








Original Article

What is the ideal grade of resection for parasagittal meningiomas with the invasion of superior sagittal sinus? Simpson I or Simpson II resection? A retrospective observational study

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ABSTRACT

Background: Parasagittal meningioma (PSM) is a tumor located in the parasagittal angle which extends to and/or invades the superior sagittal sinus (SSS). Surgical resection of the PSM, the standard treatment in such cases, poses a challenge for neurosurgery, particularly where there is an invasion of the SSS. This is due to the risk of complications through injury to the adjacent vascular structures. The objective of the study was to perform a comparative evaluation of the surgical techniques for total resection of the PSM (Simpson Grade [SG] I and SG II), which present the highest rates of success in terms of the following variables: mortality, recurrence, and postoperative complications.

Methods: Fifty-six patients undergoing resection surgery for PSM with the invasion of the SSS were enrolled. The patients were divided into two groups: Group A, comprising 26 cases of patients subjected to SG I PSM resection surgery and Group B, with 31 cases of patients subjected to SG II PSM resection surgery, with preservation of the SSS.

Results: The results showed that Group B had lower rates of postoperative deficit ($P = 0.026$), zero mortality, and reduced recurrence. The use of complementary radiotherapy for atypical meningiomas (WHO II) in Group B was satisfactory in controlling the disease.

Conclusion: The Simpson II, with preservation of the SSS, was better as it diminishes the vascular risks of surgery, reduces the frequency of severe postoperative deficit, and reduces mortality.

Keywords: Cerebral convexity meningioma, Meningioma, Parasagittal meningioma, Surgical procedure

INTRODUCTION

According to Cushing and Eisenhardt, parasagittal meningiomas (PSMs) are tumors emanating from cells in the arachnoid membrane, located in the parasagittal angle, which invades or extends to at least

one of the walls of the superior sagittal sinus (SSS), without any brain tissue between the tumor and the SSS.^[15] PSMs account for between 16.8% and 30% of all meningiomas, this being the most common site for intracranial meningiomas.^[9,19]

Although potentially benign, the standard treatment for symptomatic or developing PSMs is the surgical removal of the tumor.^[12] Resection of the PSM is still regarded as a challenge in neurosurgery, particularly where there is an invasion of the SSS, due to the anatomic involvement of the sinus and surrounding veins.^[6,9] This surgery involves a high risk of damage to the brain and adjacent vascular structures, with the possibility of severe neurological deficit.^[13,20]

According to Simpson, 1957, the invasion of the PSM into the SSS is the main risk factor for tumors recurrence.^[22] Even today, there is no definitive guideline for the management of such cases and very few studies have addressed the requisite surgical techniques for the resection of the PSM with the invasion of the SSS.^[3,20] In this regard, two main surgical approaches have been discussed: radical resection of the tumors, aiming to minimize the risk of PSM recurrence, but with a greater chance of morbidity and complications, and the more conservative approach with resection of the PSM and preservation of the SSS.^[3,16] In the case of the latter, complementary therapy, such as radiotherapy, may be used to reduce the risk of tumors recurrence.^[3,14,17,20]

The aim of PSM surgical treatment is complete tumor removal (Simpson Grade [SG] I or SG II), preserving a better quality of life for the patient.^[5] While SG I surgery entails complete macroscopic resection of the tumor, with the excision of the affected duramater, the SSS, and the abnormal bone, SG II resection involves complete macroscopic resection of the tumor and coagulation of the dural attachment.^[22] Both techniques are viable for the PSM, it is necessary to broaden the discussion about the beneficial and deleterious aspects of each.^[5,16]

This study aimed to evaluate two surgical techniques for PSM with the invasion of the lateral wall of the SSS but excluding PSM with the total invasion of the SSS. Group A constituted cases where the patients were subjected to complete resection of the tumor by SG I, while Group B comprised patients subjected to surgical resection of PSM by SG II, with preservation of the SSS wall.

MATERIALS AND METHODS

The study design followed the checklist published in the Strengthening the Reporting of Observational Studies in Epidemiology Statement.^[26]

Registration and ethical considerations

Following the Declaration of Helsinki,^[28] any study involving human beings must be registered on a publicly accessible

database. In this regard, this case series was submitted to and approved by the Ethics Committee at the Santa Paula Hospital in São Paulo, Brazil, with the respective registration on *Platform Brazil* under reference number CAAE 49897421.5.0000.5670.

Before the tumors resection surgery, all patients were provided with an explanation of the use of their data for research purposes and signed a free and informed consent form acquiescing to access to their clinical and surgical data for scientific purposes.

Study design

This study consists of a retrospective, observational study to compare two surgical techniques, namely, SG I resection and SG II resection for the surgical removal of the PSM with the invasion of the SSS. The patient's clinical data were extracted through an analysis of their medical history records.

Participants

A total of 56 patients were included, aged between 18 and 80 years, with PSMs and invasion of the SSS, subjected to Simpson II surgical resection with preservation of the lateral wall, or the Simpson I procedure. There was no restriction in terms of patients' sex or race or regarding tumor histology. The samples were divided into two groups depending on the type of surgery employed.

The sample's exclusion criteria were as follows: patients who had been subjected to SG III, IV, or V resection; patients with other malignancies; patients with other diseases or lesions affecting the bone flap; and patients whose SSS structure was completely obstructed.

- Group A

Group A comprises 26 patients with PSMs and invasion of the SSS, subjected to SG I surgical resection. This is a historic sample where surgery was performed by the neurosurgery team of the present author, P.H.P.A., between 2004 and 2010.^[2]

- Group B

Group B consists of 30 cases of patients with PSMs and invasion of the SSS, subjected to Simpson II surgical resection, with preservation of the lateral wall, performed by the neurosurgery team of the present author, P.H.P.A., between 2015 and 2021.

Perioperative preparation routine

The preoperative routine consists of the use of anticonvulsants, corticosteroids, mannitol, and pneumatic compression boots, aimed at avoiding complications.

The anticonvulsant is used intravenously and is introduced the night preceding surgery. The corticosteroid (dexamethasone 4 mg IV 6/6 h) is administered the night before the procedure. Now, the induction of anesthesia is performed in the operating theater, mannitol 10% (500 mL) is administered, and the pneumatic compression boots are fitted to avoid pulmonary embolism.

Details of the surgical intervention

The preparation of the intervention is performed with the patient under general anesthetic, induced by Propofol using the central access route.

The positioning of the patient depends on the area affected by the meningioma. For meningiomas located in the region of the anterior third, the patient is placed in the horizontal dorsal decubitus position, with the head slightly flexed. For cases of meningiomas located in the middle third, the patient is positioned laterally or in horizontal dorsal decubitus with the head turned to the side opposite to that of the tumor. For meningiomas located in the posterior third, the patient is placed prone with the head facing downward or in dorsal decubitus. In all three cases, the head is secured through the Mayfield 3-pin head clamp system (Codman, USA) or the Sugita multipurpose head frame (Mizuho, Japan) with the degree of head flexion depending on the third affected by the meningioma. To adjust the angle of the head, with the Mayfield head clamp (Codman, USA), one pin is attached to the parietal bone on the side where the incision will be made and the other two pins to the contralateral temporal region.

The operative field is cleaned using alcohol solutions of chlorhexidine or iodine.

For meningiomas in the anterior location, the skin incision is made in a curvilinear shape or following the coronal suture; for meningiomas in the mid-region, a horseshoe-shaped or extended linear incision is performed. The skin incision is performed with the aid of neuronavigation tracking (Brainlab or StealthStation software), which delimits the anterior and posterior boundaries where the incision can be made.

The craniectomy is then performed using a Midas Rex® (Medtronic, USA), Legend (Medtronic, USA), or Anspach (Anspach, USA) high-speed drill, using four holes for trepanning.

The cut in the dura mater meninges is performed in the shape of the letter "C," with the opening in the direction of the sagittal sinus.^[2]

During the entire procedure, the midline is not exceeded, and the boundary defined by the neuronavigator is respected to avoid impairment of the SSS. However, if the SSS is damaged, it is attempted to stem the bleeding using cotton wool and raising the bedhead. In addition, when working on

the removal of the PSM in the middle and posterior thirds, the vein of Trolard is under continuous observation, avoiding damaging, and sacrificing this vein through microresection.^[2]

With the brain exposed, it is possible to see the meningioma in the parasagittal region. The tumor resection operation is assisted by a view of the structures with an Opmi Pentero 800 microscope (Zeiss Medical Technology, USA).

Subsequently, the lateral isolation of the meningioma is carried out, retracting the cortex with the use of a Leyla spatula (Codman, USA) to expose the cleavage between the tumor and the cerebral cortex, separating them with cotton wool. The middle portion of the tumor, which is attached to the SSS wall, and the falx is then operated on. The coagulation of the implant is then performed, and microsurgery is employed to remove the PSM.^[2]

Surgical resection of PSMs in Group A took place through the removal by SG I, in other words, with the total removal of the tumor, removal of the dura mater, any abnormal bone, and reconstruction of the SSS.^[2]

Surgical resection of PSMs in Group B took place through the removal by SG II, totally removing the tumor with the preservation of the lateral wall of the SSS.

The surgical incisions were then closed, filling the resected space with a synthetic dural patch or natural skin graft, binding the structures with fibrin glue, hydrogel sealant, or Preclude®.

In Group A (SG I), after the removal of the tumor and the regions of the SSS wall affected by the PSM, the SSS reconstruction is performed. First, the SSS is opened with the excision of the infiltrated wall, and hemostasis is achieved through the use of hemostatic tools (like Surgicel®) and cottonoid compressing, minimizing the risk of excessive blood loss and air embolism. Subsequently, after total removal of the tumor and the affected sinus wall, the reconstruction begins with an autologous galea capitis graft. In this case, the piece of capitis galley is harvested from the pedicled galley flap previously prepared and stored in saline solution. The size of the flap depends on the area necessary for the reconstruction of the SSS and the flap must be intact and without lacerations. To suture it, a nonabsorbable monofilament thread of polytetrafluoroethylene No. 6-0 is used. Before the complete closure of the reconstruction, hemostasis materials are removed, allowing the restoration of blood flow.

It should be noted that, in elderly patients, fat grafts were employed when necessary.

All the patients were subjected to the same surgical procedure, carried out by the same medical team, ensuring uniformity in terms of technical procedures. Figure 1 shows an example of a patient subjected to this technique.

Statistical analysis

Inferential statistical analysis was performed using Fisher's exact test. An alpha of 0.05 was adopted in all statistical analyses. Multiple testing correction was not performed and, in cases with significant *P*-values, the calculation of the odds ratio and 95% confidence interval was performed (95%CI). The statistical analysis was performed using IBM SPSS Statistics for Macintosh, Version 27.0.

RESULTS

Demographic and clinical data

Group A comprised 26 patients with PSM and invasion of the SSS who were subjected to total resection of the tumor using the Simpson I technique. The group's median age was 55 (mean of 55.4 years). On admission, the main symptoms reported were headache and focal neurological deficit.

Group B comprised 30 patients with PSM and invasion of the SSS who were subjected to surgical resection with

preservation of the wall of the SSS. The median age was 54 (mean of 52.96 years). Eight of these patients were males and 22 females. On admission, the clinical characteristics presented by this group were headache in 6 patients (20%), 5 with intracranial hypertension (16.6%), 4 with seizures (13.3%), 6 presented with a focal neurological deficit (20%), and 9 cases exhibited no apparent symptoms (30%). It should be stressed that, of the nine asymptomatic cases, two had previously presented with other types of tumor and, in one case, there was a prior history of meningioma. The prior comorbidities in Group B are displayed in Table 1.

Descriptive data

The histological types in the case histories (Group A) demonstrate a prevalence of, in decreasing order, benign meningiomas (WHO I), followed by the atypical subtype (WHO II) and, to a lesser extent, malign meningiomas (WHO III). The same was true for Group B where four cases were classified as histological type WHO III. In one case, involving a female patient, there was a prior history of meningioma, and, in another case, a male patient presented with an aggressive form of tumor, with pulmonary metastasis.

In Group A, no patients were subjected to complementary therapy after Simpson I resection. For the individuals in Group B, complementary therapy with radiotherapy was used for all patients with the WHO Grade III meningiomas, on four patients with the WHO Grade II tumors, and one female patient with a WHO Grade I meningioma due to a prior history of meningioma, her young age and to the presence of dysplasia in other sites. In this last case, the patient suffered a recurrence of the tumor within 5 years, requiring repeat surgery due to the recurrence of the lesion. In addition, of those patients subjected to radiotherapy, a further three suffered recurrences within 5 years, including one case with a WHO Grade I lesion and a prior history of meningioma,

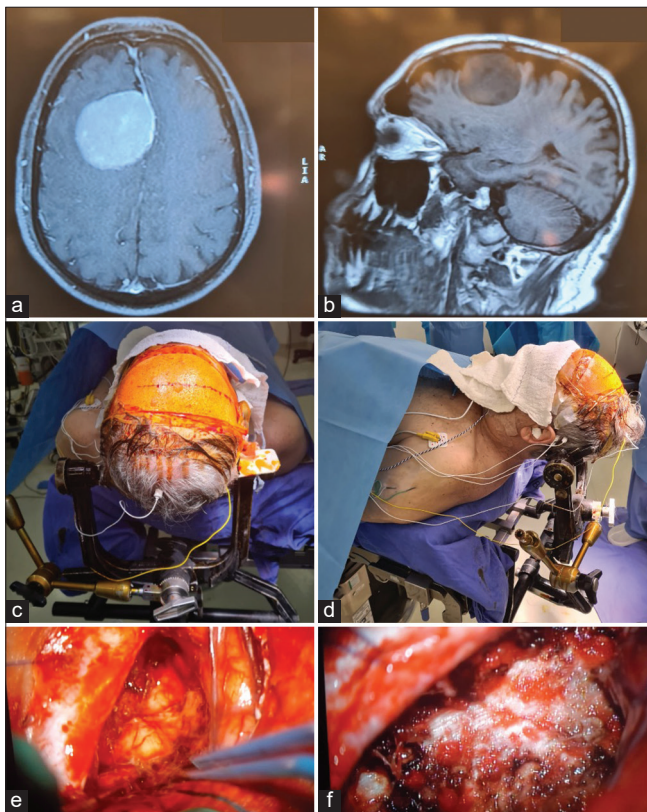


Figure 1: Images representing the surgical approach. (a and b) Computed tomography showing parasagittal meningioma (PSM) in the left middle third, affecting the superior sagittal sinus (SSS). In (c and d) patient in dorsal decubitus for surgery, and the head is secured by three pins using the Mayfield head clamp system. (e) Resection of the tumor using the Simpson II technique, with preservation of the SSS. (f) Outcome after PSM resection.

Table 1: Clinical characteristics of Group B.

Marker	Data	Group B (%)
Age (years)		52.97±11.98
Comorbidities	Prostate adenoma	1 (3.3)
	Obesity	6 (20.0)
	Diabetes mellitus	4 (13.3)
	Parkinson's disease	1 (3.3)
	Prostate cancer	0 (0.0)
	Colon cancer	1 (3.3)
	Mammary dysplasia	1 (3.3)
	Systemic arterial hypertension	4 (13.3)
	Hepatitis C	1 (3.3)
	Lung metastasis	1 (3.3)
	Obstructive sleep apnea	1 (3.3)
	Missing	19 (63.3)

Statistical analysis was performed using the Fisher's exact test. Alpha=0.05

one case of a WHO Grade II lesion, and one case of WHO Grade III, both having no prior history of lesions.

In Group A, repeat surgery was carried out in two cases due to postoperative complications. In one of these, there was an intraventricular hemorrhage requiring surgical intervention, with asymptomatic evolution after resolution.

In the second case, there was a transtentorial herniation that led to the death of the patient 48 h after procedure. Two other deaths occurred due to intraoperative intravenous infarction. The descriptive results comparing Group A and Group B are displayed in Table 2.

Differences between the Simpson I (Group A) and Simpson II (Group B) techniques

In the comparison between the two groups, it should be noted that the use of complementary therapy was more common in Group B ($P = 0.030$). However, it is known that radiotherapy was not used in Group A due to the manner of the total resection technique on the lesion. For patients in Group B, individuals' surgical and clinical factors were considered such that complementary therapy was required for patients with a prior history of the disease or where more than 1 site was affected by neoplasms, or in cases of high-grade lesions (atypical WHO Grade II or WHO Grade III).

Although there are no statistical observations regarding the rates of complications between the two techniques ($P = 0.165$), complications were more prevalent in Group A using the Simpson I technique (16% vs. 3.3%).

In addition to complication rates being more prevalent in Group A, the postoperative deficit is statistically more common in Group A than in Group B ($P = 0.026$), thus when classifying deficits as mild, moderate, severe, or terminal, there is a tendency toward moderate deficits in the patients in Group A, and it should be stressed that the one reported death was exclusive to this group (Group A).

In Group A (Simpson I), nine patients had neurological deficit before the procedure, due to tumor compression. Of these, five remained with a moderate deficit 6 months after surgery and four had a mild deficit in the same period. For Group B, 6 (6/13) patients had neurological deficit before the surgical procedure and remained with deficit after 6 months of surgery. Of these, two had mild deficits, two moderate deficits, and two severe deficits. In this group, two patients had immediate postoperative complications, both due to the development of cerebrospinal fluid fistula. The two patients underwent surgical reapproach, one patient progresses without subsequent deficits and one remained with neurological deficit already present in the clinical examination of admission, before the diagnosis of the tumor.

For patients in Group B, the type of dural substitute is important ($P < 0.001$). The types of dural substitutes were classified as organic, inorganic (artificial material), and mixed. As a result, only one case presented with postoperative complications with the presence of fistula suppuration, requiring a fresh intervention, with complete resolution of the complication and, consequently, asymptomatic evolution. The results comparing Group A and Group B are displayed in Table 3.

Table 2: Descriptive results comparing Group A and Group B.

Marker	Data	Group A (%)	Group B (%)	P-value
History of meningioma	Yes	3 (10.0)	0 (0.0)	NA
	No	27 (90.0)	-	
	Not reported	-	25 (100.0)	
Clinical condition	Cephalaea	6 (20.0)	9 (36.0)	0.619
	Intracranial hypertension	5 (16.7)	2 (12.0)	
	Seizures	4 (13.3)	3 (12.0)	
	Focal neurological deficit	6 (20.0)	6 (24.0)	
	None	9 (30.0)	4 (16.0)	
Location	Middle 1/3	23 (76.7)	1 (4.0)	<0.001
	Anterior 1/3	6 (20.0)	15 (60)	
	Posterior 1/3	0 (0.0)	9 (36.0)	
	Bilateral	1 (3.3)	0 (0.0)	
Type of resection	Simpson I	25 (100.0)	0 (0.0)	NA
	Simpson II	0 (0.0)	30 (100.0)	
WHO	I	-	19 (63.3)	NA
	II	-	4 (13.3)	
	III	-	4 (13.3)	
	Not reported	25 (100.0)	3 (10.0)	

Statistical analysis was performed using the Fisher's exact test. Alpha=0.05. NA: Not applicable

Table 3: Results comparing Group A and Group B.

Marker	Data	Group A (%)	Group B	P-value
Complementary therapy	Yes	0 (0.0)	9 (30.0)	0.030
	No	25 (100.0)	21 (70.0)	
Recurrence	Yes	0 (0.0)	4 (13.3)	NA
	No	-	26 (86.7)	
	Not reported	25 (100.0)	0 (0.0)	
Surgical complication	Yes	4 (16.0)	1 (3.3)	0.165
	No	21 (84.0)	29 (96.7)	
Dural substitute	Organic	0 (0.0)	12 (40)	<0.001
	Inorganic	0 (0.0)	7 (23.3)	
	Mixed	0 (0.0)	11 (36.7)	
	None	25 (100.0)	0 (0.0)	
Postoperative deficit	No	13 (52.0)	17 (56.7)	0.026
	Mild	4 (16.0)	11 (36.7)	
	Moderate	5 (20.0)	1 (3.3)	
	Severe	0 (0.0)	1 (3.3)	
	Terminal	3 (12.0)	0 (0.0)	
Repeat surgery	Yes	2 (8.0)	3 (10.0)	1.000
	No	23 (92.0)	27 (90.0)	
Resolution of complication	Yes	1 (4.0)	2 (6.7)	1.000
	No	24 (96.0)	28 (93.3)	
Partial invasion of the superior sagittal sinus	Yes	25 (100.0)	30 (100.0)	1.000

Statistical analysis was performed using the Fisher's exact test. Alpha=0.05. NA: Not applicable

DISCUSSION

According to the definition conceived by Cushing and Eisenhardt, 1938, PSMs are tumors of the meninges that fill the parasagittal angle where no brain tissue exists between the meningioma and the SSS.^[15] These tumors account for between 20% and 30% of intracranial meningiomas and may partially or completely obstruct the SSS.^[6,12] The most prevalent region for PSM is the middle third of the SSS (between the coronal and lambdoid sutures) accounting for between 45% and 70% of cases, followed by the anterior third (between the *crista galli* and the coronal suture) representing 15–34%, and the posterior third (between the lambdoid suture and the torcula) accounting for between 9% and 30% of cases.^[6] In neurosurgery, this classification is important as resection of the PSM in the middle and posterior thirds carries a greater risk of venous infarction and risk of sequelae, while tumor resection is easier in the anterior region without damaging normal brain^[2,6] [Figure 2].

Initially, it was believed that total resection of the anterior portion of the SSS did not present a high surgical risk; however, it is noticeable that resections that damage the SSS, including the anterior portion, increase the chances of postoperative complications.^[2]

Moreover, according to Sindou, 2001, PSM may adhere to the SSS in six different grades, where Grade I is compatible with PSMs that do not invade the SSS; Grades II, III, and IV are

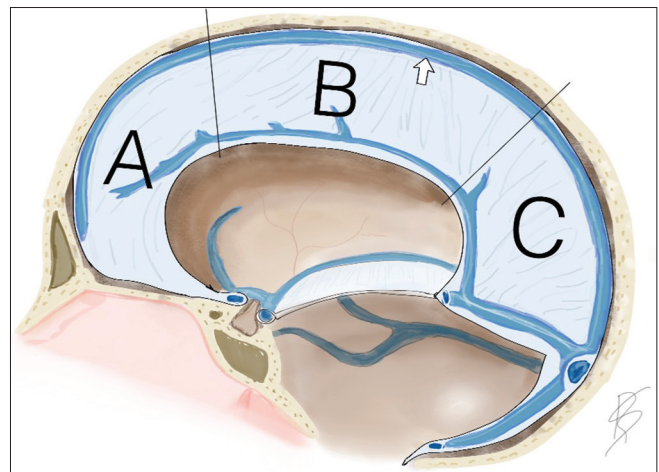


Figure 2: Anatomic representation identifying the anterior portion (a), midportion (b), and posterior portion (c) of the falx cerebelli. The superior sagittal sinus is identified through the white arrow.

PSMs with a partial invasion of the SSS, and Grades V and VI are PSMs that completely obstruct the SSS.^[23] The study analyzed the surgical approach, specifically for cases of PSM with Sindou's classification Grades II–IV, to standardize the sampling.

PSM treatment is essentially based on the surgical removal of the tumor.^[6] This form of therapy poses a challenge for neurosurgeons, particularly when the wall of the SSS is affected.^[5] This is because the adherence of the meningioma

to the SSS increases the risk of hemodynamic complications, adversely affecting cerebral circulation.^[16] Given this scenario, the positive and negative aspects of root resection of the PSM through Simpson I, and PSM resection with preservation of the SSS wall, are discussed here.^[2,8,16]

As far as the Simpson I approach is concerned, the risk of vascular injury, surgical complications, and postoperative sequelae with radical resection of the PSM means that some neurosurgeons regard the approach as a contraindication for the total removal of the lesion, despite being the approach with the lowest risk of PSM recurrence.^[2,8,16] Moreover, the morbidity/mortality rates are higher for this therapeutic approach.^[16] For Sindou and Alvernia, 2006, in their evaluation of 100 cases of meningioma with an invasion of the SSS, mortality was 3%, regarding total resection without preservation of the lateral wall of the sinus. In these three cases, death occurred as a result of cerebral edema.^[24] Besides Sindou and Alvernia, other authors have reported mortality rates ranging from 4.8% to 12.8% for patients without preservation of the sinus.^[4,10] In the present study, the mortality rate in Group A (Simpson I, without preservation of the sinus) was 12% and zero for Group B (Simpson II, with preservation of the lateral wall of the SSS).

In addition to morbidity and mortality, it is suggested that around 8% of patients suffer from some permanent neurological deficit due to cerebral venous infarction, primarily in tumors located in the middle and anterior thirds.^[24] In this regard, it should be stressed that despite total removal of the tumor through SG I being the most recommended treatment for meningiomas, the aim of PSM surgery should be to minimize the risk of tumor recurrence and to maintain the patient's good neurological condition.^[5] From our retrospective study, the neurological deficits occur primarily in patients subjected to Simpson I total resection of the sinus. In addition to being more common, the moderate neurological deficit is more prevalent in this group than the mild neurological deficit (which is more prevalent in the group subjected to Simpson II resection with preservation of the lateral wall).

Besides the risks arising from lesions of the SSS, Yamashiro *et al.*, 2021, noted that the presence of postsurgical deficit may be associated with the preservation of the diploic veins.^[29] By comparing the surgical approaches with an invasion of the sinus and the nonpreservation of the diploic veins, the presence of new deficits was noted after the procedure, unlike in patients who did not suffer an invasion of the SSS; thus, the preservation of these vessels was made easier.^[29] In the same study, the presence of the tumor does not directly alter the vessels; however, invasion of the SSS does alter the blood flow, suggesting that the diploic veins are used as an alternative route when the sinus is obstructed by the tumor lesion.^[29] Accordingly, it is important to preserve

both the wall of the SSS and the pathways used for alternative circulation in the event of tumor invasion.^[16,29] Moreover, in the event of a lesion of the communicating veins, there may be thrombosis of the damaged vessel and, consequently, ingurgitation and venostasis. This condition, on a large scale, may result in cerebral venous infarction, with irreversible neurological deficit and, in more severe cases, the death of the patient.^[16] Thus, respecting all the veins surrounding the tumor is one of the pillars of the success of PSM resection surgery.^[5]

Besides the risk of vascular damage, PSMs located in the middle third carry a high risk of motor impairment due to the anatomic distribution, primarily in the central gyrus.^[7]

The frequency of motor complications ranged from 40% to 56% in individuals subjected to Simpson I or Simpson II resection.^[7] For patients evaluated in this study, the postoperative motor deficit was between 36% and 40%, with a prevalence of moderate deficit in those subjected to Simpson I resection without preservation of the SSS.

In addition to the known complications, it is suggested that the degree of edema comprising the area of the tumor is related to lesion recurrence, particularly for PSMs and meningioma in the tentorial region.^[21]

The study published by Simpson in 1957 suggests that the disease-free survival rate diminishes depending on the type of resection employed, being higher for the Simpson I and II subtypes.^[1] The most recent analysis refers to a disease-free survival rate of 95%, 85%, 88%, and 81% for Simpson I, II, III, and IV, respectively.^[25] Note that, with other variables such as age, sex, and preoperative embolization, there is no association between survival and resection type.^[25] Sughrue *et al.*, 2010, reaffirmed that the disease-free survival rate, specifically for PSMs, is higher when individuals are subjected to Simpson I and II resection.^[25]

In the present study, disease-free survival was predominantly lower in Group A (Simpson I); however, the different follow-up times precluded the statistical evaluation of this variable. This outcome may be associated with other variables, primarily a history of cancer, advanced age, or surgical complications.

In the study conducted by Pettersson-Segerlind *et al.*, 2011, 48% (15/31) of patients evaluated died as a result of the tumor within 25 years, highlighting that 10 of these individuals received Simpson III resection or higher, suggesting that more aggressive approaches reduce the risk of mortality from the disease.^[19]

Although a controversial topic in the literature, the patients in Group B with the WHO Grade II meningioma, in addition to those suffering from malignant neoplasms (WHO Grade III), received radiotherapy as a complementary therapy to

resection. Some studies have shown that the disease-free survival period is longer when associated with total resection (Simpson I and Simpson II) employing radiotherapy.^[11,27] In the study conducted by Komotar *et al.*, tumor recurrence occurred in 92% of patients who had WHO Grade II meningioma and were not subjected to complementary radiotherapy, compared to a 7.7% recurrence in patients subjected to RT after complete resection.^[11]

In a study of 39 patients with meningioma WHO II, the disease-free survival time was longer for patients subjected to complementary radiotherapy.^[18] In addition, mortality was higher in the group not subjected to radiotherapy and, of these, eight patients died within 1 year of surgery, while in the group undergoing complementary radiotherapy, the first recurrence-related deaths occurred between 5 and 9 years after total resection surgery.^[18] In the present study, four patients in Group B presented with atypical meningioma (WHO II) and were subjected to radiotherapy. Recurrence was only observed in one individual with a follow-up period of 5 years. Radiotherapy was not used on any of the patients evaluated in Group A.^[2]

The biggest contraindication for complete resection of PSMs lies in the risk of vascular lesion; however, it should be stressed that surgical techniques have evolved significantly since 1957,^[1,25] such that the focus is now on the viability of Simpson II resection associated with the lateral wall of the SSS, with the use of imaging examinations and neuronavigation for surgical planning, as well as the use of microscopy to evaluate tumor resection margins.

CONCLUSION

PSMs with the invasion of the SSS pose a challenge to neurosurgery due to the risk of damage to the adjacent vascular structures and, consequently, a higher chance of postoperative neurological deficit. Moreover, the aim of PSM resection should be to minimize the risk of tumor recurrence and provide a good quality of life for the patient. In this regard, the present study demonstrated that the Simpson II technique, with preservation of the lateral wall of the SSS, associated with complementary therapy, is the approach with a lower risk of postoperative deficit and mortality than Simpson I PSM resection. Moreover, this technique also exhibited a low tumor recurrence rate in the group where this was performed.

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Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

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