Nature Abhors a Cavity: The Relationship between Intradural Dead Space and Risk of Cerebrospinal Fluid Leak following Resection of Olfactory Groove Meningiomas

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Background

Rates of cerebrospinal fluid (CSF leak) following endoscopic endonasal resection of olfactory groove meningiomas (OGM) range between 10-30% and remain a significant challenge in managing these tumors due to associated morbidity. Despite improvements in reconstructive techniques with multilayer reconstruction and vascularized flaps, persistent CSF leak remains a troublesome complication.

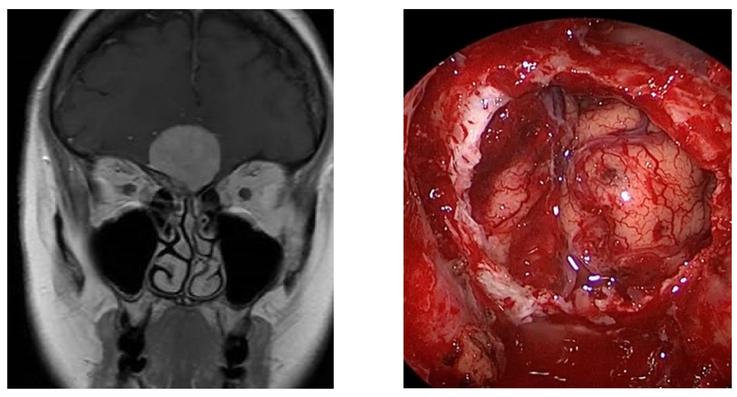

Figure 1: (Left) Coronal MRI T1 post contrast demonstrating 3cm OGM. (Right) Typical anterior cranial fossa defect following resection of bilateral olfactory groove meningioma.

Objectives

1) Is increased tumor volume, and subsequently greater intracranial cavity following resection, associated with an increased risk of post-operative CSF leak?
2) Which OGM patients are high-risk for post-operative CSF leaks, and how can we adjust the reconstructive algorithm to prevent post-operative CSF leaks?

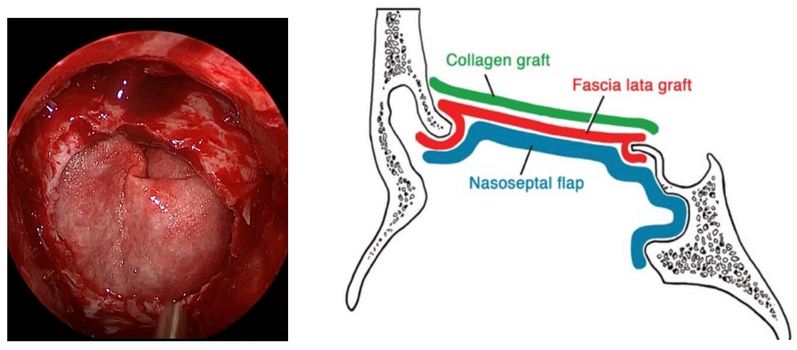

Figure 2: (Left) Typical anterior cranial fossa defect with collagen graft inlay tucked deep to the dura. (Right) Depiction of a typical reconstruction for these defects, with a collagen inlay, a fascia onlay, and a vascularized nasoseptal flap.

Methods and Materials

- Retrospective case series at a single institution.
- All patients who underwent EEA for OGM between 2014-2025 who had imaging available for review were included.
- Pre-operative MRI was reviewed to measure maximal tumor dimensions in anterior-posterior (AP), lateral (L), and cranial-caudal (CC) dimensions.
- Post-operative CT head was used to measure AP and L dimensions of the bony defect, as a proxy for the dural defect.
- Other perioperative details were reviewed including lumbar drain usage, initial reconstructive technique, and management of any post-operative leaks.
- Univariate analysis and stepwise multivariable binary logistic regression was performed.

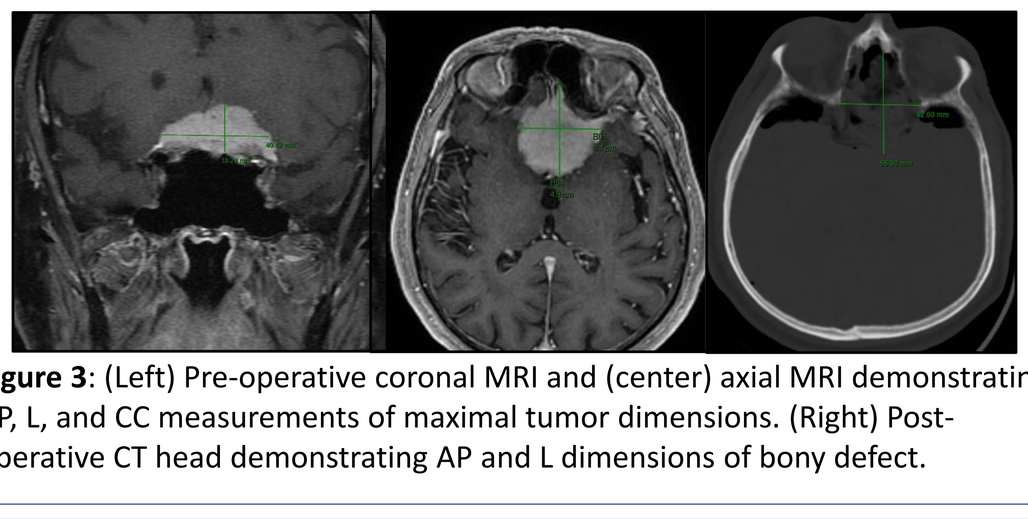

Figure 3: (Left) Pre-operative coronal MRI and (center) axial MRI demonstrating AP, L, and CC measurements of maximal tumor dimensions. (Right) Post-operative CT head demonstrating AP and L dimensions of bony defect.

Results

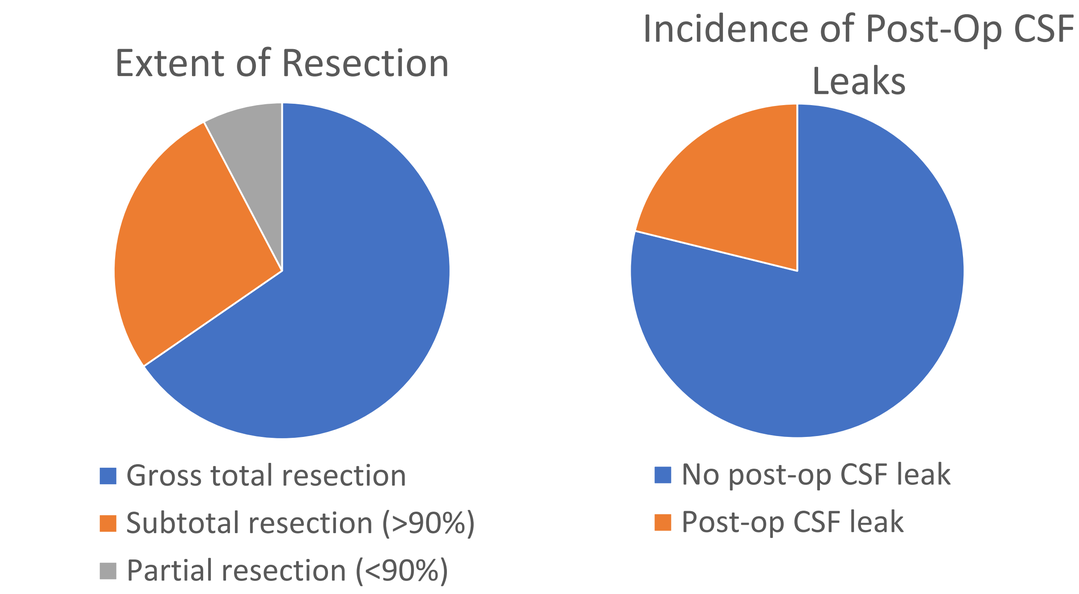

Figure 4: (Left) Gross total resection was achieved in 34 patients, subtotal resection >90% was achieved in 14 patients, and partial resection <90% was achieved in 4 patients. (Right) 52 patients were included in the study, of which 11 experienced post-operative CSF leaks (21.1%).

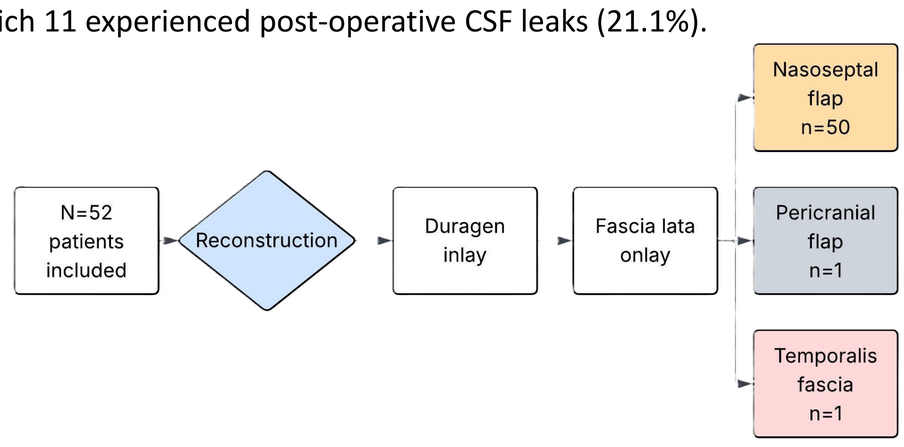

Figure 5: Summary of reconstructive techniques used in patient cohort. All patients utilized a dural substitute inlay, fascia onlay, and vascularized pedicled flap.

Table 1: Baseline characteristics excluding patients with only partial resections or pericranial flap reconstruction.

	Leak (-)	Leak (+)	P value
Age	66.21 (14.42)	54.8 (17.79)	0.28
AP max	5.01 (4.74)	3.83 (1.07)	0.39
Width max	3.77 (1.17)	3.42 (0.84)	0.84
Vertical height max	2.85 (1.13)	3.78 (4.42)	0.004
Defect AP (cm)	5.21 (5.34)	7.97 (10.3)	0.05
Defect ML (cm)	4.43 (6.14)	6.64 (9.74)	0.17
Tumor Volume (cm^2)	29.52 (21.15)	22.18 (15.06)	0.42
Defect Area (mm^2)	36.35 (148.98)	110.51 (296.46)	0.04

- No variables including gender, maximum tumor dimensions, post-resection bony defect dimensions, number of surgical modules dissected, resection status, nor use of a lumbar drain were associated with increased risk of post-operative CSF leak.

Conclusions

1. Pre-operative volume of tumor does not predict risk of CSF leak.
2. Vertical height of the tumor and size of the dural defect in the sagittal plane are associated with postoperative CSF leak.
3. Reconstruction of these tumors remains a challenge, and each patients' independent risk factors should be considered when planning a reconstructive approach.
4. We propose that a prospective root cause analysis process would be able to better identify the cause of post-operative CSF leak.
5. Importantly, patients should be counseled appropriately about the higher risk of post-operative CSF leak with OGM accessed endonasally.
6. There is a need for improved reconstructive techniques for high-risk patients.

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References

1. Fernandez-Miranda JC, Gardner PA, Prevedello DM, Kassam AB. Expanded endonasal approach for olfactory groove meningioma. Acta Neurochir (Wien). 2009 Mar;151(3):287-8; author reply 289-90.
2. de Almeida JR, Carvalho F, Vaz Guimaraes Filho F, Kiehl TR, Koutourousiou M, Su S, Vescan AD, Witterick IJ, Zadeh G, Wang EW, Fernandez-Miranda JC, Gardner PA, Gentili F, Snyderman CH. Comparison of endoscopic endonasal and bifrontal craniotomy approaches for olfactory groove meningiomas: A matched pair analysis of outcomes and frontal lobe changes on MRI. J Clin Neurosci. 2015 Nov;22(11):1733-41.
3. Algattas HN, Wang EW, Zenonos GA, Snyderman CH, Gardner PA. Endoscopic endonasal surgery for anterior cranial fossa meningiomas. J Neurosurg Sci. 2021 Apr;65(2):118-132.
4. Lee JY, Barroeta JE, Newman JG, Chiu AG, Venneti S, Grady MS. Endoscopic endonasal resection of anterior skull base meningiomas and mucosa: implications for resection, reconstruction, and recurrence. J Neurol Surg A Cent Eur Neurosurg. 2013 Jan;74(1):12-7.