Management of Planum/Olfactory Meningiomas: Predicting Symptoms and Postoperative Complications

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Key words
- Meningioma
- Olfactory groove
- Planum sphenoidale
- Surgical outcome

Abbreviations and Acronyms
ACA: Anterior cerebral artery
CI: Confidence interval
CSF: Cerebral spinal fluid
MRI: Magnetic resonance imaging
NS: Not significant
OR: Odds ratio

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■ OBJECTIVE: **Given their location and slow growth, olfactory groove and planum sphenoidale meningiomas often grow to large sizes before they present with clinical symptoms and pose significant surgical challenges. The goal of our study is to identify which preoperative symptoms and findings on magnetic resonance imaging are correlated with specific postoperative outcomes in order to better counsel patients preoperatively.**

■ METHODS: **We retrospectively identified 44 patients with planum/olfactory meningiomas treated at our institution from 1996 to 2006. We used univariate and multivariate regression models to analyze the effect of several magnetic resonance imaging characteristics (tumor volume, distance to optic chiasm, anterior cerebral artery encasement, paranasal sinus invasion, and sellar invasion) on preoperative symptoms and postoperative outcomes, including complication rate and tumor recurrence.**

■ RESULTS: **Only brain tumor volume (>42 cm^3), but not distance to the optic chiasm, is independently associated with an increased likelihood of preoperative visual symptoms. Tumors with nasal sinus invasion are significantly more likely to cause postoperative surgical complications, and tumors with anterior cerebral artery encasement are associated with a greater likelihood of both postoperative complications and tumor recurrence.**

■ CONCLUSIONS: **We conclude that tumors larger than 3.4 cm in diameter and those whose posterior edge is within 6–8 mm of the optic chiasm should be recommended for early surgical intervention. In terms of predicting surgical complications, nasal sinus invasion and anterior cerebral artery encasement are associated with greater-risk profiles when surgery becomes necessary. Thus, it is prudent to take these specific variables into consideration when advising patients about the risks of observation and surgery for olfactory/planum meningiomas.**

INTRODUCTION

Meningiomas are usually benign, extra-axial neoplasms that account for approximately 30% of intracranial brain tumors (2). Tuberculum sella meningiomas (5, 7, 9, 10, 21, 12, 15-18, 19, 20, 22, 24-27, 29, 31) arise from and are centered on the tuberculum and chiasmatic sulcus and may have extrusion to the planum sphenoidale and diaphragma, whereas olfactory-groove meningiomas (1, 4, 6, 13, 14, 23, 30, 32, 35, 36) arise further anteriorly (approximately 2 cm) in the midline of the anterior cranial fossa over the cribiform plate and frontosphenoid suture. In this work, we consider planum sphenoidale and olfactory-groove meningiomas together because they present with similar surgical issues.

Although planum/olfactory meningiomas are closely related to those of the tuberculum sellae, their clinical presentations and surgical outcomes are very different (8). Whereas tuberculum sellae tumors often present with visual symptoms, given their close proximity to the optic chiasm, planum/olfactory meningiomas often grow much larger before they become symptomatic. As a result, in series reported by Hentschel and DeMonte (14) and Turazzi et al. (36), more than 50% of patients presented with tumors larger than 6 cm. As a result, extensive bifrontal craniotomies are often required, and planum sphenoidale tumors can be even more difficult to remove, given their more posterior position.

Although there is a significant literature regarding olfactory groove and tuberculum sella meningiomas (including planum sphenoidale meningiomas) (11, 3, 4, 6-8, 10, 11, 13, 19, 20, 21, 23-26, 28-37), most of these are descriptive case series of tumor characteristics (including size and histologic grade), preoperative symptoms, surgical approach (frontolateral vs. pterional vs. bifrontal), and patient outcomes (including symptomatic improvement and recurrence rate) in anywhere from 13 to 82 patients. Moreover, there is a paucity of modern data regarding how patients with these tumors fare in the era of modern neurosurgical techniques.

Currently, there is an incomplete understanding of those variables that predict the failure of observation and those that confer excess risk in surgery for planum/olfactory meningiomas. As a result, we have limited ability to predict high-risk planum/olfactory-groove meningioma cases before surgery and thus to preoperatively counsel patients about whether they are more likely to experience postoperative complications. We therefore present our experience of 44 planum/olfactory meningiomas to determine whether any clinical or magnetic resonance imaging (MRI) characteristics (including tumor volume, paranasal sinus invasion, and anterior cerebral artery encasement) can predict postoperative outcomes and neurologic complications in these cases.

METHODS

Identifying characteristics, including name, diagnosis, and rough anatomic location of disease, have been prospectively collected for all consenting patients undergoing neurosurgical evaluation at University of California, San Francisco, in a Committee for Human Research approved program since 1991 (CHR# H7828-29842-01). We searched this database for all patients with the diagnosis of meningioma and retrospectively evaluated all patients whose tumors appeared to arise from the olfactory groove or the planum sphenoidale. Anatomic location of anterior fossa meningiomas was defined on T1-weighted postcontrast MRI, and planum/olfactory meningiomas were defined as primarily midline meningiomas with >75% of their attachment on the olfactory groove or the planum sphenoidale.

We carefully reviewed the medical records, radiographic imaging, pathology reports, and operative notes for each of these patients. We examined coronal and sagittal preoperative T1 postcontrast MRI to calculate brain tumor volume (volume = height × width × length/2, expressed in cm^3) and to measure distance from the tumor edge to the optic chiasm (in mm). We also assessed for tumor invasion into the sella turcica and the paranasal sinuses (including frontal, ethmoidal, or maxillary), as well as tumor encasement of the anterior cerebral artery (yes or no). Finally, we collected data about preoperative symptoms, surgical approach, Simpson grade of resection, histologic tumor grade, adjuvant radiation therapy, postoperative surgical complications, and clinical evidence of recurrence.

Preoperative symptoms were determined from the clinical records and included descriptions of visual symptoms (defined as field-cuts or vision loss, but not diplopia), personality changes, headaches, seizures, and anosmia. Postoperative complications were specifically surgical (as opposed to neurologic or medical complications) and included venous infarct, epidural hematoma, edema, and cerebrospinal fluid (CSF) leak. Cranial neuropathies (for example, cranial nerve III palsy) were classified separately as postoperative neurologic deficits. Medical complications (such as hyponatremia) also were recorded for these patients but have been carefully examined in previous studies (31).

Surgical Technique

In the majority of our surgeries (26 of 36 cases), we performed extended bifrontal craniotomies. The skin was incised just anterior and inferior to the tragus bilaterally and extended over the vertex along the coronal suture. After the myocutaneous flap was dissected, both supraorbital neurovascular bundles were exposed and preserved (see **Figure 1A**). The temporalis muscle was incised and retracted inferiorly, leaving a muscle cuff attached to the bone. Next, the periorbita was detached from the superior orbital wall with atraumatic, blunt dissection. We also freed the supraorbital neurovascular bundle from its attachments to the supraorbital notch. In a small number of cases, the supraorbital neurovascular bundle exits the orbit through a foramen, which must be opened with an osteotome, bone chisel, or by drilling small troughs on either side of the foramen. We performed a bifrontal craniotomy, frequently in 2 pieces, first on the right short of the midline and then by dissecting the epidural space under direct vision before cutting the secondary left-sided bone flap.

After exposing the intracranial space, and leaving the dura intact, we cut the orbital rim and part of the orbital roof with an orbital osteotomy (**Figure 1B**). For large tumors, subperiorbital dissection can be done along the medial wall of the orbit to isolate, coagulate, and divide the anterior and posterior ethmoid arteries to reduce blood supply to tumor. The rule of 24-12-6 describes the distance in millimeters from the lacrimal crest to the anterior ethmoid foramen, then from the anterior ethmoid to the posterior ethmoid foramen and from the posterior ethmoid foramen to the optic canal (32). The supraorbital bar was cleared of frontal sinus mucosa. Following this, we incised the dura, ligated the superior sagittal sinus, and cut above the crista galli. Finally, we performed careful arachnoid dissection to expose the intradural neurovascular structures (**Figure 1C**). In closing, the pericranium is laid down over the frontal sinus opening before replacing the supraorbital bar. Gaps between the bone flaps and surrounding skull above the superior temporal line are filled with hydroxyapatite, which prevents the galea from adhering to a fibrous union between bone pieces and creating a depression in the skin that outlines the craniotomy flap and worsens the cosmetic result.

Statistical Analysis

All statistical analyses were performed in SPSS Statistics (SPSS Institute, Chicago, Illinois, USA). Averages are expressed ± SD. Binary variables were compared using the Pearson's χ^2 test, and odds ratios (ORs) were calculated and expressed with 95% confidence intervals. Variables with $P < 0.05$ on univariate analysis were then used in the multivariate logistic regression analysis. The goodness of fit of the regression model was confirmed by demonstrating a nonsignificant *P*-value on the Hosmer-Lemeshow test. We tested the significance of interaction terms between each of the independent variables using backward stepwise regression. After finding that none of the interaction terms would significantly alter the log likelihood of the regression model if removed, we calculated the odds ratios without adjusting for interactions.

RESULTS

Patient and Tumor Characteristics

We identified 44 patients with planum/olfactory meningiomas seen by neurosurgeons at our institution between 1996 and 2006 (see **Table 1**). Of these, 30 patients (68.2%) were female, and 14 patients (31.8%) were male. The average age at diagnosis was 56.9 ± 13.5 years, ranging