Giant Meningiomas Invading the Cavernous Sinus: The "Inevitable Ones"

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Abstract

Introduction Giant meningiomas invading the cavernous sinus (GMICSs) are a subgroup of challenging tumors due to their volume and the extent of neurological impairment. Preserving quality of life is one of the most relevant aspects of treating patients with GMICS.

Methods A retrospective study was conducted for surgeries performed between 2012 and 2022, including 33 patients presenting meningiomas with the largest diameter of at least 5 cm invading the cavernous sinus. The data from surgical intervention, Simpson grade of resection, tumor location, and morbimortality related to the surgeries were reviewed.

Results The group comprised 25 women and 8 men with a median age of 56 years. The mean follow-up period was 52 months. The tumors were in the sphenoid wing, anterior clinoid, spheno-orbital, spheno-petroclival, petroclival, and Meckel's cave. Simpson grade I, II, and III were obtained in 70% of cases. The meningiomas were classified as WHO grade 1 in 94%, grade 2 in 3%, and grade 3 in 3%. The overall mortality was 3%. Permanent cranial nerve deficits occurred in 21%, transient cranial nerve deficits in 42%, cerebrospinal fistula in 15%, and hemiparesis in 18%. The recurrence/regrowth rate was 6%. The Karnofsky Performance Status score of 100 and 90 was 82%.

Conclusions The surgical treatment of GMICS is an effective treatment modality with acceptable morbimortality and good long-term control. Involvement of the internal carotid artery is essential to determine the extent of resection inside the cavernous sinus, and training in the microsurgical laboratory is mandatory for safe surgical treatment.

Keywords
- meningiomas
- cavernous sinus
- microsurgery
- cranial nerves

Introduction

Meningiomas are the most common primary intracranial tumor, corresponding to nearly 39% of all brain lesions, and they are the most common cavernous sinus (CS) tumors.[1,2] CS meningiomas originate either from the CS itself or invasion from adjacent sites, such as the anterior clinoid process, sphenoid wing, petrous bone, petroclival region, and Meckel's cave.[3] Primary CS meningiomas are rare, corresponding to 1% of all meningiomas.[4] Whereas, secondary invasion is much more frequent according to the epidemiology of the meningiomas of each original site.[5]

For several decades, CS tumors were considered inoperable due to neurovascular involvement. However, during the 80s and 90s, several skull base centers developed microsurgical techniques which made the aggressive removal of CS

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meningiomas possible.[3,6,7] The morbidity related to such approaches, and the increasing use of radiotherapy modalities for primary or adjuvant treatment of CS meningiomas, led to a progressive trend of avoiding CS surgery in favor of therapeutic modalities in an effort to control the disease.[8] However, when meningiomas from adjacent sites grow to considerable volumes, invading the CS, surgical intervention is mandatory, not only because of cranial nerve (CN) disturbances but also due to life-threatening intracranial hypertension and brain stem compression.[5,9–14] It is essential that skull base surgeons are prepared to deal with such challenging tumors, promoting safe and extensive resections and preserving the quality of life (QOL) of such patients. In this study, we present our experience with the surgical management of giant meningiomas invading the CS (GMICS).

Methods

Clinical and Image Evaluation

The local research ethics committee at the Hospital Ernesto Dornelles approved this study. Patient information was de-identified before analysis. A retrospective study was conducted for surgeries between 2012 and 2022, including 33 patients presenting meningiomas with the largest diameter of at least 5 cm invading the CS. A series of preoperative computed tomography (CT) and/or magnetic resonance imaging (MRI) with contrast were obtained in all cases. Bone invasion was examined by means of bone window CT studies. Tumor diameter was defined as the maximal diameter in the three orthogonal planes in T1-weighted images of the tumor into the CS in an MRI with gadolinium-enhanced contrast or CT. CS involvement was defined as infiltration of the CS space in the MRI or CT. Patients with anterior clinoid meningiomas (ACMs), sphenoid wing meningiomas (SWMs) of the middle third, and spheno-orbital meningiomas (SOMs) were included when the lesions invaded the superior and/or lateral walls or the inside of the CS. Globoid lateral SWMs without CS invasion and primary CS meningiomas were excluded. Sphenopetroclival meningiomas (SPCMs), petroclival meningiomas (PCMs), and Meckel's cave meningiomas invading the CS were included. The data from each surgical intervention were reviewed. Special attention was given to the Simpson grade of resection, tumor location, and morbimortality related to the surgery. In addition, we examined the medical records, operative reports, radiologic examinations, and follow-up information. The patients underwent surgery with the intent of the most extensive safe removal, considering each patient's medical condition and comorbidities. Postoperative CT and MRI were obtained in all cases. The QOL was graduated according to the EQ-5D-3L criteria10, applying the standard questions during the postoperative outpatient consultations.[15] The data collected in the last patient review during the postoperative period were included in the analysis.

Surgical Approaches to GMICS

The senior author (C.E.S.) used three primary surgical approaches to the SWMs, ACMs, SOMs, and SPCMs with CS invasion: the pterional approach, the cranio-orbital (CO) approach, and the CO zygomatic (COZ) approach. For PCMs, and Meckel's cave meningiomas, the author used the anterior petrosal, posterior petrosal, and combined petrosal approaches. Microsurgery and endoscopic-assisted microsurgery were performed in the cases. The meningiomas were operated on using a four-step technique divided into exposure, extradural removal, intradural removal, and reconstruction, as previously described.[5]

Results

Between 2012 and 2022, 33 patients underwent surgery to remove GMCSI. The 33 meningiomas in the sample included the following types: 3 clinoidal meningiomas, 8 SWMs, 9 SOMs, 5 SPCMs, 7 PCMs, and 1 Meckel's cave meningioma. The group comprised 25 women and 8 men with a median age of 56 years (range: 27–86 years). The mean follow-up period was 52 months (range: 4–124 months). Simpson grade I, II, and III resections were obtained in approximately 70% of the surgeries; specifically, 15.2% of the resections were Simpson grade I, 33.3% were Simpson grade II, and 21.2% were Simpson III.

The meningiomas were classified as World Health Organization (WHO) grade 1 in 94% of the cases, WHO grade 2 in 3%, and WHO grade 3 in 3%. Meningiomas that had been operated on previously accounted for 21% of patients (►**Table 1**), and meningiomas previously irradiated accounted for 9% of cases, all WHO grade 1 except for 1 WHO grade 3. All meningiomas included were giant (>5 cm).

Preoperative CN deficits occurred in 18 patients (54.5%) and seven patients presented multiple CN deficits (21.2%). Permanent new CN deficits occurred in 21.2% of cases (7 patients). Transient CN deficits occurred in 42.4% of the patients (►**Table 2**). In the group of patients with previously symptomatic CN deficits, a preoperative optic nerve deficit was present in seven cases, and improved in two postoperative patients (28%). In patients presenting postoperative third nerve deficits (10 cases), 70% recovered in up to 6 weeks.

Cerebrospinal (CSF) fistula occurred in 15%, and hemiparesis occurred in 18%, most related to PCM and SPCM. The recurrence/regrowth rate was 3% during the follow-up period. The overall mortality rate was 3%, and it was related to one patient with a SOM meningioma who died late in the postoperative period because of pulmonary infection. ►**Table 1**

Table 1 Morbimortality rate in the present series

Morbidity	*N* (%)
CSF leak	5 (15.1)
Transient CN DEF	14 (42.4)
Definite CN DEF	7 (21.2)
Hemiparesis	6 (18)
Death	1 (3)

Abbreviations: CN, cranial nerve; CSF, cerebrospinal fistula.

Table 2 Discriminative data of the patients with GMICS

Topography	SA	Simpson grade	Preop CN deficit	New definite CN deficit	KPS
1. SW	FT	2	N	N	100
2. SW	FT	2	N	N	100
3. SW	FT	2	N	N	100
4. SW	FT	2	N	N	100
5. SW	FT	1	N	N	100
6. SW	FT	2	N	N	100
7. SW	FT	2	N	N	100
8. SW	FT	2	N	N	100
9. CLIN	Pterional	1	II	N	90
10. CLIN	Pterional	4	II	N	90
11. CLIN	Pterional	3	N	N	70
12. SOM	COZ	4	II, III, IV, V, VI	N	90
13. SOM	CO	1	N	N	100
14. SOM	COZ	3	I, II	N	0
15. SOM	CO	2	N	N	100
16. SOM	COZ	2	N	N	100
17. SOM	CO	2	II	III	90
18. SOM	FT	4	II, V	III	90
19. SOM	COZ	2	II	N	90
20. SOM	CO	2	II	N	90
21. SPC	CO	3	III, V, VI	N	40
22. SPC	CO/PPA	4	VI, VII, VIII	V	90
23. SPC	COMBPA	4	V	N	100
24. SPC	COMBPA	3	VII, VIII, IX, X, XI	N	50
25. SPC	PPA	2	II	III	70
26. PC	PPA	4	IX, X, XI	VI	100
27. PC	PPA	3	VI	N	70
28. PC	PPA	4	N	VII, VIII	70
29. PC	PPA	4	VII, VIII	N	80
30. PC	PPA	4	VIII	V, VI, VII	90
31. PC	PPA	2	N	N	100
32. PC	PPA	2	N	N	100
33. MC	COMBPA	3	VI	N	90

Abbreviations: CLIN, clinoidal; CN, cranial nerve; CO, cranio-orbital; COMBPA, combined petrosal approach; COZ, cranio-orbito-zygomatic; FT, fronto-temporal; KPS, Karnofsky Performance Status; MC, Meckel's cave; PC, petroclival; PPA, posterior petrosal approach; SA, surgical approach; SOM, spheno-orbital meningiomas; SPC, sphenopetroclival; SW, sphenoid wing.

summarizes the morbimortality of the series. ►**Table 2** presents the pre- and postoperative CN deficits. The Karnofsky Performance Status score of 100 and 90 was 75%. ►**Table 3** summarizes the EQ-5D-3L10 frequencies for the 32 surviving patients.

Discussion

GMICSs are usually symptomatic lesions with visual abnormalities, neurological deficits secondary to intracranial hypertension or direct mass effect, and even cosmetic disturbances, occurring in productive patients with a long-life expectancy. With such tumors, surgical treatment is inevitable, and management options should consider removing as maximal safe as possible the meningiomas because of the inverse relationship between the grade of resection and the recurrence of the disease.[5,8,16]

The extent of resection inside the CS must consider preoperative CN deficits, whether there is narrowing of the

Table 3 EQ-5D-3L frequencies in pre- and postoperation for GMICS for 32 surviving patients

	Mobility pre-/post-	Self-care pre-/post-	Usual activities pre-/post-	Pain/discomfort pre-/post-	Anxiety/depression pre-/post-
Level 1	33 / 25	33/26	23/ 26	33/30	15/24
Level 2	0/6	0/5	11/ 5	0/2	18/7
Level 3	0/1	0/1	0/1	1/0	0/1

internal carotid artery (ICA), the estimated consistency of the tumor in imaging studies, and the experience of the neurosurgeon in dealing with CS tumors.[3,5,17–20] Our center is surgery-oriented in treating meningiomas, although radiosurgery and fractionated radiation are also available, and we use combined therapies in selected cases. This philosophy balances concern for the patient's QOL, the safety of the intervention, and the expected long-term evolution of the disease.[5,11–14,16,21–23]

Surgical Strategy

Principles of Meningioma Surgery—FEBAIR

Surgical removal is the most effective treatment for meningiomas, and it is essential to apply certain principles during the planning and performance of meningioma surgery.[3,5,8–11,16] We highlight each of these surgical principles using the acronym FEBAIR, as previously described.[5,24]

Surgical Findings According to GMICS Topography

Clinoidal Meningiomas

Clinoidal meningiomas are challenging lesions because of their relation to vital neurovascular structures. The involvement of the ICA and optic nerve is crucial during the surgical removal of the clinoidal meningiomas. Al-Mefty classified such tumors into three groups, according to the origin of the meningioma in the anterior clinoid process.[9] Group I (inferior original attachment) lacks the protection of the arachnoid membrane, preventing the radical removal of such tumors most of the time. The most frequent CN disturbances in clinoidal meningiomas are related to the optic nerve and III nerve paresis. Recent literature data described 85% of visual impairment in the preoperative period for clinoidal meningiomas.[25] Chen et al observed more than 76% of visual improvement after clinoidal meningioma removal.[26] He et al described approximately 55% of optic nerve dysfunction in CS tumors, and half of the patients improved their visual function after tumor removal.[27] In the present series, we observed one case of giant clinoidal meningioma with adherence to the medial aspect of the clinoid segment of the ICA, with a residual tumor left inside the medial part of the CS and ICA anterior bend. The other two clinoidal meningiomas were Al-Mefty group II, with an arachnoidal plane between the tumors and the neurovascular structures, allowing for a gross total removal. Nevertheless, one patient presents postoperative ischemic damage related to small perforators, and postoperative hemiparesis. Two patients improved their visual preoperative deficits (66%), and one remained unaltered.

Sphenoid Wing Meningiomas

The middle-third SWMs were more related to middle cerebral artery involvement because of their relation to the Sylvian fissure stem.[28] The compromise of the CS is of its lateral wall, compressing the CS and not indeed invading the space. Such tumors are suitable for total removal, and the extradural step of the surgery, with the peeling of the CS's lateral wall, is crucial for liberating the structure from the meningioma (►**Fig. 1**).[5] The intradural step with microsurgical dissection using the arachnoid plane separates the tumor and the middle cerebral artery branches and perforators (►**Fig. 2**).[5] The eight cases operated on in the present series were totally removed with no additional deficits. Balasa et al described 52% of visual disturbances in preoperative analysis of giant sphenoid meningiomas.[29] Such data are due to inclusion of all types of the SWMs, including the medial third in a single group. The careful evaluation of the separate groups of the meningiomas is necessary to understand the risks of each surgery. For such purpose, the original attachment of the SWMs is essential, as proposed in the original classification of Cushing and Eisenhardt.[30] The middle-third SWMs always present an arachnoid plane separating the middle cerebral artery branches from the tumor and the precise microsurgical dissection leads to a total removal with excellent functional results.

Spheno-orbital Meningiomas

SOMs are a subtype of the lateral SWMs, which are related to the Sylvian veins, and the preservation of the venous drainage may be more challenging than in deeper lesions.[5,12,14,30] In the nine cases included in the present series, the invasion of the CS occurred through the superior orbital fissure and the superior and lateral walls of the CS. These tumors involve the bone of the lateral limits of the orbit, the basal portion of the greater sphenoid wing, and its foramina. We retrospectively observed that for the SOMs previously operated on in other departments, the bone involvement of the orbit and middle fossa floor had not been removed, and the recurrence was related to these residual bone lesions. The recurrence involved the orbit, SOF, CS, or infratemporal fossa.[5,6] Such tumors present an "en plaque" pattern of involvement of the orbit, anterior and middle fossa floor, and CS. The proptosis and visual disturbances are frequent in the preoperative diagnosis. Terrier et al observed 94% of proptosis in their series, and 37% of visual disturbances.[31] Kiyofuji et al

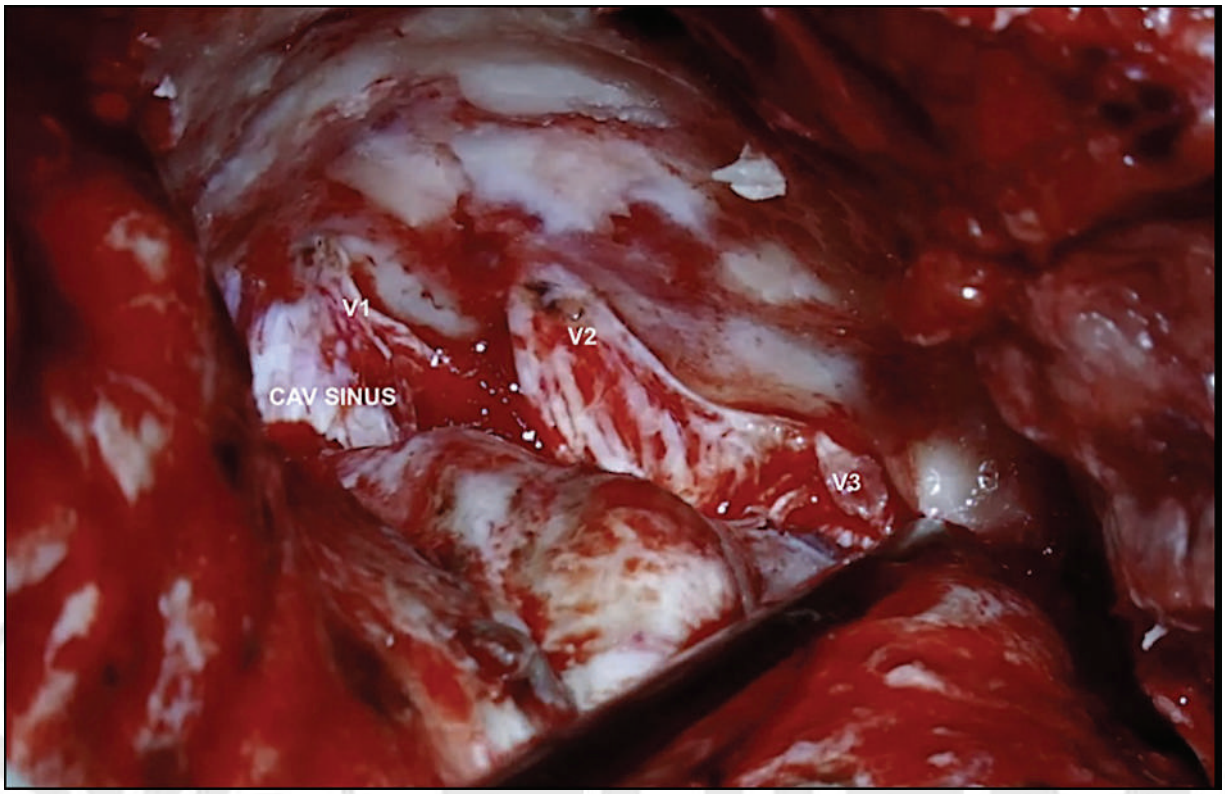

Fig. 1 Extradural exposition and right-side middle fossa peeling.

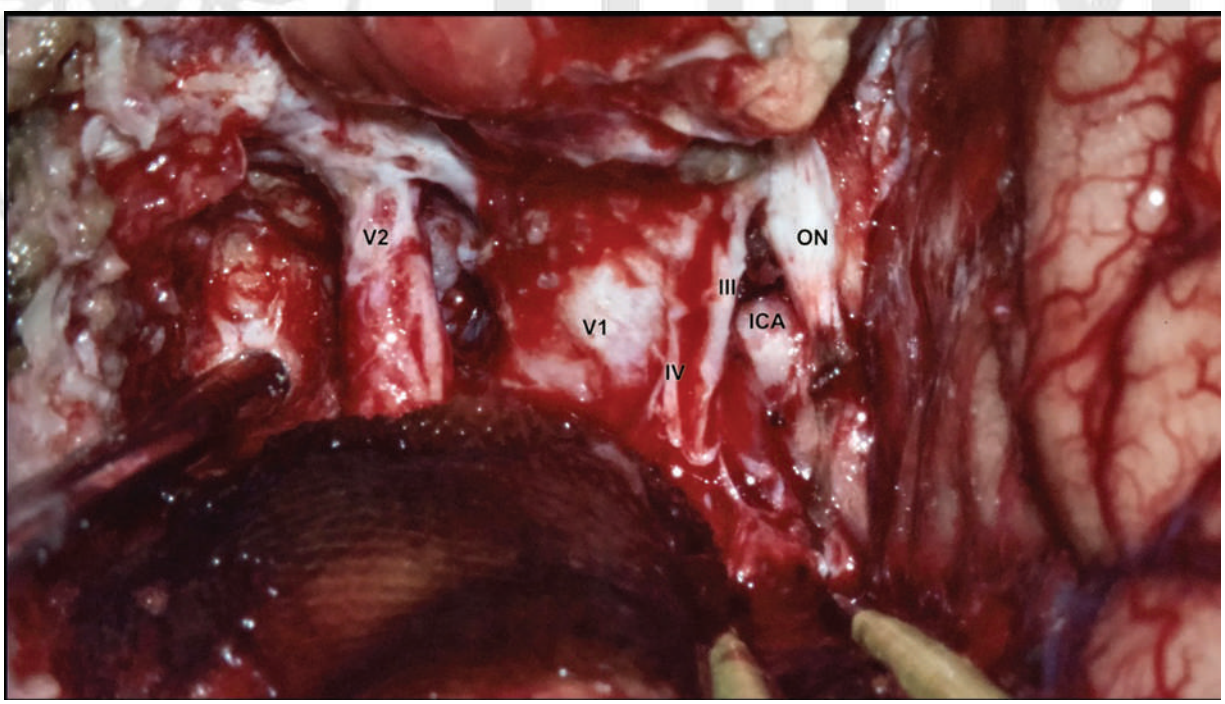

Fig. 2 Intradural dissection of the left cavernous sinus.

described 60% of visual deficits in the preoperative period of SOM, with 75% of improvement after surgery. Third nerve palsy occurred in 9 of their 47 cases, and 8 patients recover completely.[32] Gonen et al[33] presented similar results with 92% of proptosis and 37% of visual disturbances.

In all cases in the present series, patients with SOM present a proptosis. Four patients (~40%) presented visual impairment in the preoperative period. Three of such cases had been operated on in another department and one was previously irradiated, and the blindness were unaltered in

the postoperative period. In the same way of the SWMs, the extradural step of the surgery is crucial for total removal, because of the decompression of the neural structures at the optic canal and superior orbital fissure, besides the total bone removal which is the key to control the recurrence of SOM.

We do not reconstruct the lateral and superior aspects of the orbit in patients with preoperative exophthalmos. There was no postoperative enophthalmos, and all patients improved their cosmetic aspects and QOL. Some residual exophthalmos was present after total bone removal in patients with severe preoperative abnormality. We hypothesized that the venous abnormalities and fibrotic reaction in the periorbita were involved in such findings when the tumor was removed from the periorbita and the bone involvement was removed.[5,12–14]

Petroclival and Sphenopetroclival, and Meckel's Cave Meningiomas

Different surgical approaches have been described for the treatment of PCMs. The classic retrosigmoid, pretemporal COZ, anterior petrosal, posterior petrosal, combined petrosal, and endonasal endoscopic approaches are used for tumor removal.[10,23,34,35] The anterior, posterior, and combined petrosal approaches are chosen by the senior author (C.E.S.) for the surgical treatment of most PCMs.

The anterior petrosal approach was performed through a supra-petrosal craniotomy for petrous apex meningiomas, Meckel's cave meningioma, and petroclival tumors extending up to the seventh and eighth CNs.[36,37] The COZ approach was used with exposure of the superior and lateral portion of the CS, followed by peeling of the middle fossa and removal of the anterior clinoid and the petrous apex for SPCMs. Early control of part of the vascularization of the tumor through coagulation of the middle meningeal artery and bone removal is an excellent advantage of the COZ approach. The limitation regarding the extension of the tumor to the posterior fossa is the VII and VIII nerves inferiorly. SPCM meningiomas that do project below the internal acoustic meatus require the association of another complementary approach.[10,23,36]

The posterior petrosal approach presents the advantage of better exposure of the midline and contralateral clivus and the inferior projection of the tumor below the VII and VIII CNs. Tumors with a hard consistency, with projection crossing the midline, less dislocation of the middle cerebellar peduncle, and extension to the middle fossa, are exposed by the posterior petrosal approach.[10,23,34,38]

For tumor extension into the CS, the tentorial opening and access to Meckel's cave were performed by dissecting the lateral wall of the posterior CS. The most complex and crucial dissection points were the petroclinoidal ligament, Dorello's canal, and the posterior clinoid process. The preservation of the IV and VI CNs was directly related to the consistency of the meningioma. ►**Figs. 3** and **4** present examples of PCM and Meckel's cave meningioma. Wagner et al described invasion of the CS in 76% of their PCMs. They observed more than 80% of transient CN deficits with around 25% of definite morbidity of such nerves.[39] In the present series, the abducens nerve was the most common preoperative CN deficit, followed by the trigeminal and facial nerves. In the postoperative period, three cases (25%) presented new six nerve palsy and one case with new trigeminal disturbances.

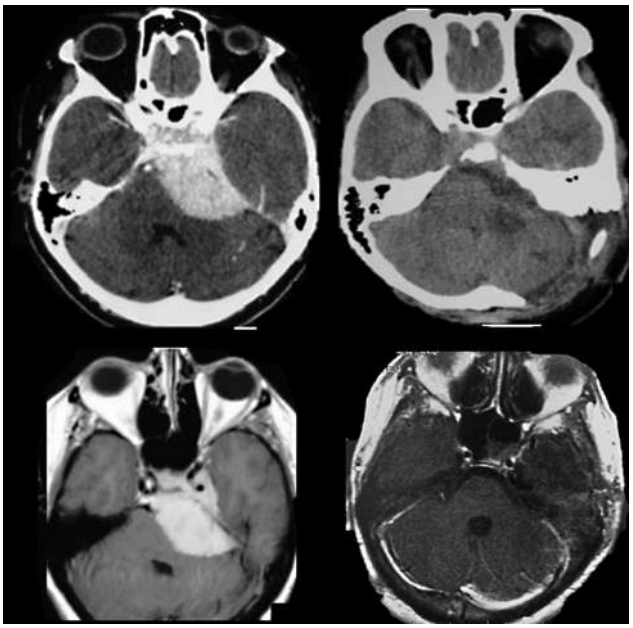

Fig. 3 Petroclival meningioma. Above: (left) preop CT of petroclival meningioma; (right) postop CT, note the mastoidectomy of the posterior petrosal approach. Below: (left) preop MRI of the case, (right) postop MRI presenting extensive removal. CT, computed tomography; MRI, magnetic resonance imaging.

The vascular involvement of the giant petroclival and SPCMs was related to four cases of hemiparesis. Venous lesions of the lateral complex of veins in the peri mesencephalic cistern and the superior venous complex were related to three brain stem infarctions. One case of posterior cerebral artery injury was related to mild postoperative hemiparesis.

Surgery of CS Meningiomas

Historical reports of CS surgery present the evolution from the concept of "no man's land" to Parkinson's pioneering studies in 1965, the high development of the CS anatomy and surgical techniques during the 80s and 90s, and the current trend toward conservative surgeries with radiation modalities associated with preservation of patient QOL.[3–8,40]

Primary CS meningiomas and secondary CS invasion in meningiomas from other topographies, as in the cases presented in this series, are distinct groups of tumors with pathologic nuances relevant to surgical strategies and results. The fundamental issue is the original attachment of the tumor. Primary CS meningiomas originate from the arachnoidal membrane surrounding the entry point of the CNs in the CS typically adhere to the nerves and the ICA, and have higher morbidity associated with their removal. Primary CS meningiomas present a more favorable natural history and in asymptomatic patients, we advocate observation.[5,40] Secondary CS meningioma invasion displaces the parasellar space, and the natural barriers of the superior, lateral, and posterior CS walls are anatomical allies to a safer dissection and neurovascular preservation.[41–43]

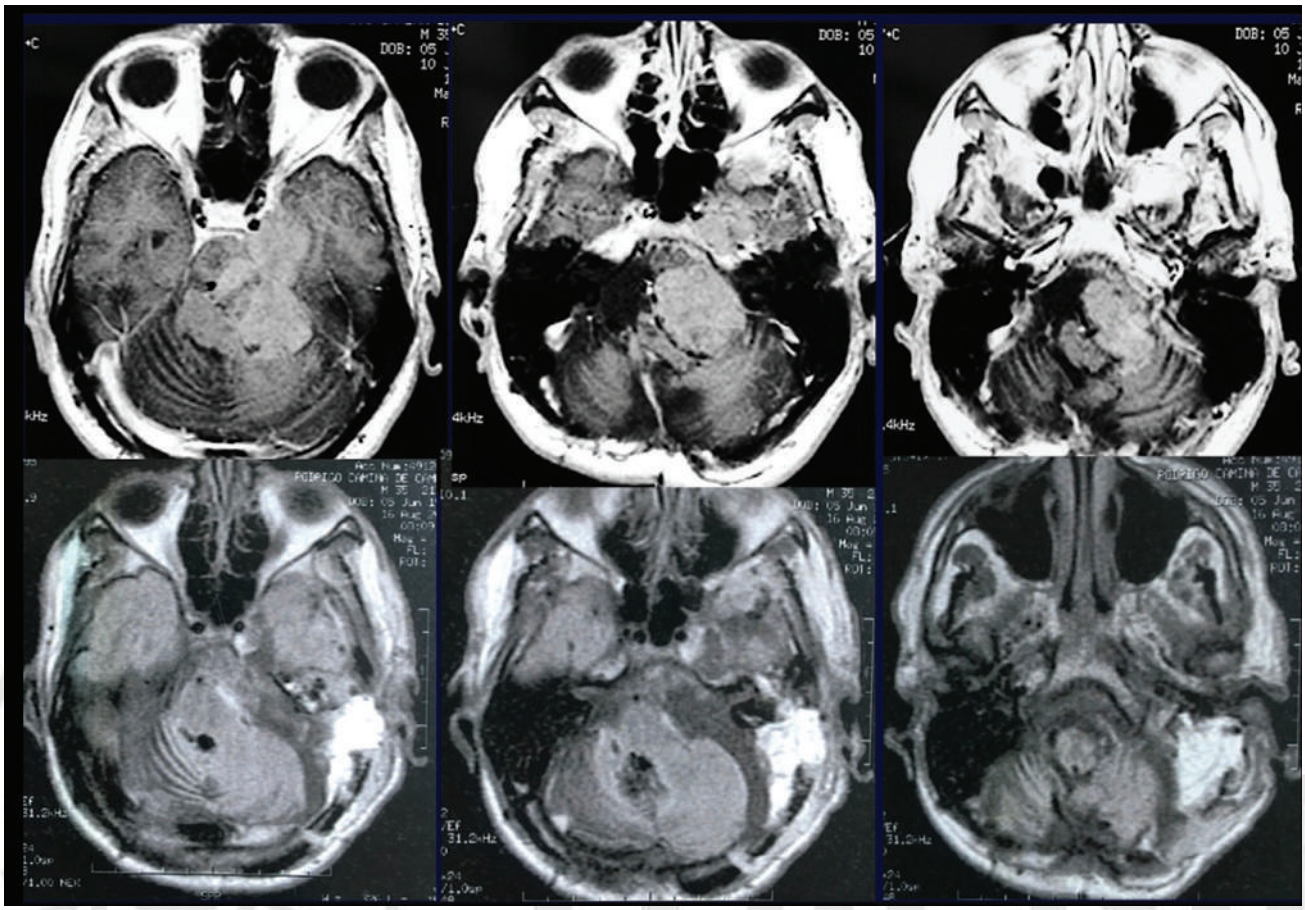

Fig. 4 Meckel's cave meningioma. Above: preop MRI of a giant Meckel's cave meningioma. Below: postop MRI presenting complete removal through a combined petrosal approach. MRI, magnetic resonance imaging.

Another crucial point is the narrowing of the ICA by the tumors. Less aggressive removal is indicated when such a finding is observed in the preoperative image studies of primary and secondary meningiomas.[3,5,35]

When the ICA exhibits such an abnormality, we confirm with digital subtraction angiography and recommend optic nerve decompression, partial removal of the tumor involvement of the lateral wall of the CS, and avoiding dissection inside the CS triangles. We do not perform intracranial bypass for aggressive surgery of the ICA encasement by intracavernous meningiomas.

In secondary CS meningioma invasion, the peeling of the middle fossa and exposure of the superior and lateral walls of the CS, with extradural anterior clinoid removal, are important for a progressive identification of the normal anatomy and relation of the CNs in order to perform effective, safe removal.[5,6] Our goal is to perform extradural surgery for the CS below the temporal lobe, preserving its venous drainage. For this purpose, we perform a small opening in the frontal dura and drain the CSF from the optic and carotid cisterns. This maneuver relaxes the brain, avoiding excessive traction and the need for lumbar external drainage. For PCMs, we drain the CSF at the beginning of the intradural step of the surgery from the cerebellomedullar cistern, and the CS portion of the tumor is removed through a transtentorial route, opening the Meckel's cave and the lateral wall of the CS.[10,37]

In our experience, the most relevant technical difficulties in meningioma surgery inside the CS are:

- The liberation of an ICA total encasement, which is more sensitive in the anterior and posterior bends.[5,43]
- The preservation of the vascular supply of the CNs in the SOF and in the inferior border of the nerves.[5,44–47]
- The anatomic preservation of the fourth CN.[5]
- The identification and preservation of the sixth CN lateral to the posterior bend of the ICA.[5]

The strategic and technical maneuvers to deal with such difficulties are:

- Avoid aggressive manipulation of the ICA if there was a narrowing of the artery in the preoperative studies.
- Wide extradural opening of the SOF by totally removing the bone in the extradural step of the surgery.
- Sharp cutting dissection parallel to the superior border of the nerves.
- Immediate CN anastomosis with fibrin glue if we observe a rupture of the nerve.

The most relevant issue related to the extent of removal of GMICS was the consistency of the tumors. Softer lesions present a higher feasibility of extensive resection than harder meningiomas.[5,48] The surgeon's intraoperative perception

of tumor consistency is an important subjective factor in avoiding vascular and CN lesions.

Several studies point to radiosurgery as a preferred primary treatment for CS meningiomas or a complementary treatment following partial removal. Hung et al described in their recent series of gamma knife for treating CS meningiomas that 74% of the tumors had volume regression and 8% progressed, with progression-free survival at 10 years of 81.2%.[49] Park et al presented a long follow-up series of gamma knives for CS meningiomas, with 85% disease control in 15 years, and tumor progression after microsurgery was an independent predictor of an unfavorable response to radiosurgery. The authors reported 7.5% of new CN deficits after radiosurgery, with larger tumor volumes presenting a higher risk of developing CN disturbances.[50] Lee et al, in a recent systematic review of stereotactic radiosurgery (SRS) for benign CS meningiomas, observed a 39% improvement in CN deficits in 3 years, and prior microsurgery was related to higher levels of definite CN disturbances.[51]

The molecular signature of the midline and parasellar meningiomas tend to present a more favorable biological behavior most of the time.[52] The natural history of these tumors also presents long-term stability and low rates of CN deficits.[40] Such fundamental aspects are important biases to evaluate the efficacy of SRS in controlling benign meningiomas, which were primarily treated by radiation. In the present series, the large tumor volume, the symptoms related to the CS and brain stem compression, and multiple previous CN deficits were indications for microsurgery before any radiation modality. We advocate observation following tumor removal, and when recurrence is diagnosed, without the possibility of surgical removal, we perform radiosurgery. In residual WHO grade 2 and WHO grade 3, we advocated complementary SRS.

Cranial Nerve Morbidity and the QOL Dilemma

The CN morbidity related to meningiomas with CS involvement has often been described as limiting to performing surgery and preserving QOL. One important issue is that many patients with CS meningiomas discover their illness due to some visual disturbance or sensitive facial abnormalities affecting their everyday lives. In the present study of GMICS, 54% (18 patients) presented with preoperative CN deficits, leading to a diagnosis of meningiomas (►**Table 2**). The most prevalent preoperative and postoperative disturbances were visual deficit and visual disorder. Nanda et al described the same findings, pointing to the importance of the preoperative impairment of the patient's QOL due to CN compression and visual disturbances in GMICS.[53] Jakola et al observed that patients improve their QOL after a meningioma surgery in an elegant prospective study.[54] Kalkanis et al, using the Functional Assessment of Cancer Therapy-Brain questionnaire, observe that 86% of patients returned to a normal life and 80% were satisfied with their QOL following the removal of a meningioma.[55] In the present series, proptosis, visual acuity impairment, and facial cosmetic abnormalities in patients presenting with SOM (9 cases, 27%) were observed in the preoperative period, with an evident impact on QOL. Anxiety-related preoperative symptoms improved for around 30% of the patients in the postoperative period, according to the EQ-5D-3L criteria10.[56–58]

The overall definite new CN deficits in the present series were 21%, but the evolution of such deficits differed according to the CN involved. Third and fourth nerve involvement were the most favorable for recovering function following the resection of the lateral cavernous component of the tumors.

Hemiparesis (18%) was related to giant PCM and SPCMs with severe brain stem compression and venous disturbances and one clinoidal meningioma with perforator injury. Removing the CS portion of the meningiomas in the present series was unrelated to injury to the ICA. The narrowing of the ICA in the preoperative period was essential to defining the extension of the intracavernous dissection, in order to avoid vascular injuries.

Conclusion

The surgical treatment of symptomatic GMICS is an effective treatment modality with acceptable morbimortality and good long-term control of the disease. Visual impairment is the most common abnormality, affecting both the preoperative and postoperative QOL of patients with GMICS. Vascular involvement of the ICA is essential to determine the extent of resection inside the CS. And finally, training in the microsurgical laboratory is mandatory for safe surgical treatment.

Conflict of Interest
None declared.

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