Fluid-attenuated $T_{1\rho}$ of the Human Brain *In Vivo*

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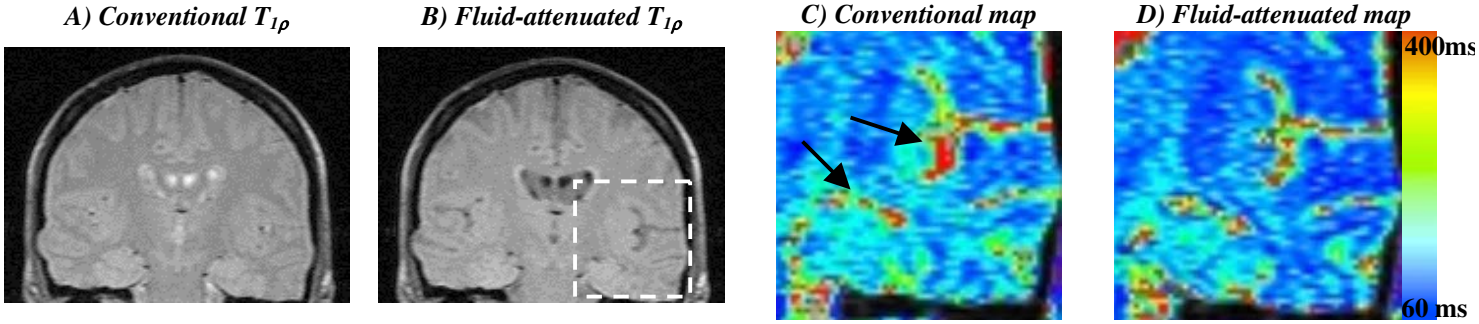
Introduction

Alzheimer's disease (AD) is the most common form of dementia in the elderly (1). Over 25 million people are affected by it and as the population ages, this number is expected to double by 2025. Classic symptoms of the disease include memory loss, confusion and biological features such as the formation of NFT and SP and gray matter atrophy in the brain. $T_{1\rho}$ MRI has been successfully applied in delineating tumors (2), gliomas (3) and other tissue pathology. Recently, $T_{1\rho}$ MRI of AD patients demonstrated that on average $T_{1\rho}$ for the AD group was 9% higher than that for controls and the difference was statistically significant (4). The observed increase could be due to fluid proliferation and secondary to other AD pathology. The purpose of this study was to develop a fluid-suppressed $T_{1\rho}$ mapping technique to reduce these effects and obtain true $T_{1\rho}$ values in brain tissue.

Materials and Methods

The Institutional Review Board of our institute approved all human experiments. MR imaging was performed on a Siemens Sonata 1.5T clinical scanner. Two normal volunteers (mean age: 70±3) and a 68-year old neurologically-confirmed AD patient were imaged twice; first with the conventional (i.e. non-attenuated) Turbo Spin-Echo based $T_{1\rho}$ sequence (5) and then with an inversion-recovery prepared version of the same sequence. Imaging parameters were TE/TR= 12/2000ms, FOV=22cm, slice thickness=2mm, matrix= 256x128, turbo factor=3 for a total imaging time of 6 minutes for four images. The duration of spin-lock pulse was varied four times between 20-80ms. The time of inversion was fixed at 2200ms for the inversion-recovery prepared $T_{1\rho}$ MRIs. $T_{1\rho}$ maps were calculated by fitting each pixel's intensity as a function of spin-lock duration by a linear least-squares algorithm. The plane of the imaged slice was perpendicular to the AC/PC plane and included the head of the hippocampus. A single user manually selected two regions of interest and recorded average $T_{1\rho}$ values. Statistical analysis was performed with the JMP software package. A student's t-test was performed to determine any significant difference between the values obtained using both methods.

Results and Discussion



Conventional $T_{1\rho}$ (figure A) and fluid–attenuated $T_{1\rho}$ (figure B) images from the AD patient's brain data are shown. Note the lack of signal from the CSF in the ventricles in figure B. As expected, the SNR of surrounding brain parenchyma was slightly lower in figure B than in A. The corresponding $T_{1\rho}$ maps from the medial temporal lobe (indicated by the dashed box in image B, are displayed in color in figures C and D, respectively. The color bar-scale on the right indicates that the $T_{1\rho}$ maps were identically windowed from 60ms (blue) to >400ms (red) in both maps. The contribution from high $T_{1\rho}$ values of CSF is reduced thoughtout image D but especially in the region of high CSF content such as in the temporal horn lateral ventricle and sylvian fissure (indicated by arrows in image C). In this region, $T_{1\rho}$ decreased from 91±8ms to 84±7ms from image C to D, respectively. This difference was significant ($p<0.01$). We are in the process of measuring $T_{1\rho}$ in a cohort of AD patients and controls ((n=10 each).

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