Hybrid Diffusion Imaging to Detect Acute White Matter Injury after Mild TBI

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Introduction:
In the present study we used multi-shell Hybrid Diffusion Imaging (HYDI) to study white matter changes in the acute stage of mild traumatic brain injury (mTBI). Non-parametric diffusion analysis, q-space imaging as well as parametric analyses including conventional DTI and novel neurite orientation dispersion and density imaging (NODDI) were used to analyze the HYDI data.

Method:
Nineteen mTBI patients and 23 trauma-controlled subjects were recruited from the Emergency Department. Participants received T1W SPGR and HYDI in a Philips 3T Achieve TX scanner with 8-channel head coil and SENSE parallel imaging. The diffusion-weighting (DW) pulse sequence scan-time was about 24 min similar to (1).

Results:
Forty-eight WM ROIs were defined in the standard MNI space by intersecting subjects’ mean WM skeleton with WM atlas of Johns Hopkins University (JHU) ICBM-DTI-81(2). Linear model analysis was used to test the significance of diffusion metrics between mTBI and trauma-controlled groups with gender and age as covariates (model 3 in Table 1). Maps of DTI, q-space and NODDI diffusion metrics of an mTBI subject are shown in Figure 1. Among various diffusion metrics, only the NODDI derived parenchymal axonal density (Vic) was sensitive to mTBI with significant decreases in 60% of WM ROIs (Table 1). The mTBI subjects had an approximately 4% decrease in Vic. The affected WM tracts concentrated on pyramidal tracts and its cortical projections (bilateral corona radiatae). Most of the cerebella related tracts and hippocampal tracts are spared.

Conclusion:
HYDI and its diffusion metrics provide insights about microstructural changes of WM in the acute stage of mTBI and may prove useful as a marker of injury.

References: