Surgical Management of Medial Tentorial Meningioma: Falcotentorial and Torcular

Andrea Talacchi, Antonio Biroli, Aurel Hasanbelliu, Francesca Locatelli

■ BACKGROUND: **Falcotentorial meningiomas (FTM) stand out for their rarity, inconsistent definition, and surgical complexity. It is appropriate to deal with them in the context of medial tentorial meningiomas (TMs).**

■ METHODS: **Clinical and radiologic characteristics of medial TMs, comprising the typical features of FTM and TM, along with surgical management and short-term and long-term outcomes, are reported.**

■ RESULTS: **FTM ($n = 16$) were typically supratentorial, large, edematous tumors that caused mainly headache and hemianopia; TM ($n = 12$) were infratentorial, smaller not edematous tumors that caused mainly headache and gait ataxia. The most frequent venous pattern was straight sinus infiltration in one third of cases of FTM and occlusion in one half of cases of TM. Total removal (Simpson grade I–II) was obtained in 46.4% of cases and subtotal removal (Simpson grade III–IV) in 53.6%. Suprainfratentorial extension in FTM and incomplete venous invasion in TM were the factors most likely opposing complete removal. The overall acute complications rate was 32.1% (higher for FTM), transient for most cases. Patients with supratentorial meningiomas performed significantly worse preoperatively (Karnofsky Performance Status ≤70 in 75% of cases); patients with infratentorial symptoms/signs recovered worse postoperatively. Stereotactic radiosurgery with subtotal removal was used as adjuvant treatment in 8 cases. Only 2 recurrences, both atypical tumors, occurred at 57.6 months (mean) follow-up.**

■ CONCLUSIONS: **As a general rule, careful venous management, tailored surgical approach for FTM, and cautious tumor removal for TM can yield good and stable results. Total removal accounts for half the cases in both groups, whereas FTM was associated with worse postoperative complications.**

INTRODUCTION

Tentorial meningiomas account for 3%– to 6% of all meningiomas, with the medial subgroup making up 27.7% of tentorial meningiomas alone.[1-5] These meningiomas are further subdivided into falcotentorial and torcular: falcotentorial meningioma (FTM) occupies the dihedral angle between the falx and the tentorium, being attached to one of the 2 or both, with or without infiltration of the straight sinus; torcular meningioma (TM) is located posterior, being attached near the confluence of the sinuses (<1 cm) with or without torcular infiltration. Hence, medial meningiomas are characterized by their midline position and may arise on the right or the left, supratentorial or infratentorial, or both. FTM and TM share the same position and classification criteria of falx and parasagittal meningiomas, respectively, in addition to tentorial involvement and often sinus involvement as well.

Frequently named and described,[6-9] the long-standing controversies over the definition of FTM have been recently settled with a thorough scheme that resolves the classification of borderline cases. Midline meningiomas that abut the quadrigeminal cistern

Key words
- Classification
- Falcotentorial
- Meningioma
- Surgical management
- Torcular

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
FTM: Falcotentorial meningioma
KPS: Karnofsky Performance Status
MRI: Magnetic resonance imaging
MTM: Medial tentorial meningioma
SRS: Stereotactic radiosurgery
TM: Torcular meningioma

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in contact with the mesencephalon anteriorly and the tentorial notch posteriorly are classified as posteromedian incisural meningiomas rather than anterior FTM and are discussed elsewhere.[10-16]

In the present study, this homogeneous group of meningiomas are described and surgical challenges in their treatment are highlighted.

METHODS

Between January 1990 and December 2010, 101 tentorial meningiomas of 1677 intracranial meningiomas (6% of the total) were operated on at the Department of Neurosurgery in Verona. They were classified as lateral, incisural, and medial (Figure 1). In 2 previous studies, we described the rationale and criteria for classifying the former 2 groups, whereas in the present study, we present the radiologic, clinical, and surgical aspects of medial tentorial meningioma (MTM).[2,14] This series comprises 28 cases, 27.7% of the total, divided in 2 subgroups: falcotentorial ($n = 16$, 57.1%) and torcular ($n = 12$, 42.9%).

All 28 patients underwent preoperative magnetic resonance imaging (MRI) with gadolinium contrast. To better define the relationship between the lesion and the adjacent sinuses (superior sagittal sinus, transverse sinuses, and straight sinus), adjunctive examinations were performed: venous MRI and angiography in 23 (82.1%) and 13 (46.4%) patients, respectively. From these studies, we were able to more precisely define the state of the sinuses and identify a normal, stenotic, or occluded sinus and collateral circles.

Patient demographics, clinicoradiologic features, and intraoperative findings were retrospectively reviewed and analyzed against the outcomes in the acute and delayed phase. In the acute phase, clinical status was assessed at 7 days and at 3 months to compare symptoms and signs with preoperative assessment. Two perioperative end points were set: extent of tumor removal and complications. The extent of removal was classified according to Simpson resection grade, total (grade I and II) or subtotal (grade III–IV), as determined by postoperative MRI. Complications were classified as local (e.g., wound infection, tumor bed hematoma, dural fistula, or epileptic seizure), neurologic (new or worsened symptoms and signs), and systemic (e.g., respiratory and heart failure, sepsis, or thromboembolic events).

In the delayed phase, clinical status was assessed at 12 months and at the last control visit to compare symptoms, signs, and Karnofsky Performance Status (KPS) with preoperative assessment. All patients were further monitored with periodic MRI. At the last follow-up visit, the occurrence of regrowth or recurrences and overall survival were recorded.

Between-group differences were analyzed using the MedCalc statistical software package (MedCalc Software, Ostend, Belgium). The χ^2 test was used to test correlations between quantitative variables and a Fisher exact test to test correlations between qualitative variables. Statistical significance was set at $P = 0.05$.

Ethical committee approval was not sought because data collection did not influence patient management in any way.

RESULTS

Eighteen women and 10 men (ratio, 1.8:1; mean age, 59.8 years [range, 40–77 years]) were operated on for the first time for MTM.

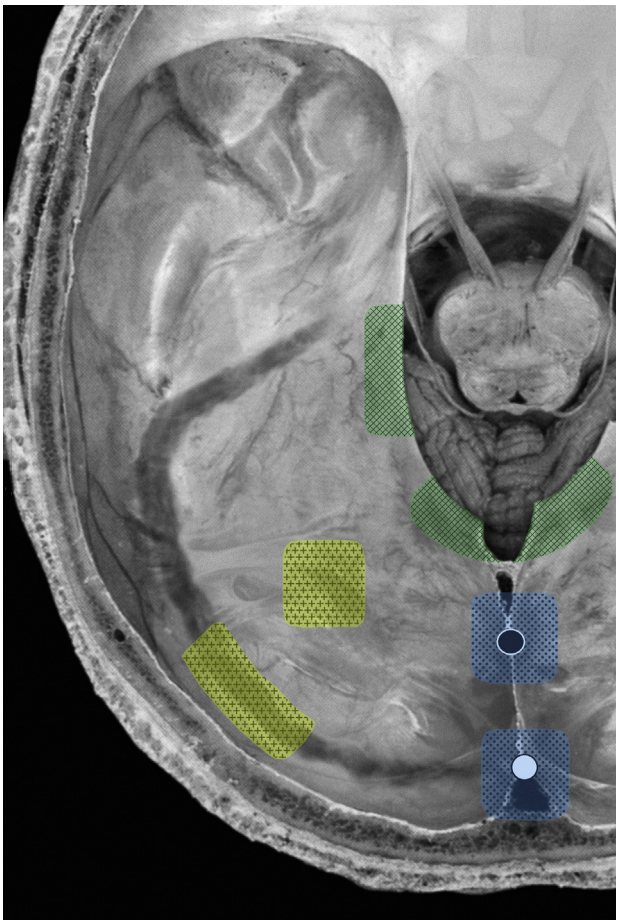

Figure 1. Classification of tentorial meningiomas. The dotted area in *blue* indicates medial falcotentorial (*black circle*) and torcular (*white circle*) meningiomas. The crossed area in *yellow* indicates lateral intermediate and posterior meningiomas. The hatched area indicates in *green* anterolateral and posteromedial incisural meningiomas.

Radiologic Findings

The 2 groups were further divided in supratentorial ($n = 12$, 42.9%), infratentorial (n=11, 39.3%), and neither with more than 20% of contralateral extension, and suprainfratentorial ($n = 5$, 17.9%), in which both components made up >20% of the total lesion volume. Although infratentorial meningiomas are strictly midline lesions, supratentorial meningiomas develop on 1 side: the left in 5 cases and the right in 7. The supratentorial site was the most common location for FTM (10/12) and the infratentorial site was the most common for TM (8/11). The suprainfratentorial site was the common location for 3 FTM and 2 TM; the supratentorial portion crossed the falx in 4 of these 5 cases.

Radiologic characteristics are presented in Table 1. The mean lesion diameter was 52 mm. FTMs were larger than TMs (54.3 vs. 49.6 mm), accounting for supratentorial tumor in which the difference between the 2 was significant ($P < 0.01$) (Figure 2).

Edema was present in 24 cases (85.7%). Severe edema was recorded in 12 cases, more often in supratentorial than in infratentorial lesions ($P = 0.01$). Edema and large tumor (60 mm) were

Table 1. Medial Tentorium Meningiomas: Radiologic Data

	Falcotentorial				Torcular			
	S (n = 10)	I (n = 3)	S-I (n = 3)	Total (n = 16)	S (n = 2)	I (n = 8)	S-I (n = 2)	Total (n = 12)
Size								
Mean diameter (mm)	56.8	41	65	54.3	55	38.8	55	49.6
Edema								
Absent	1	2	0	3	0	1	0	1
Perilesional	3	1	1	5	0	6	1	7
Massive	6	0	2	8	2	1	1	4
Sinus								
Normal	6	1	0	7	2	2	0	4
Stenotic	2	1	2	5	0	2	0	2
Occluded	2	1	1	4	0	4	2	6
Hydrocephalus	1	2	1	4	0	4	1	5

S, supratentorial; I, infratentorial; S-I, suprainfratentorial.

present in all patients with suprainfratentorial lesion (n = 5). Hydrocephalus was present in 9 patients (32.1%) and was prevalent among those with infratentorial lesions ($P < 0.03$).

Venous sinus occlusion was identified in 10 cases (35.7%) and sinus stenosis in 7 (25%). Normal sinus was present in 11 cases (39.3%), predominantly in those with supratentorial lesion compared with those with infratentorial and suprainfratentorial lesion (8 vs. 3 vs. 0). A statistically significant association was found only between occluded and/or stenotic sinus (vs. normal) and infratentorial site (vs. supratentorial site) ($P = 0.02$), whereas tumor location was not relevant.

Clinical Features

The most common symptom was headache (n = 19, 67.9%) but this was not related to the tumor site (Table 2). The second most frequent symptom was visual impairment (n = 11, 39.3%), usually described as a reduction in the visual field or blurred vision or associated with scotomas in some cases, a typical disturbance of supratentorial lesion.

The length of clinical history was longer for TM than for FTM (56.4 vs. 24.4 months), with a maximum of 81 months in supratentorial TM. The clinical history progressively decreased from supratentorial (54.8 months) to suprainfratentorial (43.5 months) to infratentorial meningioma (22.9 months).

Clinical status was assessed by KPS and neurologic examination. Of these 28 patients, 16 had a preoperative KPS of >70 (57.1%) and 12 had a KPS of ≤70 (42.9%). The score was worse for those with FTM (11/16 with KPS ≤70; $P = 0.002$) or supratentorial lesions (9/12; $P = 0.006$) compared with their counterparts. The clinical burden, measured by the number of symptoms or the number of neurologic signs per patient, gave consistent results: the ratio was highest for supratentorial FTM.

Preoperative neurologic signs are reported in Table 3. The most common sign was ataxia, (n = 12, 42.9%), which represented the most frequently recorded neurologic sign and hallmark of infratentorial lesion. Cognitive impairment, which usually accompanies intracranial hypertension, and hemianopia were recorded in 9 patients (32.1%) each and were prevalent in FTM and in those with supratentorial and suprainfratentorial lesion. The preoperative neurologic examination result was normal in 4 patients (14.3% of total: 3 TM and 1 FTM).

Surgical Treatment

The single most frequent surgical approach for MTM was the median suboccipital approach (n = 11, 39.3%), performed in all patients with infratentorial lesion (Table 4). Occipital and parieto-occipital approaches were performed in 12 patients (42.8%) for removal of 11/12 supratentorial lesions and for 1/5 supra-infratentorial lesions. A combined occipitosuboccipital approach was performed in 5 patients (17.9%): in 4/5 suprainfratentorial and in 1/12 supratentorial lesions.

Regarding patient positioning during surgery, a semisitting position was selected for 22 patients (78.6%). This position was chosen for treating all infratentorial lesions (n = 11) and for 8/12 supratentorial and 3/5 suprainfratentorial lesions. The park-bench position was used in 5 patients (17.9%): 3 with supratentorial and 2 with suprainfratentorial lesion. The prone position was used in only 1 patient (3.6%), who had a supratentorial lesion.

The extent of tumor removal was classified according to Simpson resection grade, total (grade I–II) or subtotal (grade III–IV), as determined by postoperative MRI. Total removal with removal/coagulation of the dural attachment was obtained in 13 patients (46.4%), whereas removal without coagulation of the dural attachment or with residual mass was obtained in 15 (53.6%) (Figures 3 and 4).

To determine surgical limitations, we investigated the relation between extent of tumor removal and state of the sinuses, tumor site, and size (Tables 5 and 6). We observed a favorable trend

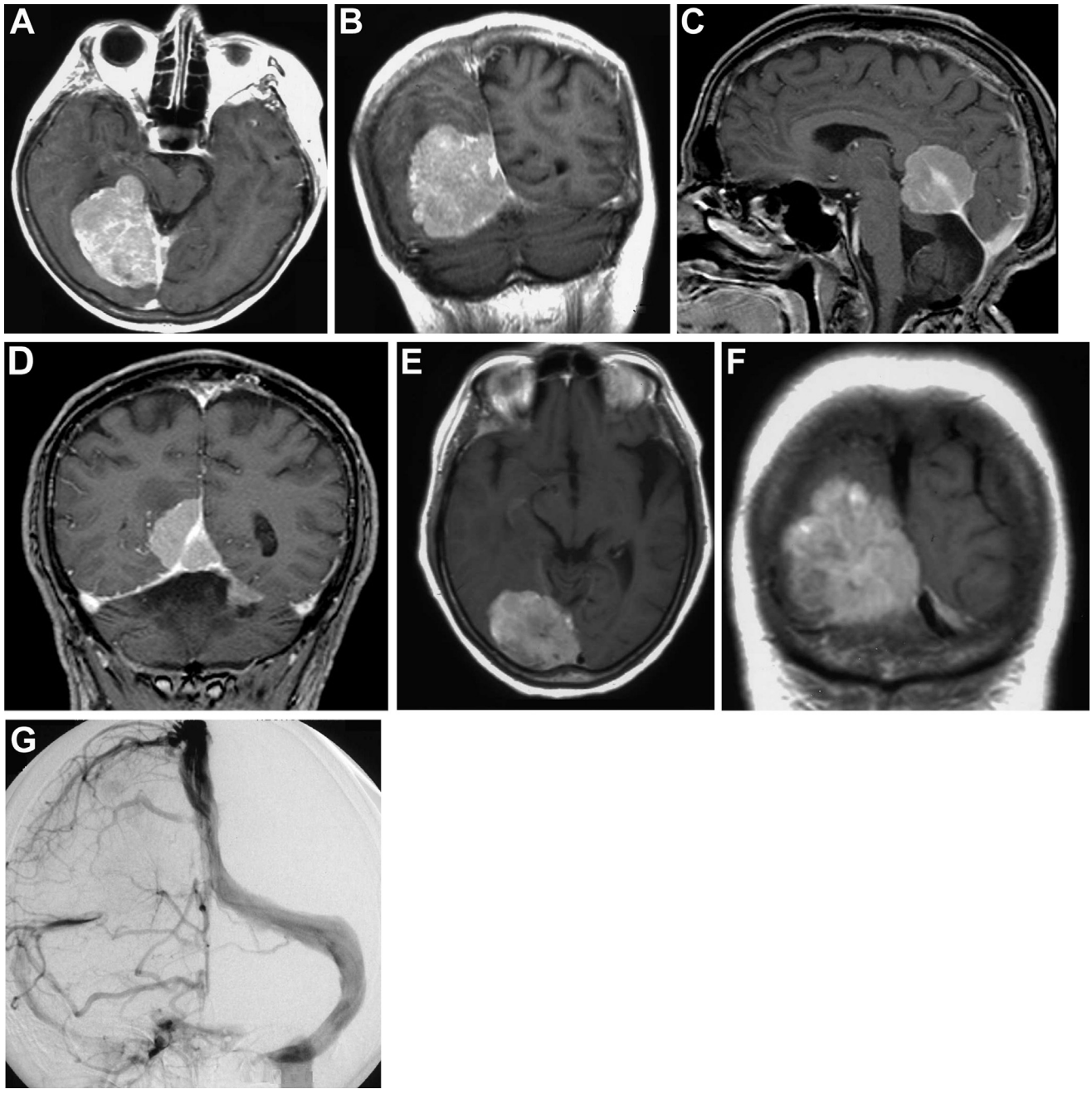

Figure 2. Exemplifying medial tentorial meningioma. Case 1. Falcotentorial meningioma. Magnetic resonance (MR) T_1-weighted images with contrast enhancement in axial (**A**) and coronal (**B**) views showing a large left supratentorial meningioma filling the dihedral angle between the falx and the tentorium, sparing the confluence of the sinuses. Case 2. Falcotentorial meningioma. MR T_1-weighted images with contrast enhancement in sagittal (**C**) and coronal (**D**) views showing a right suprainfratentorial meningioma with a portion of tumor in the context of the tentorium. Case 3. Torcular meningioma. MR T_1-weighted images with contrast enhancement in axial (**E**) and coronal (**F**) views showing a left supratentorial torcular meningioma. Venous angiography (**G**) showing a lack of visualization of the left lateral sinus and scarce filling of the superior sagittal sinus.

between total tumor removal and infratentorial FTM and suprainfratentorial TM and between subtotal tumor removal and suprainfratentorial FTM.

All 8 patients with subtotal removal (Simpson grade IV) underwent stereotactic radiosurgery (SRS) with Gamma Knife (Elekta, Stockholm, Sweden) treatment on the residue. The time

Table 2. Medial Tentorium Meningiomas: Symptoms

	Falcotentorial				Torcular			
	S (n = 10)	I (n= 3)	S-I (n = 3)	Total (%) (n = 16)	S (n = 2)	I (n = 8)	S-I (n = 2)	Total (%) (n = 12)
Headache	5	3	3	11 (68.7)	1	6	1	8 (66.7)
Visual impairment	6	0	1	7 (43.7)	2	1	1	4 (33.3)
Vertigo and gait disturbance	3	3	1	7 (43.7)	0	3	0	3 (25)
Confusion	6	0	0	6 (37.5)	1	0	0	1 (8.3)
Others	4	0	1	5 (31.2)	0	2	0	2 (16.7)
Asymptomatic	—	—	—	—	0	1	0	1 (8.3)
Symptomatic	10	3	3	16 (100)	2	7	2	11 (91.7)
Symptoms/patient	2.5	2	1.7	2.2	1.7	1.5	1.7	1.6
Clinical History (months)	28.7	8.5	36	24.4	81	37.2	51	56.4
Karnofsky Performance Status								
>70	2	3	0	5 (31.2)	1	8	2	11 (91.7)
≤70	8	0	3	11 (68.8)	1	0	0	1 (8.3)

S, supratentorial; I, infratentorial; S-I, suprainfratentorial.

between surgery and Gamma Knife treatment was, on average, 21.8 months (range, 5–80 months).

Postoperative Outcome

The postoperative course was unremarkable in most patients (Table 7). Of 28 patients operated on, 1 patient with suprainfratentorial FTM (3.6%) died on postoperative day 12 because of intractable cerebral edema. Neurologic complications were recorded in 2 patients (7.1%): 1 patient developed tetraparesis and 1 had IV cranial nerve deficit. Both had supratentorial FTM. Ocular motility deficit resolved within a few weeks, whereas tetraparesis improved but did not resolve completely.

Local complications occurred in 6 patients (21.4%): 2 developed tumor bed hematoma requiring evacuation after removal of supratentorial FTM, 2 developed cerebrospinal fluid (CSF) fistulae requiring surgical wound repair after removal of infratentorial TM, and 1 developed hydrocephalus requiring ventriculoperitoneal shunt placement. Surgical wound infection was recorded in 1 patient and resolved with antibiotic therapy.

Two systemic complications occurred in the same patient operated on for a supratentorial FTM: respiratory failure required placement of a tracheostomy and severe pleural effusion occurred in the immediate postoperative period. The patient was still wearing the tracheotomy tube at the 12-month follow-up visit.

Table 3. Medial Tentorium Meningiomas: Neurologic Signs

	Falcotentorial				Torcular			
	S (n = 10)	I (n = 3)	S-I (n = 3)	Total (%) (n = 16)	S (n= 2)	I (n = 8)	S-I (n = 2)	Total (%) (n = 12)
Cognitive impairment	6	1	2	9 (56.2)	—	—	—	—
Ataxia	3	3	2	8 (50)	0	3	1	4 (33.3)
Hemianopsia	6	0	1	7 (43.7)	1	0	1	2 (16.7)
Hemiparesis	2	1	1	4 (25)	—	—	—	—
Papilledema	—	—	—	—	0	3	0	3 (25)
Others	4	0	0	4 (25)	0	1	0	1 (8.3)
Signs/patient	2.3	1.7	2	1.9	0.5	1.2	1	1.1
No deficit	1	0	0	1 (6.2)	1	2	0	3 (25)

S, supratentorial; I, infratentorial; S-I, suprainfratentorial.

Table 4. Medial Tentorium Meningiomas: Surgical Approaches and Positioning

	Falcotentorial			Torcular			
	S (n = 10)	I (n = 3)	S-I (n = 3)	S (n = 2)	I (n = 8)	S-I (n= 2)	Total (%) (n = 28)
Approach							
Occipital	5	0	0	1	0	0	6 (21.4)
Parieto-occipital	4	0	1	1	0	0	6 (21.4)
Occipitosuboccipital	1	0	2	0	0	2	5 (17.9)
Suboccipital	0	3	0	0	8	0	11 (39.3)
Position							
Prone	1	0	0	0	0	0	1 (3.6)
Park-bench	1	0	1	2	0	1	5 (17.9)
Semisitting	8	3	2	0	8	1	22 (78.6)

S, supratentorial; I, Infratentorial; S-I, suprainfratentorial.

At 12 months after surgery, headache had resolved in all cases; this was interpreted as intracranial hypertension that resolved with tumor removal.

Regarding the group of supratentorial lesions (12 patients), visual disturbances (8 patients) improved in 3 and remained stable in the 5 others; hemianopia (7 patients) improved in 2 and the visual field remained stable in the remaining 5; mental confusion and slowing and balance disturbances recovered. In the 11 patients with an infratentorial lesion, clinical progress at follow-up was less positive. Equilibrium and gait disorders associated with ataxia improved in only one third of patients (2/6). Among the 4 remaining patients with suprainfratentorial lesions, except for the headache symptoms that resolved in all 3 patients and the gait disorders that improved in 1 patient, the symptoms remained stable at 12 months after surgery.

The average duration of follow-up was 57.6 months; 6/28 patients (21.4%) were lost to follow-up. At 12 months follow-up, 18 of 22 (81.8%) patients had KPS >70; the proportion of those with supratentorial tumor improved from 25% (3/12) to 70% (7/10), whereas those with infratentorial tumor decreased from 100% (11/11) to 77.8% (7/9). This trend shows that clinical progression during the postoperative period is better in supratentorial than infratentorial lesions.

Only 2 recurrences were recorded: one was a partially resected infratentorial TM (Simpson grade IV) that subsequently underwent SRS; the other was a completely removed supra-infratentorial TM (Simpson grade I) that recurred 18 months after the first operation. Histology showed evidence of atypical meningiomas (G2) in both patients. As mentioned earlier, only 1 of the 8 patients treated with SRS relapsed and required new surgery.

DISCUSSION

We present the largest series of FTM, and TMs have not previously been described as an individual entity.[12,13,17-22]

Clinical and Radiologic Features

We observed a higher female prevalence (64.3%) and mean age (59.8 years) in line with the epidemiology of meningiomas. FTM (n = 16) was more prevalent than was TM (n = 12) and the supratentorial site was nearly as often involved as the infratentorial site (12 vs. 11), with differences in position (lateralized in the former and median in the latter). Both types of extension indicating advanced tumor growth (60 mm) were present in several cases (n = 5). This series is characterized by large tumor size, significantly larger in supratentorial than infratentorial (56.8 vs. 41 mm) location and in FTM than in TM (54.3 vs. 49.6 mm). This trend matches the prevalence of severe edema (66.7%) in both supratentorial cases, as previously observed for lateral tumors.[2]

Regarding venous sinus involvement, which typically accompanies MTM, stenotic and/or occluded sinuses (straight sinus or torcular) were noted in 60.7% of cases and were more prevalent in infratentorial tumors, regardless of position (falcotentorial vs. torcular), size, and edema, as previously observed for lateral tumors.[2]

Its limitations of sensitivity and interpretation (occlusion vs. compression) notwithstanding, angiography remains a fundamental imaging tool to gain information about sinuses and collateral circulation.[2,12,18,19,23] Knowledge of arterial feeders is less important (meningeal branches or arteries coming from the medial or lateral posterior choroidal arteries or from the posterior cerebral arteries), because they are coagulated around the tumor mass and the approach is always posterior to the tumor, although the supply from the artery of Bernasconi and Cassinari may be useful because they come from the opposite side.[12]

The length of clinical history of supratentorial and TM was double that of infratentorial and FTM and headache was the most common presenting symptom (67.9%) irrespective of tumor position, followed by visual and gait disturbances, prevalent in supratentorial and infratentorial tumors, respectively, as reported by most investigators, whereas ataxia was the main neurologic sign (42.9%), as prevalent in TM as hemianopia (32.1%) is in FTM.[12,13,19,24,25] The overall clinical

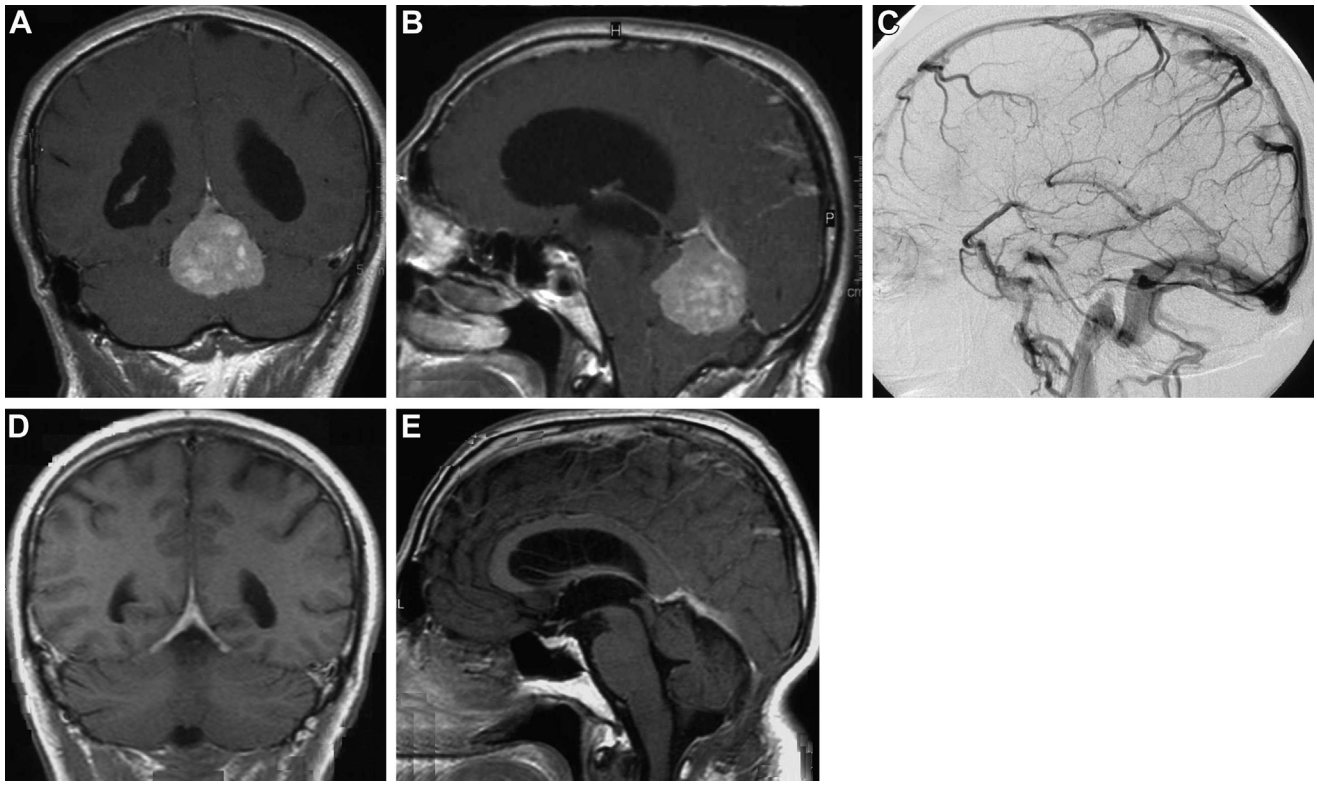

Figure 3. Falcotentorial meningioma. Preoperative infratentorial tumor on magnetic resonance T_1-weighted images with contrast enhancement in coronal (**A**) and sagittal views (**B**). Note the infiltration of the straight sinus, which corresponds to the sinus occlusion on venous angiography (**C**). Postoperative coronal (**D**) and sagittal (**E**) views showing Simpson grade II removal.

burden, as measured by symptoms and signs and KPS, was significantly higher for patients with supratentorial tumors, different from lateral tumors, and for FTM.[2]

Surgical Treatment

In this series, the semisitting position was used early, which explains why it was adopted not only for the infratentorial approaches but also for most of the supratentorial approaches. Given that hemianopia is a possible complication, we prefer to place patients in the park-bench position for approaching supratentorial tumors, so as to obtain optimal brain relaxation and minimize the risk of occipital damage.[26] If intracranial hypertension is present, a parieto-occipital corridor is preferred, at least at the beginning of the operation.

In our experience, total tumor removal accounted for 46.4% of cases (50% for FTM and 41.7% for TM). The remainder were not significantly associated with tumor size, venous sinus invasion, and tumor position. However, 2 types of tumors were at risk: TM with stenotic sinus and suprainfratentorial FTM (the first because of incomplete occlusion at the confluence of the sinuses, a complex vascular area which, on the contrary, may be removed when it is completely occluded by the tumor and carries a good prognosis; the second because of the large, probably inadequately approached, area of infiltration). Bilateral occipital and/or suprainfratentorial approaches with additional falx and/or tentorium division carry the risk of brain injury and derangement of venous drainage.[21,27] Wide craniotomy with multiple corridors has been advocated to circumscribe the tumor, bearing in mind both the risk of cortical blindness (direct injury) and the unpredictable event of venous infarction and brain edema caused by cutting the tentorium, with presumed division of the venous collateral flow in cases of tumor invasion of the straight sinus (indirect injury).[1,2,9,28,29]

Asari et al.[12] reported a different angiographic pattern of venous collateral circles, including type 4 (cerebellar veins to straight or transverse sinus) and type 5 (anastomosis through the inferior sagittal sinus), which may interfere with tentorium and falx incision. Other investigators have reported finding venous channels in the duplicature of the tentorium without angiographic evidence.[2,28] Tentorial sinus and superior sagittal sinus, whether duplicated or split into 1 separate supply vessel into each of the transverse sinuses, are an additional anatomic variation to investigate.[1,30,31] We agree with Ki Hong et al.[20] that multiple corridors may be safely pursued, giving priority to patient positioning and CSF drainage before enlarging the approach with falx and/or tentorium division, especially in invasive falcotentorial tumors. Moreover, aggressive surgery with sinus reconstruction is not advised for treating straight and torcular sinuses.[23,32]

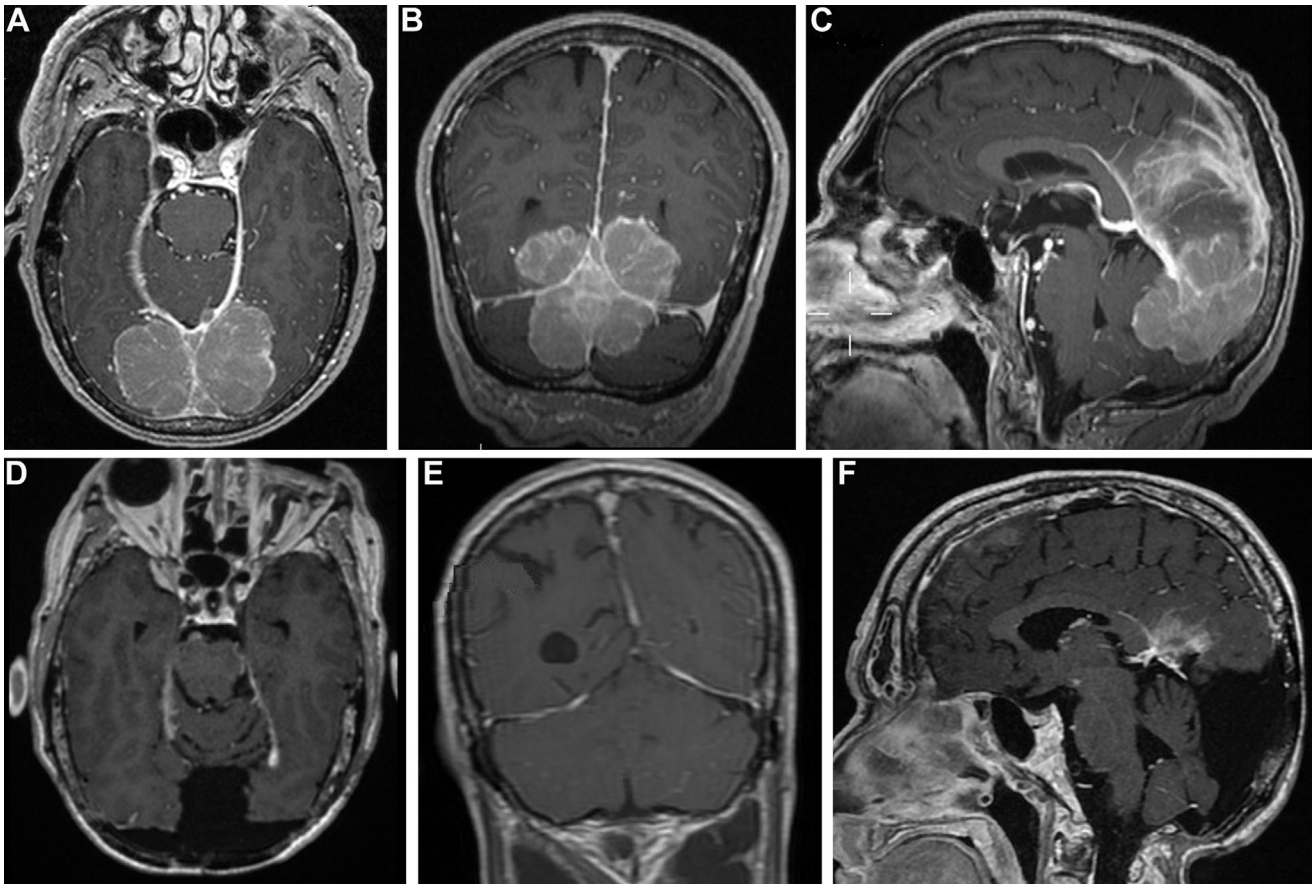

Figure 4. Torcular meningioma. Preoperative suprainfratentorial quatrefoil-like tumor on magnetic resonance T_1-weighted images with contrast enhancement in axial (**A**), coronal (**B**), and sagittal views (**C**). Corresponding postoperative views (**D**–**F**) showing Simpson grade I removal.

Clinical Outcome

The operative morbidity and mortality of tentorial meningiomas has declined steadily over the years, from 20%–29% in the 1950s and 1960s to 7%–10% in the 1980s and 1990s.[1,7,24,28,33-35] A similar trend for MTM can be noted, although functional data are hampered by the lack of a uniform reporting method. In general, MTM do worse than lateral ones, especially as a result of FTM.[6,7,9,28,35] Among tentorial meningiomas, these tumors have the worst oncologic and clinical outcomes in our experience.[2,14] Regarding clinical outcome, 1 perioperative death (3.6%) occurred, and neurologic (7.1%), local (21.4%), and systemic (3.6%) complication rates were low. In only 1 case were they permanent (tetraparesis caused by brainstem compression). Compared with the literature, this rate is remarkably low. Since the 1990s, neurologic complications in FTM have increased to 100% in the acute phase as a result of visual disturbances, starting

Table 5. Falcotentorial Meningiomas: Quality of Surgical Removal and Related Factors

		Location			Size (mm)		Sinus		
Simpson Grade	Total (%)	Supratentorial (n = 10)	Infratentorial (n = 3)	Suprainfratentorial (n = 3)	≤40 (n = 5)	>40 (n= 11)	Normal (n = 7)	Stenotic (n = 5)	Occluded (n=4)
I	2 (12.5)	2	0	0	0	2	1	0	1
II	6 (37.5)	3	3	0	3	3	4	1	1
III	5 (31.2)	3	0	2	2	3	0	3	2
IV	3 (18.7)	2	0	1	0	3	2	1	0

Table 6. Torcular Meningiomas: Quality of Surgical Removal and Related Factors

		Location			Size (mm)		Sinus		
Simpson Grade	Total (%)	Supratentorial (n = 2)	Infratentorial (n = 8)	Suprainfratentorial (n = 2)	≤40 (n = 4)	>40 (n = 8)	Normal (n = 4)	Stenotic (n = 2)	Occluded (n = 6)
I	3 (25)	0	1	2	1	2	1	0	2
II	2 (16.7)	0	2	0	1	1	1	0	1
III	2 (16.7)	1	1	0	0	2	1	0	1
IV	5 (41.7)	1	4	0	2	3	1	2	2

from 23% and increasing to 23% in the follow-up period, starting from 6% for permanent visual disturbances and hemiparesis.[1,13,17,19,22,36,37] In our series, most symptoms or signs improved, except for hemianopia in supratentorial and gait ataxia in infratentorial lesions, the latter affecting the KPS score at 12 months, as was observed for lateral meningiomas.[2]

Clinical series on the surgical management of TM are lacking; however, case reports describe a common surgical strategy for treating difficult lesions in which the ominous risk of extended brain infarction guards against venous sacrifice and opts for partial tumor removal unless venous occlusion occurs.[38-40] We observed no systemic or neurologic complications. Overall, local CSF fistula and postoperative hemorrhage occurred in 2 cases each (7.1%), only in TM, which should be considered aspecific because it may occur in other extensive midline approaches and reconstructions.[1,18,34] Treatment was completed by SRS when remnants were left inside the dural sinuses. This combined treatment may be effective, because regrowth/recurrences occurred only in atypical tumors.

CONCLUSIONS

MTM include falcotentorial and torcular types, both reclassified for purposes of comparative effectiveness. FTM are lateralized and larger when supratentorial and are median and infiltrate the straight sinus when infratentorial, with considerable functional burden. Surgical treatment is limited by tumor extension, both supratentorial and infratentorial, and can be improved by careful positioning and multiple trajectories. TMs have not previously been described as an individual entity. Although symptoms are similar to the previous group, with less clinical burden, the

Table 7. Medial Tentorium Meningiomas: Complications

	Falcotentorial			Torcular			
	S (n = 10)	I (n = 3)	S-I (n = 3)	S (n = 2)	I (n = 8)	S-I (n = 2)	Total (%) (n = 28)
Local							
Hematoma	2	0	0	0	0	0	2 (7.1)
Cerebrospinal fluid fistula	0	0	0	0	2	0	2 (7.1)
Wound infection	0	0	0	0	0	1	1 (3.6)
Hydrocephalus (ventriculoperitoneal shunt)	1	0	0	0	0	0	1 (3.6)
Total	3	0	0	0	2	1	6 (21.4)
Systemic							
Pleural effusion	1	0	0	0	0	0	1 (3.6)
Tracheostomy	1	0	0	0	0	0	1 (3.6)
Total*	1	0	0	0	0	0	1 (3.6)
Neurologic							
Tetraparesis	1	0	0	0	0	0	1 (3.6)
Cranial nerve deficit	1	0	0	0	0	0	1 (3.6)
Total	2	0	0	0	0	0	2 (7.1)

S, supratentorial; I, infratentorial; S-I, suprainfratentorial.
*One single patient had both systemic complications.

superficial location and the peculiar vascular involvement simplify the surgical strategy, which depends on the extent of sinus infiltration. Total removal accounted for half of the cases in both groups, whereas FTM was associated with worse postoperative complications.

With this study, we conclude the trilogy on tentorial meningiomas classified into lateral, medial, and incisural, each including 2 groups based on topography, clinical burden, surgical approaches, outcome, and technical challenges. Potential alternative grouping supports the validity of our methodological approach that recognizes 6 tumor subgroups of tentorial meningiomas (posterolateral, intermediate, anterolateral incisural, posteromedian incisural, falcotentorial, and torcular), which can be further subdivided into supratentorial and infratentorial. These groups may be rearranged by prioritizing one over other criteria. Topographic and surgical approaches may favor a 2-tiered classification (medial and lateral), whereas the criterion of technical challenge may consider sinus involvement, dividing the tumors into groups with or without sinus invasion, or it may consider tumor depth, dividing the tumors into incisural, intermediate, and posterior. Alternative groupings by different criteria can be made for purposes of comparison, maintaining the 6-subgroup criteria.

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