DTI: Relationship to Behavior in Cocaine Dependence

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Introduction:

Diffusion tensor imaging (DTI) is becoming increasingly used as a tool to examine subtle white matter pathology in psychiatric populations. However, to date few studies find a direct association between DTI abnormalities and behavior. The purpose of this study was to compare cocaine dependent subjects with non-drug using controls using DTI and examine whether any differences between cocaine users and controls were related to behavioral measures.

Methods:

Eighteen cocaine dependent subjects and 18 healthy controls underwent full brain Diffusion tensor imaging (DTI) acquired with a diffusion sensitized dual spin echo prepared echoplanar imaging (SE-EPI) sequence, on a 1.5 T General Electric echospeed CNV MRI scanner using a standard quadrature RF Head Coil. The diffusion tensor encoding scheme was based on the uniformly distributed and balanced rotationally invariant *Icosa21* tensor encoding set. Following the acquisition of sagittal scout images, full brain axial sections were acquired with a 4 mm slice thickness with no gap, 128X128 matrix, and a field of view of 24x24 cm. Fast spin echo proton density and T2 weighted images were acquired from the same location as DTI. DTI post processing was performed using the Automated Image Registration (AIR) package. The distortion corrected images were decoded using a least squares singular value decomposition approach to estimate the diffusion tensor elements. The corpus callosum was the focus of this analysis, which was divided into 7 segments based on the previous work by Witelson (1989) (See Figure 1), in order to compare regions of the corpus callosum and thereby examine fiber tracts linked to different cortical regions. All 7 segments of the corpus callosum were compared between cocaine users and controls using a Mixed Model ANOVA. All subjects also underwent questionnaire and behavioral laboratory measures of impulsivity, including the Barratt Impulsiveness Scale (BIS-11) and a continuous performance test: the Immediate and Delayed Memory Task (IMT/DMT).
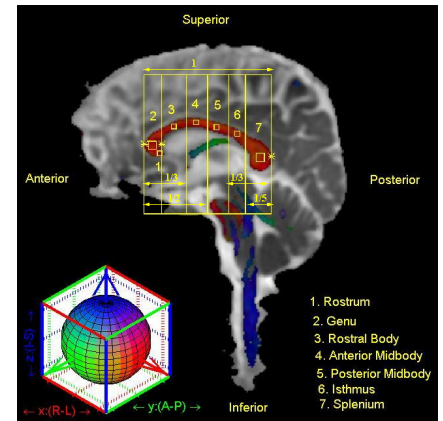

Figure 1. Division of Corpus Callosum into Regions of Interest

Results:

Results of the DTI showed significantly reduced fractional anisotropy (FA) in the genu and rostral body of the anterior corpus callosum in cocaine dependent subjects compared to controls. Within cocaine dependent subjects there was a significant negative correlation between FA in the anterior corpus callosum and behavioral laboratory measured impulsivity (See Figure 2).

Conclusions:

Since the prefrontal cortex fiber tracks cross in the anterior corpus callosum, the finding that reduced FA in the anterior corpus callosum white matter in cocaine users is related to impulsivity is consistent with prior theories regarding frontal cortical involvement in impaired inhibitory control in cocaine dependent subjects.
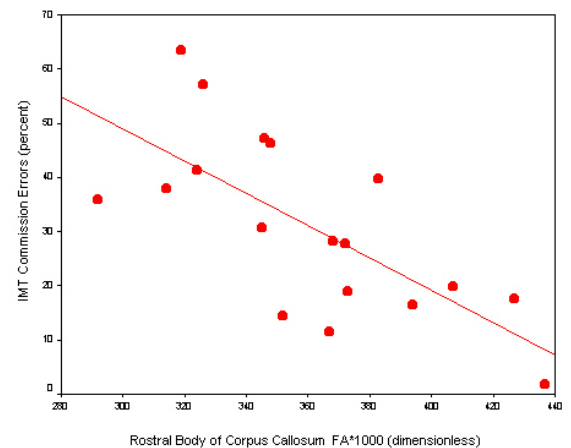

Figure 2. Correlation between Anterior Corpus Callosum FA and impulsive errors on IMT/DMT