

# Histogram analysis of Fractional anisotropy and mean diffusivity: Distinguishing Tumefactive Demyelinating Lesions from High-Grade Glioma using DTI

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**Introduction:** Tumefactive demyelinating lesions (TDLs) are defined as large (usually >2cm) demyelinating lesions mimicking brain tumors; they occur as solitary lesions or as a few separate lesions [1,2]. Mass effect and contrast enhancement on neuroimaging make it difficult to distinguish this type of lesion from high-grade gliomas [3,4]. The diagnosis of TDLs often leads to surgical biopsy with a high risk of morbidity. Therefore, it is of significant clinical importance to differentiate between TDLs and high-grade gliomas (HGGs) to avoid a brain biopsy. However, due to many similar nonspecific MR imaging features shared by both, this goal is difficult to achieve by conventional MR imaging alone. DTI have offered the opportunity to quantify pathological changes in lesions. The objective of this study is to determine whether quantitative histogram analysis of FA and MD values can be helpful in distinguishing between TDLs and HGGs.

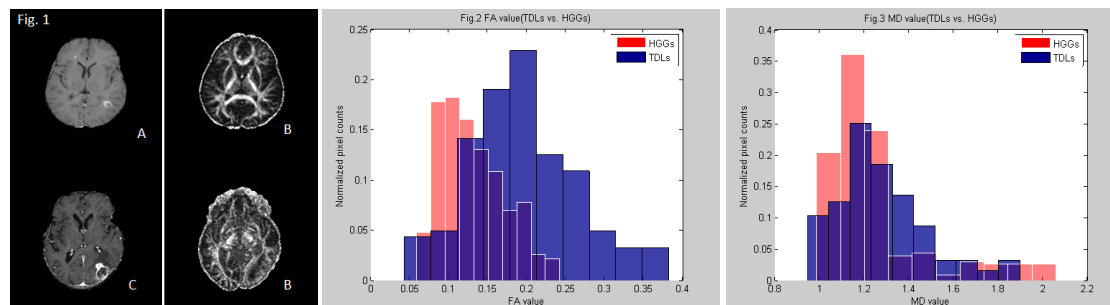
**Method: Subjects:** A total of 31 patients were studied so far, who were divided into two groups: 20 patients with histologically proved TDLs with stereotactic biopsy results for retrospective review, and 11 patients with pathology confirmed high-grade gliomas. **Image acquisition:** All studies were performed on 3T scanner (GE Medical systems) with DTI scan to produce the DTI parameters. Postcontrast 3D FSPGR T1-Weighted images were included for TDL patient group and axial T1-post images were collected for HGG patient group. The scanning parameters for Diffusion Tensor images are as follows: image matrix, 256\*256; slice thickness: 5 mm; TR/TE, 10s/126ms. **Data analysis:** All image processing steps and statistical analyses were performed using FSL package (FMRIB, Oxford, UK) and SPM (NITRC, UK). Eddy current distortion was corrected and image coregistration was performed before tensor calculation. The fractional anisotropy (FA) and mean diffusivity (MD) were measured for both enhanced TDLs and tumor portions. Histograms of FA values for enhanced TDLs and HGGs for each patient from the complete tumor ROI were also produced to assess the normalized histogram peak height of the FA and MD value distributions in lesion area. Mann-Whitney test were used to evaluate differences between TDLs and HGGs. Statistical analysis was performed with SPSS (SPSS, Chicago, III) and MATLAB (The Mathworks, USA).

**Result:** We compare the FA value and MD value for both enhanced Tumefactive demyelinating lesions (TDLs) and enhanced high grade glioma (HGGs) with the matched location. Results showed that TDLs and HGGs could be differentiated by using the histogram method (Mann-Whitney test  $P < .05$ ). The FA value was significant higher in the TDL group (mean $\pm$ SD, 0.212 $\pm$ 0.07) than that in the HGG group (mean $\pm$ SD, 0.127 $\pm$ 0.02) with  $P$  value $<.001$ . The 50<sup>th</sup> and 75<sup>th</sup> percentile of FA value histogram showed significant differences between two groups ( $P = 0.048$  and  $P = 0.037$ , respectively). And the 50<sup>th</sup> and 75<sup>th</sup> percentile of MD value histogram also indicated significant differences between two groups ( $P = 0.009$  and  $P = 0.018$ , respectively). Fig. 1 Shows MR images with coregistered FA maps of typical patients with TDL and HGG. The resulting histograms from the TDL and HGG are shown in Figure 2. A plot of the mean histogram peak heights with FA and MD value for the different glioma types investigated is shown in Fig 3. The MD values in the TDL group showed lower values (mean $\pm$ SD, 1.083 $\pm$ 0.24) than those of the HGG group (mean $\pm$ SD, 1.163 $\pm$ 0.2). While there are not significant differences for mean MD values between those two groups, the histogram method was able to distinguish TDLs from HGGs by measuring the mean MD peak height in the matched regions. The mean MD peak heights in HGG patients are significantly higher than that of TDL patients in matched regions.

Table 1. Comparison of DTI parameters for enhanced TDLs and high-grade gliomas.

DTI parameter	Enhanced TDLs (n= 20)	Enhanced HGGs (n= 11)
Mean FA	0.212 $\pm$ 0.07	0.127 $\pm$ 0.02
Mean FA peak height [%]	28.628 $\pm$ 9.45	21.854 $\pm$ 5.44
Mean FA peak location	0.172 $\pm$ 0.11	0.110 $\pm$ 0.02
Mean MD	1.083 $\pm$ 0.24	1.163 $\pm$ 0.2
Mean MD peak height [%]	20.632 $\pm$ 4.72	26.88 $\pm$ 8.73
Mean MD peak height location	1.223 $\pm$ 0.374	1.329 $\pm$ 0.13

Fig 1. A. Axial postcontrast T1-weighted image of subject 1 with TDL. B. Coregistered FA map of subject 1. C. Axial postcontrast T1-weighted image of subject 6 with HGG. D. Coregistered FA map of subject 6. Fig. 2&3 Resulting normalized histogram plots of the total distribution of FA values and MD values from the Patients shown in Fig 1.



**Conclusion:** Our results suggest that histogram analysis of FA and MD values can differentiate Tumefactive demyelinating lesions from high-grade gliomas.

**References:** [1] Dagher AP, Smirniotopoulos J. Tumefactive demyelinating lesions. *Neuroradiology* 1996; 38:560-565.2. Kepes JJ. Large focal tumor-like demyelinating lesions of the brain: intermediate entity between multiple sclerosis and acute disseminated encephalomyelitis: a study of 31 patients. *Ann Neurol* 1993;33:18-27.[3] Stevens BS, Lee C. The MRI appearance of tumefactive demyelinating lesions. *AJR Am J Roentgenol.* 2004;182:195-9. [4] Tan HM, Chan LL, Chuah KL, et al. Monophasic, solitary tumefactive demyelinating lesion: neuroimaging features and neuropathological diagnosis. *Br J Radiol.* 2004;77:153-6.