Comparison of quantitative MT and T2 properties of white matter lesions in Alzheimer's disease

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Introduction: A common feature of aging white matter on MRI images is the presence of lesions which appear bright on T2-weighted images (white matter hyperintensities - WMH). This decrease in observed T2 has been attributed to several causes including myelin breakdown and inflammation and has been attributed to declining cognitive function[1]. These lesions have been implicated in Alzheimer's disease (AD) [2], although they are equally prevalent in the normal population [3]. Quantitative MRI techniques have been applied in order to investigate whether the lesions in AD can be differentiated. In this work we compare the myelin water fraction (MWF) measured with CPMG to the magnetization transfer exchange constant, R, T2b (T2 relaxation time of the semisolid pool) and M0b (semisolid pool fraction relative to bulk water) in white matter hyperintensities.

Method: Twelve volunteers were recruited, consisting of those who had Alzheimer's disease (n=6, aged 62-80, mean age 72) and age-matched controls (n=6, aged 70-81, mean age 75), all of which had exhibited WMH on a previous examination with MRI. A whole-brain proton-density and T2-weighted scan (PD-T2) was performed to screen the patient for white matter lesions, and slices were chosen which contained the greatest lesion burden for the quantitative T2 and quantitative MT scans. ROIs were chosen from the PD-T2 images, in hyperintense regions as well as in regions of normal-appearing white matter (NAWM). Myelin water fraction, MWF, was determined by assessing the area of the short T2 component using a CPMG-based quantitative T2 sequence with composite 180º pulses [4]. Magnetization transfer parameters: R, $T2_b$ and M_{0b} were evaluated by a pulsed MT sequence [5] using a single Gaussian-shaped saturation pulse once per TR. The experiment was repeated for two saturation RF powers, causing flip angles (mtflip) of 400° and 818° respectively, with frequency offsets logarithmically spaced from 1 to 200 kHz. ROI data was fit to a two pool model of MT [5].

	Alzheimer's Disease WMH (n=13)	**Normal Control WMH (n=14)**	**Normal-Appearing White Matter (n=26)**
R (Hz)	19 ± 9	16 ± 3	22 ± 7
$T2_b$ (μs)	10.5 ± 0.9	10.4 ± 1.1	10.5 ± 1.0
M_{0b}	0.12 ± 0.03	0.11 ± 0.01	0.11 ± 0.02
MWF [%]	7 ± 6	8 ± 4	11 ± 3
Intracellular T2 [ms]	145 ± 40	137 ± 27	78 ± 10

Table 1: *Average fitted values for R, T2b, M0b and MWF for regions of interest in the AD hyperintensities, normal control hyperintensities and normal-appearing white matter.*

Results and Conclusions:
The average values of R, $T2_b$, M_{0b} and MWF are shown in Table 1 for WMH in both AD and normal control as well as in normal appearing white matter in both groups. MT parameters substantially varied within different ROIs. There are no statistical differences in M_{0b} or $T2_b$ within the groups, however the MT exchange rate, R, for WMHs was significantly faster than for NAWM ($p<0.02$). In contrast, myelin water fraction for WMH was significantly lower for WMH in comparison to NAWM. It is generally believed that both MWF and M_{0b} are the measure of myelin within WM and that they are indicators of demyelination. The results of this study suggest that MT and T2 provide distinct information about the WM structure. Decreased MWF indicates **decreased** water fraction within the myelin sheath or **increased** exchange between myelin and intra/extracellular myelin [6]. Since M_{0b} did not change, we postulate that there is no decrease in myelin lipids in WMH. However decreased MT exchange rate suggests changes in myelin lipid organization. We postulate that WMH in most of the patients represent early stages in WM degeneration.

References:

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