Characterization of abnormal diffusion properties of supratentorial brain tumors: a preliminary diffusion tensor imaging study

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Object. Diffusion tensor (DT) imaging was used in children with supratentorial tumors to evaluate the anisotropic diffusion properties between different tumor grades and between tumors and adjacent and contralateral white matter.

Methods. In this retrospective review, the authors review the cases of 16 children (age range 1–18 years) who presented to their institution with supratentorial tumors and were treated between 2004 and 2007. Eleven patients had low-grade and 5 had high-grade tumors. Fractional anisotropy (FA), mean diffusivity, and axial ($\lambda_2$) and radial ($\lambda_3$) eigenvalues within selected regions were studied. Mitotic index, necrosis, and vascularity of the tumors were compared with DT imaging parameters.

Results. The mean diffusivity was significantly higher in low-grade than in high-grade tumors ($p = 0.04$); the 2 tumor grades also significantly differed for both $\lambda_2$ ($p < 0.05$) and $\lambda_3$ ($p < 0.05$). Mean diffusivity values in low-grade tumors were significantly higher than in adjacent normal-appearing white matter (NAWM; $p = 0.0004$) and contralateral NAWM ($p = 0.0001$). In both low- and high-grade tumors, the FA was significantly lower than in NAWM ($p < 0.0001$ and $p < 0.03$, respectively) and contralateral NAWM ($p < 0.0001$ and $p < 0.003$, respectively). Tumor cellularity highly correlated with mean diffusivity and $\lambda_2$ and $\lambda_3$.

Conclusions. Diffusion tensor imaging is a useful tool in the evaluation of supratentorial tumors in children. The mean diffusivity appears to be a significant marker in differentiating tumors grades. Findings related to $\lambda_2$ and $\lambda_3$ within tumor groups and between tumors and NAWM may be an indirect manifestation of the combined effects of axonal injury, demyelination, and tumor mass within the cranial compartment. (DOI: 10.3171/PED/2008/1/4/263)

KEY WORDS • axial diffusion coefficient • diffusion tensor imaging • fractional anisotropy • mean diffusivity • radial diffusion coefficient • supratentorial tumor

Supratentorial brain tumors make up 25–40% of all brain tumors in children, with the majority being glial in origin.18 These tumors behave differently based on their WHO grade and represent a wide spectrum of prognosis. Conventional MR imaging can generally differentiate tumors that appear low grade from those that appear more aggressive based on certain characteristics such as the level of Gd enhancement and necrosis. However, the gold standard for diagnosis remains histopathological evaluation.

Diffusion tensor imaging is a new, noninvasive MR imaging technique used to evaluate the diffusivity of water in tissue. The 2 most commonly used DT imaging parameters are mean diffusivity and FA. Mean diffusivity is a measure of the average water diffusion based on the eigenvectors of the tensor in 3D space. Fractional anisotropy is used to quantify the magnitude and directionality of water diffusion through tissue, expressed as a value between 0 and 1.1,17 These parameters have been used previously in the evaluation of intraparenchymal brain and brainstem tumors.14–8 Most studies to date have been conducted in adults, with varying and controversial results. In a study of gliomas in an adult population, Inoue et al.7 reported a statistically significant inverse correlation between FA values and glial tumor grade. Mean diffusivity values were also found to be helpful, but the differences in the mean diffusivity among different tumor grades were not statistically significant. In a DT imaging study of peritumoral tissue in high-grade gliomas and metastatic lesions, Lu and coauthors20 reported that the tumors can be distinguished based

Abbreviations used in this paper: DT = diffusion tensor; FA = fractional anisotropy; $\lambda_2$ = axial diffusion coefficient; $\lambda_3$ = radial diffusion coefficient; MR = magnetic resonance; NAWM = normal-appearing white matter; ROI = region of interest; WHO = World Health Organization.
on mean diffusivity but not on FA values in the peritumoral tissue. Tropine et al. studied tumor tissue, white matter adjacent to the tumor, and white matter in the contralateral hemisphere in patients with tumors of different grades and types. These authors found that FA and mean diffusivity values are notably different between tumors in all tumor groups and contralateral white matter. In a comparison of high- and low-grade gliomas with meningiomas, FA and mean diffusivity values significantly differed between the 2 groups but did not significantly differ between different types of gliomas.

In the literature, reports of DT imaging tumor studies in children are scarce. Gauvain et al. found that the normalized mean diffusivity index (but not the value itself) differed significantly among high-grade, low-grade, and embryonal tumors. Their patient population included children with tumors in supratentorial and infratentorial locations. Interestingly, the authors found a significant correlation between tumor cellularity and mean diffusivity value, suggesting the latter as a potential predictor of tumor classification.

It has been shown that the developing central nervous system demonstrates a changing DT imaging profile over time among the major white matter regions. As a result, the developing central nervous system in the diseased state would differ significantly between low- and high-grade tumors in children; and second, that DT imaging parameters would differ significantly between tumor and adjacent and contralateral NAWM.

### Clinical Materials and Methods

We retrospectively (before July 2006) and prospectively (after July 2006) reviewed clinical DT imaging data sets acquired in 16 children with supratentorial tumors who presented to our institution between March 2004 and January 2007. Approval for the study was obtained from our Institutional Review Board.

### Patient Population

The study population included 16 patients with supratentorial tumors (Table 1). On the basis of histopathological findings, 11 patients (7 girls and 4 boys, mean age 10.1 ± 4.1 years) had low-grade tumors (WHO Grades I and II) and 5 patients (3 girls and 2 boys, mean age 7.4 ± 6.8 years) had high-grade tumors (WHO Grades III and IV). Neither age (Mann–Whitney U-test, U = 37, p = 0.32) nor sex (χ² = 0.10, p = 0.80) differed significantly between the 2 groups.

### Image Acquisition

The DT images used in the present study were from the standard clinical DT images obtained in the patients. The data were acquired on 2 different types of MR scanners: 12 patients underwent scanning in a 3.0-T scanner (Siemens Trio, Siemens Medical Solutions) and 4 patients in 1.5-T scanners (Signa, GE Medical Systems). All DT images were acquired with diffusion-weighted, spin echo planar imaging in the axial plane with a b-value of 1000 second/mm². Slight differences were found in scanning protocols in DT imaging given the occasional adjustment in clinical imaging parameters.

### Table 1: Demographic information and histopathological and DT imaging parameters in 16 children with supratentorial tumors

<table>
<thead>
<tr>
<th>Age (yrs)</th>
<th>Sex</th>
<th>Tumor Grade</th>
<th>Clinical Diagnosis</th>
<th>MIB-1 Index</th>
<th>Vascularity</th>
<th>Presence of Necrosis</th>
<th>Tumor Characteristic</th>
<th>Adjacent NAWM Characteristic</th>
<th>Contralat NAWM Characteristic</th>
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<tr>
<td></td>
<td></td>
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<td></td>
<td></td>
<td>FA</td>
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<tr>
<td>10, F</td>
<td>low</td>
<td>Grade I glioma</td>
<td>3</td>
<td>no</td>
<td>no</td>
<td>0.122</td>
<td>1567</td>
<td>1702</td>
<td>1500</td>
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<tr>
<td>9, F</td>
<td>low</td>
<td>Grade I glioma</td>
<td>7.5</td>
<td>no</td>
<td>no</td>
<td>0.137</td>
<td>2847</td>
<td>3168</td>
<td>2687</td>
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<tr>
<td>3, F</td>
<td>low</td>
<td>Grade I glioma</td>
<td>4.5</td>
<td>no</td>
<td>no</td>
<td>0.105</td>
<td>1526</td>
<td>1557</td>
<td>1510</td>
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<tr>
<td>6, F</td>
<td>low</td>
<td>Grade I meningioma</td>
<td>NA†</td>
<td>yes</td>
<td>no</td>
<td>0.22</td>
<td>1159</td>
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<td>low</td>
<td>Grade I glioma</td>
<td>1</td>
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<td>no</td>
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<td>1996</td>
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<td>no</td>
<td>0.197</td>
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<td>low-grade oligodendroglioma</td>
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<td>no</td>
<td>no</td>
<td>0.145</td>
<td>1789</td>
<td>1901</td>
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<tr>
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<td>no</td>
<td>no</td>
<td>0.164</td>
<td>1333</td>
<td>1370</td>
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<td>7, M</td>
<td>low</td>
<td>desmoplastic ganglioglioma</td>
<td>0</td>
<td>no</td>
<td>no</td>
<td>0.194</td>
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<td>3</td>
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<td>897</td>
<td>929</td>
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<td>PNET</td>
<td>12.5</td>
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<td>yes</td>
<td>0.141</td>
<td>1115</td>
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<td>1079</td>
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<td>18, M</td>
<td>high</td>
<td>GBM</td>
<td>30</td>
<td>yes</td>
<td>yes</td>
<td>0.091</td>
<td>1035</td>
<td>1054</td>
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<tr>
<td>1, F</td>
<td>high</td>
<td>ATRT</td>
<td>75</td>
<td>yes</td>
<td>yes</td>
<td>0.136</td>
<td>706</td>
<td>717</td>
<td>700</td>
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<tr>
<td>10, F</td>
<td>high</td>
<td>GBM</td>
<td>1.5</td>
<td>yes</td>
<td>yes</td>
<td>0.166</td>
<td>1645</td>
<td>1753</td>
<td>1592</td>
</tr>
</tbody>
</table>

† Numerical value for MIB-1 was not available.

*ATRT = atypical teratoid/rhabdoid tumor; GBM = glioblastoma multiforme; MD = mean diffusivity; NA = not available; PNET = primitive neuroectodermal tumor.

TABLE 1: Demographic information and histopathological and DT imaging parameters in 16 children with supratentorial tumors

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scanning for image quality optimization. Six patients underwent scanning with a 6-direction DT imaging protocol on the 3.0-T Siemens with the following parameters: TR = 5000–5300 msec; TE = 80–84 msec; resolution = 1.72 × 1.72 × 3 mm; 4 or 6 averages. The other 6 patients who underwent scanning in the 3.0-T scanner had the following DT imaging parameters: TR = 6000–6200 msec; TE = 87 msec; resolution = 2 × 2 × 2 mm; 2 or 4 averages. Three patients underwent imaging in the 1.5-T scanners with the following parameters: 15 directions; TR = 12000 msec; TE = 76–84 msec; resolution = 1.5 × 1.5 × 3 mm; 2 averages. One patient underwent scanning in the 1.5-T machine with the following DT imaging parameters: 6 directions; TR = 10000 msec; TE = 76 msec; resolution = 0.9 × 0.9 × 6.5 mm.

To evaluate for any potential differences related to our protocols or scanners, a volunteer underwent scanning multiple times. Comparisons were made of the calculated mean diffusion properties obtained from different scanners, from the same scanner but with a different number of diffusion directions (for example, 6 vs 12 directions), or from the same scanner but with a different number of averages. No statistically significant interscanner or interprotocol difference (p = 0.05) was observed in any of the DT imaging parameters calculated from any of the ROIs used in this study. The data analysis in this study may demonstrate a minor variation as the result of the interscanner difference and occasional protocol change. However, this did not affect the significance of our findings.

Data Processing

Image reconstruction, postprocessing, and ROI–based DT imaging parameter calculations were performed with software (Cincinnati Children’s Hospital Imaging Processing Software) written in interface description language (Research Systems Inc.). On a pixel-by-pixel basis, the 6 elements (Dxx, Dyy, Dzz, Dxy, Dxz, and Dyz) were calculated and then diagonalized to calculate the 3 eigenvalues (λ1, λ2, and λ3) corresponding to the 3 eigenvectors in the diffusion tensor matrix. The mean diffusivity value was calculated as the mean of the 3 eigenvalues (mean diffusivity = (λ1 + λ2 + λ3)/3). The FA map was calculated using the following formula:

\[
FA = \frac{\sqrt{(\lambda_1 - \lambda_2)^2 + (\lambda_2 - \lambda_3)^2 + (\lambda_3 - \lambda_1)^2}}{\sqrt{2(\lambda_1^2 + \lambda_2^2 + \lambda_3^2)}}
\]

We also studied specific eigenvalue indices λ1 (λi) and λ⊥ ((λ1 + λ3)/2) that represent diffusion properties along axial and radial directions, respectively. The ROI in each patient was manually determined on anatomical MR images by 1 investigator (W.Y.) under the guidance of the neuroradiologist (B.V.J.) and neurosurgeon (F.T.M.). Gadolinium-enhanced T1- and T2-weighted images were used to help identify the region of interest. For each patient, we selected a slice that demonstrated the largest tumor area and manually drew the boundary. As shown in the example in Fig. 1, 3 ROIs were selected for each patient on an axial slice that showed the maximum tumor area. The first region selected was the tumor, which included only the solid portion of the tumor, excluding any rim enhancement. The second region was the adjacent NAWM. The third region, the internal control, was selected at the corresponding region of white matter in the contralateral hemisphere. For all 3 ROIs, great care was taken to avoid cysts, edema, and hemorrhage. After an ROI was determined, mean FA, mean diffusivity, λ1, and λ⊥ were calculated across all the pixels within that region and were compared to the values obtained in the patient’s other regions.

We reviewed the histopathological results obtained in all patients, including MIB-1, level of necrosis, and vascularity. A Pearson correlation statistical analysis was performed to study the correlation of these indices with mean diffusivity and FA values derived from DT imaging.

Statistical Analysis

Statistical analysis was performed using commercially available software (SPSS, Version 14). Statistics included FA, mean diffusivity, λ1, and λ⊥ values for low- and high-grade tumors and were tested with the Mann–Whitney U-test. The statistics for these DT imaging parameters in various white matter regions were tested with the paired t-test. The Pearson correlation analysis was used in calculating the correlation coefficient between pathological test indices and DT imaging parameters. A linear regression analysis was used to study the predictive value of DT imaging parameters for tumor characteristics. Mean values are presented ± standard deviations.
Results

All mean diffusivity values and axial and radial diffusion coefficients are expressed in units of $10^{-6}$ mm$^2$/second throughout.

Comparison of DT Imaging Parameters in Patients With Different Tumor Grades

Mean diffusivity values were significantly higher in low-grade tumors ($1612 \pm 478$) when compared with high-grade tumors ($1080 \pm 352, p = 0.03$) (Fig. 2A). Additionally, an analysis of axial and radial diffusion coefficient properties demonstrated a significant difference between tumor grades for both $\lambda_a$ ($p = 0.03$) and $\lambda_r$ ($p = 0.03$). In a comparison of FA, values showed no significant differences between low- and high-grade tumor groups (Table 2).

Comparison of DT Imaging Parameters Between Low-Grade Tumors and NAWM Regions

Mean diffusivity values in low-grade tumors ($1612 \pm 478$) were significantly higher than adjacent NAWM ($933 \pm 194, p = 0.0004$) and contralateral NAWM ($821 \pm 81, p = 0.0001$) (Fig. 2A). The $\lambda_a$ values in low-grade tumors ($1727 \pm 533$) were significantly higher than in adjacent NAWM ($1162 \pm 212, p < 0.01$) and contralateral NAWM ($1064 \pm 144, p < 0.003$) (Fig. 2B). The $\lambda_r$ values in low-grade tumors were also significantly higher than adjacent NAWM and contralateral NAWM (Fig. 2C). The mean diffusivity, $\lambda_a$ and $\lambda_r$ in adjacent NAWM were all higher than corresponding contralateral NAWM with statistical significance or marginal significance ($p < 0.03$, $p = 0.06$, and $p < 0.03$, respectively; Fig. 2A–C). Fractional anisotropy values in low-grade tumors ($0.146 \pm 0.048$) were significantly lower than in adjacent NAWM ($0.424 \pm 0.079, p < 0.0001$) and contralateral NAWM ($0.434 \pm 0.037, p < 0.0001$; Fig. 2D).

Comparison of DT Imaging Parameters Between High-Grade Tumors and NAWM Regions

The mean diffusivity values in high-grade tumors ($1080 \pm 352$) were higher than both adjacent ($895 \pm 43$) and contralateral NAWM ($816 \pm 151$) but failed to reach statistical significance ($p = 0.28$ and 0.30, respectively; Table 2, Fig. 2A). Similarly, although both $\lambda_a$ ($1134 \pm 391$) and $\lambda_r$ ($1056 \pm 334$) within tumors tended to be larger than the adjacent ($\lambda_a = 1045 \pm 46, \lambda_r = 820 \pm 54$) and contralateral ($\lambda_a = 984 \pm 263, \lambda_r = 737 \pm 120$) NAWM, neither reached statistical significance (Fig. 2B and C). No significant difference was demonstrated between adjacent and contralateral NAWM for any of the DT imaging parameters in patients with high-grade tumors. Fractional anisotropy values in high-grade tumors ($0.347 \pm 0.084$) were significantly lower than in adjacent NAWM ($0.434 \pm 0.037, p < 0.0001$; Fig. 2D).
Diffusion tensor imaging study of supratentorial tumors

**TABLE 2**

Comparison of DT imaging parameters between children with low- and high-grade tumors

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Low Grade (11 children)</th>
<th>High Grade (5 children)</th>
<th>p Value†</th>
</tr>
</thead>
<tbody>
<tr>
<td>tumor</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FA</td>
<td>0.146 ± 0.048</td>
<td>0.148 ± 0.042</td>
<td>0.91</td>
</tr>
<tr>
<td>MD ($\times 10^{-6}$ mm$^2$/sec)</td>
<td>1612 ± 478</td>
<td>1080 ± 352</td>
<td>0.03</td>
</tr>
<tr>
<td>$\lambda_1$ ($\times 10^{-6}$ mm$^2$/sec)</td>
<td>1727 ± 535</td>
<td>1134 ± 391</td>
<td>0.03</td>
</tr>
<tr>
<td>$\lambda_2$ ($\times 10^{-6}$ mm$^2$/sec)</td>
<td>1558 ± 453</td>
<td>1056 ± 334</td>
<td>0.03</td>
</tr>
<tr>
<td>adjacent NAWM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FA</td>
<td>0.424 ± 0.079</td>
<td>0.347 ± 0.084</td>
<td>0.12</td>
</tr>
<tr>
<td>MD ($\times 10^{-6}$ mm$^2$/sec)</td>
<td>933 ± 194</td>
<td>895 ± 43</td>
<td>0.74</td>
</tr>
<tr>
<td>$\lambda_1$ ($\times 10^{-6}$ mm$^2$/sec)</td>
<td>1162 ± 212</td>
<td>1045 ± 46</td>
<td>0.44</td>
</tr>
<tr>
<td>$\lambda_2$ ($\times 10^{-6}$ mm$^2$/sec)</td>
<td>823 ± 206</td>
<td>820 ± 54</td>
<td>0.22</td>
</tr>
<tr>
<td>contralateral NAWM</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FA</td>
<td>0.434 ± 0.037</td>
<td>0.405 ± 0.069</td>
<td>0.58</td>
</tr>
<tr>
<td>MD ($\times 10^{-6}$ mm$^2$/sec)</td>
<td>821 ± 81</td>
<td>816 ± 151</td>
<td>0.83</td>
</tr>
<tr>
<td>$\lambda_1$ ($\times 10^{-6}$ mm$^2$/sec)</td>
<td>1064 ± 144</td>
<td>984 ± 263</td>
<td>0.58</td>
</tr>
<tr>
<td>$\lambda_2$ ($\times 10^{-6}$ mm$^2$/sec)</td>
<td>700 ± 68</td>
<td>737 ± 120</td>
<td>0.22</td>
</tr>
</tbody>
</table>

* Values represent the means ± standard deviations unless otherwise noted. † Two-tailed U-test.

**Mass Effect and Edema**

At presentation, all patients had closed anterior and posterior fontanelles. Given that some patients demonstrated midline shift on MR imaging, we evaluated and confirmed that this shifting did not affect our measuring parameters. In evaluating FA and mean diffusivity values in regions of peritumoral edema, we found no significant differences; these regions were excluded from ROI measurements.

**Histopathological Review and Correlations With DT Imaging Parameters**

We reviewed the histopathology reports on the tumors in each patient. All high-grade tumors demonstrated increased vascularity (Table 1); the group difference was statistically significant (df = 1, $\chi^2 = 138, p < 0.001$). When compared with children with low-grade tumors, children with high-grade tumors had a significantly higher percentage of tumor necrosis (df = 1, $\chi^2 = 200, p < 0.001$). Testing with the MIB-1 antibody demonstrated, as expected, few or no nuclei in low-grade tumor specimens, while the proliferation rate was much higher in 4 of 5 high-grade tumors. These indices were then compared with DT imaging parameters.

Table 3 demonstrates that mean diffusivity, $\lambda_1$, and $\lambda_2$, all had moderately strong correlations with MIB-1, vascularity, and necrosis index. In a linear regression model of the relationship between mean diffusivity and MIB-1 index (Fig. 3), mean diffusivity values decreased with increasing proliferation rates with a moderate to high strength of correlation ($R^2 = 0.288, p < 0.05$). In contrast, FA values in the tumors showed no strong association with these indices.

**Discussion**

Our preliminary results demonstrate that DT imaging is a useful tool for the evaluation of supratentorial tumors of different grades in children. Mean diffusivity values were significantly higher in low-grade lesions compared with high-grade lesions (Table 2). This trend correlates with increasing axial and radial diffusion coefficients between the tumor groups (Fig. 2). To test the validity of our findings, we performed a correlation analysis and a significant correlation was found between the magnitude of water diffusion (mean diffusivity value) and a diagnostic histopathology parameter of brain tumors (MIB-1 index, Fig. 3). Based on these data (correlation of mean diffusivity with axial and radial diffusion coefficients, and mitotic index), these DT imaging parameters may have significant potential in serving as a predictor of tumor grade. As the ability of water molecules to diffuse within tissue in high-grade tumors decreases, mean diffusivity values decrease. Therefore, the radiographic findings may reflect differences in cytoarchitecture between tumor types that include mitotic activity, vascularity, and level of necrosis. Although the authors of studies in adults have reported contrasting results, our findings are similar to some previously published studies of diffusion-weighted imaging in brain tumors in adults. In an evaluation of 15 patients with primary malignant gliomas, Castillo and associates demonstrated that the mean diffusivity values could differentiate between tumor and normal tissue. Similarly, Kitis et al. showed that mean diffusivity values differed for low- and high-grade gliomas, metastases, and lymphomas. It should be noted that the results in the present study should not be interpreted as conclusive evidence for recommending DT imaging and changing the current standard of care in tumor management in the pediatric population; rather the data may provide valuable preliminary results in the evaluation of new technological advances with the potential to change future medical practice.
Fractional anisotropy values were significantly lower in all tumors than in adjacent and contralateral white matter. However, as others have also reported, this index did not help in distinguishing between tumor grades. For example, Wieshmann et al. reported decreased FA values in pathological brain lesions that included low- and high-grade tumors, traumatic brain injury, perinatal infarcts and hypoxia, and cortical dysplasia. In a study of gliomas and meningiomas, Provenzale and colleagues concluded that FA differences in the peritumoral regions may have a role in the detection of tumor infiltration. Our findings suggest that FA may be valuable in establishing possible radiographic borders between tumor and normal-appearing margins (Fig. 2D). Similarly, in comparing the radial diffusion coefficient values between tumors and surrounding white matter, we noted that this variable was highest in tumors and lower in adjacent and contralateral white matter regions (Fig. 2C). The radial diffusion coefficient may be another variable that could prove useful in differentiation of tumor infiltration from its margins. In our study, this coefficient it did not reach statistical significance, possibly because of our relatively small number of patients. Findings related to λ within tumor groups, and FA and λ between tumors and NAWM may be an indirect manifestation of the combined effects of axonal injury, demyelination, and tumor mass within the cranial compartment. However, these findings, as well as any new findings in future DT imaging tumor studies, would need to be confirmed with tissue histopathology—the “gold standard”—before any definitive conclusions can be made regarding the role this technology may eventually play in patient care.

Another interesting observation from our study is the contrast between adjacent NAWM and contralateral NAWM (Fig. 2). Despite the difference in relative distance to the tumor, FA values between the 2 areas of NAWM did not significantly differ from each other whether the tumor groups were evaluated together or tested separately. Among low-grade tumors, the differences between the 2 areas of NAWM differed significantly with regard to mean diffusivity and λ. No such differences were observed for any of these parameters among high-grade tumors. As we collect additional data, a larger patient population may help determine if the trends toward differences in mean diffusivity and other diffusion coefficient parameters in white matter adjacent to low-grade tumors are significant, and if indeed no difference exists within the high-grade tumor group.

Several limitations of this retrospective investigation should be noted. Many specific factors (such as homogeneity of tumor type, tumor size, and patient age) are difficult to control. As an internal control, we used contralateral NAWM regions to minimize the influence of normal inherent differences in DT imaging parameters. The paired t-test used in a comparison of DT imaging parameters between tumor and NAWMs should account for some of the confounding factors. Our small sample size limited both statistical power and the ability to control for multiple variables. Another potential limitation was the DT imaging scanning protocol—different scanners and 2 different diffusion encoding gradient trajectories were used. In a recent report comparing potential effects of these differences in DT imaging, Ni et al. found no significant differences for the ROI level in FA and mean diffusivity values among protocols. To account for such differences and this potential limitation at our institution, an adult volunteer underwent scanning multiple times in various scanners and with different numbers of directions for DT imaging. No significant differences were noted. Therefore, we believe that this preliminary study can serve as a foundation for DT imaging of low- and high-grade supratentorial tumors in children. The limitations we have discussed in the present study can be further addressed in a larger scale prospective study.

Conclusions

We found significant differences in mean diffusivity, λ, and FA values between low- and high-grade supratentorial tumors in children. Measurement of these values may help predict preoperative diagnosis of supratentorial tumors in children. We also demonstrated significant differences between low-grade tumor and adjacent and contralateral NAWM. These factors may help differentiate tumor margins from tumor core. Future studies may demonstrate stratification of diffusion parameters among various tumor types. We hope to create a homogenous database that is tumor specific. Additionally, in conducting following up in our patients through adjuvant courses of therapy, we will apply DT imaging parameters to evaluate tumor recurrence and white matter abnormalities over time.

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