Measurement of proton T2 of coupled-spin metabolites in gray and white matter in human brain at 3T

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INTRODUCTION

Transverse relaxation times of brain metabolites in gray matter (GM) and white matter (WM) are important for quantitation of metabolite concentrations, especially in long-TE MRS approaches. Measurement of the transverse relaxation time of coupled resonances is not straightforward because the echo time dependence of the signals is complicated by the scalar coupling effects. Recently, spectrally-selective refocusing approaches were used for measuring the glutamate (Glu) T_2 at 3T [1,2]. It may be of great interest that the T_2 of coupled-spin brain metabolites can be measured using standard MRS methods at widely available field strengths. Here, we report T_2 measurement for brain metabolites including Glu and myo-inositol (mIns) in GM and WM by PRESS (point-resolved spectroscopy) at 3T.

METHODS

Experiments were carried out on a whole-body 3T scanner (Philips Medical Systems). A body coil was used for RF transmission and an 8-channel phased-array coil for signal reception. Apparent transverse relaxation times ($T_2^{\dagger}$) of brain metabolite were measured using four pairs of PRESS subecho times, (TE_1, TE_2) = (32, 22), (32, 80), (32, 214), and (36, 338) ms, which were obtained, with computer simulations, for optimum Glu and mIns selectivity. The numerical simulation included calculations for slice-selective RF and gradient pulses. Multi-TE data were acquired in the steady-state conditions (TR < 5×T1); TR = 3000, 3057, 3183, and 3300 ms, respectively, which gave a constant initial longitudinal magnetization for the various TEs. T_2 measurement was conducted on the medial occipital and right temporal regions (voxel size 25×30×30 mm^3), as shown in Fig. 1, which are predominantly gray- and white-matter, respectively. The number of averages was 16, 32, 64, and 128 for the four TEs, respectively. Acquisition parameters included sweep width = 2.5 kHz and number of sampling points = 2048. LCModel software [3] was employed to analyze the *in vivo* spectra using numerically-calculated model spectra as basis functions. The LCModel estimates of signal strengths at the multi-echo times were fitted with a monoexponential function, $exp(-TE/T_2)$, for creatine (Cr, 3.03 ppm), N-acetylaspartate (NAA, 2.01 ppm), choline (Cho, 3.21 ppm), glutamate (Glu), and myo-inositol (mIns).

RESULTS AND DISCUSSION

Figure 1 presents *in vivo* spectra from the gray-matter dominant medial occipital and white-matter dominant right temporal lobes, together with LCModel fits. The spectra were all reproduced by the fits well. The spectra at the four echo times exhibited a well defined Glu C4-proton multiplet at 2.35 ppm and a mIns multiplet at ~3.6 ppm. Figure 2 shows T_2 fitting for Glu, mIns, Cr, NAA, and Cho. The signal decay was well represented by a monoexponential function. Figure 3 and Table 1 present mean T_2 of the metabolites and paired t-test results for the T_2 values between the gray and white matter regions. The Glu T_2 was measure to be very similar between GM and WM. The mIns T_2 was somewhat different between GM and WM, but the difference was not statistically significant (p = 0.12). The Cr T_2 was different only by ~10 ms, but this difference was statistically significant (p = 0.01). The NAA T_2 was observed to be substantially different between GM and WM (p = 0.001), in agreement with published results [4].

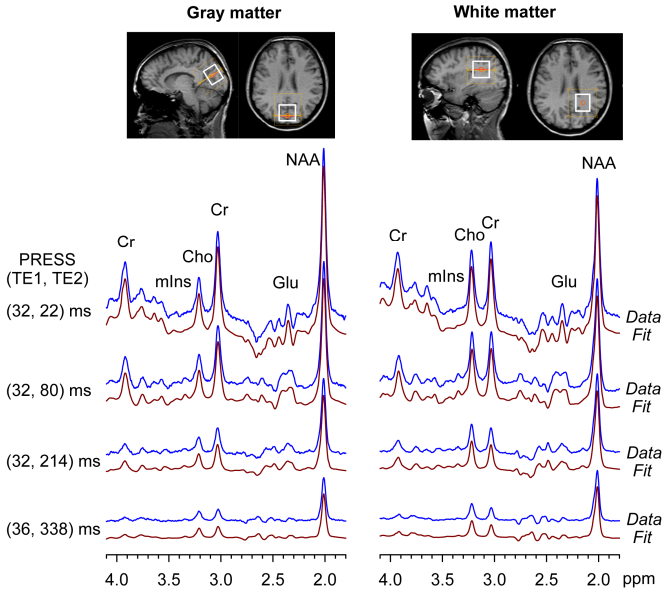

FIG. 1. Brain ^{1}H PRESS spectra at four TE's from the occipital gray and white matter regions at 3T are shown together with LCModel fits.

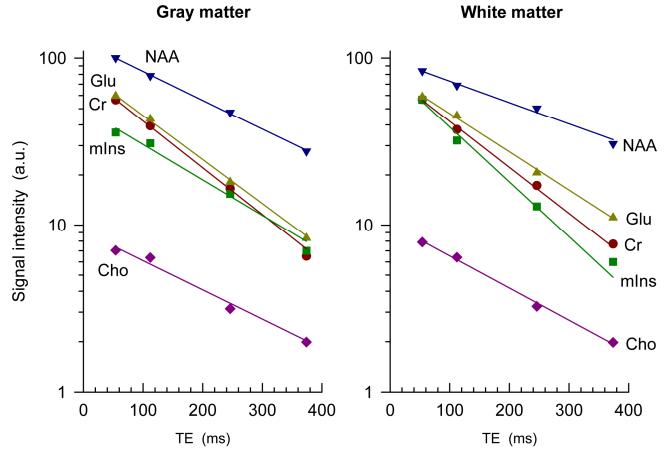

FIG. 2. Monoexponential fitting of metabolite signals for the occipital gray and white matter regions of a subject.

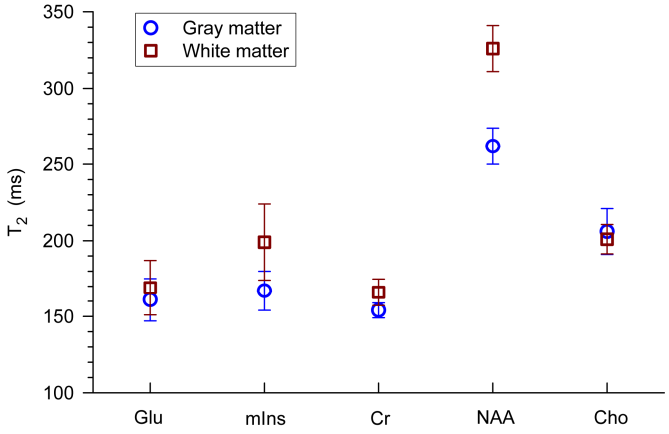

FIG. 3. Mean T_2 of brain metabolites measured from the occipital gray and white matter regions. Error bars represent standard deviation (N = 5).

Table 1. Metabolite T_2 values (mean±SD, N=5) and p-values between GM and WM.

	Glu	mIns	Cr	Cho	NAA
GM - T_2	161±18	167±16	154±5	206±20	262±16
WM - T_2	169±22	199±32	166±9	201±10	326±21
p	0.53	0.12	0.01	0.6	0.001

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