NEUROSURGERY
CLINICS
OF NORTH
AMERICA

Neurosurg Clin N Am 14 (2003) 559–569

Intraventricular meningiomas

Michael W. McDermott, MD, FRCSC

Departments of Neurological Surgery and Radiation Oncology University of California at San Francisco, 505 Parnassus Avenue, M-774, San Francisco, CA 94143, USA

Meningiomas arising in the ventricular system are rare; yet, when they do present clinically, they are often large, most often within the atrium, and most frequently on the left. For all these reasons, they are tumors for which it is difficult to achieve the perfect surgical result: complete removal of a benign tumor without complications or new neurologic morbidity. With a thorough understanding of the anatomy of structures around the ventricle, selection of the proper surgical approach, and use of modern neurosurgical techniques, however, modern-day surgical results should be superior to those of the past. This article reviews some of the important clinical and technical considerations for the surgery of intraventricular meningiomas.

Incidence

Meningiomas are the second most common primary brain tumor in adults [1]. In a surgical series reported by Cushing and Eisenhardt (N = 295) [2], intraventricular meningiomas accounted for only 1.3% of the total. Guidetti and Delfini [3] found that over a 38-year period, only 22 (1.5%) of 1451 meningiomas were intraventricular: 20 in the lateral ventricles, 2 in the fourth ventricle, and none in the third ventricle. In an earlier extensive review of the published literature up to 1986, Criscuolo and Symon [4] identified 400 intraventricular meningiomas and categorized their location. Eighty percent of intraventricular meningiomas occur in the lateral ventricles, 15% in the posterior third ventricle, and 5% in the fourth ventricle (Table 1). At our own institution, over a 15-year period, there were only 13 intraventricular meningiomas (all in female patients): 11 with benign histology and 2 anaplastic. When a meningioma does occur in the lateral ventricle, it is more often on the left than on the right and more than 90% are located in the atrium. Within the third ventricle, meningiomas are more often posterior than anterior [5].

The incidence of ventricular meningiomas is higher in pediatric patients. Germano and colleagues [6] reviewed 15 pediatric meningioma series in the literature totaling 278 meningiomas and found that 9.4% were intraventricular. Thirty-nine percent occurred in patients younger than 10 years of age, and 61% occurred in the 1- to 20-year-old age group.

Origin and anatomy

Meningiomas arise within the ventricle from the choroid plexus or from the tela choroidea within the ventricular system. As pointed out by Cushing and Eisenhardt [2], meningiomas within the ventricle tend to assume the shape of the ventricle in which they lay. The atrium is the most common location for lateral ventricular meningiomas. The atrium is formed by the junction of the temporal horn anteriorly and inferiorly, the occipital horn posteriorly, and the posterior body of the lateral ventricle anteriorly and superiorly. The floor of the atrium is formed by the hippocampus, the medial wall by the splenium of the corpus callosum, and the roof and lateral wall by the splenium and tapetum of the corpus callosum [7]. Fibers of the geniculocalcarine tract run lateral and inferior to the atrium and account

E-mail address: mcdermottm@neurosurg.ucsf.edu

doi:10.1016/S1042-3680(03)00055-X

Table 1
Common sites for intraventricular meningioma

Ventricle	Site	Frequency	Blood supply
Lateral	Atrium >80% (L > R)	80%	AChA PLChA
Third	Posterior	15%	PMChA PLChA
Fourth	Midline	5%	PICA

Abbreviations: AChA, anterior choroidal artery; L, left; PICA, posterior inferior cerebellar artery; PLChA, posterior lateral choroidal artery; PMChA, posterior medial choroidal artery; R, right.

for visual symptoms seen with larger tumors (Fig. 1).

Meningiomas of the fourth ventricle arise from the choroid or the inferior tela choroidea [3]. Tumors of the posterior third ventricle are thought to arise from the tela of the velum interpositum, the space between the two layers of the tela choroidea in the roof of the third ventricle that carry the posterior medial choroidal arteries and internal cerebral veins [5]. Tumors in this location are to be distinguished from meningiomas arising from the falcotentorial junction immediately behind the third ventricle.

Pathology

In the series of Guidetti and Delfini [3], 81% of the meningiomas were fibroblastic. Meningotheliomatous and psammomatous variants reported by others as case reports are less common. All three types are classified as grade I tumors in the World Health Organization scheme, with a low risk of recurrence and nonaggressive clinical behavior [8]. The pathologic entities encountered in the lateral ventricle also include choroid plexus papilloma, ependymoma, and metastases. The author has operated on three large "meningiomas" of the atrium, which proved pathologically to be metastases from renal cell (1 case) and thyroid (2 cases) carcinoma. Posterior third ventricular tumors that may mimic meningiomas radiographically include pineocytoma and teratoma, whereas choroid plexus papilloma, ependymoma, and hemangioblastoma should be considered in the fourth ventricle.

Clinical presentation

Meningiomas of the lateral ventricles present primarily with signs of increased intracranial pressure. Headache, nausea/vomiting, and disturbance of vision are seen in 40% to 80% of patients

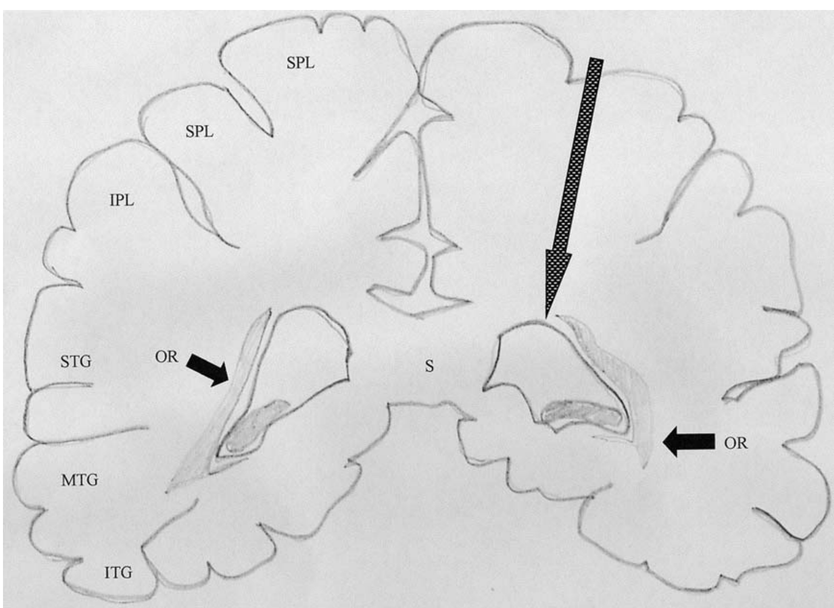


Fig. 1. Posterior coronal section of hemispheres. Note position of optic radiations lateral and inferior to atrium. Large arrow on left indicates trajectory with posterior parietal-occipital approach. SPL, superior parietal lobule; IPL, inferior parietal lobule; STG, superior temporal gyrus; MTG, middle temporal gyrus; ITG, inferior temporal gyrus; S, splenium; OR, optic radiations.

(Table 2) [3]. Visual symptoms most often relate to impaired vision from papilledema but can also include visual field deficits from large atrial tumors. Motor, sensory, and speech disturbances are also seen, and seizures were the presenting symptom in 27% of patients for one series [3]. Symptoms of impaired memory may relate to dilatation of a trapped temporal horn or to direct compression on the hippocampal formation in the floor of the atrium with larger tumors.

Tumors of the third and fourth ventricles usually present with symptoms of hydrocephalus as a result of obstruction of cerebrospinal fluid (CSF) flow. Parinaud's syndrome with impaired upgaze and pupillary light reflexes may be seen with posterior third ventricular masses [5].

Radiology

Frequently, patients still have CT scans as their first imaging study. Meningiomas in the lateral ventricle are slightly hyperdense, may have small areas of calcification, and usually show homogeneous enhancement [9]. With larger tumors, obstruction of the temporal horn, which contains the choroid plexus, results in dilatation of this portion of the ventricle and low density in the brain surrounding the atrium, which is partially related to transependymal flow of CSF and partially related to tumor-associated vasogenic edema (Fig. 2). MRI reveals superior anatomic detail compared with CT scans, with meningiomas being iso- or hypointense on T1-weighted images and T2-weighted images [10]. It is the author's experience that fibroblastic meningiomas, the most common pathologic subtype of meningioma within the ventricle, are usually prominently hypointense on T2-weighted images. On T1-weighted postcontrast images, there is uniform contrast enhancement. Thin-cut axial spoiled gradient recall (SPGR) images are routinely used for image-guided surgical systems, and these images can also provide the opportunity for creating two-dimensional (2D) and three-dimensional (3D) venograms to assist the surgeon with the preoperative selection of surgical approaches [11]. The differential diagnoses for other tumors in these locations also need to be considered, especially as they relate to patient age (Table 3) [9]. MRI also offers the ability to perform spectroscopy and blood volume time intensity maps, which, alone or together, may increase the certainty of the radiologic diagnosis. A high alanine-to-creatinine ratio has been reported as a relatively specific MR spectroscopy finding for meningiomas [10].

Table 2
Common symptoms and signs for atrial meningiomas

	Frequency
Symptoms	
Headaches	80%
Nausea/vomiting	40%
Seizures	35%
Speech disturbance	30%
Motor	25%
Mental disturbance	20%
Visual disturbance	20%
Sensory	15%
Signs	
Papilledema	60%
Visual field deficit	50%
Motor disturbance	50%
Dysphasia	40%
Sensory disturbance	20%

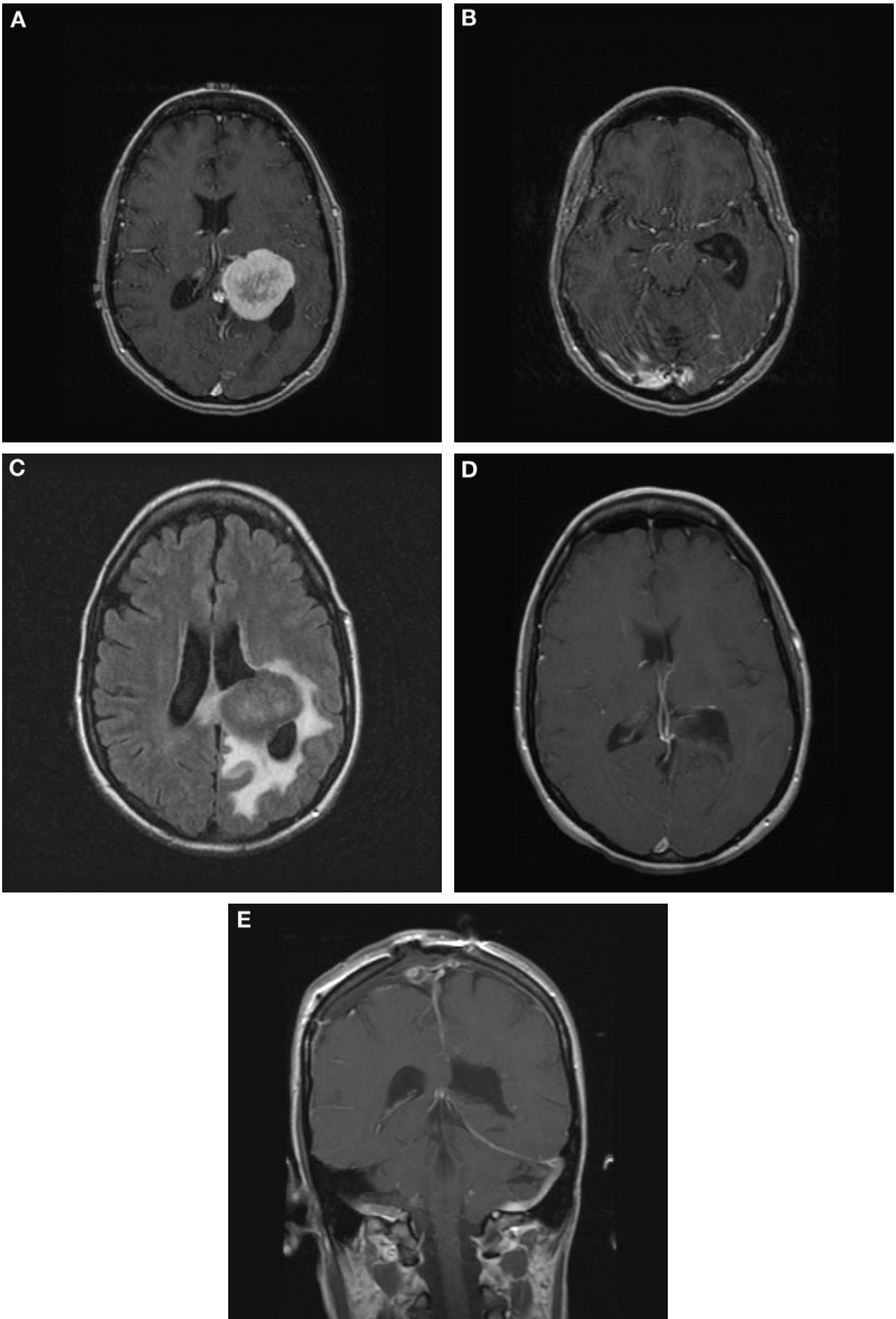
From Guidetti B, Delfini R. Lateral and fourth ventricle meningiomas: In: Al-Mefty O, editor. Meningiomas. New York: Raven Press; 1991. p. 569–81; with permission.

Cerebral angiography is rarely used these days, because intraventricular meningiomas can rarely be embolized. Angiography can confirm the predominant blood supply (see Table 1) and the position of prominent parasagittal draining veins [12]. Catheter cannulation of choroidal arteries is difficult, however, and the target for occlusion is distal in the vascular territory. Catheter-related arterial spasm of the anterior choroidal artery after attempted embolization of a vascular malformation, with subsequent infarction, has prevented us from considering preoperative embolization. Thus, in selecting an operative approach, the surgeon may need to take into consideration the potential advantage of occluding the arterial blood supply to large tumors early in the operation.

Options for treatment

Observation

Intraventricular meningiomas discovered incidentally, those that are not causing obstruction of CSF flow or hydrocephalus, and those not associated with vasogenic edema should be observed [13]. The author usually follows patients with two successive 3-month scans; if the tumor is stable, the interval is increased to 6 months for 2 years and then to once a year. It is important to compare follow-up scans with the original scan


A
B
C
D
E

and not the one immediately preceding it, because smaller changes in size may not be appreciated. Anterior-posterior, lateral, and vertical dimensions should be recorded. Documented tumor growth on serial scans in a medically fit individual or development of symptoms related to secondary tumor effects, such as hydrocephalus or vasogenic edema, may warrant surgical intervention. Certainly, for a nondominant right atrial meningioma with symptomatic trapping of the temporal horn, surgical removal of the tumor is preferred over shunting and radiotherapy. In contrast, a slowly growing meningioma in the left atrium of a 70-year-old patient that is not causing hydrocephalus or vasogenic edema may be considered for radiosurgical treatment.

Table 3
Common radiographic differential diagnoses for intraventricular meningioma

Site	Child	Adult
Atrium	CPP Ependymoma	Metastasis Ependymoma
Posterior third ventricle	Germinoma Pineocytoma blastoma Astrocytoma Teratoma	Pineocytoma Astrocytoma Metastasis
Fourth ventricle	CPP Ependymoma Astrocytoma Medulloblastoma	Ependymoma CPP Hemangioblastoma Medulloblastoma

Surgery

Surgery is the gold standard of treatment for growing symptomatic meningiomas in patients who are candidates for general anesthesia. Because most of these tumors are benign and complete excision of lateral ventricle tumors can be accomplished, surgical cures can be achieved. Potential side effects of the various surgical approaches need to be considered and reviewed with the patient [12].

Radiosurgery

Radiosurgery is an effective form of treatment for selected meningiomas, including intraventricular meningiomas. Reports on the tumor control rates achieved with radiosurgery of 85% to 98% cannot be overlooked during the informed consent process [14,15]. A size limit of 3 cm as used in other brain locations is not acceptable for intraventricular tumors of the atrium, third ventricle, or fourth ventricle at our institution, and we usually limit tumors to 1.5 to 2.0 cm depending on associated vasogenic edema. Of the 13 patients treated at our institution, 4 have had radiosurgery for their intraventricular meningioma. In 2 patients, the treatment was used for residual or recurrent disease, and in 2 patients, it was used as the primary form of therapy. Of these latter 2 patients, 1 developed symptomatic subependymal radiation toxicity despite a low marginal dose of 12 Gy. In spite of the fact that the tumor decreased in size, obstructive hydrocephalus with a trapped temporal horn developed and surgical removal was performed 20 months later. We have seen exaggerated radiation toxicity in the subependymal periventricular region as well as with fractionated radiation therapy; thus, even "noninvasive" treatments should be recommended only to those who are not candidates for, or refuse, microsurgical removal.

Radiotherapy

Fractionated 3D conformal radiotherapy offers effective tumor control for residual or recurrent meningiomas in a variety of intracranial locations [16]. Although there is no reason to believe that the results should be any different for intraventricular meningiomas, none of the four patients at our institution who required additional therapy other than initial surgery (ie, reoperation, radiosurgery) was treated with this method. Although the conformality of present-day techniques limits the volume of normal tissue irradiated, intraventricular meningiomas are such discrete targets that surgery or radiosurgery has been recommended instead.

Surgical considerations

Evaluation of the patient for surgery involves consideration of patient factors, such as age, medical conditions, and neurologic status, and

Fig. 2. (*A*) Larger intraventricular meningioma presenting with seizure and language disturbance. Trapped temporal horn (*B*) and evidence of parietal vasogenic edema (*C*). (*D, E*) Postoperative scans showing complete resection using contralateral interhemispheric approach.

tumor characteristics, such as relation to symptoms and signs, growth rate, and resectability [7]. The routine evaluations for patients and specific discussion of the approaches for intraventricular meningiomas are reviewed below.

Preoperative studies

MRI without and with contrast is the basic imaging study needed. For all supratentorial approaches to the lateral ventricles, we obtain volumetric, thin-cut, T1-weighted images for use with image-guided surgical systems. MR venography can also be obtained to look at collapsed vertex views or 3D reformats. Cerebral angiography is not routinely done, because the blood supply to tumors in various locations is known and embolization is not possible without significant risk.

For patients having a transcallosal procedure or transcortical superior parietal lobule approach in the dominant hemisphere, the author always obtains preoperative neuropsychologic testing as a baseline. This can be repeated 3 months after surgery and helps with quantitating patient status for return to work and other disability issues. It can also be used to document improvement in function for patients who undergo successful resection of large tumors or those associated with hydrocephalus. If a superior parietal occipital approach is selected, most anesthesiologists want the patient to have a bubble echocardiogram done to rule out a patent foramen ovale and a potential right-to-left shunt. Humphrey visual fields should be tested in all patients with tumors of the atrium.

General intraoperative measures

Patients undergoing transcortical approaches receive anticonvulsants for 1 week around the operation, beginning the morning of surgery. Intravenous fosphenytoin or phenytoin is used to load those patients who are not already on medications. Standard measures to reduce intracranial pressure and improve blood rheology are used. Mean arterial blood pressure should be kept in the normal range, and hyperventilation should be avoided throughout the case. Depending on the tumor location and hemisphere, every attempt is made to identify and interrupt the blood supply to these tumors early on.

Specific surgical approaches

Common surgical approaches by tumor site are outlined in Table 4.

Middle temporal gyrus approach

- Patient position: semilateral
- Head position: extended on neck, tilted 20° downward, rotated 90° to opposite side, parallel to floor

The middle temporal gyrus approach (Fig. 3) is best suited for meningiomas of the atrium of the lateral ventricle of the nondominant hemisphere. A variety of skin incisions can be used, including U-shaped incisions, reverse question mark incisions, or curvilinear incisions with posterior hockey stick extension coming off at right angles posteriorly [9,17]. A transsulcal approach in the posterior third of the temporal lobe minimizes tissue disruption, and image-guided systems can be used to define the precise trajectory to the ventricle. The advantage of this approach is the ability to pick up the anterior choroidal artery within the temporal horn and eliminate the predominant blood supply before tumor resection starts. The choroid plexus can be followed back to the tumor; internal debulking is then used, followed by capsular dissection of the tumor from the walls and floor of the ventricle. The surgeon should be mindful of visual fibers that first pass over the roof of the temporal horn and then swing back lateral and inferior to the atrium in the periventricular white matter; thus, horizontal

Table 4
Common surgical approaches by tumor site

Site	Approach	Patient position
Atrium	1. Middle temporal gyrus (nondominant) 2. Superior parietal lobule (dominant) 3. Contralateral interhemispheric, transcallosal (dominant) 4. Ipsilateral interhemispheric transcallosal	1. Left lateral 2. Supine or lateral 3. Lateral, tumor side up 4. Supine
Posterior third ventricle	1. Infratentorial supracerebellar 2. Occipital transtentorial	1. Prone or semisitting 2. Prone, approach side down
Fourth ventricle	Midline suboccipital	Prone or concord

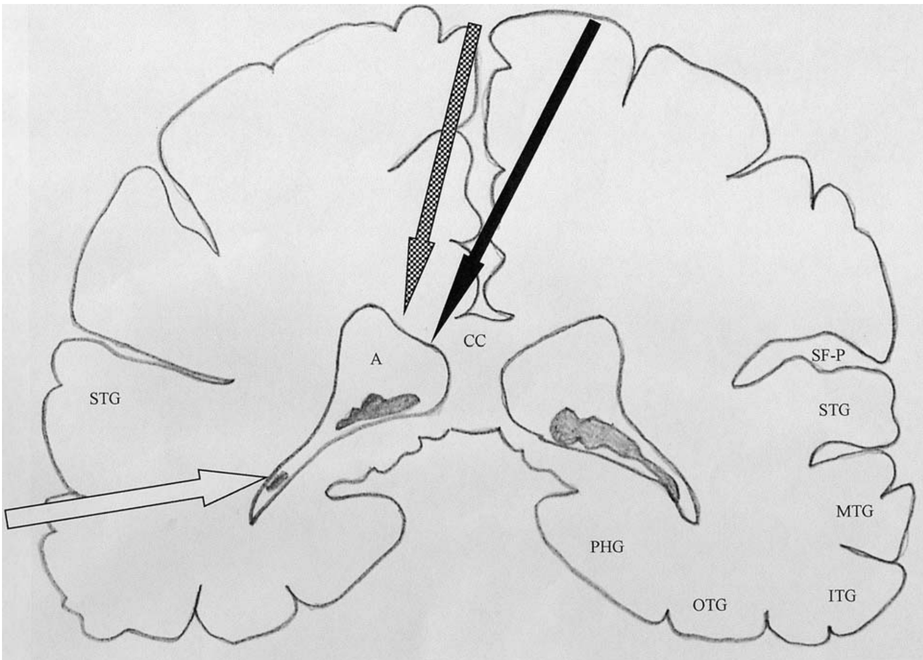


Fig. 3. Coronal section through atria, anterior cut to Fig. 1. White arrow marks middle temporal transsulcal or middle temporal gyrus approach. Ipsilateral interhemispheric transcallosal approach (*shaded arrow*) and contralateral interhemispheric transcallosal approach (*solid arrow*) are also marked. SF-*P,* Sylvian fissure, posterior; OTG, occipital-temporal gyrus; PHG, parahippocampal gyrus; CC, corpus callosum; A, atrium; STG, superior temporal gyrus; MTG, middle temporal gyrus; ITG, inferior temporal gyrus.

subcortical dissection planes should be used to minimize the risk of tract disruption. After removal of the tumor, an external ventricular catheter should be left to drain CSF until returns are clear.

Superior parietal occipital approach

- Patient position: supine with back up 15° or semilateral
- Head position: neck flexed on chest, head slightly flexed on neck, no rotation; or laterally flexed on neck tilted 10° up, rotated 90° to opposite side

The superior parietal occipital approach can be selected for either the left or right side but is most often employed for dominant hemisphere tumors [9,17]. The author prefers to have the patient supine, with the back elevated so that the patient is in a slouching position, with the neck flexed on the chest and the head flexed on the neck. Most anesthesiologists want to exclude a patent foramen ovale and right-to-left shunt before surgery as noted previously. After pin fixation and registration, the image-guided system is used to help identify the trajectory to the ventricle and the midline. A horseshoe-shaped incision is fashioned, and the brain is exposed to the parietal-occipital junction. A posterior parietal sulcus is used for the dissection, with maintenance of the plane using self-retaining retractors. The corridor to the tumor with this approach is long, and if the tumor is firm and not that vascular, this is one of the few instances where the laser is of particular utility. One disadvantage of this approach is that some of the blood supply (anterior choroidal artery) to the tumor is not identified until late in the procedure. Internal debulking followed by marginal dissection is again employed. Care should be taken not to extend the white matter dissection too far lateral to the atrium for fear of damaging visual pathway fibers.

Interhemispheric transcallosal

- Ipsilateral approach
    - Patient position: semisitting or prone

- Head position: neck flexed on chest with head flexed on neck or neck neutral with head flexed on neck

- Contralateral approach
  - Patient position: full lateral, tumor side up
  - Head position: neck neutral, head slightly flexed on neck, laterally flexed upward toward tumor

The original description of the ipsilateral transcallosal approach was provided by Kempe and Blaylock in 1976 [18]. The patient can be positioned semisitting or prone for a parietal occipital craniotomy. The bone flap should cross the midline, and the interhemispheric fissure should be opened widely. Jun and Nutik [19] described a slightly more vertical angle than along the tentorium so as to preserve part of the splenium. The posterior callosum is split for 2 cm, leaving the posterior part of the splenium intact. The tumor is debulked and removed piecemeal.

We have used the contralateral transcallosal approach with success for several cases in the dominant hemisphere (see Fig. 2; Fig. 4) [20]. The patient is positioned so that the retracted right hemisphere is toward the floor; thus, retraction is assisted by gravity. A posterior interhemispheric approach is taken through a large parietal craniotomy crossing midline, preserving parasagittal draining veins. Once the interhemispheric fissure is split along the length of the exposure, the image-guided system is used to define the most appropriate callosotomy, which is not more than 2 cm in length. The inferior two thirds of the falx are incised to allow for gentle retraction of the medial aspect of the left hemisphere and, later, the callosum. The tumor can be removed piecemeal using the long microsurgery set for the supracerebellar approach. At the completion of tumor removal, an external ventricular drain is left in place for several days.

Infratentorial supracerebellar

- Patient position: semisitting or prone
- Head position: neck flexed on chest with head flexed on neck or neck neutral with head flexed on neck

The approaches to meningiomas of the posterior third ventricle are similar to those for pineal region tumors [5]. Because meningiomas in this location are so rare, this approach is not discussed in great detail. The choice of the approach generally depends on the patient's body habitus and the angle of the tentorium on sagittal MRI. For obese patients, those with a short neck, or those with a steeply angled up tentorium, the semisitting position is preferred after preoperative cardiac screening. In our experience, massive air embolism is rare. The author uses a torcular craniotomy, exposing the transverse sinuses bilaterally and the torcular with a bipartite bone flap. The posterior fossa craniotomy below the transverse sinus is done first, followed by the second flap exposing the sinuses from above. The rest of the dissection is as described elsewhere [22].

Occipital transtentorial

- Patient position: prone
- Head position: neck neutral with head flexed on neck or head flexed and rotated downward toward floor

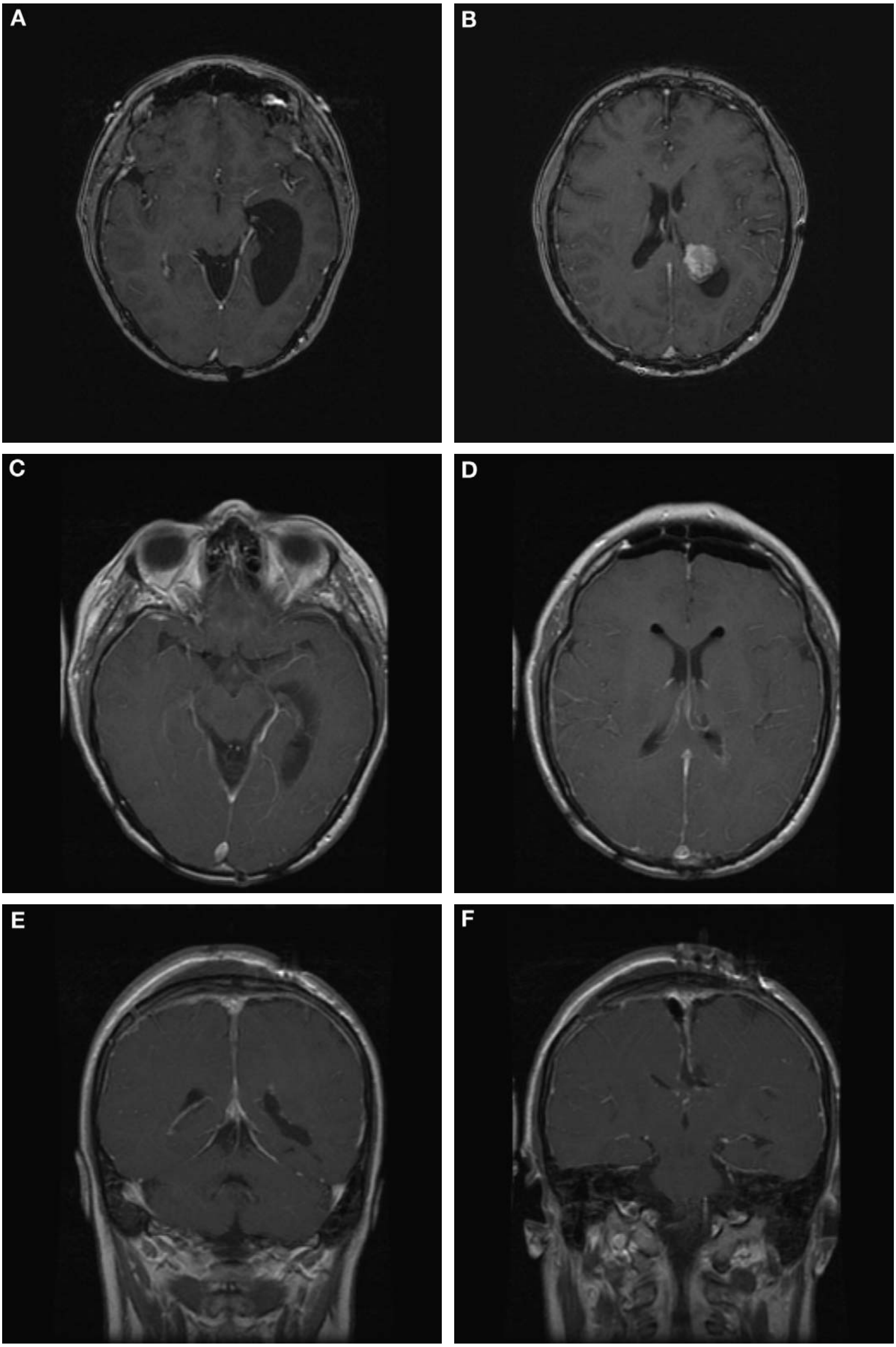
This is another approach for pineal region tumors [5]. For the prone position, the craniotomy is on the side of the sinus toward the floor so that the retracted occipital lobe is assisted by gravity. The dura is opened in a U-shaped fashion based laterally so that the brain is protected from a sharp dural edge.

Midline Suboccipital

- Patient position: prone
- Head position: neck extended on chest with head flexed on neck

Again, meningiomas of the fourth ventricle are rare, but a standard surgical approach is used [3]. A midline incision extending into the occipital region is used so that pericranium can be

Fig. 4. (*A*) Axial T1-weighted image showing trapped temporal horn in patient treated with radiosurgery for atrial meningioma 20 months earlier. In spite of reduction in tumor size, the patient developed a subependymal reaction causing obstructive hydrocephalus. (*B*) Relatively small contrast-enhancing tumor at atrium. Immediate postoperative scans with contrast showing reduction in size of temporal horn (*C*) and complete resection of tumor in axial (*D*) and coronal (*E*) planes. (*F*) Contralateral interhemispheric transcallosal approach was used.


A
B
C
D
E
F

harvested for dural repair at the end. Once the occipital bone is removed and the dura and cisterna magna are opened, the cerebellomedullary fissure is dissected to gain access to the ventricle, thus avoiding splitting the inferior vermis. The fissure is developed by dissecting the lateral aspect of the tonsil and incising the tela choroidea along the posterior lateral margin of the floor of the fourth ventricle to the level of the lateral recess [21]. The choroidal branch of the posterior inferior choroidal artery is the main supply and should be seen entering the tumor in the roof of the ventricle.

Postoperative care

Fluid is not routinely restricted in these patients so as to reduce the chance of cortical venous thrombosis. Low-molecular-weight heparin is started 24 hours after surgery and is continued for 5 days to reduce the chance of deep venous thrombosis in the extremities. Excessive drainage of CSF should be avoided so as to reduce the chance of subdural hematoma formation. Conversely, adequate clearance of blood and debris from the ventricle reduces the chance of hydrocephalus. Patients can be followed with CT scans to assess ventricle size and debris. Postoperative MRI should be delayed several days until it is clear that the patient will be safe in the MRI environment.

Summary

Intraventricular meningiomas are most often seen in the lateral ventricles of adults, more often on the left than on the right. A variety of surgical approaches can be selected depending on patient and tumor factors as well as on surgeon preference. Some of these approaches are complex and demand a thorough understanding of the ventricular and periventricular anatomy. When successful, surgery can be curative in most cases of total removal.

References

[1] Surawicz TS, McCarthy BJ, Kupelian V, et al. Descriptive epidemiology of primary brain and CNS tumors: results from the Central Brain Tumor Registry of the United States, 1990–1994. Neuro-oncology 1999;1:14–25.

[2] Cushing H, Eisenhardt L. Meningiomas. Their classification, regional behavior, life history and surgical end results. Springfield: Charles C. Thomas; 1938.

[3] Guidetti B, Delfini R. Lateral and fourth ventricle meningiomas. In: Al-Mefty O, editor. Meningiomas. New York: Raven Press; 1991. p. 569–81.

[4] Criscuolo GR, Symon L. Intraventricular meningioma. A review of 10 cases of the National Hospital, Queen Square (1974–1985) with reference to the literature. Acta Neurochir (Wien) 1986;83: 83–91.

[5] Tung H, Apuzzo ML. Meningiomas of the third ventricle and pineal region. In: Al-Mefty O, editor. Meningiomas. New York: Raven Press; 1991. p. 583–591.

[6] Germano IM, Edwards MS, Davis RL, et al. Intracranial meningiomas of the first two decades of life. J Neurosurg 1994;80:447–53.

[7] Abosch A, McDermott MW, Wilson CB. Lateral ventricular tumors: a practical guide to neurosurgical technique. In: Kaye AH, Black P, editors. Operative neurosurgery. London: Harcourt Brace; 2000. p. 799–812.

[8] Louis DN, Scheithauer B, Budka H, et al. Meningiomas. In: Kleihues P, Cavenee WK, editors. Pathology and genetics. Tumors of the nervous system. Lyon: IARC Press; 2000. p. 176–84.

[9] Tew JM, Larson JJ. Intraventricular meningioma. In: Kaye AH, Black P, editors. Operative neurosurgery. Lyon: Harcourt Brace; 2000. p. 575–85.

[10] Majos C, Alonso J, Aguilera C, et al. Utility of proton MR spectroscopy in the diagnosis of radiologically atypical intracranial meningiomas. Neuroradiology 2003;45:129–36.

[11] McDermott MW, Gutin PH. Image-guided surgery for skull base neoplasms using the ISG viewing wand. Anatomic and technical considerations. Neurosurg Clin North Am 1996;7:285–95.

[12] McDermott MW, Wilson CB. Meningiomas. In: Youmans JR, editor. Neurological surgery, vol. 4. 4th edition. Philadelphia: WB Saunders; 1996. p. 2782–825.

[13] McDermott MW. Current treatment of meningiomas. Curr Opin Neurol 1996;9:409–13.

[14] Lee JY, Niranjan A, McInerney J, et al. Stereotactic radiosurgery providing long-term tumor control of cavernous sinus meningiomas. J Neurosurg 2002; 97:65–72.

[15] Pollock BE, Stafford SL, Utter A, et al. Stereotactic radiosurgery provides equivalent tumor control to Simpson grade 1 resection for patients with small-to medium-size meningiomas. Int J Radiat Oncol Biol Phys 2003;55:1000–5.

[16] Goldsmith BJ, Wara WM, Wilson CB, et al. Postoperative irradiation for subtotally resected meningiomas. A retrospective analysis of 140 patients treated from 1967 to 1990. J Neurosurg 1994;80:195–201.

[17] Guidetti B, Delfini R, Gagliardi FM, et al. Meningiomas of the lateral ventricles. Clinical, neuroradiologic, and surgical considerations in 19 cases. Surg Neurol 1985;24:364–70.

[18] Kempe LG, Blaylock R. Lateral-trigonal intraventricular tumors. A new operative approach. Acta Neurochir (Wien) 1976;35:233–42.
[19] Jun CL, Nutik SL. Surgical approaches to intraventricular meningiomas of the trigone. Neurosurgery 1985;16:416–20.
[20] Lawton MT, Golfinos JG, Spetzler RF. The contralateral transcallosal approach: experience with 32 patients. Neurosurgery 1996;39:729–34.
[21] Matsushima T, Inoue T, Inamura T, et al. Transcerebellomedullary fissure approach with special reference to methods of dissecting the fissure. J Neurosurg 2001;94:257–64.
[22] Lozier AP, Bruce JN. Meningiomas of the velum interpositum: surgical considerations. Neurosurg Focus 2003;15(1):1–9.