Clinical and Vascular Predictors of Visual Outcomes in Skull Base Meningiomas Treated With Preoperative Embolization

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INTRODUCTION

Visual impairment is among the most debilitating presenting symptoms of skull base meningiomas. Compression of the optic nerve, chiasm, and related pathways often leads to reduced acuity, field defects, or diplopia, significantly impairing quality of life. Preoperative embolization is increasingly used to decrease tumor vascularity, reduce intraoperative blood loss, and improve surgical safety, yet its impact on visual outcomes remains uncertain.

METHODS

Thirty-six patients undergoing preoperative embolization for skull base meningiomas were retrospectively reviewed. Patients were stratified by the presence of visual symptoms. Tumor volume, vascular supply, and histologic grade were recorded. Feeding vessels were categorized as ophthalmic, anterior cerebral artery (ACA), middle cerebral artery (MCA), extradural ICA, and meningeal branches. Visual outcomes were classified as improved, unchanged, or worsened at 12 months following surgery. Logistic regression modeling identified features predictive of postoperative change.

AIMS

This study analyzed visual outcomes after embolization in a single-center cohort, integrating clinical characteristics, vascular anatomy, and postoperative results.

CONCLUSION

In this cohort, nearly half of patients with preoperative visual symptoms experienced improvement after embolization and resection, while 40% worsened. Ophthalmic artery supply showed a trend toward higher visual morbidity, although not statistically significant. Tumor volume did not differ significantly between visual and non-visual groups. Embolization was safe and achieved effective devascularization without procedure-related injury, but its direct role in visual recovery remains unclear. Predictive modeling demonstrated promising accuracy and may guide risk stratification in future practice. Larger multicenter studies are needed to validate predictive features and clarify whether targeted embolization strategies can optimize visual outcomes in skull base meningioma patients.

RESULTS

Demographics	Value
n (visual symptoms)	15
n (no visual symptoms)	21
Age mean (visual)	46.27±15.51
Age mean (no visual)	51.85±16.26
Age p-value	0.256740936
Sex Distribution	Male No visual: 7, Visual 3 Woman: No Visual: 13, Visual: 12
Frailty mfi-5 (visual)	0.93±0.79
Frailty mfi-5 (non-visual)	0.75±0.72
Pre-existing condition (visual)	60%
Pre-existing condition (non-Visual)	33%

Table 1. Patient Demographics Stratified by Visual Symptoms
Baseline characteristics of 36 skull base meningioma patients undergoing preoperative embolization, stratified by presence of preoperative visual symptoms.

Tumor Characteristics	Value
Tumor Location	Anterior Skull Base: 6 Posterior Skull Base: 6 Middle Skull base: 2 Falcine: 1
Volume Visual Median	78.8 IQR(57.38-105)
Volume Nonvisual Median	95.09 IQR(55.67-206.89)
p-value	0.45
WHO grade	1 Nonvisual: 13, Visual: 11 2 Nonvisual: 6, Visual: 3 3 Nonvisual: 1, Visual: 0

Table 2. Tumor Characteristics by Symptom Group
Tumor location, volumetric measurements, and WHO grade for patients with and without visual symptoms.

Vessel	Visual Symptoms with Vessel	Visual Symptoms without Vessel	p-value	OR	n with Vessel	n without vessel
Ophthalmic	71.42%	34.48%	0.18	4.75	7	29
Anterior Cerebral Artery	50%	41.18%	1	1.43	2	34
Medial Cerebral Artery	33.33%	42.42%	1	0.68	3	33
Extradural ICA (MHT/ILT)	42.10%	41.18%	1	1.039	19	17
Meningeal (MMA/accessory)	41.67%	41.67%	1	1	24	12
Other IMAX feeders	80%	26.92%	0.012	10.86	10	26

Table 3. Vascular Supply and Association With Visual Symptoms
Arterial feeders categorized by supply territory and compared between patients with versus without visual symptoms.

Embolized Artery Group	Improvement Rate (Embolized)	Improvement Rate (Not Embolized)	n Embolized	n Not Embolized
Ophthalmic	33%	50%	3	12
Extradural ICA (MHT/ILT)	50%	46%	2	13
Meningeal (MMA / accessory)	50%	43%	8	7
Other IMAX feeders	60%	40%	5	10

Table 4. Impact of Arterial Embolization on Postoperative Visual Improvement
Comparison of visual outcome improvement rates between embolized and non-embolized arteries across four vascular territories.

Visual Symptom Trajectory and Outcomes Over Time

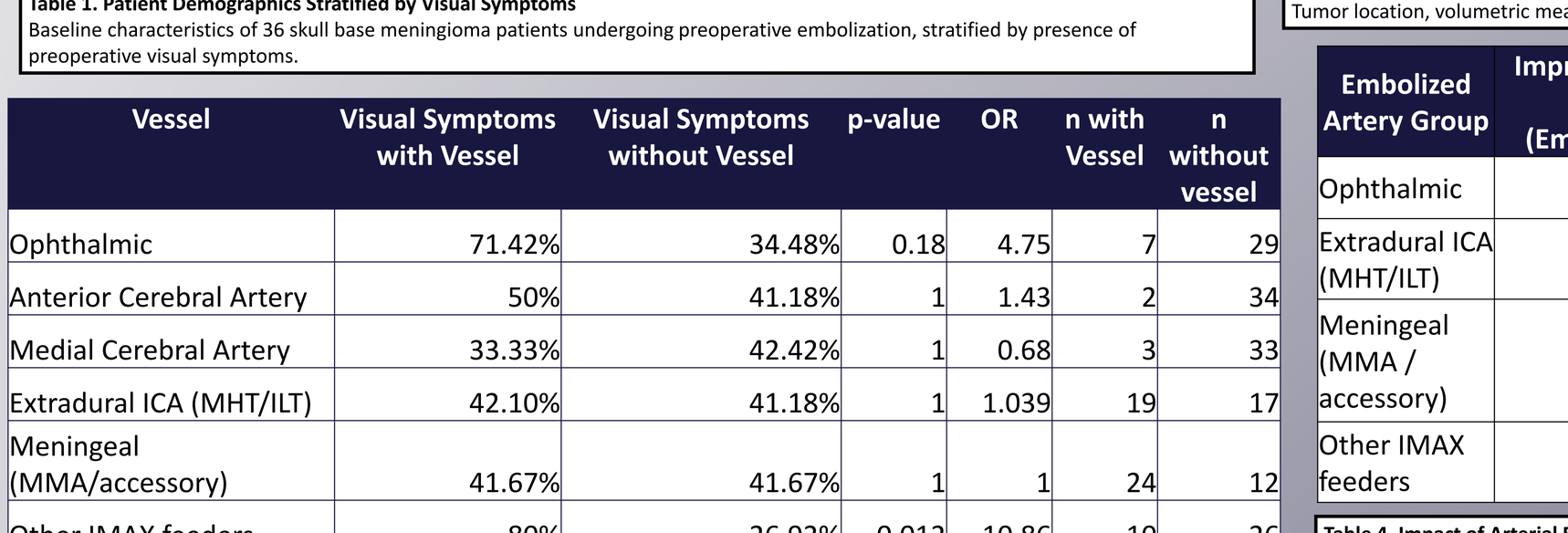

Figure 1. Trajectory of Visual Symptom Burden Over Time
Temporal changes in visual symptom severity in the 15 patients presenting with preoperative deficits, evaluated at baseline, postoperative month 6, and 12 months.

Figure 2. Distribution of Visual Recovery Outcomes Over Follow-Up
Cumulative proportions of patients exhibiting improved, unchanged, or worsened visual function following embolization and tumor resection at 6-month and 12-month intervals.

Improvement Prediction

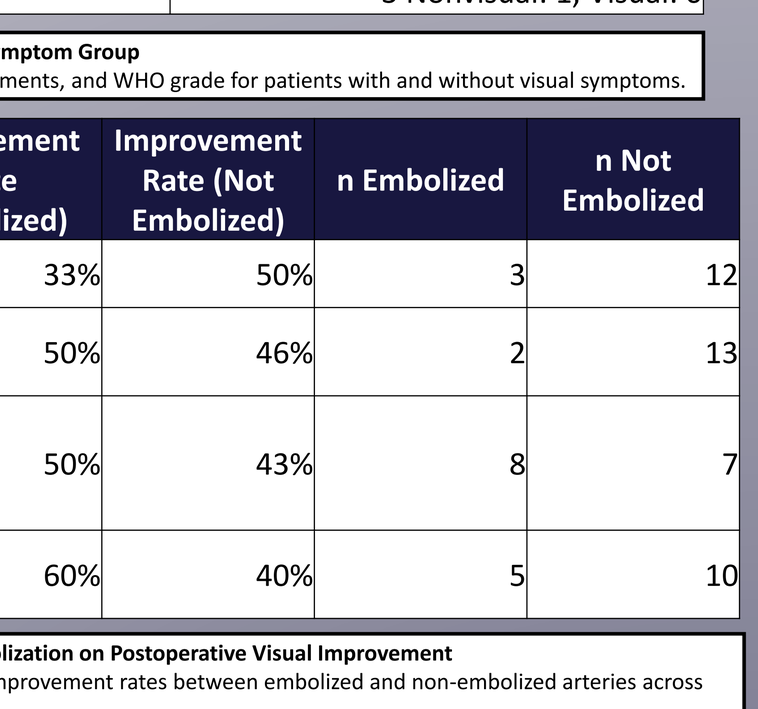

Figure 3. ROC Curve for Predicting Visual Symptom Improvement
Receiver operating characteristic demonstrating predictive performance of embolization-associated arterial features for visual improvement.

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