Correlation of Increased R2 with B0 and Cognitive Status

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INTRODUCTION: Alzheimer's disease (AD) is a neurodegenerative disease at least partly linked to the accumulation of iron gray matter structures such as the hippocampus. The accumulation of iron in storage molecules such as ferritin may have an affect upon T2-weighted MR images of subjects and the relaxation rate 1/T2 is predicted to increase with the field strength at which the images are acquired. The purpose of this study was to correlate- on a voxel by voxel basis, the increase in the relaxation rate 1/T2 with magnetic field strength, B0 with subject's cognitive 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. Images acquired on Siemens 1.5T Symphony and 3.0T Trio imagers were used in the study. 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 at each field strength were registered to the MPRAGE image acquired at the same time. The MPRAGE images and the calculated R2 images at the two field strengths were simultaneously registered to each other and the difference image derived. 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). Twenty two subjects were included in the study. From the subject's MMSE and other scores, 14 were evaluated as having either Mild Cognitive Impairment (MCI) or AD.

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 (73.7±3.0) and the AD/MCI subjects (74.8±1.6) were not significantly different at p=0.05. The MMSE scores of the two groups were significantly different. SPM5 was used to regress the difference in ΔR2 against the subject's MMSE score. Voxels with significant 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.

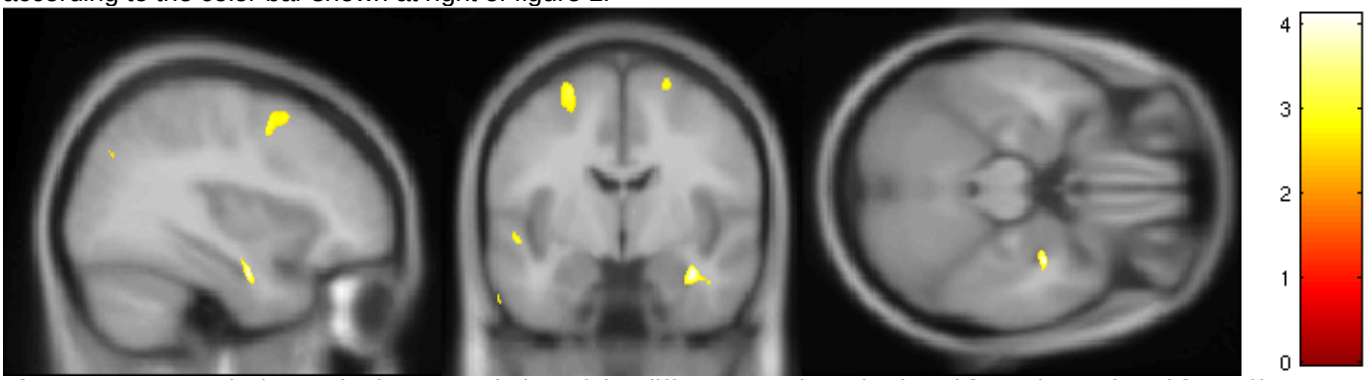

Figure 1. VBR analysis results from correlation of the difference CalcT2 (CalcT2(@1.5T) – CalcT2(@3.0T)) vs. MMSE score. Areas of significant negative correlation are indicated as color overlays on the normalized brain. The color bar indicates T score for the correlation. Regions of significant correlation include the posterior superior frontal sulcus, the left anterior-medial temporal lobe and the superior temporal gyrus.

DISCUSSION: The presence of significant correlation in the posterior superior frontal sulcus, the left anteriomedial temporal lobe and the superior temporal gyrus regions is not surprising given that these regions are affected by AD. The results are supportive of the hypothesis that the accumulation of iron in the brain increases the generation of reactive oxygen species and increases oxidative stress.

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