexuses, as necessary in some lateral approaches, involves considerable effort and possible risks. By use of a slightly larger midline skin incision and an additional retraction of muscles, a significant lateral exposure was obtained by the conventional midline posterior approach. The extent of additional bone removal necessary could be determined after the nature of the tumor is ascertained for consistency, vascularity, and the extent and site of dural attachment. Additional drilling of the condyle was possible for a more lateral exposure with directly anterior meningiomas. The condylar drilling was safer because the vertebral artery and nerves already were exposed. This is a variation of the predetermined bone drilling necessary for all lateral and anterior approaches.

The brainstem, cranial nerves, vertebral artery, and tumor were exposed in the same field, and the dissection could be performed with visualization of all structures. The exposure could be improved after retraction of the cerebellum, and the operation could be performed in the cerebellomedullary angle from a lateral perspective by use of appropriate angulations of the microscope. The exposure was wide and not deep as compared with that obtained by transcervical, transoral, and even lateral approaches. The tumors in the present series pointed laterally on one side of the midline, and the brainstem was displaced or twisted posterolaterally rather than posteriorly. The tumors were resected after they were debulked initially, and the procedure was performed within the planes provided by tumor growth. The tumor debulking relaxed the region and provided additional working space for dissection. Debulking of larger tumors provided more space anterior to the brainstem, making it unnecessary to operate from a more lateral angle. Total tumor resection was achieved in six out of eight cases, in one case the intradural VA was partially encased and the posterior inferior cerebellar artery in another patient that could not be freed, where subtotal resection was achieved. George et al. found encapsement of the vertebral artery, pure anterior tumor localization, to be associated with a lower rate of complete resections. Similarly, Guidetti and Spallone, Hakuba et al. and Stein et al. described encapsement of the vertebral artery as a limiting factor for removal of craniocervical meningiomas. All patient had early and significant improved motor power, while sensory deficits improvement was delayed and incomplete in only two out of five cases, the single case with lower cranial nerve deficit had worse results and two patients who had wasting of small muscles of the hand, did not improve in this deficit despite the improvement in motor power in these groups of muscles. Postoperative complications included pseudomeningoecele at the surgical site in two cases and the single case with exaggerated lower cranial nerves palsy. Recovery after a successful tumor resection was almost instantaneous, and recurrence rates were demonstrated as extremely low. In our study we did not have any recurrence during the period of two years follow up, taking into consideration the short duration.

CONCLUSION

On the basis of this experience, we found that the posterior midline conventional approach to most ventral and ventrolaterally placed foramen magnum meningiomas remains a viable and possibly better option versus the alternative approaches described later in the literature.
REFERENCES


