Metabolite T_1 Relaxation is Preserved in Large Multiple Sclerosis Lesions

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Introduction: Magnetic resonance spectroscopy (MRS) of multiple sclerosis (MS) lesions has shown a reduction in N-acetyl-aspartate (NAA) and an increase in Choline (Cho) and myo-inositol (mI) compared to normals (1). These differences are usually presumed to be due to changes in metabolite concentration, however, as most MRS data is collected at relatively short TR (~1s), observed metabolic changes could also be the result of changes in T_1 relaxation of the metabolites. Relaxation parameters, such as T_1 relaxation times, are sensitive to structural changes in tissue. An increase in extracellular water, such as from edema, may lead to a lengthened T_1 of water, but not of metabolites because metabolites are thought to be largely intracellular. If the intracellular environment changes however, we would expect metabolite T_1s to change. To date, no metabolite T_1 studies have been conducted in MS lesions. ***In this study the T_1s of metabolites and water in large MS lesions were measured to determine the influence of T1 weighting on metabolite concentrations.***

Methods: Eight clinically definite MS patients (5 female, 3 male, mean age=48y, disease duration=13y, median EDSS=2.2), who each had a large lesion (>1cm in diameter), underwent MR examination on a 1.5T scanner. The MRS voxel covered the entire lesion (2.4-3.4cc). Figure 1 shows a typical large lesion and voxel of interest. Spectra were acquired using PRESS (TE=30ms, TR=547, 751, 1200, 1500, 2500, 3500, 5000ms) and analyzed with LCModel (2). For each lesion, metabolite and water areas were measured and any concentrations with a standard deviation greater than 20% were discarded from subsequent analysis. T_1s were then determined by fitting the area (A) as a function of TR, solving $A(TR) = A(\infty)(1-e^{TR/T1})$. T_1s were compared with measurements from healthy control parietal normal white matter (pNWM) from an independent study (n=10).

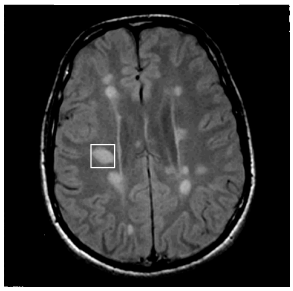

Figure 1 – Example of a large lesion with voxel.

Results: The NAA, Cho and mI peak areas in the lesion spectra were abnormal. Figure 2 shows spectra from the lesion shown in Figure 1 at the 7 different TR times and Figure 3 shows a plot of NAA signal averaged over all patients as a function of TR.

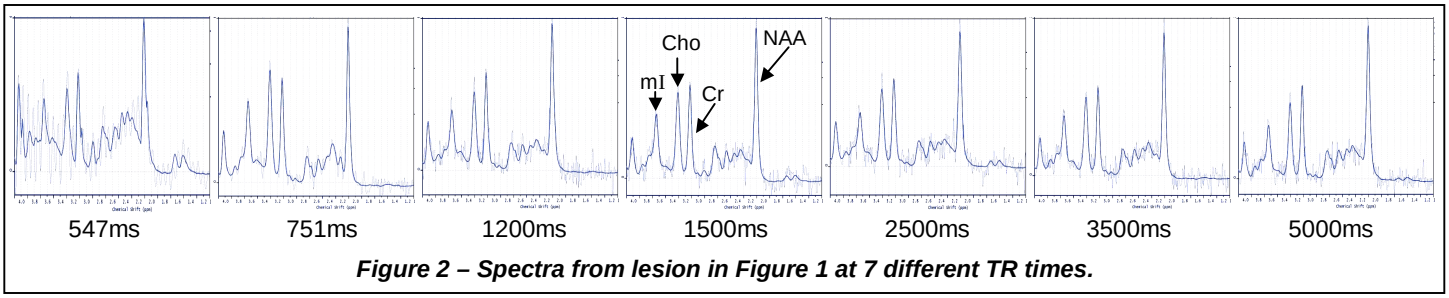

Figure 2 – Spectra from lesion in Figure 1 at 7 different TR times.

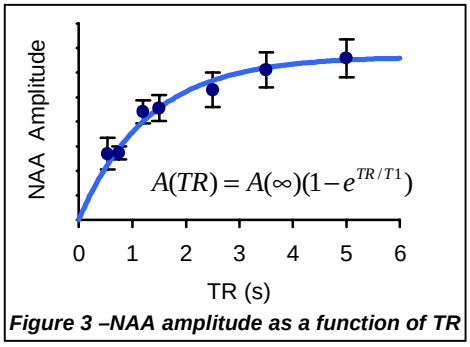

Figure 3 –NAA amplitude as a function of TR

Table 1 summarizes the mean T_1 values (and standard errors) for lesions and pNWM for the various metabolites and water. No significant differences were found between metabolite T_1s of MS lesions and pNWM, however the T_1 of water was significantly longer in lesions ($p<0.0001$).

Table 1 – Mean T_1 relaxation times (standard errors) for lesions and control pNWM for the various metabolites and water.

	NAA (s)	Cho (s)	Cre (s)	mI (s)	Water (s)
Lesion	1.30 (0.06)	1.04 (0.11)	1.40 (0.13)	1.36 (0.16)	1.03 (0.03)
pNWM	1.35 (0.06)	1.19 (0.04)	1.50 (0.05)	1.17 (0.21)	0.77 (0.4)

Conclusion: The T_1 relaxation times of metabolites are similar in MS lesions when compared to parietal normal white matter in normal, healthy control subjects. The finding of increased water T_1 is consistent with the edema expected in inflammatory MS lesions. This suggests that although the concentration of metabolites may change in lesions, the local intracellular environment surrounding the remaining metabolites remains intact. Therefore, MRS data of large MS lesions collected at a shorter TR is not adversely influenced by T_1 weighting.

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