Original Article

Surgical Management of Spheno-orbital Meningiomas En Plaque; Clinical and Radiological Outcome

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ARTICLE INFO

ABSTRACT

Background: Spheno-orbital meningiomas en plaque are located in a complex area between the orbital and intracranial compartments and characterized by carpet like growth that infiltrate the dura mater and surrounding bone. Objective: This retrospective study analyzes the postoperative clinical and radiological outcome of twenty three patients with spheno orbital meningiomas en plaque operated upon in the Neurosurgery Department, Cairo University Hospitals. Patients and Methods: Patient selection: patients with spheno orbital meningiomas en plaque. Operation: surgical resection of the tumor, involved bones and periorbita via fronto-temporal approach. Results: Between Jan 2010 and December 2013, twenty three patients were operated upon for treating spheno-orbital meningiomas en plaque via fronto-temporal approach and followed up clinically and radiologically for a mean of 18 months. During clinical follow up, improvement of proptosis was achieved in fifteen patients (78.9%) out of nineteen patients presented with proptosis at a mean of 2 months postoperatively, visual improvement occurred in seven patients (58.3%) out of twelve patients presented with decreased visual acuity within the postoperative 2-12 weeks. Postoperatively, lid and orbital swelling occurred in all patients (100%), cranial nerve palsy in ten patients in which seven were transient (30.4%) and three were permanent (13%), subgaleal CSF collection occurred in eleven patients (47.8%), intra cerebral hematoma in one patients (4.4%) and two patients (8.7%) developed postoperative fits. Radiological follow up revealed total resection in sixteen patients (69.6%) and no recurrence was encountered. Conclusion: Spheno-orbital meningiomas en plaque are located in a complex anatomical region. Surgical management is not uniform and should be tailored to fit each case. Radical tumor excision can be achieved by proper microsurgical dissection, aggressive bony removal and wide orbital decompression with low postoperative morbidity, good clinical outcome and less rate of recurrence. However, greater sample size and longer follow up would aid further documentation.

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INTRODUCTION

The term of meningioma en plaque was introduced by Cushing and Eisenhardt in 1938 to describe carpet-like basal tumor growth associated with significant hyperostosis.¹ Sphenoid wing meningiomas with osseous involvement represent 9% of all intracranial meningiomas. Spheno-orbital meningiomas en plaque also represent a part of secondary orbital meningiomas that originate intracranially and extend to the orbit.²,³

The spheno-orbital meningioma en plaque originates from outside the orbit including the sphenoid wing dura, the convexity dura and cavernous sinus and extends to the orbit through the superior orbital fissure, inferior orbital fissure and optic canal with significant bony invasion and hyperostosis of the lesser sphenoid wing, the orbital roof, the lateral orbital wall, the squamous part of temporal bone, optic canal, anterior clinoid and the sphenoid or ethmoidal sinuses.⁴

The histological features of spheno-orbital meningiomas en plaque are similar to other meningiomas with meningothelial and transitional types encountered commonly. The blood supply of the spheno-orbital meningiomas en plaque often originates from meningeal arteries but many of these tumors are relatively avascular.⁵,⁶

The spheno-orbital meningiomas typically manifest in women with an average age of 40-50 years and usually present with proptosis caused by intraorbital and periorbital tumor infiltration, venous compression and hyperostosis in addition to visual impairment and diplopia.⁷

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Computerized tomography (CT) in axial and coronal projections can demonstrate the hyperostotic changes of bones. Magnetic resonance imaging (MRI) can detect the soft tissue invasion of optic canal, superior and inferior orbital fissures and cavernous sinus.

Surgical management is the primary treatment modality for cases with spheno-orbital meningiomas en plaque to correct the disfigurement and arrest the progression of the presenting visual symptoms, but complete surgical resection is sometimes infeasible due to the involvement of the orbital apex and/or cavernous sinus in which radio surgery can be used for residual or recurrent tumors.

PATIENTS AND METHODS

Between Jan 2010 and December 2013, twenty three patients with spheno-orbital meningiomas en plaque were admitted and managed in the Neurosurgery Department, Cairo University Hospitals.

All patients underwent proper history taking including age, sex, presenting symptoms, duration of symptoms, full neurological and ophthalmological assessment focusing on proptosis evaluation, fundus examination, ocular motor, abducent nerve palsy, visual acuity and field assessment.

Proper radiological assessment was done for all patients including computerized tomography (CT) scan of the brain and orbit with thin cuts to visualize involvement of the orbital walls, optic canal and anterior clinoid as well as to determine the extent of bony work needed in the region of the sphenoid wing and temporal bone. Magnetic resonance imaging (MRI) with and without gadolinium was performed to evaluate the extent of dural, orbital and cavernous sinus involvement. Perimetry was done in all patients to assess visual field deficits.

Surgical technique:

All patients were operated upon via fronto-temporal approach. Under general anesthesia, and after installation of proper antibiotics and antiepileptic coverage, the patient is placed in supine position with head rotated 45-60 degrees to the contralateral side. The skin incision is planned to include a greater area than the bony extension of the tumor.

A large fronto-temporal craniotomy was done followed by (1) removal of the involved areas of the squamous part of the temporal bone, (2) removal of the involved areas of superior orbital wall, (3) removal of the affected lateral orbital wall, (4) drilling of the deep portions of the bony orbit down to the superior orbital fissure, (5) unroofing of the optic canal if involved to decompress the optic nerve using small diamond burr, (6) extradural drilling of the anterior clinoid process if involved.

C-shaped dural opening was performed and may be modified according to tumor location to allow proper excision of all involved convexity dura and periorbita.

Trans sylvian approach was then started first to identify the optic nerve and carotid artery. This maneuver helps preservation of the vascular supply of optic apparatus. The tumor capsule and its peripheral portions are then sharply dissected from surrounding structures under microscopic magnification. Debulking and excision of the soft tissue component of the tumor was performed using bipolar-suction technique with proper coagulation of any affected portions of the basal dura in which excision was not feasible. If the tumor invades the substance of the optic nerve, resection must be limited to the exophytic part of the tumor.

In all cases due to partial or extensive dural excision, not permitting primary water tight dural closure, fascia lata and fat dural grafting was performed by trying to avoid post operative CSF leakage. Reconstruction of the squamous part of the temporal bone should be done using bone cement and titanium miniplates for better cosmetic results.

The operative notes were analyzed to evaluate the surgical approach together with the extent of resection which was evaluated and classified according to Simpson grading scale. (Table 1) Leaving a residual tumor in cavernous sinus is considered Simpson grade III.

Table 1: Simpson grading system for removal of meningiomas

<table>
<thead>
<tr>
<th>Grade</th>
<th>Degree of removal</th>
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<tr>
<td>I</td>
<td>Macroscopically complete removal with excision of dural attachment and abnormal bone</td>
</tr>
<tr>
<td>II</td>
<td>Macroscopically complete removal with endothermy coagulation of dural attachment</td>
</tr>
<tr>
<td>III</td>
<td>Macroscopically complete removal without coagulation of dural attachment or of its extradural extension (e.g. hyperostotic bone).</td>
</tr>
<tr>
<td>IV</td>
<td>Partial removal leaving tumor in situ</td>
</tr>
<tr>
<td>V</td>
<td>Simple decompression</td>
</tr>
</tbody>
</table>
Proper postoperative monitoring is performed in the intensive care unit for 24 hours.

All the histopathological reports were recorded to be analyzed. Patients were followed up for a period ranging from 12 – 40 months (mean 18 months)

Clinical outcome was evaluated regarding the neurological, ophthalmological and cosmetic status immediately postoperative, during the hospital stay period (3-5 days) and 3, 6, 12 months intervals. Postoperative CT scan and MRI of the brain and orbit with gadolinium were done within 48 hours after surgery to assess the extent of tumor resection together with the involved bones then at 3, 6, 12 months intervals to evaluate the progression of any residual or recurrence.

RESULTS

From January 2010 to December 2013, twenty three female patients with age ranged from 22-64 years (mean 49 years) were admitted to Cairo University Hospitals with spheno-orbital meningiomas en plaque. All patients underwent microsurgical resection using the fronto-temporal approach.

Two out of the twenty three patients (8.7%) presented with recurrent tumor after four and six years of primary surgery respectively.

The main presenting symptoms were proptosis in nineteen patients (82.6%), decreased visual acuity in twelve patients (52.2%), temporal swelling in twelve patients (52.2%) and visual field deficits in nine patients (39.1%) as summarized in table 2.

<table>
<thead>
<tr>
<th>Presenting symptom</th>
<th>No of patients</th>
<th>(%)</th>
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<tbody>
<tr>
<td>Proptosis</td>
<td>19</td>
<td>(82.6%)</td>
</tr>
<tr>
<td>Decreased visual acuity</td>
<td>12</td>
<td>(52.2%)</td>
</tr>
<tr>
<td>Temporal swelling</td>
<td>12</td>
<td>(52.2%)</td>
</tr>
<tr>
<td>Visual field deficit</td>
<td>9</td>
<td>(39.1%)</td>
</tr>
<tr>
<td>Diplopia</td>
<td>6</td>
<td>(26.1%)</td>
</tr>
<tr>
<td>Headache</td>
<td>5</td>
<td>(21.7%)</td>
</tr>
<tr>
<td>Trigeminal pain</td>
<td>4</td>
<td>(17.4%)</td>
</tr>
<tr>
<td>Blindness</td>
<td>1</td>
<td>(4.4%)</td>
</tr>
</tbody>
</table>

The mean duration of symptoms was 20.1 months (range 2-36 month).

The tumor was on the left side in fifteen patients (65.2%) and on right side in eight patients (34.8%).

Preoperative CT and MRI were performed to evaluate tumor extension, bony involvement as well as the extent of resection in recurrent cases. Hyperostosis of the lateral, superior walls of orbit and squamous part of temporal bone were found in all cases (100%), optic canal involvement in fifteen patients (65.2%), anterior clinoid process involvement in ten patients (43.5%) and cavernous sinus extension in four patients (17.4%). (Table 3), (Fig. 1)

All patients underwent fronto-temporal craniotomy followed with extradural removal of the orbital roof and lateral orbital wall down to the superior orbital fissure. The squamous part of the temporal bone was drilled removing its deep part in eleven patients (47.8%) and resected in twelve patients (52.2%) and replaced by bone cement. Unroofing of the optic canal was done in fifteen patients (65.2%), extradural anterior clinoid resection was done in ten patients (43.5%).

After dural opening, the affected dura of the convexity and the periorbita were resected in all cases (100%). Intra orbital nodule was found in two cases (8.7%), temporalis muscle involvement was encountered in five cases (21.7%).

Total excision (Simpson grade I and II) was achieved in sixteen patients (69.6%) and subtotal removal (Simpson grade III) in seven patients(30.4%) , four patients due to cavernous sinus extension and three patients due to orbital apex involvement.

Repair of the dura was done using fascia lata graft and fat in all cases to prevent postoperative CSF leakage.

Histological examination revealed World Health Organization grade I meningioma, fifteen patients (65.2%) meningotheelial and eight patients (34.8%) fibroblastic.

Proptosis improved in fifteen (78.9%) out of nineteen patients at mean period of 2 months and remained unchanged in four patients (21.1%) two of them had orbital cone involvement. Out of twelve patients presented with declined visual acuity, seven patients (58.3%) improved within 2-12 weeks, four patients (33.3%) remained unchanged and one case (8.4%) which was severely affected preoperatively (hand movement) worsened to blindness postoperatively.

Radiological assessment (CT and MRI) within 48 hours post operatively revealed total excision in sixteen patients (69.6%) and residual tumor in seven patients (30.4%), four of them with residual in the cavernous sinus, two with residual in the orbital cone and one with residual in superior orbital fissure. All the seven cases with residual tumor were candidates for an adjuvant management in form of gamma knife therapy. (Fig. 2, 3)

No recurrence was encountered on radiological follow up at 3, 6 and 12 months intervals with evident
control after adjuvant therapy in all seven cases with residual tumor.

All patients (100%) developed postoperative lid and orbital swelling which resolved within 4-7 days under steroid therapy. Seven patients (30.4%) developed transient ophthalmoparesis which improved within 2-4 weeks, all of them involved the oculomotor nerve. Three patients (13%) developed permanent cranial nerve deficit, one of them had abducens nerve palsy while two patients suffered decline of visual acuity and did not show improvement at 6,12 months follow up.

Eleven patients (47.8%) developed subgaleal cerebrospinal fluid collection which regressed spontaneously within 1-2 weeks in 8 patients while three patients needed continuous lumbar drainage for 4-5 days. One patients (4.35%) developed small temporal intra cerebral hematoma which resolved spontaneously without the need for surgical intervention. Two patients (8.7%) developed postoperative fits and controlled on antiepileptic therapy within 5 days. (Table 4)

<table>
<thead>
<tr>
<th>Complications</th>
<th>No of patients (%)</th>
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<tbody>
<tr>
<td>Orbital swelling</td>
<td>23 patients (100%)</td>
</tr>
<tr>
<td>Transient cranial nerve palsy</td>
<td>7 patients (30.4%)</td>
</tr>
<tr>
<td>Permanent cranial nerve palsy</td>
<td>3 patients (13%)</td>
</tr>
<tr>
<td>Subgaleal CSF collection</td>
<td>11 patients (47.8%)</td>
</tr>
<tr>
<td>Intra cerebral hematoma</td>
<td>1 patient (4.35%)</td>
</tr>
<tr>
<td>Epileptic Fits</td>
<td>2 patients (8.7%)</td>
</tr>
</tbody>
</table>

Fig. 1 a&b: Case No 6 a: preoperative MRI brain with gadolinium axial cut and b: CT brain (bone window) showing left sphenoidal meningioma en plaque.

Fig. 2 a&b: Case No 6, CT brain a: soft and b: bone window cuts on 2nd day post operative showing removal of anterior clinoid and unroofed left optic canal.

Fig. 3: Case No 6 postoperative MRI brain with gadolinium at six months interval showing complete removal of left sphenoidal meningioma en plaque.
DISCUSSION

Spheno-orbital meningiomas en plaque are located in a complex area between the orbital and intracranial compartments and characterized by carpet like growth that infiltrates the dura mater and surrounding bone.\(^4\)

The aim of surgical management is radical removal of the tumor without morbidity to improve the long term clinical outcome and decrease the recurrence rate. Effective resection requires complete removal of all hyperostotic bone, involved dura and peri-orbita.

Different approaches have been postulated however, in the current study the fronto-temporal approach was preferred and performed in all cases. This approach allows excellent and sufficient access to the orbit and middle fossa base, facilitates the required bony work, tumor dissection, optic canal and superior orbital fissure decompression as well as extradural drilling of the anterior clinoid.

In this study, twenty three patients with spheno orbital meningiomas en plaque were operated upon and followed up clinically and radiologically for a mean period of 18 months. During the follow up period, improvement of proptosis was achieved in fifteen patients (78.9%) out of nineteen patients presented with proptosis at a mean of 2 months postoperatively, visual improvement occurred in seven patients (58.3%) out of twelve patients presented with decreased visual acuity within the postoperative 2-12 weeks. Postoperative lid and orbital swelling occurred in all patients (100%), cranial nerve palsy in ten patients in which seven were transient (30.4%) and three were permanent (13%), subgaleal CSF collection occurred in eleven patients (47.8%), intra cerebral hematoma in one patient (4.4%) and two patients (8.7%) developed postoperative seizures. Radiological follow up revealed total resection was performed in sixteen patients (69.6%) and residual tumor in seven patients (30.4%). No recurrence was encountered.

Ringel et al. surgically treated sixty three patients with spheno orbital meningiomas en plaque with mean age of 51 years, the most common preoperative presentation was proptosis (79%) followed by diminished visual acuity (27%). After surgery using pterional approach, proptosis improved in 77% of patients, 64% of the patients presented with decreased visual acuity had improved, twelve patients (19%) showed temporary occulomotor deficits and eight patients (12.7%) showed permanent deficits. Median follow up period was 4.5 years, 76% of patients had tumor residuals.\(^11\) Ringel et al. had near similar results to the current study except in their lower rate of post operative temporary occulomotor nerve palsy and higher rate of residual tumor, this is attributed to the difference in surgical technique especially the limited resection of the affected portions of periorbita (44%), as well as the higher number of patients presenting with recurrent tumors and/or cavernous sinus and orbital cone involvement in their study, in addition to the smaller sample size of the current study.

Mirone et al. studied seventy patients with spheno-orbital meningiomas en plaque operated upon by pterional approach during a 20 year period. The most common symptoms were proptosis (85.9%) and visual impairment (57.7%). Complete removal was achieved in 83% of patients and the recurrence rate in patients with total excision was 25% with 43.3 months mean recurrence time.\(^12\) Mirone et al reported higher rate of total resection. This may be attributed to the larger percentage of cases with cavernous sinus, orbital cone, superior orbital fissure involvement in the current study.

No recurrence was detected in our study throughout the follow up period (12 months) which is shorter than Mirone and colleagues follow up interval explaining, together with the slow rate of tumor growth, the difference in recurrence rate between the two studies.

Many techniques had been described for orbital reconstruction following surgical removal of spheno orbital meningioma en plaque, some authors advise firm reconstruction to avoid an enophthalmus, pulsating eye bulb, or occulomotor muscle fibrosis which may result in ophthalmoplegia by using auto graft in form of iliac crest bone, calvarial split bone, rib bone or allograft.\(^13-16\) Other authors recommend soft reconstruction by covering the orbital content with Gel foam and fibrin glue to result in thick fibrous scar giving support to the position of the orbital cone and eye bulb.\(^11,17\) However, DeMonte et al concluded that a partial or complete orbital roof resection, isolated or combined with lateral or medial orbital wall defects do not require routine reconstruction.\(^18\) Maroon et al reported 200 cases of orbital wall and roof resection without reconstruction, which resulted in no cases of pulsating enophthalmus.\(^9\) In agreement with the later theory, no orbital reconstruction was performed in this study without any reported cases of enophthalmus or pulsating eye bulb.

Proper closure of dura at the base is mandatory by using fascial graft and fat from the thigh and fibrin glue to prevent subgaleal CSF collection which may necessitate surgical revision in some patients, in our study, proper repair was performed routinely and no patient needed surgical revision, while Reingel et al encountered five cases with CSF collection, two of them needed surgical revision.\(^11\)

All patients with residual tumors in our series were candidates for stereotactic radio surgery as it has been proven to be effective in controlling growth of meningiomas.\(^19\) Some authors recommended wait and see policy depending on the slow rate of growth of meningiomas.

CONCLUSION

Spheno orbital meningiomas en plaque are located in a complex anatomical region, surgical management
is not uniform and should be tailored to each patient. Radical tumor excision can be achieved by proper microsurgical dissection, aggressive bony removal and wide orbital decompression with low postoperative morbidity, good clinical outcome and less rate of recurrence. However, greater sample size and longer follow up would aid further documentation.

REFERENCES