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DIFFUSION-WEIGHTED IMAGING OF THE BRAIN IN BIPOLAR DISORDER: A CASE REPORT

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SUMMARY

Background: *Some investigations strongly support a role of glial abnormalities in the pathophysiology of bipolar disorder. The degree of white matter axonal and myelination disruption is measured through the rate of water molecule diffusion. High ADC measures correspond to relatively unimpeded water diffusion, while low ADC measures reflect preserved myelinated axons.*

Case report: *Parietal and occipital areas may be involved in the pathophysiology of bipolar disorder, particularly in cognition and perception, along with the prefrontal and temporal cortices for the disruption of emotional processing. In the literature the widespread alterations of the cortical white matter microstructure is documented.*

Conclusions: *This case reports demonstrates the features of the increased mean ADC values in the left occipital lobe. Future DWI studies are expected to investigate the correlation of white matter changes with the functional impairment, which often persists during euthymia in bipolar disorder.*

Key words: *DWI - bipolar disorder - neuroimaging*

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INTRODUCTION

Diffusion-weighted imaging (DWI) exploits the random motion of water molecules. The extent of tissue cellularity and the presence of intact cell membrane help determining the impedance of water molecule diffusion. This impedance of water molecule diffusion can be quantitatively assessed using the apparent diffusion coefficient (ADC) value (Mascalchi 2005, Rana 2002, El Kady 2011).

Some studies strongly support a role of glial abnormalities in the pathophysiology of bipolar disorder. Post mortem reports reveled the reduced density of oligodendroglial cells in the frontal cortex and adjacent white matter (Ongür 1998, Uranova 2007) and decreased perineuronal oligodendrocytes in the prefrontal cortex of bipolar patients (Vostrikov 2007). Abnormal myelin staining of white matter in the dorsolateral prefrontal cortex was also reported in bipolar disorder (Regenold 2010).

The degree of white matter axonal and myelination disruption is measured through the rate of water molecule diffusion. High ADC measures correspond to relatively unimpeded water diffusion, while low ADC measures reflect preserved myelinated axons (Helenius 2002). In normal white matter, the axons are myelinated and tightly packed in a highly organised extracellular matrix which is largely made up of glial cells and processes. Damage to the axonal membrane, changes in its permeability, reduced integrity of intraaxonal microtubules and axonal de- or dysmyelination are all suggested to account for pathological increases in ADCs (Beaulieu 1994, Giedd 2004).

In our study, we set out to explore cortical white matter microstructure by identified regions of interest (ROIs) distributed over the frontal, temporal, parietal and occipital lobes in a patient with bipolar disorder, expecting to find wide spread disruption of white matter organisation using DWI method.

CASE REPORT

We present a case report of a 28-year-old female patient with a diagnosis of bipolar disorder type I (BD-I) with rapid cycling specifier (DSM-IV-TR diagnosis). BD-I was diagnosed at age of 19, when she had her first maniac episode. She was hospitalized 2 times due to maniac episodes and once due to depressive episode. During last hospitalization rapid cycling was diagnosed (more than 4 phases of mood episodes during last year) and CNS MRI scan was performed. She was discharged being euthymic with normothymic medication of lithium 1000mg, divalproex 1500mg and quetiapine 300mg QID.

MRI PROCEDURE

MRI scans were acquired with a 1.5T Siemens Magnetom Symphony Maestro Class (Siemens Medical Systems, Erlangen, Germany). A standard head coil with standard restraints was used to fix the patient head position. In addition to axial DW images, conventional T1-weighted, T2-weighted, fluid-attenuated inversion recovery, and proton density–weighted images were obtained to exclude gross brain disease.

DW imaging was performed with a spin-echo echo-planar imaging sequence in the axial plane with a TR/TE of 7100/92, a gradient strength of 33mT/m, 45mT/m4-mm-thick sections, an intersection gap of 0,8mm, a field of view of 241/241 mm^2, and a matrix size of 192/192. Diffusion was measured in three orthogonal directions (x, y, and z) with three b values (0.500 and 1000 s/mm^2).

IMAGE ANALYSIS

Images were displayed on a commercial Siemens workstation for the post-processing analyses. Circular ROIs corresponding to an area of 0.16 cm^2 were placed, bilaterally, in the frontal, temporal, parietal, and occipital cortices on the diffusion weighted (b=1000) echoplanar images. The ROIs were automatically transferred to the corresponding maps to obtain the ADC of water molecules. All diffusion data was measured independently by the board-certified radiologist.

RESULTS AND DISCUSSION

Bipolar disorder is characterised by deficits in neurocognitive functioning (Savitz 2005, Chamberlain 2006, Bearden 2001, Murphy 2001) and abnormal activation of parietal and occipital cortices has been found in bipolar patients during the performance of memory, attention and emotional tests, as documented by PET and functional magnetic resonance reports (fMRI). Therefore, parietal and occipital areas may be involved in the pathophysiology of bipolar disorder, particularly in cognition and perception, along with the prefrontal and temporal cortices for the disruption of emotional processing (Bellani 2012).

Helenius et al. (2002) in a group of 80 subjects determined that the mean ADC values in the white matter were $0.70\pm0.03x10^{-3}/mm^2/sec$ (range $0.62-0.79x10^{-3}$). No significant changes were observed between the age, gender and hemispheres. In our case the mean ADC values in the left occipital lobe was over the reference $0.806x10^{-3}/mm^2/sec$.

Bellani et al. (2012) found a widespread alteration of the cortical white matter microstructure in BP-I subjects. Results showed significantly higher ADC values in the temporal, parietal and occipital areas. There also emerged a trend towards an increased ADC in the left frontal lobe. Altered frontal-occipital fasciculus in previous diffusion imaging studies (Bruno 2008, Haznedar 2005) suggesting that these anomalies may represent an altered neural substrate in this disorder.

Further studies are needed to clarify whether the abnormalities we found may be characteristic of bipolar disorder. Also, future DWI studies are expected to investigate the correlation of white matter changes with the functional impairment, which often persists during euthymia in bipolar disorder (Rosa 2011).

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Conflict of interest: None to declare.

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