Sphenoid wing meningiomas: single-center surgical outcomes and factors associated with resection extent

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Introduction

Sphenoid wing meningiomas frequently involve critical neurovascular structures, including the optic canal, cavernous sinus, orbit, and internal carotid artery, making surgical resection challenging.[1,2] Tumors arising from the medial sphenoid wing are more likely to invade these structures, often limiting the extent of safe resection.[3,4] We present a single-center retrospective series evaluating anatomical and radiographic characteristics associated with extent of resection in surgically treated sphenoid wing meningiomas in our single-center institution.

Methods

We performed a single-center retrospective analysis of patients with histologically confirmed sphenoid wing meningiomas who underwent surgical resection between 2010 and 2024. Tumors were classified as medial or lateral sphenoid wing based on preoperative imaging. Radiographic variables of interest included cavernous sinus invasion, carotid artery encasement, optic canal invasion, orbital invasion, and hyperostosis. Extent of resection was determined by comparison of preoperative and immediate postoperative MRI and categorized as gross total resection or less than gross total resection. Progression-free survival was assessed using Kaplan-Meier analysis. Categorical variables were compared using chi-square or Fisher's exact tests, with statistical significance defined as $p < 0.05$.

Results

Thirty-nine patients underwent surgical resection for sphenoid wing meningioma. Median age was 62 years, and 71.8% (28/39) were female. Gross total resection (GTR) was achieved in 56.4% (22/39) of cases, while 43.6% (17/39) underwent near-total or subtotal resection (NTR/STR). Medial sphenoid wing tumors accounted for 38.5% (15/39) of cases. GTR was achieved in 79.2% (19/24) of lateral tumors compared with 20.0% (3/15) of medial tumors ($p < 0.001$).

Tumors involving critical neurovascular structures were significantly less likely to undergo GTR. Cavernous sinus invasion was present in 28.2% (11/39) of cases and was associated with a 0% GTR rate compared with 64.7% (11/17) in tumors without invasion ($p < 0.001$). Carotid artery encasement occurred in 17.9% (7/39) of tumors and was associated with no GTRs (0% vs 41.2%, $p = 0.001$). Optic canal invasion was present in 46.2% (18/39) of cases and was associated with lower rates of GTR (27.3% vs 64.7%, $p = 0.02$). Orbital invasion (30.8%, 12/39) and hyperostosis (30.8%, 12/39) were each associated with significantly reduced rates of GTR (both 9.1% vs 58.8%, $p = 0.001$).

Medial sphenoid wing tumors demonstrated significantly higher rates of cavernous sinus invasion (60.0% vs 8.3%, $p < 0.001$), carotid artery encasement (40.0% vs 4.2%, $p = 0.008$), optic canal invasion (66.7% vs 29.2%, $p = 0.02$), and orbital invasion (53.3% vs 16.7%, $p = 0.03$) compared with lateral tumors. Rates of hyperostosis did not differ significantly between medial and lateral tumors (40.0% vs 25.0%, $p = 0.32$).

Table 1. Factors associated with extent of resection in sphenoid wing meningiomas

	All Meningiomas (n = 39) n (%)	GTR (n = 22) n (%)	< GTR (n = 17) n (%)	p
Medial Wing	15 (38.5)	3 (13.6)	12 (70.6)	**< 0.001**
Cavernous Sinus Invasion	11 (28.2)	0 (0)	11 (64.7)	**< 0.001**
Carotid Artery Encasement	7 (17.9)	0 (0)	7 (41.2)	**0.001**
Optic Canal Invasion	18 (46.2)	6 (27.3)	11 (64.7)	**0.02**
Orbit Invasion	12 (30.8)	2 (9.1)	10 (58.8)	**0.001**
Hyperostosis	12 (30.8)	2 (9.1)	10 (58.8)	**0.001**

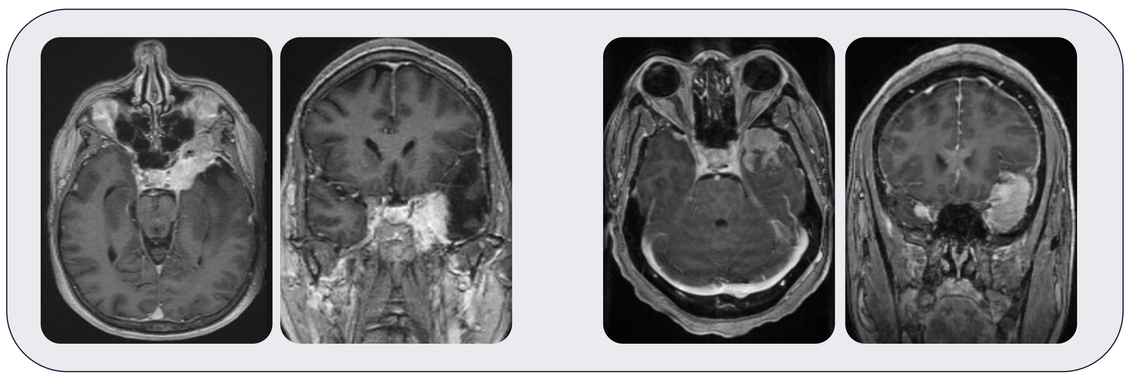

Figure 1. Representative MRI demonstrating medial (left) and lateral (right) sphenoid wing meningiomas

Table 2. Tumor characteristics stratified by medial versus lateral sphenoid wing location

	All Meningiomas (n = 39) n (%)	Lateral (n = 24) n (%)	Medial (n = 15) n (%)	*p*
GTR	22 (56.4)	19 (79.2)	3 (20)	**< 0.001**
Cavernous Sinus Invasion	11 (28.2)	2 (8.3)	9 (60.0)	**< 0.001**
Carotid Artery Encasement	7 (17.9)	1 (4.2)	6 (40.0)	**0.008**
Optic Canal Invasion	18 (46.2)	7 (29.2)	10 (66.7)	**0.02**
Orbit Invasion	12 (30.8)	4 (16.7)	8 (53.3)	**0.03**
Hyperostosis	12 (30.8)	6 (25.0)	6 (40.0)	0.32

Results

Progression-free survival differed significantly by extent of resection. No progression events occurred in patients undergoing gross total resection (0/22). In contrast, six progression events occurred among patients undergoing near-total or subtotal resection (6/17), corresponding to a one-year progression-free survival of 74.2% ± 11%. Kaplan-Meier analysis demonstrated significantly reduced progression-free survival in the NTR/STR group compared with the GTR group (log-rank $\chi^2 = 7.77$, $p = 0.0053$).

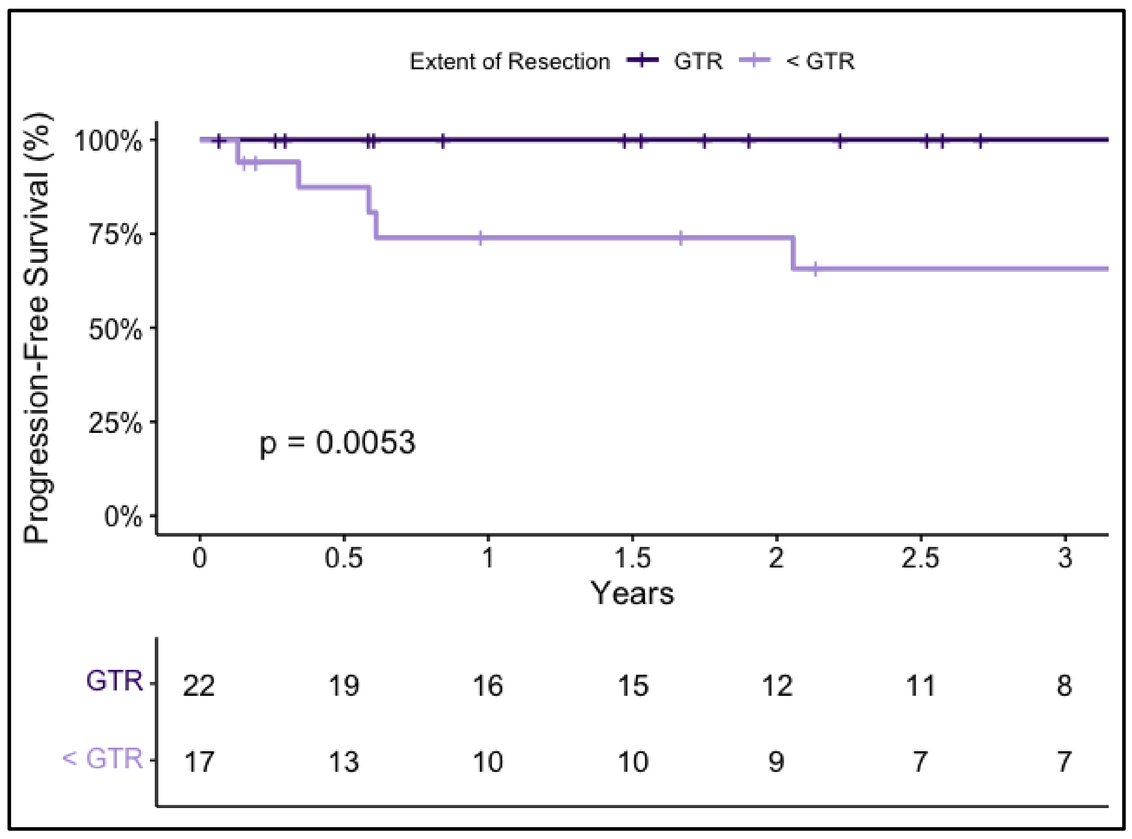

Figure 2. Progression-free survival stratified by extent of resection

Conclusions

Extent of resection for sphenoid wing meningiomas was impacted by tumor location and invasion of surrounding structures. Medial tumors were more likely to involve the cavernous sinus, carotid artery, optic canal, and orbit, resulting in lower rates of gross total resection. These findings support prioritizing neurovascular structures when gross total resection carries risk.

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