RECURRENCE OF PARASAGITTAL MENINGIOMAS FOLLOWING SIMPSON GRADE II EXCISION THROUGH UNILATERAL CRANIOTOMIES NOT CROSSING THE MIDLINE

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ABSTRACT:

Background: *The classic-teaching craniotomy for the venous-sparing approach to a parasagittal meningioma (PSM) crosses the midline. This crossing might endanger the superior sagittal sinus (SSS) and the venous lacunae. Accordingly, some consultants employ the technique of not crossing the midline with the craniotomy in the venous-sparing approach for a unilateral PSM.*

Aim: *This study aimed to assess the recurrence of parasagittal meningiomas after Simpson grade II excision through unilateral craniotomies not crossing the midline.*

Methods: *The study retrospectively reviewed the medical records of patients who underwent surgical excision of a PSM at our university hospital from 2008 to 2016. The inclusion criteria were PSM that were Simpson Grade II excised through unilateral craniotomies without crossing the midline. We included 72 nonconsecutive cases.*

Results: *The mean age of the included patients was 58.7 years. The mean follow-up period was 103.4 months. Thirty-one cases were followed for more than ten years. The performed craniotomies were uneventful. There was no reported incidence of any venous injuries. There was no operative mortality and no persistent neurologic deficit. The five-year recurrence rate was 4.1%. The ten-year recurrence rate among the thirty-one cases with long follow-ups was 16.1%.*

Conclusion: *The recurrence rate of the parasagittal meningiomas excised through unilateral craniotomies not crossing the midline was comparable to that of other studies that performed craniotomies crossing the midline. The results indicated that it may be unnecessary to cross the midline with the craniotomy for the venous-sparing approach for a unilateral PSM.*

Keywords: *Craniotomy; parasagittal meningioma; recurrence; superior sagittal sinus; venous-sparing approach*

INTRODUCTION:

Parasagittal meningioma (PSM) accounts for up to 30% of all intracranial meningiomas. It is attached to the falx cerebri, the superior sagittal sinus, and the adjacent convexity dura [1].

Parasagittal meningiomas are classified into anterior, middle, and posterior thirds. The anterior third extends from the crista galli to the coronal suture. The middle third extends from the coronal to the lambdoid sutures, and the posterior third extends from the lambdoid suture to the torcular herophili[2].

Parasagittal meningiomas have the propensity to invade the superior sagittal sinus. The SSS can be partially or completely occluded by the invading tumor [3].

The optimal surgical management of meningiomas involving major venous sinuses is still debatable [4].

Currently, there are two accepted surgical strategies to excise a PSM. The first is radical tumor resection, including the portion invading the sinus, followed by venous repair or reconstruction [2,5]. The second represents the venous-sparing approach in which the tumor mass outside the SSS is excised, the dural attachments are coagulated, and the invasive fragment is left. The venous sparing approach can accomplish Simpson Grade II tumor excision [6-8].

The first strategy involves a potentially significant risk of venous infarction, and the second strategy may increase the tumor recurrence rate [9]. Many authors found that radical tumor resection and sinus reconstruction did not offer a significant advantage in recurrence rate over the venous-sparing approach [8-10].

The classic craniotomy for the venous-sparing approach to a PSM crosses the midline to completely expose the SSS. Craniotomies crossing the midline may be complicated by injury to the large venous lacunae or the SSS itself [11,12]. Consequently, some neurosurgeons do not cross the midline with the craniotomy in the venous-sparing approach.

Ethical Consideration:

The study protocol was reviewed and approved by the Research Ethics Committee of the Faculty of Medicine at Ain Shams University (FWA 000017585-FMASU R63/2023) on March 20, 2023.

AIM OF THE STUDY:

This study aimed to assess the recurrence of parasagittal meningiomas after Simpson Grade II excision through unilateral craniotomies without crossing the midline.

PATIENTS AND METHODS:

The Research Ethics Committee of the Faculty of Medicine at our university approved the protocol for this retrospective case series. All data was anonymized to prevent patient identification. This case series has been reported in line with the PROCESS Guideline [13].

The study procedures were conducted following the "Ethical Guidelines for Medical and Health Research Involving Human Subjects" and its later amendments. The patients had consented to the surgical procedures.

The study retrospectively reviewed the medical records of all patients who underwent surgical excision of a PSM at our university hospital from 2008 to 2016.

Eligibility criteria:

Parasagittal meningiomas that were Simpson grade II were excised through unilateral craniotomies without crossing the midline.

Exclusion criteria

- Recurrent cases
- Postoperatively pathologically-proven meningiomas, World Health Organization (WHO) grades 2 and 3.
- Patients who underwent the index operation at an age of more than 75 years
- Patients with multiple intracranial meningiomas

A series of non-consecutive 72 cases were included in the current study.

Patients' demographics, preoperative clinical state, imaging features, operative notes, the degree of tumor excision, postoperative management, and follow-up clinical and radiological findings were all collected.

The degree of tumor excision was classified according to the Simpson grade [7].

The Simpson grade of tumor excision was detected by the operative notes and the first postoperative magnetic resonance imaging (MRI) brain.

The tumor volume was measured on the preoperative MRI brain with contrast utilizing the following formula: $\frac{abc}{2}$; where a, b, and c were tumor dimensions.

Preoperative magnetic resonance venography was performed to assess the patency of the SSS.

Surgical technique

All the operations were performed by consultants in neurosurgery. Under general anesthesia, the patient's head was secured in the Mayfield three-point fixation. In the case of tumors located in the anterior third of the SSS, the patients were positioned supine with mild head extension. Regarding tumors involving the middle third, the patients were positioned supine with their heads flexed. For those lesions located in the posterior third, the patients were in the prone position.

Antibiotics, dexamethasone, antiepileptics, and mannitol were routinely administered.

A coronal scalp flap was used for the anterior third tumor. For tumors of the middle and posterior thirds, the scalp flap was designed as an inverted U-shape with a wide base.

The bone flap outline was designed to surround the tumor by 2 cm on the anterior, posterior, and lateral edges. The craniotomy was performed by the craniotome. However, when there were no available miniplates, the craniotomy was done using the Gigli saw. The performed craniotomies were unilateral, not crossing the midline as seen in figure (1). The medial limb of the craniotomy was cut in a slanting way (the craniotome or the Gigli saw were inclined medially) so, the outer table of the bone flap was cut just near the midline as revealed in figure (2).

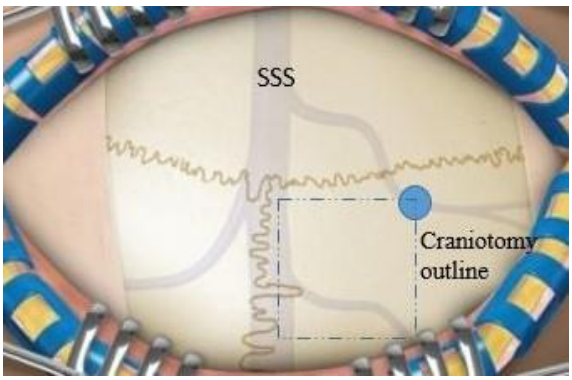

Figure 1: The craniotomy outline for a Left middle third parasagittal meningioma

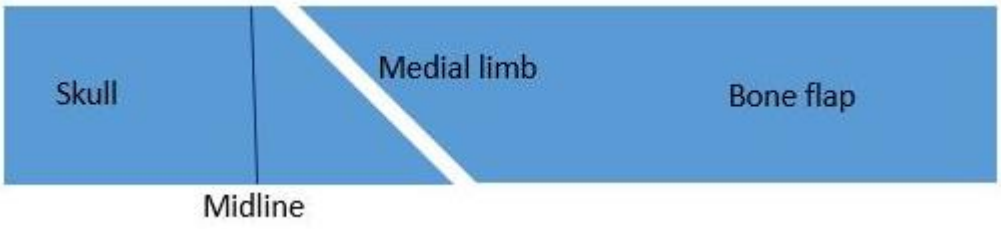

Figure 2: The medial limb of the craniotomy was cut in a slanting way (the craniotome or the Gigli saw were inclined medially) so, the outer table of the bone flap was cut just near the midline.

The bone flap was elevated gently and dissected from the underlying dura. The medial edge of the skull defect was slightly removed just to expose the lateral edge of the SSS.

The edges of the skull defect were covered by bone wax to seal the diploic space of the skull to avoid a venous air embolism.

A dural flap was opened circumferentially around the tumor and reflected medially on a gelfoam. Every attempt was made to preserve the cortical veins and the bridging veins.

The tumor capsule was coagulated and incised to begin the internal debulking of the tumor in a piece-meal technique. An uncoagulated tumor fragment was preserved for histopathological examination.

An arachnoid plane at the tumor-brain interface was identified and protected with wet cotton strips to minimize cortical injury. Traction was always applied to the tumor rather than the surrounding brain. In the case of large tumors, the branches of the anterior cerebral artery on the deep surface of the tumor were identified and spared.

The SSS was not incised or excised. No attempt was made to remove the tumor infiltrating the SSS. The tumor was shaved from the falx cerebri. The origin of the tumor from the falx cerebri was coagulated and not excised.

To achieve appropriate hemostasis, the tumor bed was coated with a surgicel fibrillar hemostat, and the patient's blood pressure was kept at a normotensive level for at least 10 minutes.

The infiltrated convexity dura and a one-centimeter circumferential margin were resected. The dura was closed with a pericranial graft in a water-tight fashion. The bone flap was replaced and fixed to the surrounding skull by miniplates. In the absence of miniplates, the bone flap was fixed by heavy sutures. A subgaleal drain was routinely inserted. The scalp was closed in two layers.

Postoperative evaluation:

Postoperatively, patients were transferred to the intensive-care unit for at least one day, then returned to the ward. All patients underwent computed tomography (CT) brain on the first postoperative day to exclude any hematoma in the tumor bed.

Postoperatively, an MRI brain with contrast was done 48 hours after the operation, then 6 months later, and yearly thereafter.

Gross total tumor resection was defined as the total removal of the tumor tissue outside the SSS. The residual tumor was defined as the tumor tissue that was left outside the SSS on the initial postoperative MRI.

Recurrence was defined as the reappearance of any tumor tissue in the follow-up MRI that was not present on the initial postoperative MRI.

Patients were followed up at our outpatient clinic every two weeks in the first month, monthly for the next six months, and then yearly after that.

Statistical analysis:

The statistical analyses were conducted using SPSS software version 21 (IBM Corp., Armonk, New York, USA). Quantitative data was described by the mean and range, while qualitative data was described by frequencies. A Chi-square test was used to evaluate the recurrence rate according to the location of the PSM. The p-value < 0.05 was considered significant.

RESULTS

A series of 72 cases were included in the current study. Their mean age was 58.7 years (ranging from 49 to 70 years). The clinical characteristics of the patients are revealed in Table 1.

The mean preoperative tumor volume was 41.4 cm^3 (ranging from 20.3 to 63.8 cm^3). The location of the parasagittal meningiomas and the main complaints of the patients are illustrated in Table 2.

Preoperatively, thirty-nine patients (54.1%) and thirty-three cases (45.8%) had complete and partial occlusion of the SSS, respectively.

The craniotomies were uneventful. There was no reported incidence of venous injury.

Simpson grade II was accomplished in all cases. No operative mortality in this study.

None of the patients received postoperative radiotherapy.

Nine patients with a middle-third PSM suffered from a new postoperative weakness in the contralateral lower limb. The pre and postoperative neurologic deficits gradually improved within three months of the index operation. No persistent neurologic deficit has occurred.

The mean follow-up period for all the included patients was 103.4 months (ranging from 61 to 167 months). Thirty-one cases were followed for more than 10 years.

The five-year recurrence rate was 4.1% (3 out of 72 cases). The earliest recurrence was four years after the index operation. These cases were managed expectantly with serial MRI brain with contrast every six months as the recurrent tumor was less than 1 cm^3.

As demonstrated in Table 3, the location of the PSM was a statistically insignificant factor in the recurrence (*p-value = 0.67*).

The ten-year recurrence rate among the 31 cases with long follow-ups was 16.1% (five out of 31 cases). Two cases suffered from symptomatic recurrence and required reoperation eight and nine years after the index operation, respectively. The other three patients experienced radiological recurrence (> 1 cm^3) without new symptoms and received radiosurgery and follow-up with serial MRI brain with contrast every six months.

Table 1: The patients' clinical characteristics

Clinical characteristics	**Number of patients (%)**
Gender	
Male	25 (34.7%)
Female	47 (65.2%)
Mean age (years)	58.7
Medical diseases	
Hypertension	28 (38.8%)
Diabetes mellitus	19 (26.3%)
Ischemic heart disease	3 (4.1%)
Preoperative Karnofsky Performance Status	
90	61 (84.7%)
80	8 (11.1%)
70	3 (4.1%)

Table 2: Tumor location and the main complaint

Tumor location and the main complaint	N (%)
Right-sided PSM	43 (59.7%)
Left-sided PSM	29 (40.2%)
Anterior third	13 (18%)
Headache	13
Middle third	35 (48.6%)
Seizures	18
Motor weakness	11
Headache	6
Posterior third	24 (33.3%)
Visual deficit	5
Headache	19

PSM: parasagittal meningioma

Table 3: Five-year recurrence rate in relation to the tumor location

Location of the PSM	N (%)	Five-year recurrence rate	P-value*
Anterior third	13 (18%)	0	0.67
Middle third	35 (48.6%)	2	
Posterior third	24 (33.3%)	1	
Total	72 (100%)	3 (4.1%)	

PSM: parasagittal meningioma * Chi-square test

DISCUSSION:

The venous-sparing approach for parasagittal meningioma is gaining popularity for the safety of patients. The classic-teaching craniotomy for this approach crosses the midline. This crossing might endanger the SSS and the venous lacunae. Consequently, some consultants in neurosurgery in our university hospital perform a craniotomy without crossing the midline to excise the unilateral PSM.

In this case series, the performed craniotomies were uneventful. Simpson resection Grade II was accomplished in all cases. There was no reported incidence of any venous injury. There was no operative mortality and no persistent neurologic deficit.

In the present study, the mean follow-up period was 103.4 months. Thirty-one cases were followed for more than 10 years. The five-year recurrence rate was 4.1% (3 out of 72 cases). The ten-year recurrence rate among the 31 cases with long follow-ups was 16.1% (5 out of 31 cases).

Munich et al. examined the venous sparing approach to PSM. Their performed craniotomies crossed the midline. Simpson resection Grade I was accomplished in 11% of cases and Grade II in 89% of cases. The perioperative mortality rate was 1%. Within a mean follow-up period of 38.5 months, the symptomatic recurrence rate was 21% [6].

Sindou et al. performed radical tumor resections through craniotomies that extended across the midline. Simpson resection Grade I was accomplished in 85.3% of cases and Grade II in 14.6%. However, 4.87% of cases died postoperatively from edema and venous infarction. The recurrence rate in the remaining patients was 4.3% in a mean follow-up period of 8.5 years [14].

In their retrospective analysis of the venous sparing approach for PSM, Tomasello et al. reported an operative mortality rate of 4.5%. They attained Simpson Grade II in all cases except those with occluded SSS, in which they resected the invaded sinus and reached Simpson Grade I tumor resection.

The recurrence rate was 10.4% within a mean follow-up duration of 80 months. They concluded that *radical tumor resection offered no advantage in terms of recurrence rate* over the venous-sparing approach[8].

Regarding the craniotomy, the craniotome produces a larger bone gap than the Gigli saw. In addition, it is difficult to produce a slanting bony edge with the craniotome. These limitations make it necessary to use miniplates to fix the replaced bone flap produced by the craniotome. However, the craniotome produces a faster craniotomy than the Gigli saw.

Traditionally, the anterior third of the SSS was thought to be safe to remove. However, venous infarctions caused morbidity and mortality[15]. So, the venous-sparing approach was also applied to the PSM in the anterior third.

In the present study, it seemed unnecessary to cross the midline with the craniotomy for the venous-sparing approach for unilateral PSM. This technique may be used as an option in the venous-sparing approach for a unilateral PSM. Further corroboration by prospective, controlled multicenter studies is required for more evidence.

The limitations of this study are the selection criteria, the single-center experience, the unavailability of intraoperative images, and the limited number of patients.

Conclusion;

The recurrence rate of the parasagittal meningiomas excised through unilateral craniotomies not crossing the midline was comparable to other studies that performed craniotomies crossing the midline. The results indicated that it may be unnecessary to cross the midline with the craniotomy for the venous-sparing approach for a unilateral PSM.

Conflict of Interest:

The authors report no conflicts of interest.

Financial Disclosures:

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Authors' contributions:

The conception and the design of the study were made by MA. MA, AD, MG, and SH collected the date of the patients. MA and SH analyzed and interpreted the patients' data. MA, AG, MG and SH wrote the manuscript. All authors read and approved the final manuscript.

This paper has not been published in its current form or substantially similar form elsewhere including on a web site and also, it has not been accepted for publication elsewhere.

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ارتجاع الأورام السحائية المجاورة للوريد السهمى العلوى بعد الاستئصال من الدرجة الثانية عن طريق فتح الجمجمة بدون عبور خط الوسط

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الخلفية: تعتبرفتح الجمجمة وعبور خط الوسط هى العملية التقليدية لاستئصال الأورام السحائية (PSM) المجاورة للوريد السهمى العلوى. قد يعرض هذا العبور خطر الاصابة للوريد السهمى العلوى (SSS) وللجيوب الوريدية الاخرى. وفقًا لذلك ، يستخدم بعض الاستشاريين تقنية عدم عبور خط الوسط لتجنب اصابة الاوردة.

الهدف: تهدف هذه الدراسة إلى تقييم ارتجاع الأورام السحائية بعد الاستئصال من الدرجة الثانية من خلال فتح الجمجمة من جانب واحد دون عبور خط الوسط.

الطريقة: استعرضت هذه الدراسة بأثر رجعي السجلات الطبية للمرضى الذين خضعوا لعملية استئصال جراحي لـ PSM في مستشفانا الجامعي من عام 2008 إلى عام 2016. وكانت معايير التضمين PSM التي تم استئصالها من الدرجة الثانية من Simpson من خلال عمليات فتح أحادى الجانب دون عبور خط الوسط. قمنا بتضمين 72 حالة غير متتالية.

النتائج: كان متوسط عمر المرضى المشمولين 58.7 سنة. وكان متوسط فترة المتابعة 103.4 شهرا. تمت متابعة 31 حالة لأكثر من عشر سنوات. تمت جميع العمليات بدون مضاعفات ولم ترد تقارير عن حدوث أي إصابات وريدية. لم يكن هناك وفيات جراحية ولا عجز عصبي مستمر. كان معدل ارتجاع الاورام خلال خمس سنوات 4.1٪. بلغ معدل ارتجاع الاورام خلال عشر سنوات بين 31 حالة 16.1٪.

الخلاصة: إن معدل ارتجاع الاورام السحائية المجاورة للوريد السهمى العلوى بعد الاستئصال من الدرجة الثانية عن طريق فتح الجمجمة بدون عبور خط الوسط كانت مماثلة مع الدراسات الأخرى التي فتحت الجمجمة وعبرت خط الوسط. أشارت النتائج إلى أنه قد يكون من غير الضروري عبور خط الوسط لاستئصال الأورام السحائية المجاورة للوريد السهمى العلوى (PSM).