Voxel Based Relaxometry of Alzheimer's Disease

H. Chebrolu[1], C. D. Smith[2], and P. A. Hardy[1]

[1]Biomedical Engineering, University of Kentucky, Lexington, Kentucky, United States, [2]Neurology, University of Kentucky, Lexington, Kentucky, United States

INTRODUCTION: Alzheimer's disease (AD) is a neurodegenerative disease resulting in cortical atrophy and reduction in axonal density in specific regions of the brain particularly the hippocampus. The purpose of this study was to correlate- on a voxel by voxel basis, the relaxation time T2 with the subject's cognitive status. Our hypothesis is that regions experiencing cortical loss and replacement with CSF will demonstrate a positive correlation with declining mental status.

METHODS: Images of subjects were taken from the Alzheimer's Disease Neuroimaging Initiative (ADNI) which is following a large number of subjects whose medical and cognitive status have been extensively characterized. Images from multiecho fast spin echo sequences were used to derive a calculated R2=1/T2 image. Images using the same protocol were acquired on a phantom consisting of multiple vials with different concentrations of Mn. Only images acquired on Siemens 1.5T Symphony imagers were used in the study to ensure that the images were comparable. The T2 derived from the fast spin echo images was correlated with T2 derived from a series of single slice, single echo spin echo images acquired with a range of echo times. The calculated R2 images were registered to the MPRAGE image acquired at the same time. These images were normalized to a template derived from the average of 146 combined normal and AD subjects. These steps were carried out in SPM5. The cognitive status of the subjects was derived from their mini mental state examination (MMSE). Thirty one subjects were included in the study. From the subject's MMSE and other scores, 21 were evaluated as having either Mild Cognitive Impairment (MCI) or AD and ten were normal.

RESULTS: The T2 estimated from the fast spin echo sequence correlated well with the true T2 estimated from the multiple, single echo acquisition indicating there would be a one-to-one correspondence of T2 estimated from the ADNI images and the true T2. The age of the normal subjects (70.6±5.4) and the AD/MCI subjects (75.1±6.1) were not significantly different at p=0.05. The MMSE scores of the three groups were significantly different at p=0.01. SPM5 was used to regress T2 against the subject's MMSE score. Voxels with significant negative correlation are shown in figure 1 as colored zones. The significance (uncorrected for any family wise errors) of the correlation is indicated by color according to the color bar shown at right of figure 1.

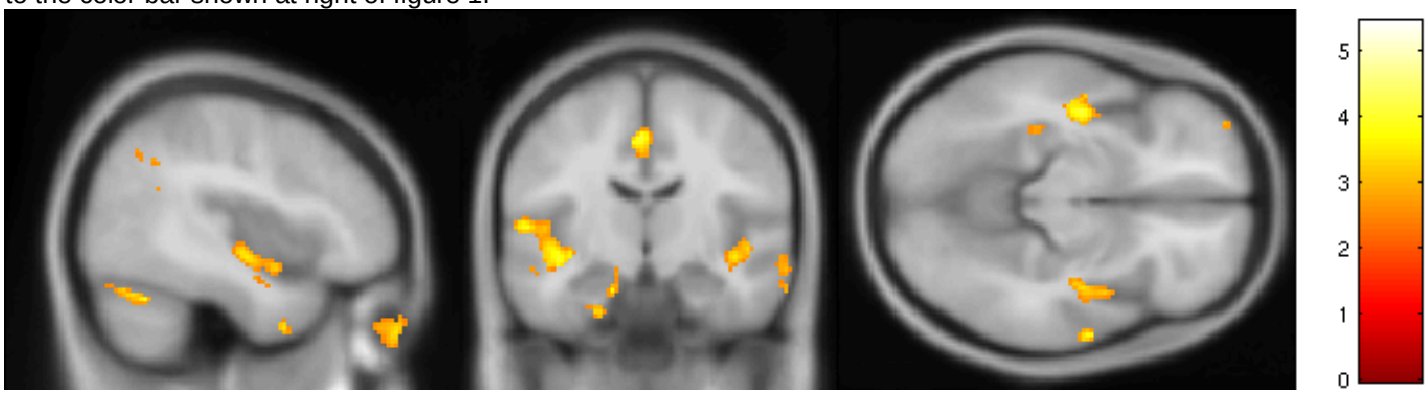

Figure 1. VBR analysis results from correlation of calculated T_2 at 1.5T and MMSE score. Color bar indicates T values showing regions with significant negative correlation between calculated T2 and MMSE. Areas of significant correlation (p=0.05) are indicated with color overlay on the three orthogonal images of the reference brain.

DISCUSSION: The regions with significant negative correlation are in the temporal lobe and in areas known to be affected by atrophy during the progression of AD. The results are supportive of the loss of white and gray matter accompanying the progression of AD and are supportive of the use of MR anatomical and relaxation estimating imaging for early identification of individuals affected by AD.

REFERENCES:

Smith CD, Chebrolu H, Wekstein DR, Schmitt FA, Markesbery WR. Age and gender effects on human brain anatomy: a voxel-based morphometric study in healthy elderly. Neurobiol Aging 2007;28(7):1075-1087.