Surgical Approaches to Foramen Magnum Meningioma
—Report of Three Cases—

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Abstract

Although foramen magnum meningiomas are usually removable, their location poses considerable surgical risk. The authors present three cases of foramen magnum meningioma. The first involved a ventral type tumor extending to the second cervical body. Following bilateral mandibulotomy, surgery was performed via the anterior transoral approach and the tumor was totally removed. Nine days postoperatively, she developed meningitis, which was successfully treated with antibiotics. The second patient’s tumor was dorsal type and was deeply embedded in the lateral part of the vermis. The tumor was totally removed via the midline suboccipital approach and she recovered uneventfully, with only slight upper-extremity paresthesia. In the third case, the tumor was ventral type and situated mainly in the clivus. Craniotomy was performed by the bilateral suboccipital approach and extended nearly to the jugular tubercle. The tumor, which severely displaced the lower cranial and upper cervical nerves, was totally removed. The postoperative course was lengthy and complicated. Artificial ventilation was required for 2 months, and difficulty in swallowing persisted during long-term follow-up. As illustrated by the second case, dorsal and lateral type foramen magnum meningiomas can usually be removed via the lateral suboccipital approach. In the case of ventral type tumors, the anterior transoral approach entails the risk of infection, as occurred in the first case. The authors conclude that the lateral suboccipital approach is preferable; craniotomy extending to the jugular tubercle lowers the risk of brainstem damage.

Key words: foramen magnum, meningioma, magnetic resonance imaging, transoral surgery, surgical adhesive

Introduction

Most foramen magnum meningiomas can be approached suboccipitally. However, when the tumor is situated ventrally, the surgical risk may be considerable. The authors report three cases of foramen magnum meningioma and discuss their operative approaches as well as the literature concerning the surgical treatment of these tumors.

Case Reports

Case 1: A 59-year-old female was admitted to our facility with a 21-month history of suboccipital headache and progressive gait disturbance. On admission, she exhibited severe symmetrical spastic tetraparesis, which was worse on the left side than on the right. Computed tomographic (CT) scans revealed an anteriorly situated ventral type meningioma extending from the clivus to the C2 vertebral body (Fig. 1 upper). CT cisternography showed the tumor to be located on the midline and the medulla to be markedly compressed and flattened (Fig. 1 lower). The upper cervical cord and the medulla were expanded and pushed backward, where they adhered to the arch of the atlas.

Since we felt the suboccipital approach posed considerable surgical risk in this case, we chose the anterior transoral approach (Fig. 2). After tracheostomy and establishment of continuous spinal drainage, a segment was resected from the body of the bilateral mandible to provide a sufficiently wide operative field. The segment and the tongue were pushed downward together. A Davis retractor was used to hold the mouth open, and a midline incision was made in the nasopharyngeal mucosa, ex-
After its removal, a compression defect was noted on the ventral surface of the medulla and upper cervical spinal cord. The dural defect was repaired with a fascia patch and fibrin glue, without suturing, and the bone defect with a graft taken from the iliac bone (Fig. 3 right). Finally, the pharyngeal wall was closed in two layers.

Nine days after surgery, she developed meningitis, accompanied by a high fever. Her cerebrospinal fluid (CSF) cell count was about 10,000/mm³, and CSF culture yielded Gram-positive Streptococcus. Antibiotics were administered intravenously and intrathecally, and she recovered within 1 month, by which time she was able to walk unassisted.

Case 2: A 50-year-old female presented with a 1-year history of paresthesia in bilateral upper extremities. On admission, there was no obvious impairment of cranial nerve function other than tetraparesis, which was most severe on the right side. Sensory perception was reduced in bilateral upper extremities. Magnetic resonance (MR) images revealed an extra-axial foramen magnum tumor of dorsal orientation, extending from the C1 body to the medulla (Fig. 4 left).

Surgery was performed via the midline suboccipital approach. After midline suboccipital craniotomy and C1-C2 laminectomy, the tense dura mater was opened and the tumor was found just beneath it. The tumor was totally removed without damage to the lower cranial nerves and small vessels (Fig. 4 right).

The postoperative course was satisfactory and she was discharged with only slight paresthesia in the upper extremities.

Case 3: A 39-year-old female was hospitalized with a 6-month history of paresthesia in all four extremities and a 5-month history of bilateral lower extremity...
weakness. On admission, function of the 10th cranial nerve was noted to be impaired bilaterally. The left 12th cranial nerve function was also disturbed, and motor weakness and increased muscle tone were observed in the left lower and right upper extremities. CT scans and MR images revealed a ventrally oriented meningioma and compression of the medulla (Fig. 5).

In this case, we used the bilateral suboccipital approach, for two reasons. First, the lower end of the tumor was at the level of the C1 vertebral body, which was higher than the tumor in Case 1 (Fig. 6 left). Second, our experience in Case 1 suggested that the anterior transoral approach entails a high risk of infection, even when careful preventive measures are taken. After C1–C2 laminectomy, an extensive bilateral, retromastoid craniotomy was performed and the posterior lateral aspect of the foramen magnum was removed. The sigmoid sinus was preserved and the vertebral arteries were not exposed at the C1 level. The dura mater, which was very tense and hard, was opened. The upper cervical cord and the medulla were extremely compressed and the radicular arteries, cranial nerves, and cervical nerve roots were spread over the surface of the tumor. The tumor was carefully dissected so as not to damage these arteries and nerves, and finally removed in total.

The postoperative course was complicated. Mechanical ventilation was required for 2 months. Although her tetraparesis gradually decreased, 2 years after surgery she continued to have difficulty in swallowing and a permanent tracheostomy became necessary. Follow-up MR images showed that the tumor had been removed totally but that a small contusion remained on the ventral side of the medulla (Fig. 6 right).

**Discussion**

Foramen magnum meningiomas have been classified as craniospinal type (arising above the foramen magnum) and cervicomedullary type (arising below the foramen magnum). The cervicomedullary type has been further divided into two subtypes: dorsal and ventral. The dorsal type is more common and typically involves the upper cervical cord, causing symptoms such as upper extremity weakness and sensory changes. The ventral type, as seen in our cases, involves the lower cervical cord and medulla, resulting in more severe symptoms such as tetraparesis and respiratory failure.

In our cases, the bilateral suboccipital approach was chosen due to the location of the tumor. The approach allowed for extensive removal of the tumor while preserving the sigmoid sinus and vertebral arteries. The postoperative course was complicated, with mechanical ventilation required for 2 months. However, the tetraparesis gradually decreased and a permanent tracheostomy was necessary. Follow-up MR images showed complete tumor removal with a small contusion on the ventral side of the medulla.

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For dorsal and lateral type tumors, the suboccipital approach is indicated and tumor removal can be safely accomplished. Our Case 2 involved a typical dorsal type tumor, which was removed by the midline suboccipital approach, and she recovered uneventfully. For lateral type tumors, the lateral suboccipital approach is advisable. However, if the tumor is anterior to the lower cranial nerves and upper cervical nerve roots, intraoperative manipulation is restricted by these structures. The ventral portion of the tumor cannot be directly visualized and total removal is difficult. For ventral type tumors, whether the lateral suboccipital or anterior transoral approach is preferable remains controversial.

The clinical symptoms of foramen magnum meningioma may be caused by chronic ischemia of the pyramidal tract, posterior column, and medial lemniscus. When the suboccipital approach is used, mechanical compression during cervical laminectomy and/or posterior shifting of the spinal cord after opening of the dura poses some risk of exacerbating the ischemia.

According to the literature, the operative mortality with removal of benign foramen magnum tumors by the suboccipital approach is 3.5–5% for all three sites. Ventral type tumors, however, carry an especially high operative risk; in three reported series, one of four patients, one of 10, and three of 10 died.

Vertebral artery control, with the artery elevated from the groove of the atlas, has been recommended for widening of the exposure to about 70° from the sagittal plane at the C1 level to the craniospinal junction. Also, a more lateral exposure can be obtained by transposing the vertebral artery with the unroofed C1 transverse foramen. Extensive craniotomy after sigmoid sinus sectioning has been reported to provide an excellent view from C1 to the dorsum sellae.

The anterior transoral approach to the craniocervical junction is not new; it has been widely employed as a means of gaining access to extradural lesions. The transoral approach to such lesions is anatomically reasonable because it results in less damage to lower cranial and upper cervical nerves. However, this approach has been limited by technical difficulty, concerns over inadequate exposure, and mainly by the incidence of postoperative meningitis and CSF fistula.

With extradural lesions, such as odontoid pathology and extradural neurinomas, postoperative infection is rare and recovery is uneventful. In the literature, there have been 29 reported cases of intradural lesions treated via the anterior transoral approach. Of these, four of seven patients with tumors and 11 of 21 with vascular diseases had postoperative complications of meningitis or a persistent CSF fistula. There were only four meningioma patients, in three of whom the anterior transoral approach may have caused a wide dural defect at the site of tumor attachment (Table 1). Thus, including our Case 1, four of five reported cases were complicated by CSF fistulae or meningitis following transoral surgery.

The most important measure in preventing postoperative infection is to minimize the pharyngeal mucosa defect to the extent possible. A few operative techniques have been reported to achieve this. Hemostasis should not be performed by electrosurgical cautery because it aggravates flap shrinkage. The type of mucosal incision must be carefully selected. In the event that closure of the pharyngeal mucosa is difficult, the usage of a rotational flap of the septal mucosa to the floor of the posterior nasal cavity is advisable.

Concerning the repair of dural defects, one report mentioned that primary closure with fascia is suf-

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**Table 1** Reported cases of foramen magnum meningioma operated by the transoral approach

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Author (Year)</th>
<th>Age, Sex</th>
<th>Tumor location</th>
<th>Extent of tumor removal</th>
<th>Complications</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Chono et al. (1985)(^2)</td>
<td>60, F</td>
<td>spinocranial</td>
<td>subtotal</td>
<td>CSF leak → reoperation</td>
</tr>
<tr>
<td>2</td>
<td>Yamada et al. (1985)(^2)</td>
<td>23, F</td>
<td>craniocerebellar</td>
<td>not reported</td>
<td>none</td>
</tr>
<tr>
<td>3</td>
<td>Miller and Crockard (1987)(^6)</td>
<td>47, F</td>
<td>craniocerebellar</td>
<td>subtotal</td>
<td>CSF leak → V-P shunt</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>52, F</td>
<td>craniocerebellar</td>
<td>subtotal</td>
<td>meningitis</td>
</tr>
<tr>
<td>5</td>
<td>Present Case 1</td>
<td>59, F</td>
<td>spinocranial</td>
<td>total</td>
<td>meningitis</td>
</tr>
</tbody>
</table>

V-P: ventriculoperitoneal.
ficient to prevent CSF leakage. In an experimental canine model, however, primary suturing with a fascia patch resulted in CSF leakage immediately after surgery, whereas attachment of a fascia patch with fibrin glue achieved satisfactory results. In our Case 1, CSF leakage was prevented by the use of fibrin glue, and suturing was unnecessary. Fibrin glue has a strong long-term adherent effect and is relatively nonirritating to the surrounding tissue. In contrast, Alon-alpha and Biobond are not strongly adhesive in the presence of watery fluids.

Finally, with each of these operative techniques, preoperative antibiotic therapy and postoperative continuous spinal drainage must be carried out.

Nonetheless, even when careful measures are taken, postoperative meningitis and CSF fistula are difficult to prevent with transoral surgery. Although the suboccipital approach carries some risk in cases of ventral type meningiomas, there is not a great likelihood of postoperative infection, as there is with the transoral approach. For the ventral type meningiomas of the foramen magnum, we feel that it is appropriate to employ the lateral suboccipital approach first. If there is residual tumor and the anterior transoral approach is chosen for its removal, the large potential for postoperative infection must be taken into consideration.

Foramen magnum meningiomas were often undetected or misdiagnosed with earlier neuroradiological methods. The median interval between the onset of symptoms and surgery has been reported to be 2 years or longer. With increasing use of MR imaging, foramen magnum meningiomas should be correctly diagnosed at an earlier stage and more precisely localized as ventral, lateral, or dorsal. Meningioma is a benign tumor and surgically curable. We wish to emphasize that it has now become important to choose the operative approach that best corresponds to the tumor location.

References

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