Tentorial Posterior Fossa Meningioma

Which Is the Ideal Surgical Approach: Supra/Infratentorial Combined or Retrosigmoid?

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Abstract: Tentorial meningiomas account for 2% to 3% of all intracranial meningiomas. The authors present their experience with posterior fossa tentorial meningiomas, and discuss the main features, which influence approaches and complications of the different surgical techniques. Twenty-four patients had meningiomas localized predominantly in posterior fossa. Their historical records and radiologic examinations were reviewed in accordance with Simpson's classification. The extension of tumor removal was Simpson grade I in 12 patients (50%), grade II in 12 patients (50%), and grades III and IV in none of the patients. In 22 patients (91.66%), the meningioma was classified as grade I and in 2 cases (8.33%) classified as grade II (atypical meningioma). The combined supra/infratentorial was employed in 12 cases, and complete resections were most common with this approach compared with retrosigmoid technique. Postoperative complications occurred in 10 patients (41.6%) with major deficits in 3 patients (12.5%). The authors believe that careful preoperative choice of the surgical approach should be based on tumor location and extension. It is then possible to achieve the best radical microsurgical tumor resection, avoiding additional injury to neurovascular structures.

Key Words: tentorial meningioma, surgical approach, supra/infratentorial, combined craniotomy

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The first report of a tentorial meningioma was published in 1833 by Andraal discovered on an incidental lesion attached to the tentorium.[1] Tentorial meningiomas account for 2% to 3% of all the intracranial meningiomas.[2–5] Cushing and Eisenhardt[6] found in their series of 295 intracranial meningiomas, 11 tumors (3.7%) which were attached to the tentorium. Olivecrona[7] presented a series, which included 21 tentorial meningiomas representing 2.5% of his intracranial meningiomas. In his series, 52% of these lesions were above the tentorium and 48% below.

We present their series of about posterior fossa tentorial meningiomas, here, and discuss the main features regarding approaches and complications of the employed surgical techniques.

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MATERIALS AND METHODS

Forty-two patients harboring tentorial meningiomas were treated surgically from February 1999 to August 2007 in the Division of Neurosurgery at Hospital das Clinicas, Sao Paulo Medical School. Twenty-four patients had their meningiomas predominantly located in the posterior fossa. Their historical and radiologic records were reviewed. Sex, age, location, symptoms, signs, radiologic examinations, postoperative evaluation, grade of resection, complications, and follow-up were recorded. We classified the patients with tentorial meningiomas into 2 main groups, using the classification of Aguiar.[8] A—supratentorial and B—infratentorial, each one divided into 6 groups depending on localization: 1—posterior incisural space, 2—anterior lateral incisural space, 3—paramedian in the middle between the posterior incisural space, 4—in the torcular area, 5—lateral, 6—far lateral in the external tentorial ring. The study group had meningiomas with predominant attachment in the inferior surface of the tentorium and thus in the posterior fossa.

PREOPERATIVE EVALUATION

In all patients with tentorial meningiomas, a contrast-enhanced computed tomography (CT) scan and a magnetic resonance imaging (MRI) of the brain was ordered (Figs. 1A–C—illustrative case 1, Figs. 2A, B—illustrative case 2). The CT scan in axial and coronal views was carefully evaluated to see the relations of the lesion with the falx and tentorium. The CT images still provided superior bone details and were invaluable where tumors invade bone. The MRI was performed with special attention to where the tumor was located. With MR and MR angiography (MRA), the size, dominance, and collaterals of the transverse sinuses could be

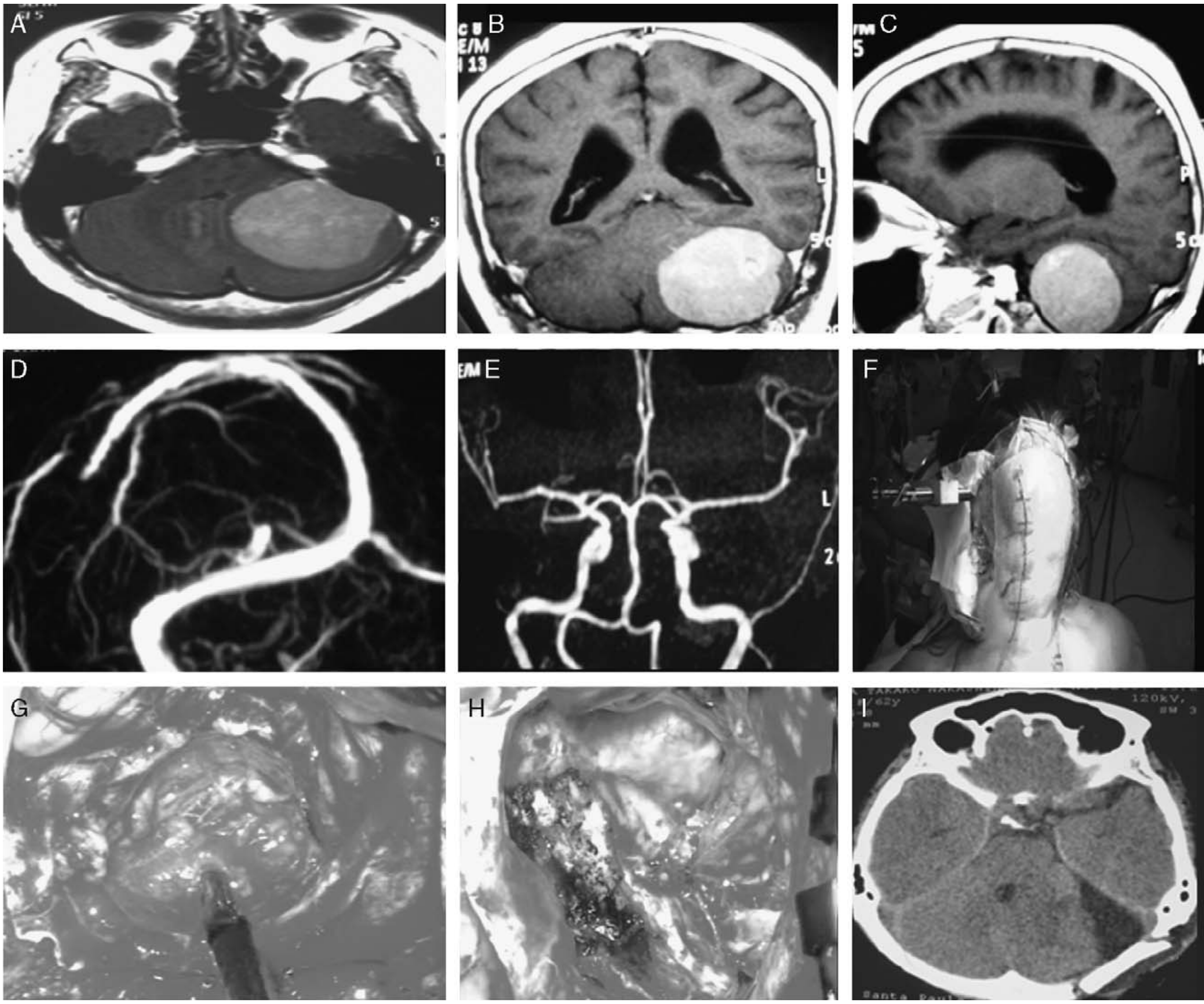

FIGURE 1. A, MRI axial slice in T1 images with gadolinium shows a large homogeneous tumor in CPA, which pushes the brain stem and compresses the fourth ventricle (illustrative case 1—62-year-old female woman harboring headache and gait disturbance). B, MRI coronal slice in T1 images with gadolinium shows the insertion of the tumor in inferior surface of tentorium and ventriculomegaly (illustrative case 1). C, MRI sagittal view with gadolinium shows the extension of tumor in the whole left side of posterior fossa (illustrative case 1). D, Angiogram by MRI in venous step of examination shows a narrowing of left transverse sinus compared with right side, however, without occlusion (illustrative case 1). E, Angiogram by MRI in arterial step of examination shows an enlarged meningotentorial artery originated in the cavernous sinus portion of left carotid artery (illustrative case 1). F, Patient placed in semi-sitting position with the head turned for the side of tumor and flexion of head. A generous retroauricular incision may be done (illustrative case 1). G, Surgical view after retrosigmoid craniectomy shows a layer of cerebellum over the tumor, and in this step of surgery, the debulking has been accomplished in piecemeal (illustrative case 1). H, After the radical removal, it is possible to se the petrous surface, and the large cavity after the removal of tumor (illustrative case 1). I, The postoperative brain CT scan with enhancement shows a total removal of tumor (illustrative case 1). CPA indicates cerebellopontine angle; CT, computed tomography; MRI, magnetic resonance imaging.

recognized. All patients were submitted an angiogram by means of MRI (Figs. 1D, E—illustrative case 1, Fig. 2C—illustrative case 2).

OPERATIVE TECHNIQUE

Retrosigmoid Approach

The patient is placed in a semi-sitting position (Fig. 1F—illustrative case 1) under general anesthesia with the head fixed by means of 3-pin head fixator or Sugita's head fixator (Mizuho, Tokyo, Japan). Iodine is used to wash and clean the field to be incised. The incision is marked in a line tangent to mastoid and perpendicular to line from same side epicanthus to external acoustic meatus. The burr hole should be performed in the bicetrix of inferior external angle formed by the 2 mentioned lines to avoid the damage to sigmoid sinus and its efferent veins. The craniectomy or craniotomy was accomplished

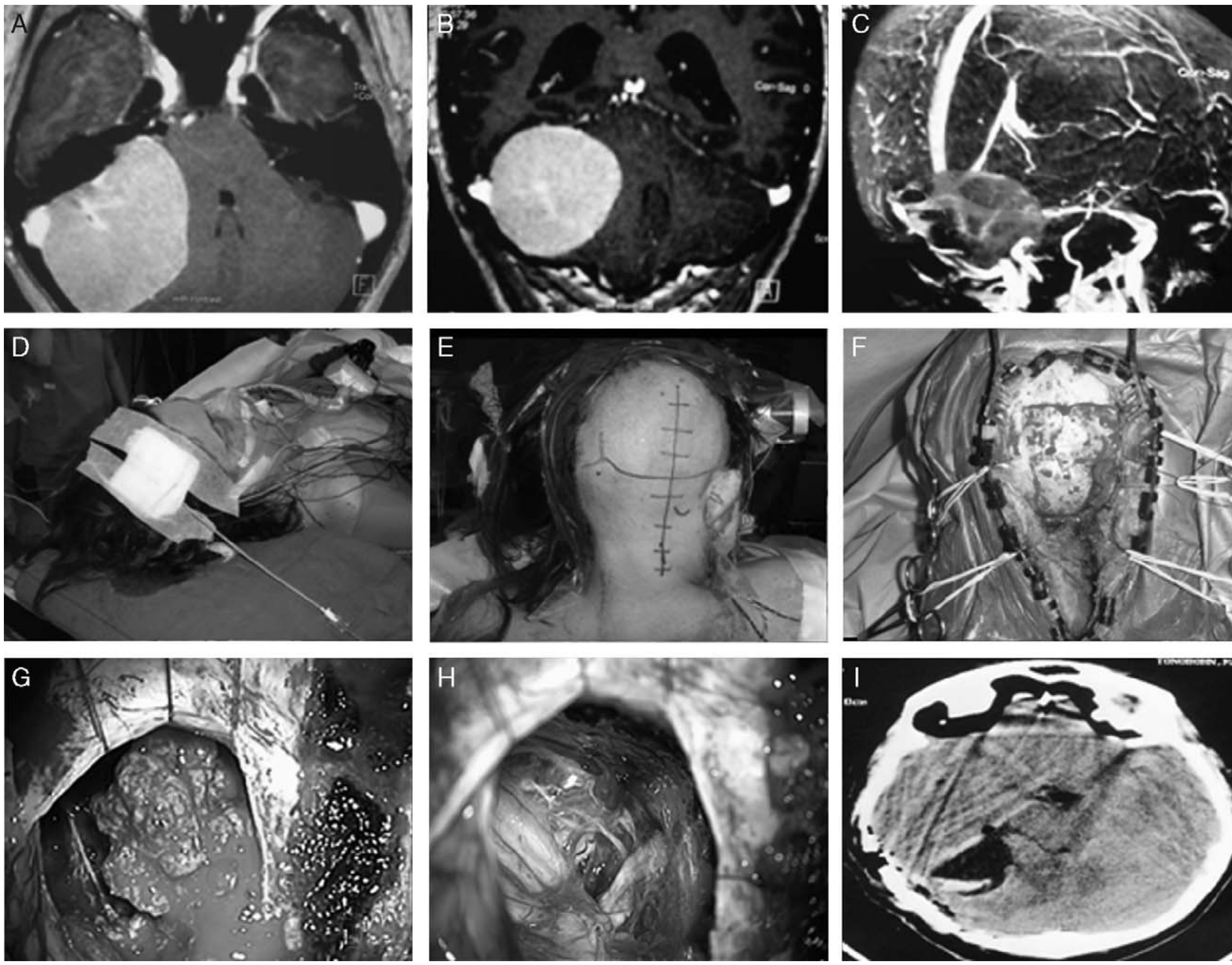

FIGURE 2. A, MRI axial slice in T1 image with gadolinium shows a voluminous tumor in the right CPA with extension over the tentorium (illustrative case 2—49 female patients harboring hypoacusia and headache). B, MRI in coronal slice in T1 image with gadolinium shows the caudocranial extension of tumor and ventriculomegaly (illustrative case 2). C, Angiogram by MRI shows the tumor evolving in the right transverse sinus in venous phase (illustrative case 2). D, Ventricular external drainage should be placed before the posterior fossa approach and place the patient in semi-sitting position (illustrative case 2). E, Patient placed in semi-sitting position with marked generous incision (illustrative case 2). F, Surgical view shows the posterior fossa unilateral craniectomy and occipital craniotomy in combined approach to remove the infiltrated tentorium (illustrative case 2). G, Surgical view shows the tumor in CPA compressing the cerebellum (illustrative case 2). H, Surgical view shows after microsurgical total resection of the cranial nerves (VII, VIII) in CPA (illustrative case 2). I, Immediate postoperative CT scan shows an adequate removal of the tumor (illustrative case 2). CPA indicates cerebellopontine angle; CT, computed tomography; MRI, magnetic resonance imaging.

with burr in a high speedy drill and by means of craniotome (Midas Rex-Medtronic). We are able to complete the flap based on the anatomic landmarks: transverse sinus and sigmoid sinus. The dura is opened in a C shape and then we access the inferior portion of cerebellopontine angle cistern to drain cerebrospinal fluid (CSF) and to reduce the adherence of the cerebellar tentorial and petrous surface. At this point, it is usually easy to identify the meningioma, as a yellow, gray, or pink mass (Fig. 1G—illustrative case 1), pushing the cerebellum toward back, and above, with strong attachment to petrosal dura and tentorial area.

Microsurgical Technique

Under microscopic magnification, we separate the plane between the tumor and cerebellar surface with a slight dissector and we maintain it using cotton strips. The bipolar coagulation may be necessary to coagulate some arterial feedings to the tumor. The core debulking can be performed with ultrasonic aspirator or piecemeal (Fig. 1H—illustrative case 1), with tumor forceps and sharp microinstruments. The last point to access is the attachment to the sinus and the wall of the venous sinus. The dissection can be performed with bipolar coagulation and knife (number 11). If bleeding begins in the sinus wall, it can be packed with Surgicel, or hemostatic fibrillar agents, and/or cotton. Sometimes, it is necessary to repair the sinus wall with a continuous line suture of nonabsorbable 5-0. In case resection of invaded sinus is needed, the proximal and distal portion of invaded area has to be closed with suture of nonabsorbable 2-0. After closure, we remove the portion of the sinus with tumor. To perform Simpson 1 resection, the tentorium (Fig. 1I—illustrative case 1) has to be cut and coagulated by bipolar which is limited by the proximities of sinus and Galenic vein, avoiding their injury.

Combined Approach Supra/Infratentorial

The patient is positioned in a semi-sitting position (Fig. 2E—illustrative case 2), which has been our preference to manage lesions in the posterior fossa for more than 15 years. In this position, the surgical field remains dry and exposed during the whole procedure (Fig. 2F—illustrative case 2). The venous pressure is very low and there is less venous bleeding. The main disadvantage of this position is the risk of occurrence of air embolism, which is rapidly and precisely diagnosed with the transesophageal Doppler. The air can be aspirated from the right atrium with the central lines placed preoperatively in the correct position. After appropriate preparation and draping, a U-shaped or linear incision is made. The preference of the incision is dictated by the size of the tumor. Subsequently, the skin flaps and muscle are retracted in a single layer. The craniotomy is performed in a single piece. The size of the craniotomy is also dictated by the size of the tumor. We place burr holes above and below the transverse sinus in a majority of the cases. The bone over the sinus is drilled away (Fig. 2F—illustrative case 2). For the superior and inferior components of the craniotomy, the craniotome can be used. The dura is dissected gently with a fine dissector from the bone. After the craniotomy, the dura of the occipital lobe and the suboccipital compartment are exposed. The transverse sinus is located between both compartments (Fig. 2F). The transverse sinus and its junction with the torcular Herophili are exposed. The suboccipital dura is opened in a transverse triangular fashion just inferior to the transverse sinus (Fig. 2G—illustrative case 2). This type of opening facilitates the subsequent watertight closure. The cisterna magna is opened to permit the relaxation of the brain. Then, the occipital dura is opened in the same fashion, just superior to the transverse sinus and laterally to the superior sagittal sinus. If the occlusion of the sinus is planned, a judicious investigation with MR, MRA, and venous phase of angiography should be performed. If the sinus is already occluded with tumor, the sinus can be divided and removed. After the dura is opened including the surfaces to both compartments, a wide exposure of the meningiomas along the tentorium can be appreciated.

Microsurgical Techniques

Using microsurgical techniques, the surgeon should start with the evacuation of the tumor content (Fig. 2G—illustrative case 2). Gentle traction was exerted on the capsule to separate it from the neighboring vascular and nervous structures. In this maneuver, the surgeon must distinguish the vessels and nerves that lie outside the tumor and have been displaced and stretched from those embedded in the tumor. In the first situation, the vessels and nerves must be gently separated and protected with sponges. The small arteries that supply the tumor must be identified and not stretched, not to tear them at the base of their insertion; they should be coagulated and sectioned flush with the tumor. Then the tumor can be radically removed (Fig. 2H—illustrative case 2). In cases in which the nerves and vessels are involved by the tumor, the use of higher magnification and a piecemeal removal around those structures should be used. Often, it may be wise to leave a thin layer of the tumor around arteries and nerves. For those kinds of microsurgical dissection, a precise bipolar coagulation technique is essential. Usually the tumor displaces the normal structures and after the debulking, no retraction is really necessary. The use of the ultrasonic surgical aspirator has proved to be useful. It is especially valuable to decompress a large tumor with a soft consistency. After removal of the tumor, the infiltrated dura must be removed as thoroughly as possible. The tentorium is cut just lateral to the straight sinus and toward the tentorial notch. Through this approach, the entire tentorium can be visualized from above and below, facilitating extremely dural removal. A CT scan can be performed in the first 24 hours after the surgery to check the completeness of the resection and absence of surgical bed hematoma (Figs. 2H, I—illustrative case 2).

RESULTS

A group of 24 patients, 21 females and 3 males, with a mean age of 53.79 years and range, 24 to 86 years was diagnosed with posterior cranial fossa meningioma. The most common presenting symptoms were headache in 16 patients (66.6%), cerebellar ataxia in 6 patients (25%), and dizziness in 4 patients (16.6%). The duration of symptoms before diagnosis varied widely, ranging from a patient presenting with collapse due to hydrocephalus and raised intracranial pressure, to 2 patients without symptoms. The average duration of the symptoms was 10 months before clinical admission.

A complete occlusion of the transverse sinus was revealed by preoperative angiography in 5 patients (20.8%) and confirmed during surgical exploration. The transverse sinus was partly obstructed by the tumor in 4 patients (16.6%), as revealed by MRA or conventional angiography. All patients with partial and complete invasion were accessed by the combined supra/infratentorial approach. Tumor location according to the Aguiar classification[8] was 14 patients (58.33%) who presented 6B location, which was the commonest location followed by 4B with 4 patients (16.6%) and 4B4A (1% to 4.16%), 5B (1% to 4.16%), 5B5A(1% to 4.16%), 5B4A (1% to 4.16%), 6B6A (1% to 4.16%), 6B5B5A (1% to 4.16%). The complications were most common in the 6B tumor location.

According to Simpson's classification, the extension of tumor removal was Simpson grade I in 12 patients (50%), grade II in 12 patients (50%), and grades III and IV in none of the patients. The combined supra/infratentorial was applicated in 12 cases, and complete resection was more frequent in this approach than compared with retrosigmoid technique. Pathologic documentation of the meningioma was obtained in all patients. In 22 patients (91.66%), the meningioma was grade I according to the classification of World Health Organization. There were only 2 cases (8.33%) classified as grade II (atypical meningioma). There was no case of malignancy.

Clinical and radiologic MRI follow-up assessment was available for all patients, with follow-up average of 47 months ranging from 15 days to 196 months. Of these, 19 patients (79.16%) had resumed a normal life with no symptoms (Karnofsky performance scale score of 100%). Four patients (16.6%) returned to their previous activity level, but had symptoms. None of the patients were severely disabled. One of these patients died in immediate postoperative period from pulmonary embolism. The most frequent postoperative complication was postoperative CSF fistula in 5 patients, who were managed successfully with temporary CSF drainage (Fig. 2D—illustrative case 2). Other complications were surgical bed hematoma in a patient, and a case with wound infection and pulmonary embolism in 2 patients.

A permanent shunt was needed in 4 patients. There were no preoperative deaths from the neurologic complications. A patient died in the seventh postoperative day due to pulmonary embolism. Another patient died 96 months after surgery due to other clinical cause. Overall, major surgical morbidity was observed in 12.5%.

DISCUSSION

The first attempt to classify the tentorial meningioma was made by Olivecrona[7] in 1967. The transverse sinus may be invaded in 52%. In our series the invasion was detected in 37.4%, complete in 5 patients and partial in 4 cases. As in many reported series of intracranial meningioma, our series also demonstrated a strong female preponderance for posterior cranial fossa meningioma, equivalent to 70% to 80% in literature.[5,9] In our series, 21 of the 24 patients were women, with a median age of 53 years.

The choice of best approach for tentorial meningiomas must be based on their attachment or origin and their extension. Many authors propose different classifications of the posterior fossa meningiomas.[1,8,10–12] During the era of pre-CT scan, majority of the authors agreed that the tentorium was the most common site of the posterior fossa meningioma.[6] With the advent of CT in the early 1970s, numerous authors have attempted to order these lesions by assigning classification.[1,9–11,13–16]

We believe that the 3 classification systems proposed by Asari et al,[10] Yasargil,[1] and Bret et al,[13] are accurate; however, they do not demonstrate the precise idea of anatomic location and also do not permit an immediate identification of infratentorial or supratentorial compartment. In our opinion, the anatomic consideration helpful to define the surgical approach, are those of Aguiar.[8] He divides the tentorial meningiomas into 2 main groups: A—supratentorial and B—infratentorial, each one divided into 6 groups depending on localization: 1—posterior incisural space, 2—anterior lateral incisural space, 3—paramedian in the middle between the posterior incisural space and the torcular area, 5—lateral, 6—far lateral in the external tentorial ring.

Cerebral angiography is sometimes necessary to obtain additional information about the arterial and venous system. Using the 4-vessel angiography, we are able to delineate the vascular component of the lesion and its relations to the various arteries and veins in this area. The vascular supply of the tumor is carefully analyzed to plan both endovascular and surgical procedures. The vein of Galen, the internal cerebral veins and the basal vein of Rosenthal should be also evaluated by angiogram, as well as the superficial and deep venous system. The occlusion of the straight sinus, and the collateral venous drainage and enlargement of the normally present sinus should also be analyzed. Preoperative embolization can be used. If the sitting position is planned to approach the tentorial meningiomas, a complete evaluation of the cervical spine is mandatory. MRI and x-rays of the cervical spine should be studied carefully to avoid complications with the positioning.

Early attempts at removal of tentorial meningiomas have been associated with high mortality and morbidity rates. Series published before 1980 reported a postoperative death rate ranging from 14% to 44%.[17,18] After the emergence of modern imaging techniques and advances in microsurgery, mortality has dramatically decreased below a 10% level in most series in the last 2 decades. However, the postoperative morbidity rate has remained a problem, even in experienced hands, with figures ranging from 18.9% to 77%.[9,12,19] In our series, complications were verified in 41.6% of the patients, and major morbidities observed in 12.5%. The choice of operative approach depends mainly on the site of the lesion. The size of the lesion will dictate the size of the craniotomy. The majority of the posterior fossa tentorial meningiomas can be removed by the retrosigmoid and a combined supra/infratentorial approach. In our series, 12 patients were operated by retrosigmoid and 12 by combined supra/infratentorial. Complete resection was most common with the second technique. This combined supra/infratentorial approach is a modified adaptation of the approach described by Ziyal et al[20] for pineal tumors.

Supra/Infratentorial Combined Approach

This approach provides a wider exposure of the supra/infratentorial region with less brain retraction. With this approach, the occipital lobe and the cerebellum are exposed along the tentorium.[21]

We believe that careful preoperative planning of the surgical approach based on tumor location and extent is quite important to achieve a radical microsurgical tumor resection, avoiding additional damage to neurovascular structures. The authors make an important point that resection of the infiltrated but patent venous sinus is not recommended. The goal of tentorial meningioma surgery should be radical resection if recurrences are to be prevented. However, this goal should not be achieved at any cost and the decision to leave a tumor fragment behind in cases of tumor's adherences to vital venous structures maybe associated with a long recurrence—free survival and no permanent deficits.

We emphasize that the unilateral, suboccipital retrosigmoid approach, and midline suboccipital craniotomy are adequate to access infratentorial meningiomas (group B). For the mixed infra/supratentorial meningiomas (AB), the authors recommend the combined approaches. The bioccipital/suboccipital are suggested for 4AB, or 4A, 5B. The risks of direct surgical approaches to tentorial meningiomas, and a high rate of subtotal resection has raised renewed interest in alternative therapeutic modalities, especially radiosurgery. The authors believe that in the near future, radiosurgery may represent a standard option for recurrent tumors and in patients with small tumors producing no mass effect, in those with no preoperative deficit, and in those who refuse surgery or are ineligible for conventional approaches.

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