

The Predictive Value of Diffuse Tensor Imaging and Tractography in Determining Neurological Status and Outcome in Patients with Brainstem and Posterior Fossa Tumors

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INTRODUCTION: Diffusion tensor imaging allows in vivo anatomic delineation of the brainstem white matter tracts. Tensor metrics in these tracts are abnormal in patients with brainstem/posterior fossa masses. The purpose of this study is to determine if abnormalities of DTI metrics and fiber tractography correlate with clinical findings including neurologic deficits and clinical outcome in patients with brainstem/posterior fossa tumors.

MATERIALS AND METHODS: A retrospective study of patients with posterior fossa tumors who underwent MRI with DTI was performed. Histopathology, physical exam findings, treatments (surgical, radiation, and chemotherapy) and clinical follow-up data were collected. MRI images of the brain were reviewed by a blinded observer. Images were obtained on a standard head coil at 1.5T and included diffusion tensor imaging using a single-shot echo planar imaging sequence (TR/TE/SL: 4000/99/5, 128x128 matrix, 240x240 FOV) obtained in 6 directions at a b value of 1000 s mm⁻². Diffusion tensor images were post-processed using a Siemens Leonardo workstation and Siemens/MGH DTI taskcard.

FA color-maps of the brainstem were used to localize white matter tracts: medullary pyramids, pontine corticospinal tracts, transverse pontine fibers, medial lemniscus/central tegmental tracts, brachium pontis, and cerebral peduncles. Using regions of interest, FA, MD, and eigenvalues were measured in each visualized white matter tract. Fiber tractography was performed and each tract was categorized as normal, diminished/disrupted, or displaced.

Correlations between DTI metrics and clinical outcomes, and correlations between DTI metrics and neurological exam findings were assessed using Fisher's exact test. Mann-Whitney test was used to assess the diagnostic utility of DTI measures and tractography in predicting clinical outcome and the presence of neurologic deficits.

RESULTS: We studied 29 patients: brainstem glioma (n=13), mixed neuronal/glioma tumor (n=4), CNS sarcoma (n=1), juvenile pilocytic astrocytoma (n=7), ependymoma (n=3), hemangioblastoma (n=1). Twenty-six patients had physical exam documented within 48 hours of MRI; three had bilateral motor weakness, 6 had unilateral motor weakness (3 left, 3 right), 17 had no motor deficit. Of the 6 patients with right-sided weakness, 3 demonstrated diminished/disrupted left-sided motor tractography and 3 demonstrated normal tractography. Of the 18 patients without right-sided weakness, 1 demonstrated diminished/disrupted left-sided motor

tractography and 17 demonstrated normal tractography. Of the 6 patients with left-sided weakness, 2 demonstrated diminished/disrupted right-sided motor tractography, 1 displaced right-sided motor tractography, and 3 normal tractography. Of the 19 patients without left-sided weakness, 1 had diminished/disrupted right-sided motor tractography, 2 had displaced right-sided motor tractography, and 16 had normal tractography (Table 1).

Right-sided Weakness	Left-sided Motor Tractography			Total
	Diminished/Disrupted	Displaced	Normal	
No	1 (25%)	0	17 (85%)	18 (75%)
Yes	3 (75%)	0	3 (15%)	6 (25%)
Left-sided Weakness	Right-sided Motor Tractography			Total
	Diminished/Disrupted	Displaced	Normal	
No	1 (33.3%)	2 (66.7%)	16 (84.2%)	19 (76%)
Yes	2 (66.7%)	1 (33.3%)	3 (15.8%)	6 (24%)

Table 1.

Fisher's exact test indicated patients with diminished/disrupted left-sided motor tractography were more likely (p=0.035) to have right-sided motor deficits than subjects with normal left-sided motor tractography. A similar association did not reach significance between right motor tractography and left-sided weakness (p=0.125).

Mann-Whitney test, used to compare patients with and without progression, demonstrated the MD and the E^{long} in the pyramidal tracts to be predictive of patient outcome and progression (p=0.031 and 0.038). Similarly, the FA in the medial lemniscus/central tegmental tracts was predictive of patient outcome and progression (p=0.006).

CONCLUSION: Preliminary data show an association between diminution/disruption of the left-sided motor tracts as demonstrated by fiber tractography and the presence of right-sided motor deficits. Several DTI metrics were also shown to be predictive of patient outcome and progression in posterior fossa tumors.