Postoperative morbidity and mortality with multi-layer, multi-parameter fMRI/DTI presurgical brain mapping: a retrospective, single-institution experience.

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Learning Objectives

(1) Describe data on incidence of morbidity and mortality in patients undergoing resection of supratentorial tumors with the use of presurgical brain mapping in a modern series
(2) Discuss and critically evaluate results of this single institution in the context of previous series

Introduction

Diffusion tensor (DTI) and functional magnetic resonance (fMRI) imaging are used to guide the resection of intracranial neoplasms. Reported neurologic morbidity of any severity ranges 20-41%, with major morbidity and perioperative mortality as low as 12% and 1.7%, respectively (2,4,6). In this study, we conduct a non-comparative analysis of post-operative outcomes with DTI and fMRI pre-surgical brain mapping.

Methods

Reviewed medical records of all patients undergoing gross tumor resection by a single neurosurgeon, with fMRI and DTI for pre-surgical planning, over 54 months at a single academic tertiary referral center.

Patient medical records included:

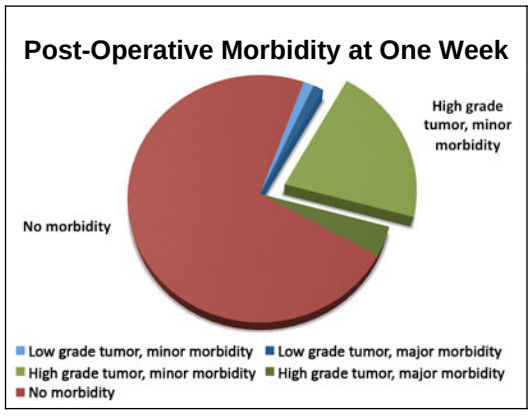
- Elective resection of supratentorial neoplasm with complete neurologic evaluation
- Demographic patient data, including age at time of operation and gender
- Pre-operative fMRI and DTI Radiologic report and Surgical Pathology report describing pathological characteristics of tumor and diagnosis
- Recorded response to pre-operative deficits at immediate, 1 -wk, 1-mo, and 6-mo post-operatively.

Grading Neurological Morbidity

COMPLICATION	MINOR	MAJOR
Neurological		
Motor or sensory deficit	Resolved within 30 days	Neurological deterioration persisted more than 30 days or required surgery
Aphasia/dysphasia	Resolved within 30 days	Persisted more than 30 days
Visual field deficit	Resolved within 30 days	Persisted more than 30 days

Adapted from "Sawaya et al, 1998"

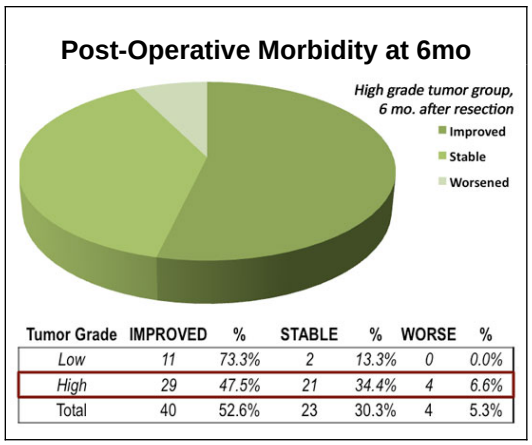
Results



Tumor Population

	n	%	LIVING	%	DECEASED	%	LFU*	%	HISTOLOGY (n)
Low Grade	15								
Grade I	3	3.9%	2	66.7%	0	0.0%	1	33.3%	Meningioma (3)
M	1	33.3%	1	50.0%	0	0.0%	0	0.0%	
F	2	66.7%	1	50.0%	0	0.0%	1	100.0%	
Grade II	12	15.8%	9	75.0%	2	16.7%	1	8.3%	Astrocytoma (5), Mixed Astrocytoma/ Oligodendroglioma (4), Oligodendroglioma (3)
M	8	66.7%	6	66.7%	1	50.0%	1	100.0%	
F	4	33.3%	3	33.3%	1	50.0%	0	0.0%	
High Grade	61								
Grade III	16	21.1%	11	68.8%	4	25.0%	1	6.3%	Anaplastic Astrocytoma (6), Anaplastic Oligodendroglioma (3), Anaplastic Oligoastrocytoma (2), Anaplastic Mixed Glioma (2)
M	13	81.3%	10	90.9%	3	75.0%	0	0.0%	
F	3	18.8%	1	9.1%	1	25.0%	1	100.0%	
Grade IV	38	50.0%	7	18.4%	23	60.5%	8	22.2%	Glioblastoma multiforme (35), Malignant neuroglial tumor (1), metastatic neuroendocrine tumor vs GBM (1), fibrillary astrocytoma/GBM (1)
M	21	55.3%	3	42.9%	12	52.2%	6	75.0%	
F	17	44.7%	4	57.1%	11	47.8%	2	25.0%	
Metastatic	7	9.2%	2	28.6%	3	42.9%	2	28.6%	Non-Small Cell Lung Cancer (4), Small Cell Lung Cancer (1), Squamous cell carcinoma (1), Poorly differentiated metastatic carcinoma (1)
M	1	14.3%	0	0.0%	0	0.0%	1	50.0%	
F	6	85.7%	2	100.0%	3	100.0%	1	50.0%	
TOTAL	76		31	40.8%	32	42.1%	13	17.1%	
M	44	57.9%	20	64.5%	16	50.0%	8	61.5%	
F	32	42.1%	11	35.5%	16	50.0%	5	38.5%	

* LFU, Lost to Follow-Up



Tumor Grade	IMPROVED	%	STABLE	%	WORSE	%
Low	11	73.3%	2	13.3%	0	0.0%
High	29	47.5%	21	34.4%	4	6.6%
Total	40	52.6%	23	30.3%	4	5.3%

- 76 patients underwent pre-surgical DTI/fMRI brain mapping prior to resection for 69 primary and 7 metastatic lesions. 61% were primary operations.
- Over 80% were for high-grade (WHO-III, -IV, or metastatic) lesions. Of patients with pre-operative neurological deficits (N=67), 53% demonstrated improvement post-operatively while 5% demonstrated worsened symptoms.
- Four patients (5%) experienced major morbidities: 2 cases of meningitis, a stroke, and one episode of severe hemiparesis.
- One perioperative mortality at 22 days; six-month mortality was 14%, all in patients with high-grade lesions. Mean post-operative length of stay was 4 ± 2 days and 76% of patients were discharged home.

Conclusions

- Our study reiterates the benefit of DTI and fMRI in pre-surgical planning for resection of supratentorial tumors and highlights the need for further prospective validation of this promising technology.

References

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[4] Berntsen EM, et al. Functional magnetic resonance imaging and diffusion tensor tractography incorporated into an intraoperative 3-dimensional ultrasound-based neuronavigation system: impact on therapeutic strategies, extent of resection, and clinical outcome. Neurosurgery. 2010 Aug;67(2):251-64.
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[6] Sawaya, Raymond, et al. Neurosurgical Outcomes in a Modern Series of 400 Craniotomies for Treatment of Parenchymal Tumors. Neurosurgery.1998 May;42(5): 1044-1055.

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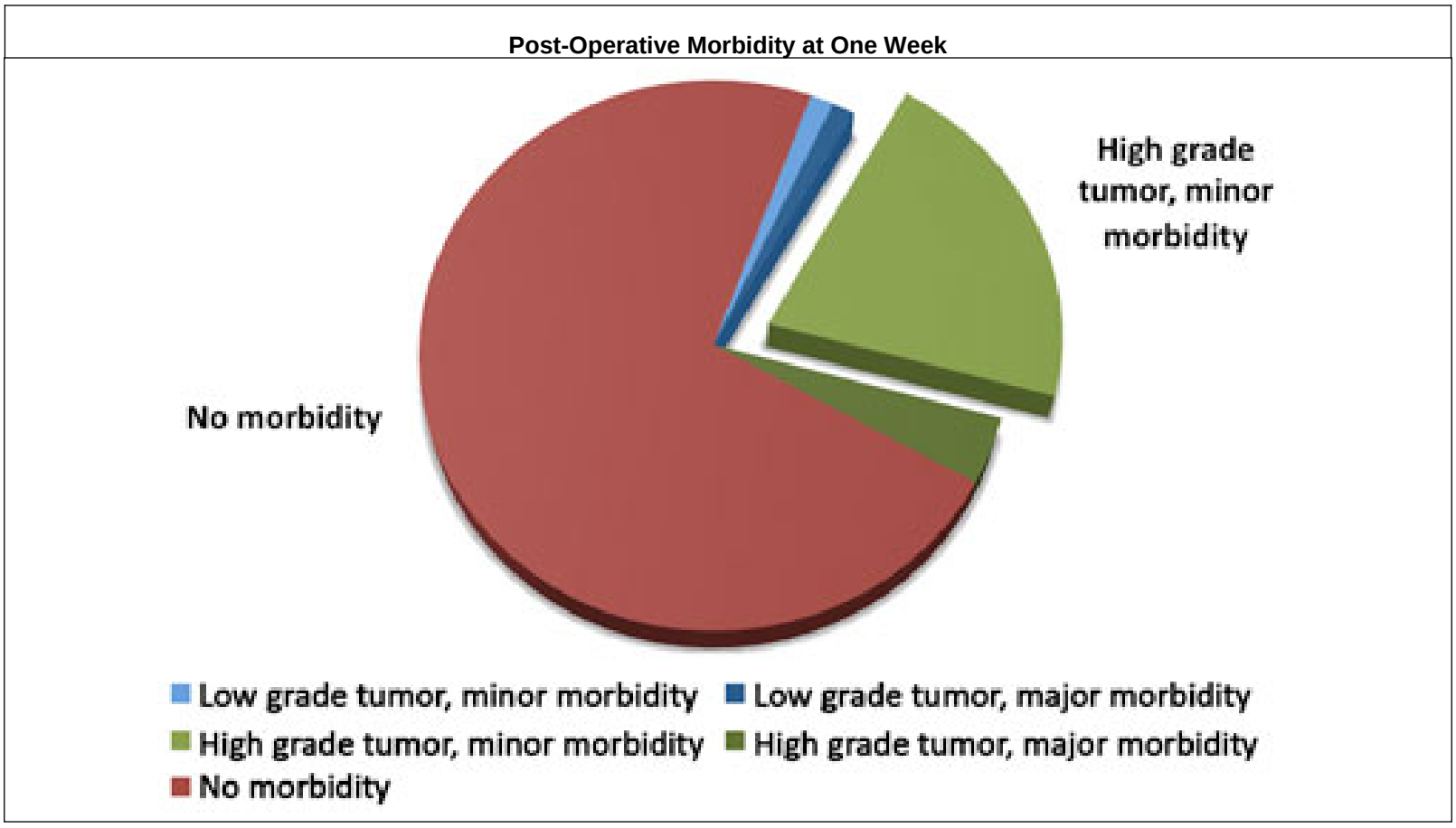
Post-Operative Morbidity at One Week
High grade tumor, minor morbidity
No morbidity
Low grade tumor, minor morbidity
Low grade tumor, major morbidity
High grade tumor, minor morbidity
High grade tumor, major morbidity
No morbidity

Tumor Population

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Low Grade	**15**								
Grade I	**3**	**3.9%**	**2**	**66.7%**	**0**	**0.0%**	**1**	**33.3%**	**Meningioma (3)**
M	*1*	*33.3%*	*1*	*50.0%*	*0*	*0.0%*	*0*	*0.0%*	
F	*2*	*66.7%*	*1*	*50.0%*	*0*	*0.0%*	*1*	*100.0%*	
Grade II	**12**	**15.8%**	**9**	**75.0%**	**2**	**16.7%**	**1**	**8.3%**	**Astrocytoma (5), Mixed Astrocytoma/ Oligodendroglioma (4), Oligodendroglioma (3)**
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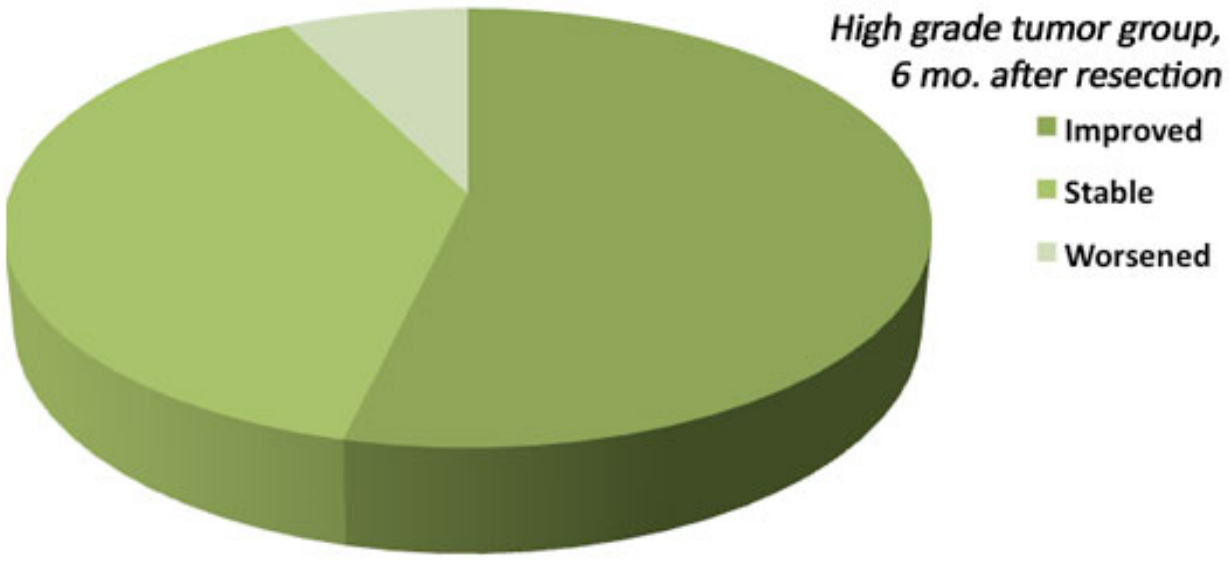
Post-Operative Morbidity at 6mo



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High	*29*	*47.5%*	*21*	*34.4%*	*4*	*6.6%*
Total	40	52.6%	23	30.3%	4	5.3%