Human Brain-Structure Resolved T2 Relaxation Times of Proton Metabolites at 3 Tesla

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Introduction

Determination of the transverse T_2 relaxation time is one of the major concerns for absolute metabolite quantification in proton magnetic resonance spectroscopy (^{1}H-MRS). Only three studies reported T_2s of human brain metabolites at 3T(1-3). Since all used large single voxels, 8 to 25 cm^3, multiple examinations were needed for different brain regions at considerable gray and white matter (GM, WM) partial volume. Therefore, to obtain the spatial T_2 distribution of *N*-acetylaspartate (NAA), total creatine (Cr) and choline (Cho) over extensive human brain regions, at 3T, with minimal partial volume, we propose to use: *(i)* 3D ^{1}H-MRS, at *(ii)* 1 cm^3 voxel resolution, in a *(iii)* two-point protocol optimized for the least error per given time by adjusting both the echo delay (*TEi*) and number of averages, *Ni*, at each point (4).

Materials and Methods

Eight healthy 26±2 year-old subjects (4 male and 4 female) underwent the hour-long procedure 3D acquisitions: TE_1=35ms, N_1=1 and TE_2=285ms, N_2=3. Experiments performed in a 3T (Trio, Siemens) used a TR=1s PRESS to excite a 10×8×4 cm^3 volume of interest partitioned into 320 voxels of 1 cm^3 each within a 16×16×4 cm^3 field of view. Proton T_2 relaxation times of NAA, Cr and Cho at 2.02, 3.03 and 3.21 ppm were assessed using $T_2 = (TE_2-TE_1)/\ln(S_1/S_2)$ where S_1 and S_2 are the metabolite's peak areas at TE_1 and TE_2. The metabolites' T_2 values were averaged within outlines GM: caudate, thalamus, cingulate gyrus; and WM structures: genu and splenium of corpus callosum, parietal, occipital and centrum semiovale, as shown in Fig. 1.

Results

Across all subjects, the NAA and Cr T_2s in GM structures, 226±17 and 137±12 ms, were 13 – 17% shorter than the corresponding 264±10 and 155±7 ms in WM. The T_2s of Cho were not different, 207±17 and 202±8, in GM or WM. Note the inter-subject similarity within the T_2 distributions of NAA, Cr and Cho from all 320 voxels in each of the 8 subjects shown in Fig. 2.

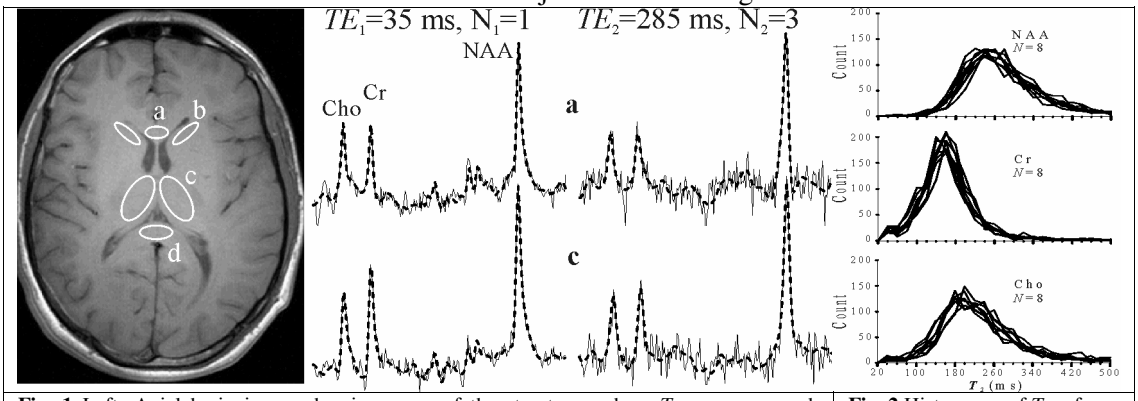

Fig. 1 Left: Axial brain image showing some of the structures where T_2 was measured: Splenium (a) and genu (d) of the corpus callosum, caudate (b), thalamus (c). Right: Spectra at 35 and 285 ms *TEs* from single voxels within the outlines structures superimposed with the fitted lineshapes.

Fig. 2 Histograms of T_2s of NAA, Cr and Cho from all 320 voxels for each of the 8 subjects.

Discussion and Conclusion

These T_2 values, obtained to our knowledge for the first time at this field, spatial resolution, coverage and precision, are essential for reliable absolute quantification. Within ±10%, these results validate two assumptions commonly made *(i)* that the entire brain or at least WM or GM tissues have the same T_2(s) and *(ii)* that all healthy subjects share the same T_2 value(s).

References 1.Mlynarik V *et al.* NMR Biomed 2001;14(5):325-331./ 2.Traber F *et al.* J Magn Reson Imaging 2004;19(5):537-545./ 3.Barker PB *et al.* Magn Reson Med 2001;45(5):765-769./ 4.Fleysher L *et al.* Magn Reson Med (in press)