Management of High Convexity, Parasagittal and Falcine Meningiomas

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ABSTRACT

Background: Neurosurgery has witnessed steady change in both technological capacity and in conceptualization of certain diseases. High convexity and falco/parasagittal Meningiomas are good examples of this change. Objectives: We aimed to analyze 25 consecutive cases of high convexity, parasagittal and falcine meningiomas with respect to surgical technique, image-guidance, complication rate, and pathological factors leading to recurrence in this particular midline location. Patients and Methods: We retrospectively reviewed 25 cases of closely related meningiomas by location operated by the first author over 6 years in two centers in KSA between 2007 and 2013. The median follow-up time was 29.7 months (range, 12–42 Ms). Results: High convexity and falco/parasagittal meningiomas represented 30 % of all meningiomas operated by the first author. Median age was 58.8 years (range, 48–72 yr), there was a female: male ratio of 1.8:1(16 female and 9 male). Image guided surgery was used on 10 cases (40%) operated at the second center (2010-2013). 8 cases (32%) presented with preoperative neurological deficit showed improvement during the postoperative follow up period. The incidence of new neurological deficits was 8% (2 cases), No permanent deficit and the overall complication rate was 16% (4 cases). The 30-day mortality rate was one case (4%). The pathology of the tumors was benign in 21 (84%), atypical in 4 (16%), and no cases diagnosed as anaplastic/malignant. In 3/21 cases designated “benign, ”there were borderline atypical features with Ki-67 LI more than 5%. No cases of recurrence within the follow –up period for purely benign meningioma (72%). We reported two cases of recurrence (8%), one case of falce benign meningioma (Grade I) with features of atypia and another case of atypical parasagittal meningioma (Grade II) recurred in 39 months and 21 months respectively. Both were sent to radiosurgery. Conclusion: High convexity, parasagittal and falcine meningiomas can be safely removed using modern image guided surgical techniques with acceptable operative morbidity and mortality. The conservative surgical approach with saving the sinus and the major veins with adjuvant radiation therapy for the misbehaving residual has a very satisfactory long-term effect. The real behavior of the borderline tumors (Grade I with atypia) needs more cases, deep research and long term follow up.

INTRODUCTION

In 1938, Cushing and Eisenhardt stated that “...it is apparent that sub-varieties of the meningiomas, because of their differences in behavior, would have to be distinguished.” Since then, it has been well established that the chance of meningioma recurrence is dependent on both the extent of resection and the biological aggressiveness of the tumor. High convexity and falco/Parasagittal meningiomas are a special subtype of meningiomas for which radical excision (Simpson Grades I and II) usually means excision of the dura/falx with safety margin, opening the superior sagittal sinus (SSS) and removing tumor from within it. On the other hand, a less aggressive surgical approach to parasagittal meningiomas usually means excision of the tumor up to the sinus wall, and the sinus was left intact. Residual tumor was followed up and treated with radiosurgery at recurrence. Meningiomas are known to recur frequently, even after complete resection. The recurrence cannot be predicted by histopathological features alone. Cell proliferation indices and hormone receptor status can be used as a guide in grading of meningioma and therefore in predicting their recurrence potential. Meningiomas with higher proliferation index and negative progesterone receptor are very likely to be atypical (grade II) or malignant (grade III) and can potentially considered to be recurrent.
Comparing recurrence rates with historical studies is problematic because of the nonstandard and changing definitions of what constitutes atypical and malignant pathological features as well as progress in imaging technology and Changes in surgical techniques, including navigation guidance.

Jääskeläinen and coworkers found a recurrence rate of 3% for completely removed benign meningiomas at 5 years, 9% at 10 years, and 21% at 25 years. The 5-year recurrence rates were significantly higher for higher-grade tumors: 38% for atypical and 78% for anaplastic. A recent review of 100 completely resected benign meningiomas by Maiuri and coworkers found that MIB-1 index, mitotic index, and progesterone receptor absence were significantly correlated with tumor recurrence.

The prognostic significance of the Ki-67 LI and other proliferation indices in meningiomas is well known. According to the current WHO grading system, meningiomas with high proliferation indices, i.e., Ki-67 LI more than 5% to10% should be classified as meningiomas with a greater likelihood of recurrence and/or aggressive behavior. Objectives:

We retrospectively reviewed a series of 25 cases of high convexity and falco/parasagittal meningiomas operated by the first author in two institutions in (KSA) over the past 6 years in a trial to understand the effect of draining veins and the superior sagittal sinus on extent of resection of these tumors, the impact of neuronavigation (second center) to maximize the resection and minimize the surgical trauma, the anatomical gray zone between the high convexity and parasagittal meningioma, the biology of gray zone between begin meningioma (Grade I) and atypical (Grade II) and the appropriate follow-up period in comparison to the extent of surgical excision and the histopathological behavior.

PATIENTS AND METHODS

This retrospective study carried out in two centers in KSA in collaboration with departments of radiology and pathology of Zagazig university hospitals (Egypt) over a period of 6 years from 2007 to 2013.

In the first center (King Abdl Aziz specialist center-Taif), the lesions topography was localized by convention with rough guidance from preoperative images, using the fixed craniometric parameters especially the coronal suture on CT scan and the central sulcus on MRI necessitating large flaps and extensive shaving. MRI/MRV can give important preoperative information about the relation of a tumor to eloquent areas and venous system especially if the location was relevant to the motor strip.

However, in the second center (Prince Salman military hospital- Tabuk), frameless stereotactic guidance was used for precise localization. We used Stealth station /S7 (the seventh generation of surgical navigation system of Medtronic) that offers both optical camera and AxiEM™ electromagnetic guidance. The optical camera can precisely track the surgical instruments in relation to the patient anatomy. This accurate image guidance has refined our technique to minimal shaving, linear incisions, and small Craniotomies. These changes minimized patient morbidity, wound healing time, hospital stay and cosmetic disruption. Moreover, Intraoperative imaging may provide important information about possible residual tumor on the preregistered image on the neuronavigation workstation and about its relation to the sinus and the motor area draining veins.

The aim of every operation was to achieve complete macroscopic resection of the tumor, including the dura/falx attachments and any involved surrounding bony structures. This usually necessitated taking a margin of dura/falx of approximately 5 mm surrounding the tumor. Occasionally, a Simpson Grade I resection was not possible because of dural attachments around the sinuses or draining venous channels, in such case a Grade II resection (aggressive coagulation of the dura/falx) was achieved.

The approach and positioning were chosen on the basis of the segment of the superior sagittal sinus (SSS) or the falx involved. Patients with tumors involving the anterior third of the SSS/Falx were positioned supine with the head flexed. Patients with tumors involving the middle third were positioned supine with the head turned to the side of the tumor so that gravity causes the brain to shift from the tumor. This eliminates the need for brain retraction. Patients with tumors involving the posterior third were positioned prone.

A craniotomy was done with high speed Midas Rex craniotome (Medtronic Midas Rex) in two stages. The first stage was to elevate a bone flap on the side of the tumor approximately 1 cm away from the SSS, and in the second stage the dura overlying the SSS was separated from the bone, and a second bone flap was elevated, which ended immediately across the SSS on the contralateral side. The dura was opened over the tumor with careful brain retraction to go to the falx attachment and more attention to the overlying stretched veins.

The strategy was to coagulate the dural blood supply, internally decompress the tumor by the ultrasonic surgical aspirator of (Elekta surgical instruments Hampshire, UK), and then carefully dissect the margin from the surrounding brain circumferentially. The surgeon should pay careful attention to the arachnoid plane to avoid injury to the brain especially in the large tumors where the arachnoidal plane may be violated. Therefore, the dissection should be more careful at the tumor-brain interface to make sure that no residual tumor was left.
behind and to achieve proper hemostasis. Excessive cautery with bipolar loop (irrigator supported Codman Mmis bipolar) was used for the bloody and calcified resectable tentorial meningioma. Surprisingly, the follow up contrast-MRI showed remarkable necrosis in two cases of falcotentorial meningioma in this series. No attempt was made to open or reconstruct the SSS. We preferred the conservative surgical approach taking into consideration the possibility of adjuvant radiation therapy in attempt to maximize the functional outcome.

For the falcine meningiomas, the dura should be opened on the side of the non-dominant hemisphere or the side of the larger component of a dumbbell-shaped tumor. The dural incision should be continued to the lateral portion of the superior sagittal sinus. Before internally decompressing the tumor, the anterior and posterior margins of the falx, preferably at least 5-10 mm margin from the tumor edge should be divided from superior to inferior in order to interrupt the falce arteries and sinuses. Once the major portion of tumor has been removed and dissected from the medial aspect of the hemisphere as usual, an incision of the falx just under the superior sagittal sinus can be made to expose the contralateral hemisphere. The unilateral approach is appropriate for the small tumors; however, larger lesions usually necessitate another approach to the contralateral hemisphere.

For closure, the dura is always closed as watertight as possible with a pericranial graft (5/15 cases) or Codman dural patch (duraform) (10/15 cases) were operated at the first center. Codman dural patch does not carry risk of infection. At the second center, 10 cases were closed with Codman dural patch supported with Glubran-2 (Italy) at its margins for sealing. The bone flap was generally replaced, and titanium mesh cranioplasty was performed if there was any suspicious of tumor invasion. 12/25 (48%) necessitated removal of bone flap and the resulting defect was covered with titanium mesh. All Operations were performed through standard craniotomies using microsurgical techniques in all cases. Routine antibiotics, dexamethasone, antiseizure prophylaxis, and diuretics were used.

Postoperatively, the patient was cared for in intensive care unit followed by postoperative CT on the following day before returning to the ward. Postoperative MRI with gadolinium within 4-6 weeks following criteria: Ki-67 LI >5%, Simpson Grade II resection or starting radiological misbehaving. One case of atypical parasagittal with considerable residual in direct relation to the sinus and major draining vein over the motor strip and the other was falco-tentorial (benign with atypia) with deep residual portion in relation to the major venous system. Both were sent to radiosurgery upon start radiological misbehaving on the follow-up contrast-MRI. Close observation with 6-month MRI with gadolinium for 4 cases of histopathological grade I with Simpson II-III excision.

RESULTS

Of the total 83 patients with meningiomas were operated by the first author, 6 cases (24%) had high convexity tumors, 10 cases (40%) of Parasagittal and 9 cases (36%) of falcine meningioma. The median age at diagnosis was 58.8 years (range, 48–72yr). There were 16 women (64%) and 9 men (36%), giving a female: male ratio of 1.8:1. The majority of tumors were found in relation to the frontal lobe 14 cases (56%), followed by the parietal 7 cases (28%) and occipital lobes 4 cases (16%). There were 12 left-sided and 13 right-sided tumors.

The median tumor diameter was 4.2 cm (range, 1–8 cm). The presenting complaints; Headache was, by far, the most common symptom, followed by seizures and hemiparesis. 9/25 (36%) patients were asymptomatic; their tumors were found incidentally on imaging. The most common reasons for surveillance scans were multiple injuries or mets survey. Twenty seven operations were performed in this series of patients (Two extra operations, one for residual and another for postoperative hematomata). Simpson Grade I resections were achieved in 18 cases (72%), Simpson II in 5 cases (20%) and Simpson III in 2 cases (8%). Ten cases (40%) were done using the image-guided frameless stereotactic navigation system. This particular system (in the second center) the Stealth station/S7 system has become standard on this particular midline region with its relation to the draining veins and the superior sagittal sinus. However, one case showed...
significant residual (in postoperative CT) necessitated re-surgery.

In our series, anterior third of the SSS was involved in 2 cases (8%) of tumors, the middle third in 4 cases (16%), and the posterior third in one case (4%). For 10 patients with parasagittal meningioma, one patient showed 5 mm residual tumor on postoperative imaging, and that had tumor progression and sent to Stereotactic radiosurgery. In 9 falcine meningiomas, there was 7 mm of contralateral falcine meningioma resting on the tentorium and the major venous system that sent to radiosurgery upon radiological misbehaving. The all 6 cases of high convexity meningiomas were completely resected. In 10 cases of parasagittal meningioma, we achieved Simpson I for 7 cases and Simpson II for 3 cases. In 9 cases of falcine meningioma, we achieved Simpson I for 5 cases (2 of them had contralateral significant mass). The falx was crossed and the contralateral portion was completely taken out. Simpson II and III for 4 cases, 2 of them with large contralateral portion and the rest (2 cases) had significant veins on both sides of the falx.

In our series, 6 out of 8 cases with preoperative deficit showed improvement during the postoperative follow up period. Two cases (8%) had postoperative hemiparesis and mild cognitive deficit that responded to the physiotherapy and psychotherapy. No permanent deficit and the overall complication rate was 16% (4 cases). The 30-day mortality rate was 4% (One case of 71-year old male died of severe chest infection and heart failure). The average length of hospital stay has decreased from 7 days in the first center to 5.5 days in the second center. The overall rate of infection was nil.

The pathology of the tumors was benign (grade I) in 21 cases (84%), atypical (grade II) in 4 cases (16%) with Ki 67 LI was >5% and the mitotic index > 4 per 10 high-power fields and no anaplastic cases. In three cases of grade I the pathology was reported as benign but with “borderline atypical” features, though Ki 67 LI was >5% but the mitotic index was <4 per 10 high-power fields. The median follow-up time was 29.7 months, with a maximum of 42 months. Thirteen patients (52%) were followed for 30 months or more.

There were two recurrent cases (Simpson II) within the male group in our series, making the overall recurrence rate during the follow-up period 2/25 (8%). One case of falcine benign with features of atypia and one case of parasagittal atypical meningioma recurred in 39 months and 21 months respectively (8%). Both had lack of calcification with Ki 67 LI >5% and the mitotic index was less than 4 per 10 HPF in the first case and more than 4 per 10 HPF in the second case.

Table I: The radiological findings in our series (25 cases)

<table>
<thead>
<tr>
<th>Radiological Finding</th>
<th>No.</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Location</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Convexity</td>
<td>6</td>
<td>24%</td>
</tr>
<tr>
<td>Parasagittal</td>
<td>10</td>
<td>40%</td>
</tr>
<tr>
<td>Falcine</td>
<td>9</td>
<td>36%</td>
</tr>
<tr>
<td>Vasogenic edema</td>
<td></td>
<td></td>
</tr>
<tr>
<td>GI</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>GII</td>
<td>10</td>
<td>40%</td>
</tr>
<tr>
<td>GIII</td>
<td>6</td>
<td>24%</td>
</tr>
<tr>
<td>GIV</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>SSS Involved</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Anterior third</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>Middle third</td>
<td>4</td>
<td>16%</td>
</tr>
<tr>
<td>Posterior third</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>Haemorrhage</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>Brain invasion</td>
<td>2</td>
<td>8%</td>
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</tbody>
</table>

Table II: Classification of the cases according to Simpson grading

<table>
<thead>
<tr>
<th>Classification according to Simpson convexity</th>
<th>Parasagittal</th>
<th>Falcine</th>
</tr>
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<tbody>
<tr>
<td>Grade I</td>
<td>6</td>
<td>7</td>
</tr>
<tr>
<td>Grade II</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>Grade III</td>
<td>0</td>
<td>0</td>
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Table III: Histopathological classification of the cases

<table>
<thead>
<tr>
<th>Histopathological grading</th>
<th>Convexity</th>
<th>Parasagittal</th>
<th>Falcine</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grade I</td>
<td>6</td>
<td>10</td>
<td>9</td>
</tr>
<tr>
<td>Grade I + Atypia</td>
<td>1</td>
<td>1</td>
<td>1/7mm/39M(1)</td>
</tr>
<tr>
<td>Grade II</td>
<td>1</td>
<td>1/5mm/21M(2)</td>
<td>2</td>
</tr>
</tbody>
</table>

1-One patient with 7 mm of contralateral falcine meningioma resting on the tentorium and the major venous system was sent to radiosurgery upon radiological misbehaving after 39 months.

2-Another patient with parasagittal meningioma showed 5 mm residual tumor on postoperative imaging, and tumor progression after 21 months and sent to Stereotactic radiosurgery.

**Fig. 1a:** Coronal MRI T1 WI post-contrast shows the extra-axial right frontal parasagittal mass showing intense enhancement and involving SSS.

**Fig. 1b:** Early postoperative axial Flair MRI shows the tumor bed after tumor resection with residual edema and postoperative reaction.

**Fig. 1c:** A mitotic figure can be seen at the center of the field. (H&E x400)

**Fig. 1d:** Ki67 (proliferation marker) positivity, seen as positive nuclear staining. High Ki67 LI (15%) (Immunohistochemistry x 200)
Fig. 1e: Low power view: Geographic area of spontaneous necrosis surrounded by viable tumor tissue and mononuclear inflammatory cells (arrows) (H&E x 200)

Fig. 1f: Strong progesterone receptor immunoactivity seen as positive nuclear staining. (IHCx400)

Fig. 2a: Axial CT examination without contrast shows extra-axial left SOL extending through the mid line to other side, the lesion surrounded by moderate perifocal edema and fresh blood exerting mass effect on the left lateral ventricle and mid line shift.

Fig. 2b: Axial MRI T2 WI shows the extra-axial left frontal lobulated falcine lesion. It shows slightly hyperintense signal and extensive perifocal edema. There is mass effect on the left lateral ventricle and mid line shift.

Fig. 2c: Postoperative axial CT examination shows area of hyperdensity at tumor bed (surgical pad coated with fresh blood) with small left frontal epidural hematoma, the tumor bed appear hypodense due to residual edema, the mass effect still present in this early post operative image.

Fig. 2d: Intraparenchymal codman microsensor inserted at the operative side for continuous ICP monitoring.
Fig. 2e: Postoperative axial CT examination (after a week), there is residual area of postoperative reaction at left frontal lobe; the mass effect has disappeared in this image comparing it with the early postoperative film.

Fig. 3a: Coronal MRI T2 WI showing right extra-axial high convexity/parasagittal slightly hyperintense SOL with related mild perifocal edema, the lesion exerts mass effect on the frontal horn of right lateral ventricle.

Fig. 3b: MRV of the same patient showing an indentation on the right aspect of the mid SSS without invasion.

Fig. 3c: Intraoperative neuronavigation with Stealth station /S7 (Medtronic) for localization.

Fig. 3d: Intraoperative imaging of radiologically diagnosed parasagittal meningioma that was in direct relation to the middle SSS and the major draining veins of the motor strip. However, this mass was completely excised (Simpson I) with saving the venous system. This mass was reclassified as high convexity rather than parasagittal meningioma.
Fig. 3e: Postoperative axial plain CT examination showed mild scattered subarachnoid and falxine hematoma with pneumocephaly.

**DISCUSSION**

In this article we did stress on specific location of meningioma (high convexity and falco/parasagittal) and we focused on some imperative points: Time of surgery, the best surgical technique assisted by neuronavigation to improve the outcome, the surgical versus the radiological definition of high convexity and parasagittal meningioma, the biological behavior of the gray zone between benign meningioma (Grade I) and atypical meningioma (Grade II) and what is the appropriate follow up period in respect the pathological grade and extent of the resection?

Because almost one-third of these tumors are now discovered as an incidental finding on magnetic resonance imaging (MRI) or computed tomography. Our policy was to observe patients older than age 60y with a tumor less than one inch in the maximum diameter, no vasogenic edema, and seizure-free or medically controlled patients who cannot withstand major surgery. For the radiation therapy supporters, we do not believe the role of radiosurgery or radiotherapy as a primary treatment for any brain mass for which histology is not established. In a patient younger than age 60, we were guided by the relation of the tumor to the venous system, the patient general condition and the patient wish.

One drawback of this approach, however, is that Grades II and III lesions can be missed, with the subsequent delay in surgery making decision the operative risk higher and possibly affecting the long-term outcome. The observation period may also allow the tumor to progress to a higher grade. Therefore, in the second center where too many facilities there, we had to adopt an increasingly early intervention.

Yano and Kuratsu stated that 37% of meningiomas showed growth on imaging during a period of observation of 3.9 years. In this series, we operated on 9/25 (36%) asymptomatic patients refused the surgery at the beginning and they were kept on 6 months contrast-MRI follow up. They showed radiological misbehaving between 26-40 months. Two of them had seizures during the observation time. Black and coworkers reported 28.2% of parasagittal tumors were asymptomatic and eventually had surgery.

The results of Yano and Kuratsu suggest that there is an approximately 1.6% chance per year (6.4% over 4 yr) of a meningioma becoming symptomatic. Taking into consideration that the operative morbidity is less than 6% for these lesions, this would seem to favor removing the lesion while it is still small, before it has a chance to become symptomatic. Extrapolating from the results of Yano and his colleagues, that a healthy 60-year-old person who might be expected to live another 20 years, there would be a 28% chance of this lesion becoming symptomatic in their remaining lifetime. Similarly, there would be an 86% risk of tumor growth in this time period. Noting that the operative morbidity is in the range of 4 to 10%,

High convexities and falco/parasagittal meningiomas are special subtypes of meningiomas for which radical excision usually means 5mm safety margin of dura/falx excision, crossing the falx to the contralateral side and opening the superior sagittal sinus (SSS) and removing tumor from within it. This has been a common practice when the sinus is totally occluded and far frontal taking into consideration complete saving the collateral veins that carefully studied in the preoperative venogram. However, if the sinus is only partially occluded, sinus repair and venous grafting when necessary.

Such radical approaches, although leading to a lower rate of recurrence, are more complicated and increase the risk of hemorrhage, superior sagittal sinus compromise, or venous infarction leading to brain
edema and neurological deterioration. This approach has been questioned in recent years, especially with reports of radiosurgery as a primary or adjunct treatment for this group of meningiomas.13 In our series, we proposed a less aggressive surgical approach. Tumor was resected up to the sinus wall, and the sinus was left intact except two cases with totally occluded sinus and the mass was far frontal (Fig. 1a). Residual tumor within sinus was followed up and treated with radiosurgery/radiation therapy at recurrence. Although this approach led to 4 cases (16%) (2 cases of parasagittal and 2 cases of falcotentorial meningiomas) with postoperative residual tumors. Two cases with Ki 67 LI >5% (one falcine with atypia and another atypical parasagittal) of those eventually progressed. No cases with either histological grade I or Simpson grade I meningiomas progressed. Therefore, neither the histopathological behavior nor the extent of resection has independent major impact role in terms of recurrence. 

For high convexity and falcoparasagittal tumors, intraoperative imaging may provide important information about residual tumor and about its relation to the sinus. New software of Stealth/S7 can mix CT, MRI and venogram that helped a lot in preoperative planning and which vein can be sacrificed and which must be saved even with residual underneath. Modern image-guided surgery has helped to minimize the size of craniotomy, reduce postoperative pain, potential complications and reduced the median hospital stay from (7 days) in the first center to (5.5 days) in the second center (Fig. 3c).

Although there is a “gray area” in terminology of “high convexity” versus “parasagittal,” Morokoff and colleagues considered a tumor with only minimal attachment to the dura of the sinus, or the draining veins, that was able to be detached easily and completely during surgery, a convexity tumor rather than a parasagittal tumor.22 We agree with that assumption that easily and completely dissectible and resectable meningioma without venous injury or a need to sinus grafting is high convexity rather than parasagittal meningioma. In this series, 3 out of 10 cases diagnosed radiologically as parasagittal found as high convexity intraoperatively. On the other hand, 3 out of 6 cases diagnosed radiologically as high convexity found parasagittal intraoperatively. One of those 3 cases could not be resected completely and had a postoperative 5mm residual. The dural attachment, the venous relation and the tumor resectibility can define the terminology of those two surgical entities. Too many authors stated that the high convexity meningioma could be easily resected completely.5,12,15,17 Therefore, we believe that this term is surgical rather than radiological definition (Fig. 3-a,d).

We reported the overall recurrence rate during the follow up period was 8%. One case of benign falcine grade I with features of atypia and one case of atypical parasagittal meningioma grade II recurred in 39 months and 21 months respectively. Both had 7mm, 5mm residuals in the postoperative imaging. Simpson28 identified three possible causes of recurrence: inadequate resection, multifocality of tumor cells in the dura, and de novo tumor formation. He felt that the most likely reason was unrecognized spread of tumor cells at the time of operation, particularly through the falx or the tentorium. A more widespread dural multifocality of disease beyond the margin of the tumor itself has been postulated by others as well.1,11,20

Because most convexity tumors can have a Simpson Grade I removal, they provide an important test of the role of histological grade in recurrence. Mirmannoff and colleagues29 studied 45 convexity meningiomas and also found a recurrence rate of 3%. Yamashiki and coworkers30 reported a rate of 11.1% after a follow-up period of 3 years in 54 patients. In their review of 9000 patients in the National Cancer Data Base, McCarthy and coworkers18 found a rate of 20.5% for completely resected benign tumors, but their study was self reportedly inaccurate as a result of vague definitions of recurrence. Before treatment, some meningiomas have already deposited cells in the meninges around the tumor because of their histological grade, and this may be a cause for recurrence.24 In this series, there were no recurrences in the tumors that were completely benign in 18 cases (72%) even with postoperative residual. On the other hand, Palma and his colleagues reported that a standard Simpson grade I resection was enough to eliminate even atypical and anaplastic meningiomas for up to 19 years.25 This supports our data that no reported recurrence in purely benign meningioma (grade I) or completely excised (Simpson grade I) in spite of limited number of patients. The relative contribution of histopathological grade and Simpson grade is often unclear, because many studies did not look at these variables independently.11 However; the histopathological grade appears to be the most important independent factor correlating of the risk of recurrence.2

The likelihood of this specific group of meningiomas recurrence depends on the extent of resection and the biological aggressiveness of the tumor Occasionally, Simpson Grade I resection is not possible because of proximity to sinuses, draining venous channels or major veins across the falx. There are several technical adjuncts that may help surgery substantially.3,14 With the advent of image-guided surgical techniques, they can be removed with precision. 

Residual tumor cells in thickened arachnoid membrane have also been proposed as a source of recurrence.7 To deal with the problem of recurrence, some authors have suggested the necessity of an additional margin of 2 cm around the tumor (the so-called “Simpson grade zero”), although there are no
treated with fractionated radiotherapy. However, for the invasion or a MIB-1 index of 4.2% or more should be and atypical tumors subtotally excised with brain contrast MRI follow-up. Modha and Gutin 21 and needs more clarification and research.

Atypia fulfilling the mentioned criteria and close 6-months contrast MRI follow-up. Modha and Gutin 21 suggested that the MIB-1 index may be useful to distinguish borderline atypical meningiomas. 16

Takahashi and colleagues 30 found that a MIB-1 index of more than 5%, even in the presence of a low mitotic index (4 per 10 high-power fields), was strongly predictive of a short progression-free course. Moreover, Schiifer and coworkers noted that recurrent tumors appear to already have an initial higher proliferation capacity, as measured by the MIB-1 index, even when of benign histology, suggesting that increasing tumor aggressiveness is not an important cause of recurrence. 27

The histological diagnosis of atypia remains controversial with significant inter-observer variability that creates difficulties in assessing the prognosis and postoperative management of patients. 14

Uninterrupted patternless or sheet-like growth, increased cellularity and small cells with a high nuclear: cytoplasmic ratio, all of which are WHO criteria for the diagnosis of atypia. 6

Black and his coworkers found that the recurrence rate for the benign group becomes zero, whereas the borderline atypical group has a 5-year recurrence rate of 33%, which is in the same range as that of the atypical tumors (the 5-yr recurrence rates were 38% for Grade II and 78% for Grade III tumors). These data emphasize the role of biology in determining recurrence and growth. 5 In other ward, the borderline atypical group of (grade I) behaves like grade II rather than grade I. 13 We believe that this point still not so clear in the literature and needs more clarification and research.

Our policy to support our surgery by radiation therapy for all atypical meningioma II and grade I with atypia fulfilling the mentioned criteria and close 6-months contrast MRI follow-up. Modha and Gutin 21 in their 2005 review, suggested that all anaplastic tumors and atypical tumors subtotally excised with brain invasion or a MIB-1 index of 4.2% or more should be treated with fractionated radiotherapy. However, for the “gray zone” tumors that have only some atypical criteria, or for benign lesions with invasive features, they suggested observation if completely excised or fractionated radiotherapy if the MIB-1 is 4.2% or more. 21

Do patients require yearly or biennial MRI studies for the rest of their life? A true appreciation of the lifetime growth potential of meningiomas might require a much longer follow-up period than 3 to 5 years. Di Meco and colleagues 7 published a series of 108 patients, in which they achieved Simpson Grades I and II resections in 100 patients. They had a 13.9% recurrence rate, with most recurrences in the higher-grade tumors. Patients with benign meningiomas had recurrence-free survival rates of 98 and 93% at 5 and 10 years, respectively. Older series (between 1978 and 1990) with 5- to 10-year follow-up showed recurrence rates between 8 and 23.9%. 5

Di Meco and colleagues 7 had a recurrence rate of 3.5% for Grade I meningiomas and 13.9% for all parasagittal meningiomas using an aggressive approach resecting the sagittal sinus. Older series showed recurrence rates between 14 and 24%. Sindou and Alvernia 29 had an exceptional low recurrence rate of 4% by implementing complex venous graft surgery. On the other hand, with black and coworkers conservative surgical approach for the parasagittal meningioma, they found no residual tumor on postoperative MRI scans in 63.2% of the cases. These tumors did not recur on follow-up MRI scans. In 14 patients (36.8%) residual tumor was found on postoperative imaging, and 13.2% of those had tumor progression. Mean and median time to progression was 8 years. Recurrence-free survival was 94.7% at 5 years.

Therefore, a limitation of our study was the small number of the cases and the follow up period was too short to predict the real rate of recurrence of completely excised benign meningiomas and the biological behavior of the gray zone between grade I and II for this variety of meningiomas.

CONCLUSION

High convexity, parasagittal and falcine meningiomas can be safely removed using modern image guided surgical techniques with acceptable operative morbidity and mortality. The conservative surgical approach with saving the sinus and the major veins with adjuvant radiation therapy for the misbehaving residual had a very satisfactory long-term effect. The real behavior of the borderline tumors (Grade I with atypia) needs more cases, deep research and long term follow up.

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