Examination of White Matter Abnormalities in Cocaine Dependence Using Multi-slice T2 Relaxography

B. A. Mueller[1,2], S. M. Specker[1], L. Vidarsson[3], J. R. Wozniak[1], J. M. Pauly[3], K. O. Lim[1,2]

[1]Psychiatry, University of Minnesota, Minneapolis, MN, United States, [2]Center for Magnetic Resonance Research, Minneapolis, MN, United States, [3]Electrical Engineering, Stanford University, Stanford, CA, United States

BACKGROUND: Previous magnetic resonance imaging (MRI) studies have found white matter abnormalities in subjects with cocaine dependence (CD). Studies utilizing FLAIR imaging have found an increased number of white matter hyperintensities in CD subjects compared with controls (1). Studies using diffusion tensor imaging (DTI) have reported reductions in fractional anisotropy in the orbitofrontal white matter (2) and in the corpus callosum (3). These findings have been attributed to damage caused by the vasoconstrictive effects of cocaine. T_2 relaxography has recently been proposed as an additional method for examining white matter. We use T_2 relaxography to quantitatively measure the water trapped between myelin sheath. Studies in multiple sclerosis and schizophrenia (4) have reported reductions in the myelin water fraction in these disorders compared to normals.

METHODS: Subjects consisted of 10 actively using, cocaine dependent individuals (6 male, mean age 46) and 8 age matched healthy, non-drug using controls (5 male, mean age 42). MRI data were collected on a Siemens 3T Trio scanner. T_2 relaxography data were collected using three consecutive multi-slice, spin echo acquisitions with TR/TE (698/8, 723/33, 800/100), with common acquisition parameters of: twelve 8mm thick slices, skip 0mm, 2 concatenations, 256 mm FOV, 128x128 matrix, aligned to the AC-PC plane. Data from the three acquisitions were linearly combined to obtain estimates of the total water signal and myelin water (5). Myelin water fraction (MWF) was defined as the myelin water divided by the total water signal. A white matter mask derived from tissue segmentation was used to select those voxels to include in the MWF calculation over the whole cerebrum and in three cerebral subregions of interest (ROI): inferior frontal (INF), superior frontal (SUP), and occipital (OCC). The cerebrum region was defined to be the whole brain, excluding the cerebellum and brain stem. The frontal region was defined to be anterior to a coronal plane located at the anterior extent of the genu, and was subdivided at the AC-PC plane. The occipital region was defined to be posterior to a coronal plane located at the posterior extent of the splenium, superior to the AC-PC plane, and inferior to the superior extent of the corpus callosum.

RESULTS: There was no significant difference in the mean age of the two groups. Cocaine users were found to have significantly higher MWF in the white matter part of the whole cerebrum, $F(1,17)=5.31$, $p=0.035$ ($d=1.09$). Cocaine users were also found to have a trend toward higher MWF in the white matter from two of three cerebral subregion investigated, SUP: $F(1,17)=4.02$, $p=0.062$ ($d=0.95$); INF: $F(1,17)=2.88$, $p=0.109$ (0.80); OCC: $F(1,17)=3.74$, $p=0.071$ ($d=0.92$).

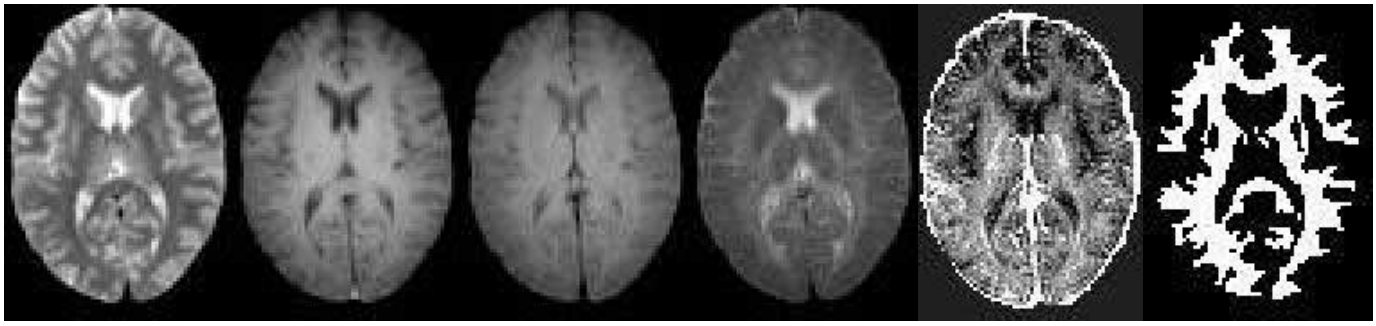

Figure 1 Images of a 45 year old female cocaine dependent subject. (a) PD weighted TSE. (b,c,d) T_2 relaxography images (TE=8, 33, 110 ms). (e) Myelin fraction image. (f) White matter mask.

DISCUSSION: These preliminary data suggest that the signal attributed to myelin water, an indicator of myelin status, is increased in the cerebral white matter of cocaine using subjects. These data also find a trend toward higher MWF in superior frontal and occipital white matter. Current reports have found reductions in fractional anisotropy in cocaine using subjects, an indicator of reduced white matter integrity. The increase in MWF may reflect an alteration in myelin organization in the cocaine using subjects. Comparison with other white mater imaging methods, such as magnetization transfer imaging, may also be informative.

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