

Foramen Magnum Meningiomas

Part II: Surgical Approaches, Surgical Anatomy, Complications of Treatment and Results

Kenan I. Arnautović, M.D., and Ossama Al-Mefty, M.D.

Learning Objectives: After reading this article, the participant should be able to:

1. Identify the surgical anatomy and approaches to the foramen magnum region.
2. Recall the transcondylar approach to foramen magnum meningiomas.
3. Describe the suboccipital approach to foramen magnum meningiomas.
4. Explain the postoperative care and complications related to surgical techniques of foramen magnum meningiomas.

Operative Indications and Aims of Operation

Meningiomas arising at the foramen magnum are a neurosurgical challenge because of the large number of vital anatomic elements concentrated in this deep, hidden, central, and small area. These lesions can be divided into two distinct groups according to their site of attachment and position: anterior or anterolateral, and posterior or posterolateral. These two types differ in operative approach and resectability, the rate of complications, and prognosis. The medulla and the upper cervical spinal cord and adjacent anatomic elements are displaced posteriorly by a tumor originating anteriorly. Anterior origin is most common, occurring in 68% to 98% of patients. Removal is difficult, the rate of total resection is lower, and the rates of complications, morbidity, and mortality are higher. Meningiomas that originate posteriorly (2% to 32% of these lesions) displace structures anteriorly. The surgical goal, regardless of the size of a foramen magnum meningioma, should be to preserve and improve neurological function by radical tumor removal. Such removal should be attempted zealously at the initial operation, which is the best time to achieve a cure. The surgeon sometimes may be forced to accept subtotal removal, however, when the tumor is severely adherent to vital neurovascular structures.

Dr. Arnautović is a resident, and Dr. Al-Mefty is Professor and Chairman, Department of Neurosurgery, 4301 West Markham, Slot 507, University of Arkansas for Medical Sciences, Little Rock, Arkansas 72205.

The authors have disclosed that they have no significant relationships with or financial interests in any commercial organizations pertaining to this educational activity.

Surgical Approaches and Surgical Anatomy

Two surgical approaches are routinely used to treat foramen magnum meningiomas: the transcondylar approach and the inferior suboccipital approach. Hemilaminectomy of the atlas and the axis is added to either of these two approaches as indicated. The transcondylar avenue is used for anterior or anterolaterally located meningiomas at the foramen magnum. Meningiomas located posteriorly or posterolaterally are approached through the inferior suboccipital route with a suboccipital craniotomy and a laminectomy. The approach is determined according to the individual circumstances of each tumor. For example, large tumors may require additional exposure. Those extending inferiorly require an additional laminectomy of the atlas and the axis. Tumors that extend superiorly require the petrosal or retrosigmoidal approach, whereas meningiomas extending laterally into the jugular foramen require infratemporal exposure.

The transoral approach to the foramen magnum provides direct midline exposure of a foramen magnum meningioma. We do not favor this approach, however. Its midline exposure is limited laterally, there is a significant risk of contamination by flora of the oral cavity, not all neurovascular structures can be visualized during dissection, and the operative field is deep.

Category: Tumor

Key Words: Foramen magnum, Meningioma, Transcondylar Approach, Suboccipital Approach.

Transcondylar Approach and General Surgical Strategy

We prefer the transcondylar approach for ventral and ventrolateral foramen magnum meningiomas. This approach may be referred to by different name—e.g., far lateral, posterolateral, extreme lateral, or transcondylar. In essence, however, it is one approach with variations in the patient's position, the skin incision, muscle reflection, and craniotomy. The following paragraphs describe the transcondylar approach as we use it.

Patient position. The anesthetized patient is placed supine. The head and neck are kept in a neutral position to maintain the anatomic course of the vertebral artery and for easier stabilization, if necessary. The patient is then log-rolled rotated approximately 40°. The patient's head is fixed in position with a Mayfield-Kees headrest. The arch for the frameless stereotaxy is attached to it, encircling the head. Care is taken to avoid any obstruction of the surgical view. The ipsilateral shoulder is gradually pulled downward and taped to keep it from obstructing the field. The ipsilateral thigh also is prepared and draped for the removal of fat and fascia lata (Fig. 1).

Skin incision. The skin is incised behind the ear in a curvilinear fashion two fingerbreadths behind the mastoid. The curved incision begins at the level of the external auditory canal and turns downward to the level of the C4 vertebra, where it gradually curves anteriorly into the horizontal neck crease. The skin flap is then retracted laterally and secured with fishhook retractors. Two nerves, the greater auricular nerve laterally and the lesser occipital nerve medially, are identified in subcutaneous tissue as potential graft donors. This skin flap is well vascularized and can easily be tailored to accommodate other approaches, if necessary.

Muscle dissection. The muscles are dissected in three layers. First, the sternocleidomastoid muscle is detached from its origin at the occipital bone (the superior nuchal line) and mastoid and retracted inferiorly and medially. Its innervation (by the accessory nerve) should be preserved and freed as it enters the medial aspect of the muscle at the level of the C3 vertebra. The splenius capitis, longissimus



Figure 1. Operative position of the patient. Note the 40° log-rolled rotation of the patient, maintaining the head and neck in the neutral position. Note also the skin incision, the ipsilateral shoulder taped and pulled out of the way, the EMG electrodes in place for intraoperative monitoring, and the arch of the frameless stereotaxy (arrows) attached to the head rest.

capitis, and semispinalis muscles—the muscles of the second muscular layer—are also detached along with the sternocleidomastoid muscle and retracted inferiorly and medially. This retraction turns the muscles away from the working area, which is mainly lateral. Between the second and third muscular layers lies a rich suboccipital venous plexus, which may be a source of bleeding or air embolism. Another source is the mastoid emissary vein, which is encountered as it exits the mastoid foramen. This emissary vein connects the sigmoid dural venous sinus and the complex extracranial venous system in the suboccipital area.

The muscles of the third, deep layer create two triangles—the superior and inferior suboccipital triangles. The superior suboccipital triangle is delineated by the rectus capitis, posterior major, obliquus capitis superior, and obliquus capitis inferior muscles. In the depth of this triangle is the venous compartment, which cushions the horizontal part of the suboccipital vertebral artery, its branches,

and the C1 nerve. The inferior suboccipital triangle is delineated by the obliquus capitis inferior, semispinalis cervicis, and longissimus cervicis muscles. Within this triangle is the vertical part of the suboccipital vertebral artery, its branches, its surrounding venous plexus, and the C2 nerve with its anterior and posterior rami. The lateral corners of both triangles meet at the transverse process of the atlas, which is located 1 cm below the mastoid tip. The muscles of this third layer are detached and reflected medially or resected. To improve exposure, the posterior belly of the digastric muscle also can be detached and reflected laterally.

Exposure, mobilization and transposition of the vertebral artery complex. In most people, the vertebral artery is larger on the left side. During surgery of a foramen magnum meningioma, two segments of the vertebral artery are encountered: the suboccipital (V3) and the intracranial (V4). Exposing and mobilizing the V3 complex allows full proximal control of the artery. Transposing the V3 complex allows full drilling of the condyle, ventral exposure of the tumor, and safe dissection. The V3 segment is subdivided into two parts, the vertical (V3v) and horizontal (V3h).

The venous compartment located between the occipital bone and the atlas was earlier named the suboccipital cavernous sinus because of its similarity to the cavernous sinus. It is bordered posteriorly by the posterior atlanto-occipital membrane, anteriorly by the occipital condyle and the atlanto-occipital dura, laterally by the lateral periosteal ring at the transverse foramen of the atlas, and medially by the dural ring, which surrounds the vertebral artery as it pierces the dura. V3h, its branches, and the C1 nerve are cushioned within this compartment. V3h has two arterial branches—the muscular artery, which originates at its midportion and courses dorsally, and the posterior meningeal artery, which originates a few millimeters proximal to the dural ring. These two arteries are coagulated and divided. V3v extends from the transverse foramen of the axis, where the artery makes an inferomedial loop, and immediately turns into the inferolateral loop, which brings the artery into the transverse foramen of the atlas. V3v is surrounded by a venous plexus, which is an inferior continuation of the suboccipital cavernous sinus (Fig. 2).

The V3v complex is crossed dorsally at its midportion by an anterior ramus of the C2 nerve. This nerve is attached to V3v by a fibrous adhesion, which must be released to allow caudomedial transposition of the V3 complex. V3v gives off two branches, the radiculomuscular artery medially and the muscular artery laterally. These branches also must be divided to allow caudomedial transposition of the vertebral artery. In the transverse foramen of the atlas, the V3 complex is surrounded by a periosteal, lateral ring. At this point, V3v turns into V3h through the superolateral loop and enters the suboccipital cavernous sinus.

Once the posterior atlanto-occipital membrane is opened, the posterior wall of the transverse foramen of the atlas is drilled, and careful, subperiosteal dissection is done. This dissection spares the lateral (periosteal) ring, which is used to manipulate the V3 complex. The suboccipital cavernous sinus anastomoses through the condylar veins with the jugular bulb and vein. These vessels must be divided to allow caudomedial transposition of the V3 complex.

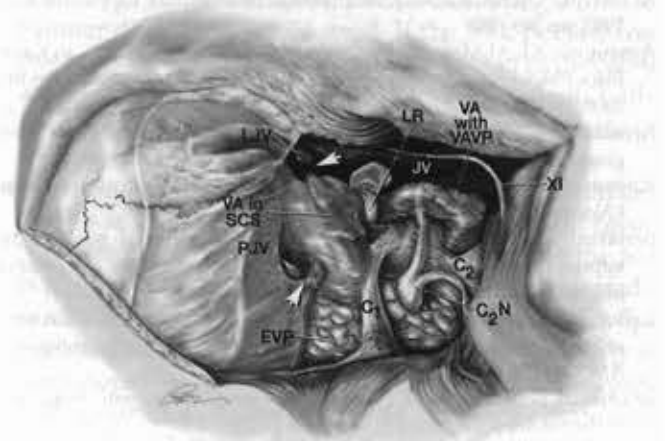


Figure 2. Right-sided intraoperative illustration after the dissection and retraction of muscles and detachment of the posterior atlantooccipital membrane. The suboccipital cavernous sinus (SCS) is exposed, cushioning the horizontal part of the suboccipital VA. Note also the vertical part of the suboccipital VA surrounded by a VA venous plexus (VAVP), lateral (periosteal) ring (LR) after the drilling of the transverse foramen of C1, posterior (PCV) and lateral (LCV) condylar veins, which are divided (arrows), the jugular vein (JV), the atlas (C1), the second cervical nerve (C2n), the axis (C2), the external vertebral venous plexus (EVP) and the eleventh nerve (XI) entering the sternocleidomastoid muscle. (Reprinted with permission from Arnautovic KI, Al-Mefty O, Husain M: Ventral foramen magnum meningiomas. *J Neurosurgery (Spine)* 92:71, 2000.)

The posterior ramus of the C1 nerve (the suboccipital nerve) must be sacrificed. In addition, the retroglenoid ligament, which connects the V3h complex and the occipital condyle, must be divided to unlock the sinus. The fibrous membrane around the sinus along with the areolar tissue on that membrane must be kept intact to prevent bleeding and the possibility of an air embolus. Any venous bleeding can be easily controlled with Gelfoam and gentle compression. The V3 complex (preferably with intact venous structures around it) is then transposed caudomedially if the intraoperative situation requires, as decided by the inferior extension of the tumor beyond the atlas, the encasement of the vertebral artery, and the extension of the tumor to the contralateral side.

Bony resection. For bony resection, a lateral, posterior fossa craniotomy is done, and the mastoid tip is drilled to expose the occipital condyle. The sigmoid sinus and jugular bulb are fully exposed, and the atlantal and occipital condyles are drilled. Drilling of the condyle must be tailored to suit the needs of each case. For ventrally located tumors, extensive drilling is required, whereas laterally placed tumors need only partial drilling of the condyle. In other words, the more ventrally the tumor extends, or the more it extends across the midline, the more of the condyle is drilled. Drilling of the condyle never extends to more than half of it, however. Thus, stabilization is not required. Laminectomy of the atlas often is necessary, and sometimes laminectomy of the axis is required as well.

Dural opening. The dura mater of the foramen magnum, and, therefore, any meningioma located there, is supplied by the following arterial branches: the posterior meningeal artery originating from the V3 segment of the vertebral artery; the anterior meningeal artery originating from the V2 segment of the vertebral artery; the meningeal branch of the occipital artery entering the cranium through the foramen with the mastoid emissary vein; and the meningeal branch of the ascending pharyngeal artery, which enters the cranium through the hypoglossal canal. Occasionally, the intracranial segment of the vertebral artery, the posterior inferior cerebellar artery (PICA), the posterior spinal arteries, and the internal carotid artery may also vascularize the tumor. These branches mutually anastomose. The vertebral artery and the branches of the occipital artery are encountered early in the surgical exposure and should be dissected, coagulated, and divided to reduce the bleeding rate and permit easier removal of the tumor.

The dural incision is centered on the dural ring surrounding the vertebral artery. Opening the dural ring leaves a dural cuff of sufficient size around the artery. An incision along the sigmoid sinus is extended inferiorly to the dural ring. This incision extends further inferiorly and laterally to the level of the atlas, or lower if necessary. The dura is tented laterally.

Intradural tumor dissection. In up to one half of patients, a meningioma at the foramen magnum encases the intracranial segment of the vertebral artery. The tumor also can displace this intracranial segment of the vertebral artery backward and laterally. In many instances, the tumor around the vertebral artery can be separated from the vessel because of an intervening arachnoidal membrane. If the tumor is located laterally, the vertebral artery is hidden beneath it. In patients with ventrally located meningiomas, the vertebral artery is at the lateral aspect of the tumor. The PICA usually is displaced dorsally or medially; it also may be embedded in the tumor. The anterior and posterior spinal arteries usually adhere to the tumor. Intra-arachnoidal dissection allows these arteries to be preserved.

The brain stem and cervical spinal cord are displaced posteriorly and to the contralateral side by an anteriorly or anterolaterally located meningioma. This displacement facilitates the exposure and the approach to the most anterior segment and dural attachment of the tumor. Early debulking of the tumor decreases the pressure on and displacement of the surrounding structures and makes the subsequent surgery easier and safer. The tumor is debulked with either the ultrasonic aspirator or suction and bipolar coagulation (Fig. 3). The upper pole of the tumor should be separated from the lower cranial nerves; the lower pole is separated from the medulla and the spinal cord at its lower extension into the spinal canal.

The length of the spinal portion of the accessory nerve varies, and the nerve often is short. Freeing this nerve may allow additional mobilization and create more working space. The accessory nerve usually is stretched, and its rootlets spread over the lateral aspect of the tumor. The glossopharyngeal, vagal, and hypoglossal nerves usually are displaced superiorly. Crucial factors in preserving these

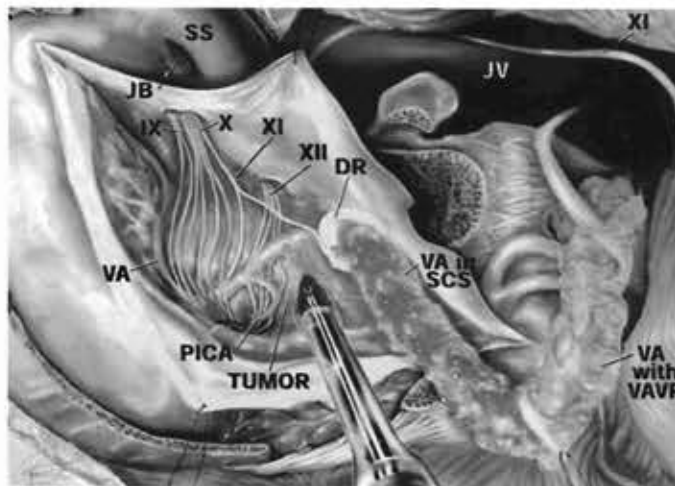


Figure 3. Right-sided intraoperative illustration after the VA complex transposition and the dural opening; the arachnoid membrane is opened. Note the transposed suboccipital VA complex (horizontal part) cushioned in the SCS, the vertical part of the suboccipital VA surrounded by the VA venous plexus (VAVP), the posterior inferior cerebellar artery (PICA), the dural ring (DR) around the VA, cranial nerves IX through XII, the sigmoid sinus (SS), the jugular bulb (JB), and the jugular vein (JV). Cavitron ultrasonic aspiration of the tumor is underway. (Reprinted with permission from Arnautovic KI, Al-Mefty O, Husain M: Ventral foramen magnum meningiomas. *J Neurosurgery (Spine)* 92:71, 2000.)

nerves are the presence of an arachnoidal membrane and dissection within this membrane and along these nerves and their rootlets. Dividing the first dentate ligament, which is attached to the dura behind and above the dural ring, increases the amount of maneuvering and working space.

The dural attachment of the tumor should be devascularized as early as possible. The dura also must be excised. The tumor often invades the adjacent dura, and clusters of tumor cells often can be verified histologically within the dura. Any hyperostotic bone should be drilled away, because it represents tumor invasion. This surgical strategy allows removal of the tumor to Simpson grades I and II, and significantly decreases the recurrence rate (Fig. 4).

Closure. After the tumor is removed and meticulous hemostasis has been attained, the dura is closed in a watertight fashion. A dural cuff of sufficient size at the dural ring, left around the vertebral artery at opening, facilitates dural closure and prevents leakage of cerebrospinal fluid. The routine use of autologous fat grafts, fascia lata grafts, and rotated posterior cervical muscles during closure also can prevent a postoperative leak of cerebrospinal fluid.

The Inferior Suboccipital Approach

The median inferior suboccipital approach and its modifications have been used since the earliest attempts at surgery of foramen magnum meningiomas. We use this approach for posterior and posterolateral foramen magnum meningiomas. The approach often is done with the patient in a sitting position, but prone and lateral positions also have been used.

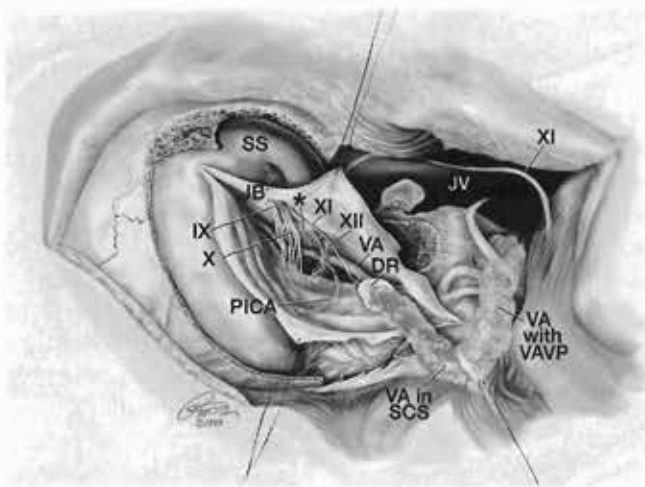


Figure 4. Right-sided intraoperative illustration after the tumor resection. Note the previous site of tumor attachment after the dural resection and the bone drilling (*), Simpson grades I and II. The same anatomic elements seen in Figures 2 and 3 are shown after radical tumor resection. (Reprinted with permission from Arnautovic KI, Al-Mefty O, Husain M: Ventral foramen magnum meningiomas. *J Neurosurgery (Spine)* 92:71, 2000.)

The pertaining inferior suboccipital approach regional anatomy is described earlier in this lesson. In its classic form, this approach is done through a midline skin incision from the occipital protuberance down to the C2-C3 spinous process. The posterior cervical muscles are split at the midline to expose the suboccipital squama and atlanto-axial spinous processes. Even if transposition of the V3 complex (the suboccipital cavernous sinus) is not necessary, exposing this complex is recommended to allow the surgeon secure proximal control of the artery should it be necessary.

After a single bur hole is drilled below the level of the external occipital protuberance and the torcula herophili, the dura is freed from the internal table of the occipital bone. A craniotomy is performed, and the foramen magnum is opened. Laminectomies of the atlas and the axis are done according to the extension of the tumor into the spinal canal. The dura is opened longitudinally, with two laterosuperior and lateroinferior extensions on each end. The arachnoid over the cerebellomedullar (magna) cistern is incised, and the midline arachnoidal septum can be observed. Cerebrospinal fluid is released, and the medulla and spinal cord are displaced posteriorly and to the contralateral side. The general surgical strategy and tumor removal techniques described earlier in this lesson pertain to this approach as well.

Postoperative Care and Complications

The rate of complications in the treatment of foramen magnum meningiomas is relatively high, and it is higher for anterior tumors than for posterior ones. Morbidity ensues primarily from deficits of lower cranial nerves, specifically the glossopharyngeus, the vagus, and the hypoglossus. Such complications may lead to aspiration pneumonia. Other important complications are leakage of cerebrospinal fluid and meningitis. In the case of cerebrospinal fluid leak,

additional stitches and compressive dressing and external lumbar drainage may be used. If the leak persists, operative revision may be indicated. In the case of hydrocephalus, a ventriculoperitoneal shunt is indicated. Patients with low preoperative clinical grading scores are particularly prone to complications and poor outcomes.

After surgery, careful assessment of the caudal cranial nerves is paramount to the patient's successful recovery. Aspiration precautions should be taken before the patient is allowed oral intake, and the diet is advanced gradually from a dysphagia diet to a regular one as indicated. Speech pathologists and otolaryngologists are involved early in the postoperative course. Intensive pulmonary care, aggressive pulmonary toilet, and antibiotic prophylaxis are used to prevent fatal respiratory complications in patients with deficits of the lower cranial nerves. Patients with a deficit of the glossopharyngeal and vagus nerves may need an aggressive tracheostomy to protect the airway and manage secretions, and also may require a gastric tube or a gastrostomy. Paralysis of the vocal cords early in the postoperative course can be approximated by vocal cord medialization, or the cord can be injected with Gelfoam or Teflon. Such treatment protects the airway until the nerve recovers or the patient learns to compensate for the deficit, which may take up to 8 months.

Postoperative images are obtained routinely after surgery. These images help the surgeon evaluate the extent of tumor removal and possible complications and also serve as a baseline for future follow-up. Computed tomography (CT) scan and magnetic resonance imaging (MRI) are obtained immediately after the surgery, followed by MRIs at 3 months, 6 months, 12 months, and annually thereafter.

Prognosis

Surgical results in patients with foramen magnum meningiomas are worse than those for patients with meningiomas in most other locations. Worse results appear in three categories: mortality; the patient's postoperative clinical status and complications; and the degree of tumor removal. The radicality of the tumor removal and the perioperative mortality rates are understandably worse for patients with ventrally placed foramen magnum meningiomas. Fortunately, postoperative results for this category have improved over time. In the past 15 years, mortality has decreased, and ranges from 0% to 29%. The rate of radical ("gross total") removal has also increased, and ranges from 60% to 75%. The improved results are greatly influenced by the use of microsurgical techniques and the transcondylar approach.

Acknowledgments

We are indebted to Ms. Julie Yamamoto for editorial assistance and Mr. Ron M. Tribell for original artwork.

Readings

Al-Mefty O, Borba LAB, Aoki N, et al: The transcondylar approach to extradural nonneoplastic lesions of the craniovertebral junction. *J Neurosurg* 84:1 1996

- Al-Mefty O: *Operative Atlas of Meningiomas*. Philadelphia: Lippincott-Raven, 1997, pp 249-382
- Arnautovic KI, Al-Mefty O: Foramen magnum meningiomas, in Kaye A, Black PMcL (eds): *Operative Neurosurgery*. Vol I. London: Harcourt Brace, 2000, pp 623-634
- Arnautovic KI, Al-Mefty O, Husain M: Ventral foramen magnum meningiomas. *J Neurosurgery (Spine)* 92:71, 2000
- Arnautovic KI, Al-Mefty O, Pait TG, et al: The suboccipital cavernous sinus. *J Neurosurg* 86:252, 1997
- Bertalanffy H, Seeger W: The dorsolateral, suboccipital, transcondylar approach to the lower clivus and anterior portion of the craniocervical junction. *Neurosurgery* 29:815, 1991
- Caruso RD, Rosenbaum AE, Chang JK, et al: Craniocervical junction venous anatomy on enhanced MRI images: the suboccipital cavernous sinus. *AJNR* 20:1127, 1999
- de Oliveira E, Rhoton AL Jr, Peace D: Microsurgical anatomy of the region of the foramen magnum. *Surg Neurol* 24:293, 1985
- George B, Lot G: Anterolateral and posterolateral approaches to the foramen magnum: technical description and experience from 97 cases. *Skull Base Surg* 5:9, 1995
- George B, Lot G, Boissonnet H: Meningioma of the foramen magnum: a series of 40 cases. *Surg Neurol* 47:371, 1997
- Guidetti B, Spallone A: Benign extramedullary tumors of the foramen magnum. *Adv Tech Stand Neurosurg* 16:83, 1988
- Kratimenos GP, Crockard HA: The far lateral approach for ventrally placed foramen magnum and upper cervical spine tumors. *Br J Neurosurg* 7:29, 1993
- Miller E, Crockard A: Transoral transclival removal of anteriorly placed meningiomas at the foramen magnum. *Neurosurgery* 20:966, 1987
- Salas E, Sekhar LN, Ziyal I, et al: Variations of the extreme-lateral craniocervical approach: anatomical study and clinical analysis of 69 patients. *J Neurosurg (Spine)* 90: 206, 1999
- Samii M, Klekamp J, Carwalho G: Surgical results for meningioma of the craniovertebral junction. *Neurosurgery* 39: 1086, 1996
- Scott EW, Rhoton AL Jr: Foramen magnum meningiomas, in Al-Mefty O (ed): *Meningiomas*. New York: Raven Press, 1991, pp 543-568
- Sen CN, Sekhar LN: An extreme lateral approach to intradural lesions of the cervical spine and foramen magnum. *Neurosurgery* 27: 197, 1990
- Welling B, Park YK, Al-Mefty O: Primary extramedullary tumors of the craniovertebral junction, in Dickman CA, Spetzler RF, Sonntag VKH (eds): *Surgery of the Craniovertebral Junction*. New York: Thieme, 1998, pp 239-252
- Yasargil MG: *Microneurosurgery of CNS Tumors*. Vol IVb. Stuttgart: Georg Thieme Verlag, 1996, pp 178-179

To earn CME credit, you must read the CME article and complete the quiz, answering at least 70% of the questions correctly. Select the best answer, and darken the corresponding space on the response card. Use #2 pencil only. To earn credit for this article, response card must be mailed on or before February 22, 2001.

Lippincott Williams & Wilkins is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

Lippincott Williams & Wilkins designates this educational activity for a maximum of 1.5 hours in category 1 credit of the AMA Physician's Recognition Award. Each physician should claim only those hours of credit that he/she actually spent in the educational activity.

- | | |
|---|---|
| <p>1. Anterior or anterolateral foramen magnum meningiomas are best removed through the transcondylar approach.</p> <p style="text-align: center;">True or False?</p> | <p>6. The posterior meningeal artery is a branch of the middle meningeal artery.</p> <p style="text-align: center;">True or False?</p> |
| <p>2. The rich suboccipital venous plexus usually is located under the sternocleidomastoid muscle layer.</p> <p style="text-align: center;">True or False?</p> | <p>7. The meningeal branch of the ascending pharyngeal artery enters the cranium through the jugular foramen.</p> <p style="text-align: center;">True or False?</p> |
| <p>3. The muscles of the third deepest layer to be exposed in transcondylar approach form two (inferior and superior) triangles.</p> <p style="text-align: center;">True or False?</p> | <p>8. The transcondylar approach is needed for posterior and posterolateral meningiomas.</p> <p style="text-align: center;">True or False?</p> |
| <p>4. Drilling of the occipital condyle is indicated to provide more ventral exposure of the cervicomedullary junction.</p> <p style="text-align: center;">True or False?</p> | <p>9. The most serious postoperative complication after surgery of foramen magnum meningiomas is related to lower cranial nerve dysfunction.</p> <p style="text-align: center;">True or False?</p> |
| <p>5. Drilling of 50% of the condyle is always an indication for occipitocervical stabilization.</p> <p style="text-align: center;">True or False?</p> | <p>10. Encasement of the vertebral artery by foramen magnum meningiomas occurs in up to 50% of cases.</p> <p style="text-align: center;">True or False?</p> |