Sphenoid wing meningiomas: surgical results

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RESUMO

Meningiomas da asa esfenoidal. Resultados cirúrgicos

Objetivo: *Analisar o resultado do tratamento cirúrgico dos meningiomas esfenoidais.* ***Método:*** *Estudo retrospectivo de 32 pacientes com meningiomas da asa do esfenóide, operados de janeiro de 2000 a janeiro de 2004 na Clínica Neurocirúrgica do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo.* ***Resultados:*** *A média etária dos pacientes foi de 43 anos, sendo 26 do sexo feminino e 6 do sexo masculino. Crises convulsivas foram a primeira manifestação clínica de 16 pacientes. Quanto à localização, 3 pacientes apresentavam meningiomas em placa, 8 localizados no terço interno, 14 no terço médio e 7 no terço externo. Ressecção Simpson I foi obtida em 9 pacientes, Simpson II em 15, Simpson III em 6, e Simpson IV em 2. Quanto aos resultados do tratamento cirúrgico, observamos 22 resultados excelentes, 7 bons, 2 ruins e 1 óbito.* ***Conclusão:*** *O tratamento cirúrgico é o tratamento de escolha para meningiomas da asa do esfenóide, com bons resultados e reduzidas complicações.*

PALAVRAS-CHAVE

Meningioma, cirurgia.

ABSTRACT

Objective: *To present neurosurgical aspects of the sphenoid wing meningiomas treatment.* ***Method:*** *Retrospective study of 32 patients with sphenoid wing meningiomas submitted to surgery from January 2000 to January 2004, in the Neurosurgical Clinic of São Paulo University Medical School.* ***Results:*** *The average age of the patients was 43 years, being 26 females and 6 males. As to the clinical presentation, the most frequent first manifestation was seizure, presented by 16 patients. As to location, 3 patients presented en plaque meningiomas, 8 were located in the inner third segment, 14 in the middle third segment and 7 in the outer third segment. Simpson I resection was obtained in nine patients, Simpson II in 15, Simpson III in 6 and Simpson IV in 2 patients. The surgical results were considered excellent in 22, good in 7, bad in 2 and there was 1 death.* ***Conclusion:*** *The main treatment of sphenoid wing meningiomas is the surgical resection with good results and little complications.*

KEY WORDS

Meningioma, surgery.

Introduction

Meningiomas are primary neoplasm derived from meninges arachnoid's cap cells. They are extra-axial and usually benign tumors. Meningiomas constitute one of the main groups of central nervous system primary tumors with an incidence of 19% of central nervous system tumors in an analysis of 18.171 tumors[23]. The incidence as an incidental finding in necropsy is around 2.3% of patients examined or 30% of tumors found[5].

The meningiomas originated in any portion of the sphenoid wing represent approximately 14% to 31% of all intracranial meningiomas. Sphenoidal wing is one of the three most common locations of meningiomas described in the literature[1,2,3,5,10,19,23,32].

Its great incidence and its intricate anatomic location render the clinical, neuroimaging, histopathological and biological study fundamental to the correct handling, elaboration of treatment strategies and prevention of complications.

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This study details the authors' results and main treatment aspects of sphenoidal meningiomas with emphasis to microsurgical anatomy.

Patients and methods

This is a retrospective study of patients submitted to surgical treatment in the Cerebral Tumor Group of Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo (Sao Paulo University School of Medicine Hospital).

Thirty-two surgically resected sphenoidal meningiomas were included in this study, during a period of four years, from January 2000 to January 2004. Clinical, surgical and neuroimaging reports were reviewed in all cases.

They were classified depending on their site of implantation along the sphenoid wing as inner third (clinoidal and sphenocavernous), middle third (alar tumors), outer third (pterional tumors) or "en plaque" tumors, by analysis of preoperative computed tomography (CT) and magnetic resonance imaging (MRI) images.

The clinical results were classified as excellent (patients with no disability), good (patients with mild disability and good functional life), bad (patients with severe disability) and death.

The extent of the surgical removal was graded according to Simpson criteria[29].

This study was approved by the Ethics Committee of the Hospital (CAPPesq protocol number 328/05).

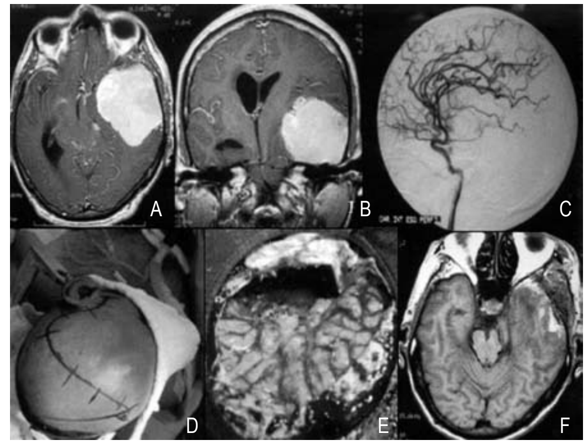

Figura 1 – This 40 year old male presented with seizures. A, B and C: The MRI and angiography illustrate a large middle third sphenoid wing meningioma. D and E: The patient was submitted to surgical treatment. F: With complete ressection.

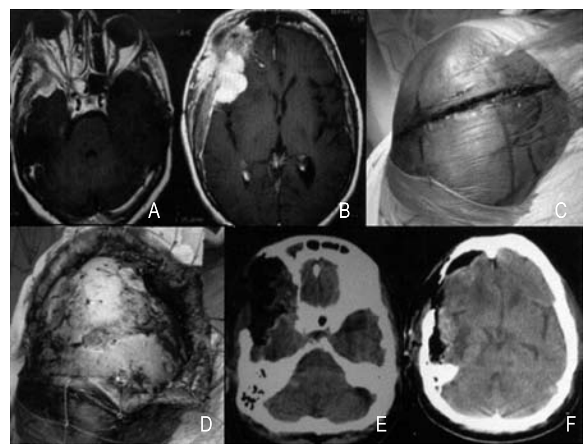

Figure 2 – This 59 year-old female patient with a prior surgery 10 years before, presented with visual loss and proptosis. A, B: The MRI demonstrated an en plaque meningioma. C, D: The patient was submited to surgery. E, F: The lesion was ressected.

Results

Thirty-two patients were studied: 26 females and 6 males with an average age of 43 years.

In 16 patients the first symptom were seizures, mostly complex, however some were simple with secondary generalization (Figure 1). Headache was present in 12 patients, and 12 patients had intracranial hypertension symptoms. Four patients showed motor weakness.

The distribution of the patients according to location was: 3 patients presented en plaque meningiomas (Figure 2), in 8 the tumor was located in the inner third segment, 14 in the middle third (alar) segment and 7 in the outer third (pterional) segment. Seven of these patients presented sphenoorbital involvement. Twenty-four patients were submitted to preoperative angiography, 11 of them being submitted to preoperative embolization.

The surgical procedures performed were: pterional approach in 19, orbito-zigomatic extension in 7, and a combined anterior clinoidal process resection (Dolenc's approach) in 6.

As to the extent of resection, Simpson I resection was obtained in 9 patients, Simpson II was obtained in 15, Simpson III in 6 (patients with cavernous sinus or medial cerebral artery involvement) and Simpson IV in 2 patients (patients with carotid artery involvement).

The most common postoperative complication was cerebral fluid fistula present in 6 patients. Most of these patients (total of 5) were submitted to drilling of the anterior clinoid process, sphenoid wing or orbital wall with inadequate reconstruction of the dura mater. They were all treated with external lumbar drainage with good results. There were 3 cases associated with meningitis after dural fistula caused by *Pseudomonas* sp., and one case with osteomielitis caused by *Staphylococcus aureus*. Three cases developed surgical bed hematoma, one associated with the use of external lumbar drainage; one patient was submitted to reoperation to evacuate the hematoma.

Intraoperative carotid artery lesion occurred in one patient which needed to have the artery clipped. In this case dissecting Sylvian fissure was very difficult, the carotid artery was involved by the tumor and there was no preoperative angiographic study. This patient developed an isquemic process and was submitted to a decompressive craniotomy, but died a few days later.

The patients with Simpson III and IV degree of resection did not present an increase of the lesion up to now, and were not submitted to chemotherapy or radiation therapy.

The overall results were: 22 excellent results, 7 good, 2 bad and 1 death.

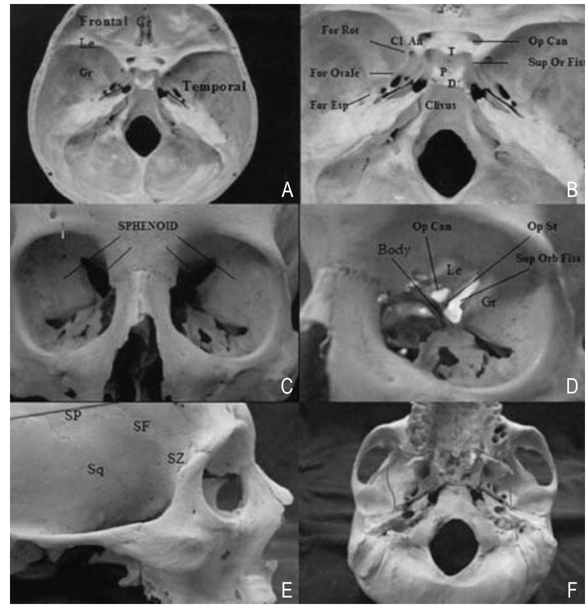

Figure 3 – Osseous relationships of the sphenoid bone. A: The sphenoid bone is located in the center of the cranial base. It has a central portion called the body, two lesser wings (Le), two greater wings (Gr) and two pterygoid processes with their medial and lateral pterygoid plates that emerges caudally from the body. It is related to the ethmoid bone – crista galli and cribriform plate (Cr) – and frontal bone (Frontal) on the anterior cranial base. A bone crista of the posterior margin of the lesser wing (Le), the sphenoid ridge delimits the anterior fossa from the middle fossa. The squamosal and petrosal parts of the temporal bone (Temporal) forms with the greater wing the endocranial surface of the middle fossa. B: The pituitary fossa (P) occupies the central part of the body and is located posteriorly to the tuberculum sellae (T) and anteriorly to the dorsum sellae (D). The upper part of the clivus (clivus) is formed by the sphenoid bone and the lower by the occiptal bone.The optic canal (Op Can) is separated from the superior orbital fissure (Sup Or Fiss) by the optic strut, which extends from the base of the anterior clinoid (An Clin) to the sphenoid body[35]. Forame ovale (For Ovale), rotundum (For Rot) and spinosum (For Spin) are all located in the sphenoid bone. C: The walls of the orbit are formed by seven bones, including the sphenoid bone (Sphenoid). D: The lesser wing (Le) forms the posterior part of the of the orbital roof, and the lateral wall is formed by the greater wing (Gr) and zygomatic bone. The body (body) of the sphenoid bone forms the posterior part of the medial wall. The optic canal is situated in the junction of the lesser wing and sphenoid body. E: Lateral aspect; the greater sphenoid wing is bounded posteriorly by the squamous suture (Sq), superiorly by the sphenofrontal suture (SF) and sphenoparietal (SP), and anteriorly by the sphenozygomatic suture (SZ). F: Inferior view of the cranial base, the sphenoid bone is outlined.

Discussion

Microsurgical anatomy

The sphenoid bone is located in the center of the cranial base. It has a central portion called the body, two lesser wings, two greater wings and two pterygoid processes with their medial and lateral pterygoid plates that emerges caudally from the body. The sphenoid bone is anatomically complex and integrates several cranial regions, forming the anterior and middle cranial base (Figure 3).

The anterior cranial base, formed by the ethmoid, sphenoid and frontal bones, is divided into a middle portion formed by crista galli and cribriform plate of the ethmoid bone anteriorly and by the planum of the sphenoid body posteriorly, covering the superior nasal cavity and the sphenoidal sinus; a lateral portion, formed by the frontal bone and the sphenoid lesser wing, covers the orbit and the optic canal[25].

The middle cranial base can be divided into a medial portion formed by the sphenoidal bone body where the tubercullum sellae, pituitary fossa, middle and posterior clinoidal process, carotid sulcus and dorsum sellae are found; and a lateral portion formed by sphenoid greater and lesser wings. The greater sphenoid wing forms the major part of the middle fossa floor, which is complemented by the squamosal and petrous portion of the temporal bone[25,26].

The sphenoid ridge is a bone crista of the posterior margin of the lesser wing, which from the anterior clinoid describes an antero-lateral curve in the horizontal planum up to the lateral portion of the cranial wall (Figure 4). This anatomic structure delimits the anterior fossa from the middle fossa, projects into the Sylvian fissure and separates the frontal and temporal bones and is divided in three segments: inner (clinoidal), middle (alar) and outer (pterional)[10]. The supraclinoidal portion of the internal carotid artery emerges from the medial side of the anterior clinoidal process and courses posterior, superior and laterally to reach the lateral side

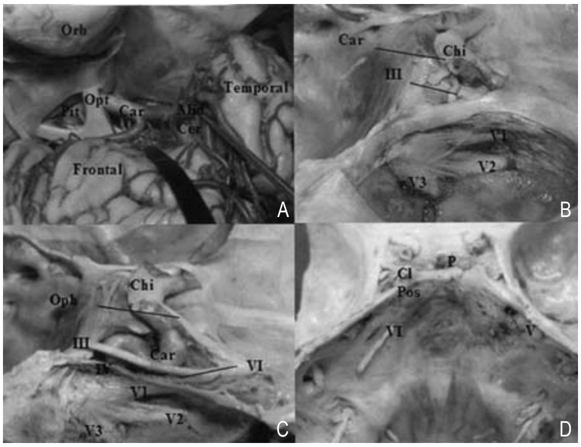

Figure 4 – Neural, arterial and venoius relationship. A: The olfactory tract and the frontal lobe, rest against the upper surface of the lesser wing. The temporal lobe rests against the greater wing.The middle cerebral artery (Mid Cer) courses parallel to the sphenoid ridge. B: Lateral view; the II to VI nerves are intimately related to the sphenoid bone, here V1 exit the cranium through the superior orbital fissure, V2 through the foramen rotundum and V3 through the foramen ovale; III cranial nerve enters the cavernous sinus. C: The anterior clinoidal process has been ressected, the carotid and ophthalmic arteries exposed. The carotid artery forms a serpiginous proeminence lateral to the sphenoid sinus (contained in the sphenoid body).The superior orbital fissure is situated between the greater and lesser wings and body of sphenoid bone. The III, IV, VI, and VI cranial nerves exit through the superior orbital fissure. D: The upper part of the clivus is formed by the sphenoid bone and is located anteriorly to the basilar artery and the pons and mesencephalon.

of the optic chiasm where it bifurcates. It gives rise to the anterior and middle cerebral arteries at the medial end of the Sylvian fissure, just below the anterior perforated substance. The sphenoidal segment of the middle cerebral artery courses parallel, and slightly posterior to the sphenoid ridge in the sphenoidal compartment of the cisternal part of the Sylvian fissure[27].

The olfactory tract and the frontal lobe rest against the upper surface of the lesser wing. The temporal lobe rests against the greater wing. The II to VI nerves are intimately related to the sphenoid bone. The oculomotor nerve courses through the superior orbital fissure and the oculomotor foramen of the annular tendon of Zinn and divides into the upper and lower divisions. The abducens nerve enters the superior orbital fissure and the oculomotor foramen to the lateral rectus muscle. The ophthalmic nerve enters the superior orbital fissure and divides just behind the annular tendon. The trochlear nerve also passes through the superior orbital fissure. The optic nerve passes superior and medial from the globe to reach the optic canal, and the ophthalmic artery courses below the nerve in the optic canal. The maxillary and mandibular nerves pass through the foramen rotundum and ovale, both located in the greater wing of the sphenoid.

The cavernous sinus extends from the superior orbital fissure in its anterior edge to its posterior wall located between the dorsum sellae medially and the ostio of the Meckel cave laterally[35]. The main venous afferent to the cavernous sinus are the superior and inferior ophthalmic veins and the sphenoparietal sinus. The pituitary gland is located in the sella which is partially closed above by the diaphragm sellae.

Clinical and radiological features

The clinical presentation of the meningiomas is rather diverse, being related to its location, size and the bone alterations which it provokes.

The clinoid meningiomas produce visual deterioration and visual field deficit, possibly coursing with Foster Kennedy syndrome (primary optical atrophy and contra lateral papilloedema).

In patients with sphenocavernous meningiomas, alterations of extrinsic ocular motricity is the most common sign, generally beginning with a abducens nerve palsy, possibly evolving to ophthalmoplegia. Other associated symptoms are trigeminal dysthaesia and exophthalmia, caused by the venous compression in the cavernous sinus[5,20,23].

Alar meningiomas normally produce symptoms only when reach greater sizes, being detected more lately and presenting a larger diameter. The initial symptoms are normally related to the increase of intracranial pressure, coursing with headache, papilloedema, possibly evolving to olfactory nerve dysfunction, visual loss, visual field deficit, facial nerve palsy, hemiparesis and seizures[5,23].

En plaque meningiomas produce an evolutive proptosis, caused by regional bone hyperostosis, presence of intraorbital tumor, periorbital tumoral infiltration or yet secondary to the venous stasis of the cavernous sinus. Upper eyelid swelling is another characteristic sign that can be present, as well as bone deformities by temporal bone hyperostosis or by the temporal muscle infiltration[12,13].

Globoid pterional meningiomas course mainly with symptoms related to their intracranial growth, such as contralateral hemiparesis, intracranial hypertension, headache, seizures[5,9,18,19,21,34].

The most common symptoms at the moment of admission in our study were seizures, headache and signs of intracranial hypertension.

CT is used for diagnostical evaluation, and demonstrates characteristic findings proper to meningiomas, such as widened implantation base, homogenous capitation of contrast, hyperostosis and bone erosion[5,14,24,32]. The MRI does not demonstrate precisely the bone architecture as the computed tomography does, however its capacity to demonstrate the intracranial anatomy makes it very useful in these tumors study. MRI can identify the position of carotid and medial cerebral arteries, as well as other vessels, allowing to delimitate the tumor vascular involvement and offering strategies for the treatment. MRI can also show intracranial dural involvement that is not visualized on the computerized tomography. Preoperative angiography is used for a better visualization of the feeding vessels of the tumor and when the preoperative embolization is considered[5,14,24,32]. In our series twenty-four patients were submitted to preoperative angiography, 11 of them being submitted to preoperative embolization once they presented predominant irrigation by large meningeal branches or by ethmoidal branches.

Classification and surgical treatment

The meningiomas originated from the sphenoidal wing are rather complex, due to its intricate anatomy, presenting a close relation to anterior circulation arteries, oculomotor and optic nerves. Several classifications were proposed in the past years in order to standardize the study of meningiomas in this region.

The meningiomas of this area can occur as a nodular or en plaque shape. The nodular tumors are encapsulated, of different sizes, which displace or involve adjacent structures, such as nerves and arteries. They generally present an implantation point through which the irrigation occurs. In the en plaque meningiomas the pathological cells fill in the Havers's bone canals and can disseminate to the pterion, orbit, malar, zigoma, middle fossa and temporal bones. This bone infiltration results in hyperostosis, producing proptosis and temporal bulging[2,3,5-7,10,19,24].

Cushing and Eisenhardt[10] classified the nodular meningiomas according to its implantation place as the inner third, middle third or outer third. In certain voluminous tumors that occupy all the extension of the sphenoid wing the correct identification of the tumoral implantation may be difficult. Petit-Dutaillis divided them into lesser wing and greater wing tumors.

Brotchi, Bonnal et al.[7,8] classified them according to their implantation and shape, namely: clinoidal or sphenocavernous (tumors extending from the dura of the cavernous sinus or anterior clinoid process, and the internal part of the sphenoid wings; they are tumors in close contact with carotid artery, optic nerve and tract); en plaque meningiomas of the sphenoid wings (tumors spreading in the dura of the cavernous sinus and sphenoid wings, producing hyperostosis, the optic nerve can be compressed in some cases and the tumor can have an extracranial component); invading meningiomas of the sphenoid wing en masse (tumors combining the components of the two preceding groups); middle third globous, with no invasion, and no contact with the carotid artery or optic nerve; and pterional, on the limit of the cranial base and convexity, emerging on the Sylvian fissure and displacing the frontal and temporal lobes.

Al Mefty[1-3] subdivided the clinoid tumors into three categories. The first one comprises the tumors originated proximal to the end of the carotid cistern, originating from the inferior aspect of the anterior clinoid, engulfing the carotid artery, adhering directly to the adventitia without an interfacing arachnoidal membrane, making dissection of the tumor from the arteries impossible. In the second group are the tumors that involves the carotid artery; however they present a cleavage planum, originating from the anterior clinoid supero-laterally. The third group refers to the generally small tumors, which originate in the optic foramen, extending into the optic canal, usually an arachnoids interface is present between the tumor and the carotid artery, but may be absent between the optic nerve and the tumor.

As to the meningiomas of the cavernous sinus, Hirsch[28] proposes a classification according to the neuroimaging findings and reflects the degree of difficulty to remove the tumor. The first group includes tumors presenting contact with the internal carotid artery without involving it. The second group corresponds to tumors that involve the carotid artery, but do not cause stenosis. In the third group are the tumors that involve the artery and cause its stenosis.

In our series we have divided the sphenoid bone meningiomas in four categories, inner third, middle third, outer third and en plaque. We found 8 meningiomas located in the inner third segment, 14 in the middle third and 7 in the outer third. There were 3 patients presenting en plaque meningiomas.

The treatment of sphenoid meningiomas aims the complete surgical excision of the tumor and involved meninges, though the resection difficulty exists in certain cases. The introduction of microsurgical techniques and contemporary cranial base concepts with knowledge of the anatomy of the skull base have made possible radical tumoral resections with better outcome. Sphenocavernous meningiomas involving cranial nerves or carotids and en plaque meningiomas which infiltrate the orbit apex are subjected to subtotal resection.

Surgical technique

The classical pterional approach and its variants allow the approach and adequate exposition of the great majority of the sphenoidal meningiomas.

In our series, all 7 tumors located in the outer third segment were submitted to a frontotemporosphenoidal craniotomy. In 4 cases the Simpson I resection was obtained and there were 3 patients with orbital involvement that needed an extended resection of the lateral orbital wall with Simpson II resection. García-Navarrete and Sola[17] observed complete resection in 13 of 16 patients with similar tumors.

Total removal was obtained in all of 14 middle third segment tumors, 4 graded Simpson I and 10 Simpson II. The pterional approach was selected in 11 patients and 3 patients were submitted to a fronto-orbito-zygomatic craniotomy. There have been no complications and no recurrence among these patients. Ojemann[24] had similar results with seven patients.

All patients presenting en plaque meningiomas were submitted to a pterional approach combined with extradural anterior clinoidal process resection (Dolenc's approach). The degree of resection was Simpson III in all 3 patients. Honeybul et al.[19], in a series with 14 patients of en plaque sphenoid wing meningiomas, achieved 5 patients with no residual tumor, 7 patients with residual tumor and no progression of the disease and 2 clinical recurrences.

Tumors of the inner third segment of the sphenoid wing were found in 8 patients of our series. Most of the complications and the poor degree of resections involved tumors in this location. Two patients had carotid artery involvement with early interruption of the surgery (Simpson IV). In one surgery the interruption was due to an accidental carotid lesion which needed to be clipped. There were three patients with invasion of the cavernous sinus approached by a pterional approach combined with extradural anterior clinoidal process resection (Dolenc's approach). The selected approaches were fronto-orbito-zygomatic craniotomy in 4 patients, Dolenc's approach in 3 and pterional in 1. For similar cases, Al-Mefty[1] reported total removal in 20 of 27 patients and Brotchi and Bonnal[8] found total removal in 9 of 28 patients.

The frontotemporosphenoidal craniotomy with wide Sylvian and basal cisterns opening allows a safe tumoral removal in most of the cases[4,15,17,33]. According to the tumor extension this approach can be adapted for a better tumor handling; in this way, tumors involving the orbit cavity can be better approached through a fronto-orbitary craniotomy, with the removal of the orbital ridge[30,31]. The fronto-orbito-zygomatic craniotomy allows, with the additional removal of the zygomatic arch, a better infra-temporal exposition, decreasing the cerebral retraction, increasing the vision angle and bringing the surgeon near his working position. The anterior clinoid resection enables a better vision of the carotid artery clinoidal segment in cases where its involvement occurs. Superior orbital fissure and optic canal decompression are employed when necessary[1,5,16,19,22,24,32].

Skull base techniques are used specially in large meningiomas involving the cavernous sinus. Using a high speed drill, with skeletonization of the optic sheath and unroofing of foramen spinosum, ovale, rotundum, superior orbital fissure to expose its contents create space to work on the tumor and give an early access to the main feeding arteries[1,2,3,11,24,32].

Conclusion

The meningiomas of the sphenoid wing are a frequent tumor encountered in the central nervous system. Its main treatment is surgical resection with good results and little complications. The knowledge of the microsurgical anatomy of the region is essential for the good outcome.

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