

1.5T versus 3.0T MRI texture analysis in the normal appearing white matter of multiple sclerosis patients

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Introduction

MRI texture analysis is a measure of the distribution pattern of pixel intensities; specific pattern that creates a unique texture also generates a unique frequency distribution. Indeed, MRI texture analysis based on polar Stockwell transform (PST), a new local time-frequency analysis, differentiates MS lesions that persist from those that recover^{1,2}; moreover, the degree of coarseness in texture correlates with the extent of pathological damage in postmortem multiple sclerosis (MS) brain³. Growing evidence shows that texture analysis has the potential to detect subtle structural alterations and is robust to the variations in MRI protocols^{4,5}. However, the impact of field strength to texture analysis in human MRI is not fully understood while use of different scanners with variable field strength is common in multi-center clinical trials. The goal here was to evaluate texture analysis conducted at 1.5T and 3.0T MRI of MS patients.

Method

Ten patients (mean age=43, disease duration=4 years, 9 females) were scanned at both 1.5T and 3.0T (GE Healthcare) within 48 hours in random order. T2-weighted MRI were acquired using identical clinical protocols: TR/TE=4000/80 ms, matrix=256x256, FOV=22x22 cm², slice thickness=3 mm, no gap. All of the MR images were corrected for potential non-uniformity, and then were linearly co-registered to ensure measurement of the same structure within scanners. Regions of interest (ROIs) were drawn at 3.0T MRI in normal appearing white matter (NAWM) including bilateral superior corona radiata (SCR) and forceps minor (FM), the genu and splenium of corpus callosum, which were matched to the 1.5T MRI (Fig. 1). PST texture was calculated at each pixel of the image showing the best delineation of chosen structures. ROI texture was extracted from corresponding texture maps. Inter-scanner comparisons were conducted to assess texture difference between patients and structures ($p \leq 0.05$ deemed as significance).

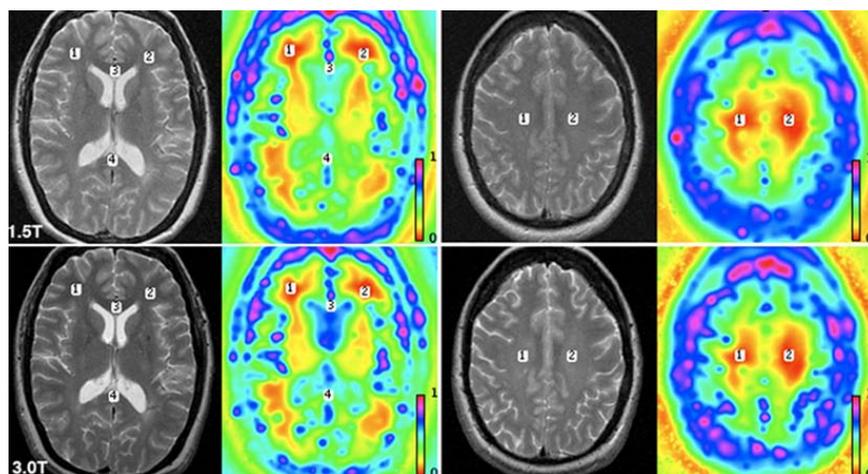


Fig. 1: ROIs in forceps minor (1&2), the genu (3) and splenium (4) of corpus callosum in MR images (column 1) and corresponding texture maps (column 2) at 1.5T (top row) and 3.0T. Right two columns show ROIs of superior corona radiata (1&2). Similar texture patterns (color maps) were observed at 1.5T and 3.0T MRI while texture appears coarser (green) in the genu and splenium than in the other areas of NAWM structure (red).

Discussion

This pilot study shows that 3.0T MRI detected greater texture heterogeneity than 1.5T MRI. However, texture analysis at each scanner identified the same pattern of regional variability in NAWM structure. The fact that corpus callosum texture is coarser than the other areas of NAWM may suggest a differential role of this structure in MS pathogenesis; an outcome evaluation of corpus callosum pathology may be useful to confirm this finding. In addition, given the lack of laterality of bi-hemispheric structures texture analysis at different scanners may be feasible by using contralateral NAWM as control. This approach may be also beneficial to generalize texture analysis given the heterogeneity of MS pathology.

References: [1] Zhang Y et al. *Neuroimage* 2009; 47: 107-111. [2] Zhang Y et al. *Multi Scler J* 2011; 17: 532-40. [3] Zhang Y et al. *Ann Neurol* 2011, Under Revision. [4] Waugh SA et al. *Med Phy* 2011; 38: 5058-66. [5] Harrison LC et al. *Acad Radiol* 2010; 17: 696-707.

Results

120 NAWM ROIs were evaluated; 60 per scanner. There was no laterality in the texture of SCR or FM in either field strength; thus the mean of bi-hemispheric texture was used to represent these two structures. Mean texture heterogeneity was greater at 3.0T than at 1.5T in each NAWM structure [(0.06-0.48) vs (0.05-0.36), $p < 0.01$] except for forceps minor (both = 0.05); however, the regional variance of NAWM texture was similar between field strength (Fig. 2). In particular, the texture in the genu and splenium of corpus callosum was significantly coarser than the texture in SCR and FM ($p < 0.001$) at both 1.5T and 3.0T; no texture difference was detected between genu and splenium or between SCR and FM. As expected, there was great variability (coefficient of variance, COV) in NAWM texture between patients; it was greater in FM at 3.0T (39% vs 30%) and in the genu of corpus callosum at 1.5T (25% vs 19%), and the same in SCR and splenium (41% and 19%).

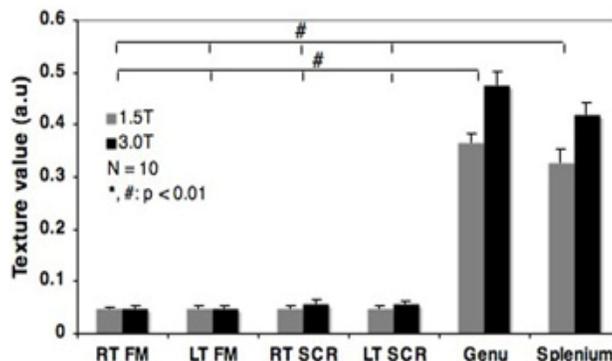


Fig. 2: Mean (standard error) texture of 10 MS patients assessed at 1.5T and 3.0T MRI in correspondent regions of NAWM. RT: right; LT: left. The a.u. reflects arbitrary unit.