Measurements of whole-brain T1 and T2 distributions and the effect of B0 : 3T versus 1.5T

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PURPOSE

To measure and compare the whole-brain distributions of T1 and T2 obtained on the same healthy subjects scanned at 1.5T vs. 3T under otherwise nearly identical experimental conditions.

INTRODUCTION

With emerging interest in 3T MRI for clinical and research purposes, there is increased need for correlating MR relaxation times with magnetic field strength. It has been established that relaxation times affect not only MR image contrast, but also have implications on the limiting spatial resolution, signal-to-noise ratio, and overall imaging time (1). Previous studies of relaxation times base their analysis on a ROI approach, typically using only a small sample of the existing data. For this study, a fast multi-time points pulse sequence (mix-TSE) (2,3) was used to generate whole-head distributions of the T1 and T2 relaxation times with very similar scanners operating at 1.5T and 3T.

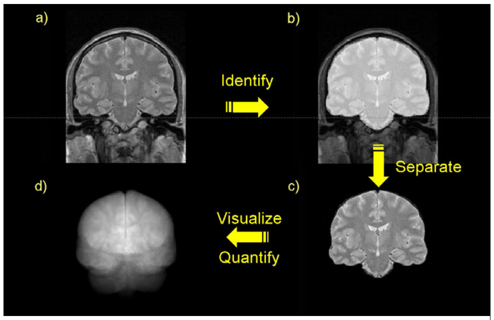

Fig 1: Image processing steps: DICOM image (a), clustering algorithm (b), resulting intracranial pixels (c), and 3D visualization of intracranial voxels (d).

METHODS

Imaging: Two healthy subjects were imaged with nearly identical 1.5T and 3T clinical MR scanners (Philips Intera, Philips Medical Systems). The mixed turbo spin-echo (mix-TSE) pulse sequence (2,3) was used at both field strengths: 80 contiguous slices; repetition time [TR] = 21 sec; effective echo times [TE1, TE2] = 8.1, 115 ms; inversion times [TI1, TI2] = 700, 10,500 ms; turbo factor [TF] = 20; voxel dimensions = 0.9 x 0.9 x 2.5 mm^3, with a scan time of 9 min 40 sec.

Image processing: DICOM images were transferred to a PC workstation where T1 and T2 histograms were computed. The intracranial tissues were segmented from the extra-cranium using a dual-space clustering algorithm (3, 4) and intracranial segmental histograms were generated. Multi-Gaussian decomposition into white matter (WM), grey matter (GM), and cerebrospinal fluid (CSF) was performed.

RESULTS

For each magnetic field strength, the inter-subject spectral differences for T1 and T2 were not significant. Intra-subject T1, T2 Q-MRI frequency distributions differences at 3T and 1.5T were significant. Compared to 1.5T spectra, the 3T distributions exhibited very similar shapes but were shifted to longer values (WM 19% and GM 14%) in the case of T1, and to shorter values (10%) in the T2 case.

CONCLUSIONS

Under very similar experimental conditions, imaging at 3T resulted on average T1 lengthening (WM and GM: 18% and 16%) and T2 shortening (WM and GM: 11% and 10%) relative to imaging the same subjects at 1.5T. This work could have implications to 3T protocol development and for the study of tissue relaxation as a function of magnetic field strength.

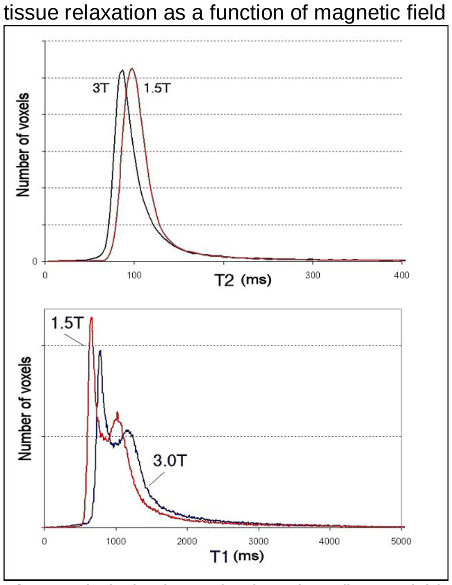

Fig 2: Whole-brain T2 (top) and T1 (bottom) histograms

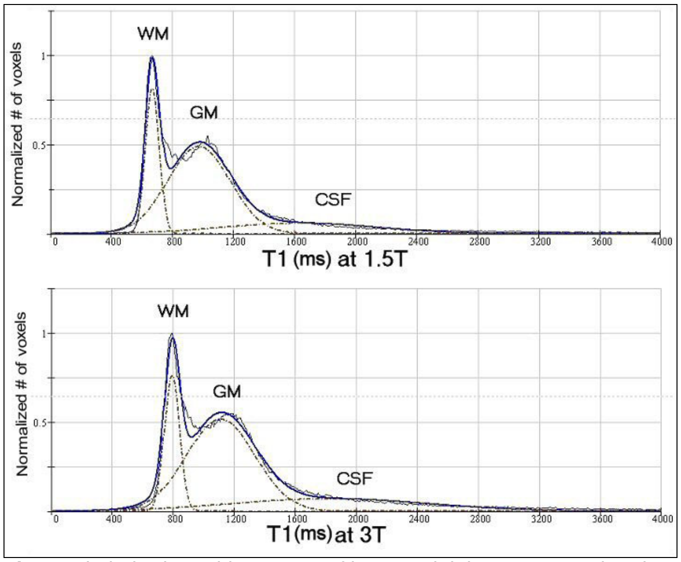

Fig 3: Whole-brain T1 histograms of intracranial tissues: Gaussian deconvolution

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