Diffusion tensor imaging characteristics of dementia with Lewy bodies and Alzheimer's disease

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Background and Objective: Diffusion tensor MR imaging (DTI) measurements of water diffusivity depend on the integrity of tissue microstructure. The magnitude of diffusivity measured with the apparent diffusion coefficient (ADC) increases, and the directionality of diffusivity measured with fractional anisotropy (FA) decreases with neurodegeneration. The most common neurodegenerative disorder associated with dementia in the elderly is AD and the second most common is dementia with Lewy bodies (DLB). Early in the disease process, clinical differentiation between these disorders is often difficult; hence imaging methods to distinguish them would be helpful. Our objective was to determine the regional DTI characteristics of patients with DLB compared to patients with AD and cognitively normal subjects (CN).

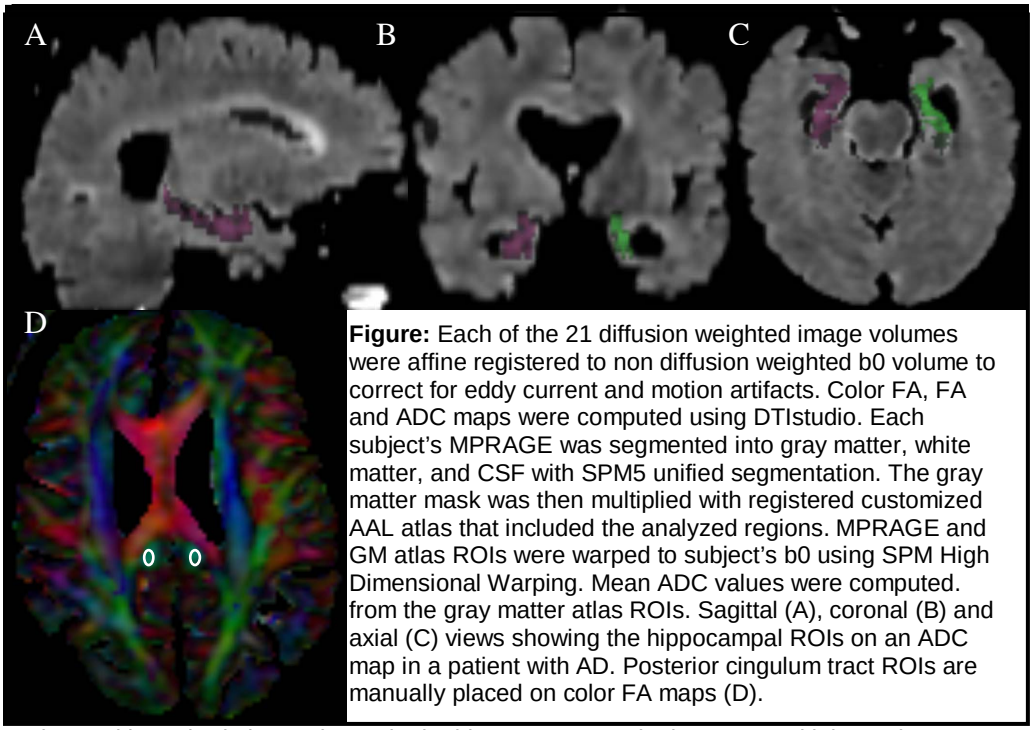

Figure: Each of the 21 diffusion weighted image volumes were affine registered to non diffusion weighted b0 volume to correct for eddy current and motion artifacts. Color FA, FA and ADC maps were computed using DTIstudio. Each subject's MPRAGE was segmented into gray matter, white matter, and CSF with SPM5 unified segmentation. The gray matter mask was then multiplied with registered customized AAL atlas that included the analyzed regions. MPRAGE and GM atlas ROIs were warped to subject's b0 using SPM High Dimensional Warping. Mean ADC values were computed. from the gray matter atlas ROIs. Sagittal (A), coronal (B) and axial (C) views showing the hippocampal ROIs on an ADC map in a patient with AD. Posterior cingulum tract ROIs are manually placed on color FA maps (D).

Methods: We studied clinically diagnosed age, gender and education matched patients with DLB (n=24), AD (n=24), and CN (n=24). DLB and AD subjects were further matched on dementia severity based on Clinical Dementia Rating Sum of Boxes scores. 3D MPRAGE was performed for anatomical segmentation and labeling. EPI FLAIR DTI (TR/TI/TE=8800/2200/60ms) with 21 diffusion sensitive gradient directions (b=1000 s/mm^2), and approximately isotropic resolution (3x3x3.3mm) was performed at 3T using an 8-channel phased array head coil. We measured ADC from segmented cortical gray matter in regions derived from the automated anatomic labeling atlas. Color FA maps were used for measuring tract-based FA and ADC **(Figure).**

Results: Patients with DLB and AD had elevated ADC in the amygdala compared to CN subjects (p=0.01). Patients with AD had elevated ADC in the hippocampus and other temporal lobe regions, compared to patients with DLB and CN subjects (p<0.01). The posterior cingulum white matter tract ADC was elevated (p<0.01) and FA was decreased (p<0.05) in patients with AD compared to patients with DLB and CN subjects. The ADC values were not different among the clinical groups in precentral and postcentral gyrus regions that are not typically involved with the neurodegenerative dementia pathologies of AD and DLB– this result serves as an internal negative control **(Table).**

Conclusion: DLB is characterized by elevated ADC in the amygdala only. This finding is consistent with the neurodegenerative pathological involvement during the limbic-transitional stage of Lewy body disease. Regional elevation in ADC and the decrease in posterior cingulum FA in patients with AD are consistent with the neurofibrillary pathological involvement in AD. DTI findings agree with the expected pattern of neurodegenerative pathological involvement in clinically diagnosed patients with DLB and AD, and may be useful in differential diagnosis and disease characterization.

Table: Atlas-based cortical gray matter ADCs and posterior cingulum ADC and FA in clinical groups

ROI values on DTI (mean ± SD)	Cognitively normal	Dementia with Lewy bodies	Alzheimer's disease
N	24	24	24
Amygdala ADC ($mm^2/s*10^{-6}$)	794 ± 23	820 ± 39*****	842 ± 66*****
Hippocampus ADC ($mm^2/s*10^{-6}$)	819 ± 17	827 ± 35	869 ± 55******
Temporal lobe ADC ($mm^2/s*10^{-6}$)	770 ± 16	771 ± 18	788 ± 25******
Postcental gyrus ADC ($mm^2/s*10^{-6}$)	764 ± 23	763 ± 22	768 ± 23
Precentral gyrus ADC ($mm^2/s*10^{-6}$)	761 ± 21	752 ± 19	761 ± 19
Posterior cingulum ADC ($mm^2/s*10^{-6}$)	715 ± 37	713 ± 42	744 ± 32******
Posterior cingulum FA	0.58 ± 0.05	0.60 ± 0.06	0.55 ± 0.08*******

*ADC is higher than CN (p≤ 0.01);** ADC is higher than DLB and CN (p<0.01);*** FA is lower than DLB and CN (p<0.05)

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