Primary meningiomas of the jugular fossa

KENAN I. ARNAUTOVIĆ, M.D., AND OSSAMA AL-MEFTY, M.D.

Department of Neurosurgery, University of Arkansas for Medical Sciences, Little Rock, Arkansas

Object. Primary jugular fossa meningiomas (JFMs) are one of the rarest subgroups of meningioma, with fewer than 40 cases reported in the literature. The authors retrospectively analyzed the results of surgical treatment in their series of patients, including clinical, pathological, and complication features. The surgical approach was mandated by the pathological anatomy of the tumor as well as by the anatomy of the individual patient.

Methods. During a 6.5-year period, the authors performed nine surgeries in eight patients (seven women [88%] and one man [12%]) with JFMs. Six lesions occurred on the right side and two on the left. The most common presenting symptoms were altered hearing in five patients (62%), swallowing difficulties in four patients (50%), and a deficit of the 11th cranial nerve in three patients (38%); a combination of two or more signs or symptoms was common. The surgical approach was tailored to the local anatomy (tumor—neurovascular relationships) found in each patient; three different routes were used. Radical tumor removal was achieved in all patients; one tumor recurrence occurred after 20 months in a patient in whom the tumor had displayed atypical histological features. This woman underwent a second operation. The mean length of hospital stay was 1 week. The mean and the median follow-up period were 45 and 40 months, respectively. The most common complications were transient lower cranial nerve deficits, which resolved or were compensated for in all patients within 1 month.

Conclusions. With a careful, extensive preoperative evaluation and appropriate tailoring of the operative approach, JFMs can be radically resected with the expectation of good outcome.

KEY WORDS • meningioma • brain neoplasm • jugular foramen • jugular fossa • lower cranial nerve • skull base • surgical approach

FROM the disposition of arachnoid cell nests... one might expect to find basilar meningiomas more often in the region of jugular foramen than at any other points of emergence of cranial nerves. . . . But as a matter of fact, the foramina of the 9th, 10th, 11th and 12th cranial nerves seem to be exempt from these lesions; no report at least of a small isolated tumor arising from these loci is known to us. —Harvey Cushing

Primary meningiomas of the jugular fossa represent one of the rarest subgroups of meningiomas, as reflected in the quotation by Cushing. Castellano and Ruggiero do not mention these lesions in their work either. These JFMs presumably arise from arachnoid cells lining the JB in the jugular fossa. Published series include eight cases reported by Molony and colleagues, four cases reported by Vrionis, et al., and three cases reported by George and associates. Other reports mostly contain descriptions of single cases. In many aspects, JFMs mimic glomus jugulare tumors and lower cranial nerve neoplasms. Clinically, however, their treatment may be even more fraught with difficulties because of their intimate relationship with the lower cranial nerves and the jugular bulb and vein, their involvement with the temporal bone, and their tendency to extend intracranially or extracranially. These features make patients’ symptoms bothersome and lower their quality of life. The radical removal of these tumors is difficult and the potential rate of pre- and postoperative complications is significant.

In this article, we present the various diagnostic, clinical, and pathological features of JFMs. We also describe our treatment protocol and the surgical results we achieved in a series of eight patients along with the complications and pitfalls we encountered. Furthermore, we elaborate the decision-making process pertaining to the tailoring of the surgical route used for the resection of JFMs. Finally, we review the local bone anatomy and nomenclature of this rare subgroup of posterior fossa meningiomas.

Clinical Material and Methods

We retrospectively analyzed a series of JFMs treated by the senior author (O.A.) over a 6.5-year period (January 1995–September 2001). Our series excluded meningiomas that originated elsewhere (for example, petrosal, temporal bone, and foramen magnum meningiomas) and those that secondarily extended into the jugular fossa through the jug-
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The grade of tumor resection was classified according to surgical findings confirmed by postoperative neuroradiological images. Gross-total resection included excision of the tumor and its dural attachment as well as drilling of the adjacent bone (Simpson Grade I) or excision of the tumor, and coagulation of its dural attachment (Simpson Grade II). Simpson Grade III was defined as resection of the tumor without resection or coagulation of dural attachments or, alternatively, of its dural extensions.

Perioperative Protocol

The perioperative protocol was developed over the years of our experience and was based on the general principles of perioperative management of the skull base and posterior fossa. Treatment was tailored to each patient. The extensive preoperative diagnostic neuroradiological workup included MR imaging with and without contrast enhancement, MR angiography performed during both arterial and venous phases, and CT scanning. Imaging studies were used to define the local anatomy of the jugular foramen and fossa, the temporal bone, and the condyles. We also studied the tumor’s involvement with bone (signs of hyperostosis): calcification within the tumor (detected by CT scanning), and the tumor’s features, extensions, and consistency (demonstrated by CT scanning and MR imaging with and without contrast enhancement). Examinations were also made of the regional vascular anatomy; the vertebrobasilar arterial system; the size and dominance of the transverse and sigmoid sinuses; the superior and inferior petrosal sinuses; the bilateral vein of Labbe; and the position, patency, and size of the JB visualized by MR angiography during both arterial and venous phases. We abandoned the routine use of four-vessel angiography because MR angiography performed during both arterial and venous phases provided all necessary preoperative information regarding the vascular anatomy. Intraoperative image-guided frameless stereotaxy was introduced 4 years ago and was used in five patients. Postoperative imaging included a CT scan obtained 24 hours after surgery and MR images obtained during the early postoperative period, followed by MR imaging performed at 3 months and 6 months, and thereafter on an annual basis.

Perioperative multidisciplinary evaluations included audiological evaluation both before and after surgery, speech pathology and otolaryngological evaluations, and pre- and postoperative swallowing studies. Patients were placed on a nothing per mouth regimen postoperatively with parenteral nutrition until swallowing studies confirmed satisfactory results. If a patient had difficulty swallowing, appropriate actions, such as the nothing per mouth regimen with parenteral nutrition, swallowing exercises, soft mechanical diets with swallowing precautions, and vocal cord medialization (performed in one patient), were taken.

Intraoperative neurophysiological monitoring included measurements of somatosensory evoked potentials and brainstem auditory evoked potentials bilaterally. The 10th cranial nerve was monitored through an endotracheal tube used for electromyography. The seventh, 11th, and 12th cranial nerves were monitored unilaterally by needle insertion into the corresponding muscle.

Surgical Approach

The surgical approach was tailored according to the findings of preoperative imaging, the local anatomy, and the tumor’s characteristics and extension in each patient. This is a paradigm applied to skull base meningiomas. Although the approaches for tumor resection, in a broader sense, were variations of the transcondylar approach, in detail and concept three different routes were used (Fig. 1): 1) the suprajugular approach, a presigmoid, infralabyrinthine route, was selected if the JB was patent and the tumor extended primarily anteriorly; 2) the retrojugular approach, a transcondylar, transstercle, retrosigmoid route, was chosen if the JB was patent and the tumor extended predominantly behind it; and 3) the transjugular approach, an infratemporal route, was chosen in cases in which the JB was totally occluded by tumor. These approaches were described in detail in previous publications. Herein, we focus only on critical points pertaining to JFM.

Suprajugular Approach. After the skin flap has been turned and the sternocleidomastoid muscle has been dissected, mobilized, and reflected inferiorly, mastoidectomy is performed. This is followed by the complete skeletonization of the SS, JB, and the JF. The jugular fossa is accessed in the presigmoid, infralabyrinthine space. The dura matter located superior to the patent JB and inferior to the labrynth is opened. The cerebrospinal fluid is released from the cerebellomedullary cistern, and the tumor is dissected away from the lower cranial nerves (ninth–11th nerves) and the PICA, anterior inferior cerebellar artery, and VA, while maintaining the arachnoidal surgical dissection planes. Debulking of the tumor is achieved by suction and bipolar coagulation or by applying an ultrasonic aspirator. The procedure is completed with microsurgical radical resection of the tumor (Fig. 2).

Retrojugular Approach. The inferior and medial transposition of the VA complex is usually not needed for JFM surgery. The suboccipital bone is exposed and a small, inferior, lateral suboccipital craniotomy is performed, followed by mastoidectomy and complete skeletonization of the SS, JB, and JF. Drilling approximately one third of the condyle...
usually suffices for the exposure, and postoperative stabilization is not necessary. The attention is then turned to the jugular tubercle, which is completely drilled away. This facilitates the opening of the jugular fossa, which lodges the JB. With the aid of an operating microscope, the dura mater is incised along the posterior border of the SS. The tumor is carefully separated from the medulla oblongata, lower cranial nerves, VA, and PICA along arachnoidal planes, and is followed toward the jugular fossa. Careful, meticulous dissection of the tumor from the JB and JV wall is important. Ultrasonic aspiration or suction and bipolar coagulation are used. The involved dura mater and the bone of jugular fossa should be resected to minimize the chance of future tumor recurrence (Fig. 3).

**Transjugular Approach.** The transection of the external ear canal and mobilization of the facial nerve is usually not indicated in JFM surgery. The neurovascular structures in the neck (ninth–12th cranial nerves, JV, and carotid artery) are dissected and exposed. A radical mastoidectomy exposes the SS down to the JB and is followed by a posterior fossa craniotomy. The JV is followed superiorly to the JB. To enlarge the exposure the posterior belly of the digastric muscle and the stylohyoid muscle are transected and the styloid process is removed. The SS and JV are ligated at a location proximal to the mastoid emissary vein and distal to the tumor obstruction. The inferior pole of the tumor is then dissected off the internal carotid artery and the JV. The extradural tumor is thus completely exposed. Bleeding from the inferior petrosal sinus may be profuse and is controlled by packing it with Gelfoam. The dura mater is opened with the aid of the microscope posterior to the SS and carried forward. The intradural tumor extension is then exposed. The meticulous intradural dissection of the tumor, performed while maintaining the arachnoidal surgical dissection planes, helps functional preservation of the lower cranial nerves and the VA, PICA, and anterior inferior cerebellar artery at the anterolateral surface of the medulla oblongata (Fig. 4).

**Results**

The most important demographic, clinical, and histologic-

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### Table 1

**Summary of eight patients harboring JFMs**

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Age (yrs), Sex</th>
<th>Side of Tumor</th>
<th>Hospital Stay (days)</th>
<th>Histological Diagnosis</th>
<th>Follow Up (mos)</th>
<th>Preop Symptoms</th>
<th>Postop Symptoms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>50, F</td>
<td>lt 3</td>
<td>psammomatous</td>
<td>CN IX, X, XI, &amp; XII deficits, deafness</td>
<td>80</td>
<td>CN IX, X, XI, &amp; XII deficits; R/C</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>53, M</td>
<td>rt 7</td>
<td>transitional</td>
<td>CN IX, X, &amp; XI deficits, moderate conductive hearing deficit</td>
<td>67</td>
<td>CN IX, X, XI, &amp; XII deficits (IX–XI deficits worsened); R/C</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>55, F</td>
<td>rt 10 (op 1)</td>
<td>meningotheliomatous</td>
<td>CN IX &amp; X deficits, deafness (op 1); CN V, IX, &amp; X deficits (op 2)</td>
<td>63</td>
<td>CN IX &amp; X deficits (op 1); R/C</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>39, F</td>
<td>rt 7</td>
<td>transitional</td>
<td>CN V deficit</td>
<td>40</td>
<td>CN IX &amp; X deficits (op 2); R/C</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>56, F</td>
<td>rt 8</td>
<td>transitional</td>
<td>CN IX, X, &amp; XI deficits, headaches</td>
<td>40</td>
<td>CN IX, X, &amp; XI deficits (new deficits); R/C</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>31, F</td>
<td>rt 9</td>
<td>meningotheliomatous</td>
<td>dizziness, mild sensorineural hearing deficit</td>
<td>35</td>
<td>CN IX &amp; X deficits (new deficits); R/C</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>61, F</td>
<td>rt 3</td>
<td>meningotheliomatous</td>
<td>dizziness, mild sensorineural hearing deficit</td>
<td>30</td>
<td>CN IX &amp; X deficits (new deficits); R/C</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>47, F</td>
<td>lt 5</td>
<td>transitional</td>
<td>headaches, nausea</td>
<td>1</td>
<td>CN IX &amp; X deficits (new deficits); R/C</td>
<td></td>
</tr>
</tbody>
</table>

* R/C = recovered/compensated.
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Fig. 4. Drawing of the transjugular approach. Note the tumor occluding the JB, which is open; the SS and JV, both of which are ligated; the SPS; the internal carotid artery (ICA); the lower cranial nerves (ninth–11th nerves) extracranially; and the labyrinth (right side is shown).

Fig. 5. Photographs of dry anatomical specimens from the right side. Upper: Anterior perspective, in which the view extends from the outside to the inside, delineating the jugular foramen (white arrows) and jugular fossa (black arrows). Lower: Posterior perspective, in which the view extends from the inside to the outside, delineating the jugular foramen (black arrows) and jugular fossa (white arrows). Note the difference between the two perspectives.

Demographic Data

The patients’ ages ranged from 31 to 61 years (mean 49 years). Four of the eight patients were in the sixth decade of life. There were seven women (88%) and one man (12%), providing a female/male ratio of 7:1. Hospital stays ranged from 3 to 10 days (mean 7 days). The lesion was located on the right side in six patients (75%) and on the left side in two patients (25%). The durations of the follow-up periods ranged from 1 to 80 months (mean 45 months; median 40 months).

Presenting Symptoms, Signs, and Findings

Five patients (62%) reported altered hearing as the initial symptom. Two of these patients had a complete loss of hearing at presentation, one had a moderate conductive hearing deficit, and the remaining two had a discrete sensorineural deficit. The second most common symptom was difficulty in swallowing (four patients [50%]), followed by a deficit of the 11th nerve (three patients [38%]). Other signs included facial pain, dizziness, and headaches (two patients [25%]), and a 12th nerve deficit (one patient [12%]). The combination of two or more signs, symptoms, and findings was more the rule than the exception.

Histological Findings

On histological examination, the transitional type of meningioma was the most commonly found (four patients [50%]), followed closely by the meningotheliomatous type (three patients [38%]). One patient harbored a psammomatous meningioma (12%). In one patient who harbored a meningotheliomatous meningioma, the tumor displayed atypical features.

Postoperative Complications

In all patients radical tumor resection (Simpson Grades I and II) was achieved. The most common postoperative complications were deficits of the ninth and 10th cranial nerves, which occurred in three patients (38%); in one case the patient had a preexisting deficit that worsened and in two patients the deficits were new. Three other patients who displayed ninth and 10th nerve deficits preoperatively remained unchanged immediately after surgery. The latter five patients recovered or were able to compensate to achieve functional swallowing and progressed from dysphagia to a regular diet within 1 month after surgery. The patient whose preoperative ninth and 10th nerve function worsened after surgery underwent an arytenoid adduction. Two patients experienced a transient 12th nerve deficit, which resolved within 3 and 4 weeks, respectively.

Discussion

Definition and Demographic Features

Although basal posterior fossa meningiomas often ex-
compress, narrow, or obstruct the JB; or extend into the posterior cranial fossa or extracranially.

Early reports, particularly those found in the oto- laryngological literature, tended to include JFMs in another rare subgroup, temporal bone meningioma. This subgroup also included intratympanic, attic, and hypotympanic meningiomas, as well as those of the geniculate ganglion, the sulcus of the greater and lesser superficial petrosal nerves, the jugular foramen, the internal acoustic meatus, the mastoid process, and the petrous bone (with or without extensions into the middle or posterior cranial fossa). Because of the impreciseness of such a broad subgrouping, JFMs were later separated into their own subgroup. To date, fewer than 40 cases of JFMs have been published. Some of these, however, were tumors that only passed through the jugular foramen and did not actually arise from the jugular fossa; thus, they did not in essence represent primary JFMs. Therefore, the actual reported number of primary JFMs may be even smaller. For example, in comparison with jugular fossa schwannomas, which represent 2.9 to 4% of all intracranial schwannomas, the number of JFMs among the total number of intracranial meningiomas is far lower.

Women comprised 88% of the patients in our series, a number slightly less than that reported by Molony and colleagues but higher than that of other published cases (67%). The mean age of our patients, 49 years, is also higher than that listed in other reported cases (mean 32 years).

Up to 20% of all intracranial meningiomas eventually extend extracranially. Although other locations are more common for these extensions (orbit and the external table of the calvaria, followed by the nasal cavity and the paranasal sinuses), the meningioma invades the parapharyngeal space through either the foramen lacerum or the jugular fossa.

Nomenclature and Anatomy: the Jugular Fossa and the Jugular Foramen

We elected to name these meningiomas “jugular fossa meningiomas” as a departure from the previously used term “jugular foramen meningiomas.” We did this to clarify and emphasize that the jugular foramen and jugular fossa are two distinct anatomical entities, although frequently they are confused or their names are used interchangeably. As clearly described by Williams and Warwick and illustrated in our anatomical studies (Fig. 5), the jugular foramen is an opening (or gap) in the skull that connects the posterior cranial fossa and the jugular fossa. It is formed by the jugular notches in the temporal and occipital bones, respectively. It assumes an oblique position, extending from the lateral aspect posteriorly toward the medial aspect anteriorly. The jugular fossa at the inferior aspect (inferior surface) of the petrous portion of the temporal bone is a deep depression whose size varies in different skulls. It communicates with the posterior cranial fossa via the jugular foramen. It lodges the JB, which continues as the JV inferiorly.

Because meningiomas can originate from arachnoid cells at any point of the jugular fossa, their appropriate nomenclature is JFM. This term also has an implication for the growth pattern and growth direction of these tumors, which is transmitted to the three JFM types we described earlier.

Fig. 6. Case 3. Neuroimages obtained in a patient with a meningotheliomatous meningioma with atypical features who required a second operation for tumor recurrence 20 months after the initial surgery. Upper: Images obtained before the first surgery. Upper Left: Axial contrast-enhanced MR image (upper portion of panel) revealing the right jugular fossa tumor (asterisk) and axial CT scan (bone window) (lower portion of panel) demonstrating tumor extension and enlargement of the jugular fossa (arrows). Upper Right: Preoperative MR angiogram obtained during the venous phase (coronal reprojection image) demonstrating the patent bilateral transverse sinuses (TS), SSs, JB, and JVs. Because the SS and JB on the side of the tumor were patent, and the tumor extended superiorly, we tailored this surgery by using the suprajugular route. Center: Axial (left) and coronal (right) contrast-enhanced MR images obtained before the second surgery for tumor recurrence. Asterisks indicate the right jugular fossa tumor extending more posteriorly. This surgery was performed through the retrojugular route. Lower: Axial (left) and coronal (right) contrast-enhanced MR images obtained after the reoperation demonstrating radical tumor resection on the right side.
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and to the need to use three different routes for their resection. Surprisingly, in the neurosurgical literature (and even in extensive anatomical studies), both the jugular foramen and the jugular fossa have frequently been called “the jugular foramen.” This use of the term may have been either erroneous or intended as a broad anatomical description. One may speculate that this confusion may be the underlying reason for the present lack of agreement regarding the internal anatomical organization of the jugular foramen.7,16,27,44,52

Differential Diagnosis

The preoperative radiological diagnosis and the differential diagnosis are very important for jugular fossa lesions, because their preoperative management and operative planning differ considerably (that is, preoperative embolization for glomus jugulare tumors, amount of tumor-involved bone for meningiomas). Two common differential diagnoses given for lesions in the jugular fossa are glomus jugulare tumors and neuromas of the lower cranial nerves (ninth–11th nerves). Glomus jugulare tumors display a salt-and-pepper appearance on noncontrast-enhanced T1-weighted MR images; this appearance represents a flow-void network within their rich vascularity and it enhances inhomogeneously following injection of contrast material. These tumors have a propensity to erode and destroy the bone, particularly the jugular spine and the carotid crest (caroticojugular spine), the bone that separates the petrous carotid artery from the JB.3,10,20,39,52 Meningiomas, as our experience indicates, frequently invade bone (including the jugular spine and, particularly, the jugular tubercle) producing hyperostosis and bone thickening, but without bone erosion (Figs. 6 upper and 8 center).

Jugular fossa neuromas originate from the lower cranial nerves (ninth, 10th, 11th nerves, in descending order of frequency).22 They enlarge the jugular fossa with smooth, distinct sclerotic margins seen on CT scans obtained with bone windows22,28 (“bone scalloping”), and they may contain cysts, whereas frank bone invasion is very rare.49 Although they may mimic the appearance of meningiomas on both T1- and T2-weighted MR images, the enhancement displayed by meningiomas is usually considerably greater.49 These neuromas often assume a dumbbell shape, which can best be recognized on coronal or sagittal MR imaging projections. A broader differential diagnosis of jugular fossa tumors may include chordomas, epidermoid tumors, chondroid plexus papillomas, chondromas, temporal bone carcinomas, salivary gland tumors, aneurysms, metastases, and cerebellar hemangioblastomas.39,49
Surgical Approach

The development of modern diagnostic techniques, microsurgical anatomical studies, and skull base approaches, along with the refinement of microsurgical techniques, careful multidisciplinary perioperative planning, and programs in neuroanesthesia and intraoperative neurophysiological monitoring have advanced the treatment of JFMs, allowing radical resection and decreasing the rate of complications.1–12,16–28,31–40,54–59 Possibly more so than in any other skull base surgery, the approach to a JFM should be tailored to each patient.

By virtue of the tumor’s involvement with the jugular fossa and beyond, removal of the lesion requires the skull base approach. The patency and dominance of the involved JB, however, dictates the surgical approach. The procedure can be performed either by opening the JB itself (transjugular approach [Fig. 4], commonly practiced in glomus tumor resections) or by maintaining the integrity of venous flow through the JB (using either the suprajugular or retrojugular approach [Figs. 2 and 3, respectively], depending on the extension of the tumor).

Surgical Results and Complications

Due to the rarity of JFM cases, experience related to their treatment, long-term follow-up results, and recurrence is limited. As Molony and colleagues34 demonstrated previously, we achieved radical resection in all our patients. Both series, however, had short follow-up periods. In the series conducted by Molony and colleagues, there was a 25% recurrence rate during the follow-up period. In our series, the patient who had harbored a meningothelial meningioma with atypical features experienced recurrence. Three of the four patients in the series of Vrionis, et al.56 (mean follow-up period 8 years) experienced recurrence. This strongly suggests that a mean follow-up period longer than the 45 months referred to in our series is necessary to confirm our results.

The main concern pertaining to JFMs is deficits of lower cranial nerves (ninth and 10th nerves). Three patients in our series experienced postoperative swallowing deficits (ninth and 10th cranial nerve deficits). Particularly interesting is the significantly lower incidence (38%) and shorter (by half) time to recovery or compensation of swallowing deficits (30 days) of JFMs, compared with those associated with swallowing deficits in patients with ventral foramen magnum meningiomas (56%; 66 days).6 This is also true for the mean length of hospitalization of patients with JFMs (7 days in this series and 13 days in the series conducted by Molony and colleagues34), compared with that in patients with ventral foramen magnum meningiomas (18 days).6 We can speculate that this difference is either due to the fact that JFMs usually do not compress brainstem glossopharyngeal and vagal nuclei and nerve root entry zones, as do ventral foramen magnum meningiomas. On the contrary, they affect the nerve more laterally.

Radiosurgical Treatment

Experience with radiosurgical treatment of meningiomas is accumulating. Because of the rare incidence of JFMs, however, stereotactic treatment has so far been limited to four cases.8,29,30 Nonetheless, radiosurgery of JFMs can be considered in cases of meningiomas with atypical or malignant features and in the rare situation in which a patient has a single functioning ipsilateral SS and JB.

Fig. 8. Case 6. Upper: Preoperative contrast-enhanced coronal (left) and axial (right) MR images revealing the right jugular fossa tumor (asterisks). Center: Additional preoperative images including CT scans (bone window) demonstrating bone invasion (hyperostosis) by tumor (asterisk) (left: upper half depicts axial and lower half coronal reconstructions) and axial image of an MR angiogram obtained during the venous phase. Note the occluded JB on the right side, ipsilateral to the tumor. This approach was tailored via the transjugular route. Lower: Postoperative images including axial contrast-enhanced MR image (left) demonstrating radical tumor resection (right side of panel) and CT scans (bone window) (right) confirming that the radical resection of the tumor involved bone (right: upper half shows axial and lower half coronal reconstructions).

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Conclusions

Meningiomas of the jugular fossa represent a rare subgroup of posterior cranial fossa meningiomas. With careful, extensive preoperative evaluation, planning, and appropriate tailoring of surgical approach, radical tumor resection can be achieved with the expectation of a good clinical outcome.

Acknowledgments

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References

15. Cushing H, Eisenhardt L: Meningiomas: Their Classification, Regional Behavior, Life History and Surgical End Results. Springfield: Charles C Thomas, 1938, p 199

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Address reprint requests to: Ossama Al-Mefty, M.D., Professor and Chairman, Department of Neurosurgery, University of Arkansas for Medical Sciences, 4301 West Markham, Slot 507, Little Rock, Arkansas 72205. email: almeftyossama@uams.edu.