Spheno-Orbital Meningiomas: A 16-Year Surgical Experience

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OBJECTIVE: **To examine the efficacy of spheno-orbital meningioma (SOM) resection aimed at symptomatic improvement, rather than gross total resection, followed by radiation therapy for recurrence.**

METHODS: **A retrospective review of all patients having undergone resection between 2000 and 2016 was performed. Demographics, operative details, postoperative outcomes, recurrence rates, and radiation treatment plans were analyzed. Statistical analysis was performed to assess for factors affecting recurrence (Fisher exact and Student *t* test), changes in exophthalmos index (EI) (Student *t* test), and progression-free survival (Kaplan-Meier and log rank).**

RESULTS: **Twenty-five patients were included; 92% of participants were women. Mean age was 51 years. World Health Organization grades were I (n = 21) and II (n = 4). Simpson grades were I (n = 14), II (n = 3), and IV (n = 8). Mean follow-up time was 44.8 months. Proptosis was significantly improved at the 3- to 6-month postoperative visit (mean ΔEI, 0.15; $P < 0.05$) and at last follow-up (mean ΔEI, 0.13; $P < 0.05$). Visual acuity was either improved or stable in 18 of 19 patients. There were 12 recurrences; mean time to recurrence was 21.8 months. Increased recurrence rate was significantly associated with younger age. Eight patients received fractionated radiation at time of recurrence. To date, all treated patients are progression free.**

CONCLUSIONS: **Among this cohort, surgery provided a lasting improvement in proptosis and improved or stabilized visual deficits. Surgery followed by radiation at recurrence provided excellent tumor control and lends credence to the growing body of literature demonstrating effective control of subtotally resected skull base meningiomas.**

INTRODUCTION

Spheno-orbital meningiomas (SOMs) represent a distinct category of invasive tumors hallmarked by pathologic hyperostosis of the sphenoid ridge.[1-8] Tumor bone invasion along with proximity to and invasion into critical structures within the orbit, optic canal, superior orbital fissure (SOF), and cavernous sinus result in a classic presentation of proptosis, vision loss, abnormal ocular motility, and headache[2,6,9-18] and make complete surgical resection challenging.[3,6,9-13,19-28]

Existing literature demonstrates postoperative recurrence is inversely related to the extent of tumor resected[2-5,7,9-13,19-21,29-31]; however, the recurrence rate is highly variable (0%–71%).[2-5,7,10-13,19-22,29]

Given that most SOMs are indolent WHO grade I tumors and gross total resection (GTR) is associated with high morbidity, subtotal resection (STR) with postoperative fractionated radiation has been used with promising results.[6,32] There is no consensus, however, as to the optimal use of radiation for skull base meningiomas in general.[33-35]

This study examines the treatment algorithm used for SOMs at the University of Colorado Hospital from 2000 to 2016. Our protocol includes resection of tumor within the sphenoid bone, orbit, and dura with no attempt at resection of tumor in the cavernous

Key words
- Fractionated radiation
- Gross total resection
- Spheno-orbital meningioma
- Tumor recurrence

Abbreviations and Acronyms
CSF: Cerebrospinal fluid
EI: Exophthalmos index
GTR: Gross total resection
SOF: Superior orbital fissure
SOM: Spheno-orbital meningioma
SRS: Fractionated stereotactic radiosurgery
STR: Subtotal resection
WHO: World Health Organization

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sinus and SOF. Surgery is followed by fractionated radiation therapy at the first sign of recurrence. This treatment plan was used in all patients regardless of WHO grade, with the exception of 1 patient who refused radiation at time of recurrence, 1 patient who could not receive radiation secondary to an underlying psychiatric disorder, 1 patient who was referred for radiation but never presented for treatment and was lost to follow-up, and 1 patient who developed symptomatic recurrence (worsening proptosis, pain, and visual changes) and elected repeat resection.

MATERIALS AND METHODS

Patient Selection

A retrospective cohort of all patients with SOMs treated surgically at University of Colorado Hospital by the senior author (K. O. L.) between 2000 and 2016 was generated using chart extraction. Tumor invasion into the sphenoid bone and orbit was required for inclusion. Both primary and recurrent cases were included. Approval from the Colorado Multi-Institutional Review Board (number 14-1502) was obtained.

Chart Extraction, Imaging Review, and Clinical Analysis

Patient charts and neuroimaging were reviewed to identify demographics, current medications, medical and surgical histories, presenting and postoperative signs and symptoms, and primary versus recurrent tumor and for calculation of the pre- and postoperative visual acuity and exophthalmos index (EI). Operative reports were used to assign Simpson grade. The presence and location of any residual tumor on postoperative imaging, histologic grading, and use and timing of radiotherapy were recorded. During the 16 years of this study, the WHO classification for meningiomas underwent revision twice, once in 2007 and again this year, 2016.[36-38] Each patient's pathology was reviewed to confirm that the results presented in this article are congruent with the revised WHO classification criteria.

Proptosis was evaluated using the EI (Figure 1), which was measured on preoperative imaging (magnetic resonance imaging or computed tomography scan if magnetic resonance imaging was not performed), at the second postoperative visit approximately 3–6 months after surgery, and at the last postoperative follow-up visit. The change in EI was then calculated for each stage of follow-up.

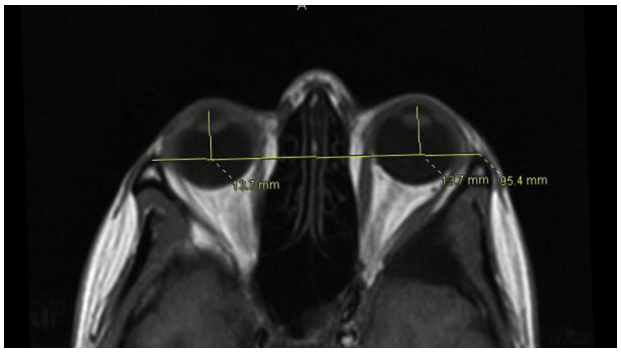

Figure 1. Exophthalmos index (EI) measurement on preoperative axial T1 magnetic resonance imaging of a representative patient from our cohort. The zygomatic line is generated from the frontal processes of each zygoma. A perpendicular line from the anterior aspect of each globe to the zygomatic line is generated and measured in millimeters. The EI is obtained from the ratio of pathologic eye ratio to the normal eye.

Changes in visual acuity were assessed using the Rosenbaum near vision chart. Vision loss was considered improved or worse only when the patient's vision changed by more than one level on the Rosenbaum near vision chart. Changes of less than or equal to 1 level on the Rosenbaum chart could have been because of interobserver variability and may not represent true change in vision, and were therefore considered stable. Visual acuity was reviewed for each patient at the following time points: preoperative, first postoperative visit (2 weeks), second postoperative visit (3–6 months), and at last follow-up.

Other relevant symptoms and examination findings including headache; bony contour deformity; trigeminal nerve numbness/paresthesias; ptosis; cranial nerve III, IV, or VI palsy; grand mal seizure, and pulsatile enophthalmos were reviewed at the 3-month postoperative visit and at last neurosurgical follow-up.

Surgical Technique

All patients underwent frontotemporal craniotomy followed by extra-dural drilling of the hyperostotic sphenoid ridge and involved portions of the middle cranial fossa (Figures 2 and 3). Bony decompression of the orbital roof and lateral orbital walls was then performed. When necessary, the anterior clinoid was removed, the optic canal was decompressed, and the SOF, and the second and third divisions of the trigeminal nerve, was skeletonized. Tumor infiltrated frontotemporal dura up to the limits of the SOF and lateral wall of the cavernous sinus was removed. Intraorbital tumor was removed, including tumor-laden periorbita and tumor around the extra-ocular muscles and cranial nerves. For tumor obviously invading the optic canal, the dura was opened, but no attempt was made to resect tumor from around the optic nerve. In addition, no attempt was made to resect intracavernous portions of the tumor. Attempted water tight dural closure was accomplished using a suturable dural substitute and fibrin glue. Tumor involving the bone flap was drilled away, and the flap was reapproximated to the skull. Titanium mesh was used to reconstruct the cranial defect. No orbital reconstruction was performed.

Defining Tumor Recurrence

Tumor recurrence was defined radiographically as increase in residual tumor mass or return of tumor tissue after surgical resection. Follow-up time was defined as the interval between the date of surgery and the most recent clinical encounter with neurosurgery.

Radiation

Fractionated intensity modulated radiotherapy or fractionated stereotactic radiosurgery (SRS) was administered at the first sign of recurrence in 8 of 12 patients, which included 5 patients with WHO grade I and 3 patients with WHO grade II meningiomas. One of the patients with a WHO II SOM developed 2 small remote meningiomas 5 years after surgery. These lesions were successfully treated with single fraction SRS.