White Matter Integrity Alterations in Disruptive Behavioral Disorder

Y. Wang[1], K. M. Mosier[1], A. J. Kalnin[1], C. Lin[1], D. W. David[1], W. G. Kronenberger[1], and V. P. Mathews[1]

[1]Indiana University School of Medicine, Indianapolis, Indiana, United States

Purpose:

There has been a great deal of interest in using diffusion tensor imaging (DTI) for studying white matter development in the brain and for noninvasive mapping of neuronal connectivity. Disruptive behavioral disorders (DBD; Oppositional Defiant Disorder or Conduct Disorders) with their substantial short and long term risks continue to be among the most common psychiatric problems referred for mental health intervention. Previously, our group reported a DTI study using an optimized MR DTI protocol to assess any possible structural abnormalities associated with DBD. We found that there was significantly reduced fractional anisotropy (FA) in frontal and temporal regions in DBD group compared to control subjects [1]. To determine differences in DBD and control groups, a voxel-based analysis using SPM was applied on FA maps. Recently, more papers [2] reported alignment issues using FA to drive affine alignment across subjects.

The purpose of the present study is to evaluate changes in white matter integrity in DBD, using a new approach referred as Tract-Based Spatial Statistics (TBSS) [2], to confirm and extend our findings of DTI study in DBD.

Methods:

Fifty-four adolescents with an average age of 14.6±1.2 years were included in this report. All subjects met DSM-IV criteria for either Oppositional-Defiant Disorder or Conduct Disorder based on the K-SADS Semistructured Diagnostic Interview. Twenty-seven were diagnosed DBD with aggressive symptoms within the past 6 months, and another 27 subjects were normal controls with no psychiatric disorder. Both groups matched exactly on age and gender (male/female=20/7 for each group). The MR measurements were acquired on a 3.0T MRI scanner using an 8 channel phased array head coil. A SE-EPI DTI sequence was performed using parameters: matrix=128x128; FOV=256x256mm; TE/TR=100/10100ms; 60 transversal slices with 2mm thickness; 60 diffusion directions with gradients b=1000s/mm2, and 10 samplings at b=0.

The DTI data were analyzed in the frame of FSL, in combination with AFNI software. Post-processing included head motion correction and eddy current correction. Six principle direction tensors were calculated using nonlinear diffusion tensor estimation in AFNI. FA was calculated according to the scheme proposed by Pierpaoli [3], and mean diffusivity (MD) was calculated as simple average of eigenvalues. After that, TBSS analysis was utilized. All individual FA maps were nonlinearly registered to each other and then affine-transformed into standard MNI space. A mean track skeleton map presenting common tracts to all subjects was generated based on the mean FA image of all subjects. Each subject's aligned FA image was projected onto the mean FA skeleton, resulting in an individual skeletonised FA map. The nonlinear warps and skeleton projection were also applied to individual MD maps. Finally, all skeletonised FA and MD maps were fed into voxelwise cross-subject statistical analysis.

Results:

Statistical analysis on skeletonised FA and MD maps revealed significant reduction of FA and significant increase of MD in DBD patients compared to normal controls. Reduced FA and increased MD were observed in prefrontal region in DBD, along the anterior region of the corona radiata, as well as some short-range association fibers. This trend was also found bilaterally along the superior longitudinal fasciculus.

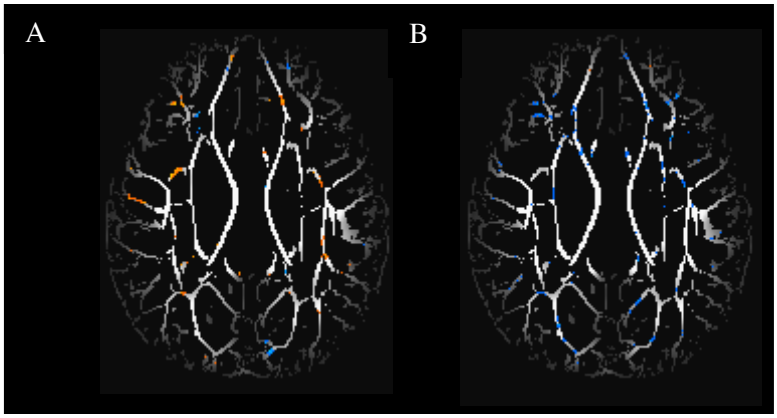

Fig. 1: Statistical group comparison results overlaid on mean FA skeleton map. (A). group differences in skeletonised FA. (B) group differences in skeletonised MD. (red-yellow color showed locations where control group was significantly greater than DBD group, while blue-light blue color indicated control group was significantly less than DBD group, $p < 0.05$).

Conclusions:

Using TBSS analysis approach, FA and MD measures demonstrated altered changes in white matter integrity, specifically in the frontal lobe area. This may reflect abnormalities associated with brain connectivity in DBD. These alterations seem to be in agreement with results from our fMRI studies in adolescents with DBD [4].

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Reference:

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