Metabolite ^{1}H transverse relaxation rates measured in the healthy young versus elderly human brain at 4 T

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INTRODUCTION: The extent to which ^{1}H MRS measured human brain metabolite concentrations change in normal aging and disease is currently of high interest[1,2]. Due to the time consuming nature of measuring the transverse relaxation rates (T_2) of these metabolites, T_2 are typically assumed constant among study groups. However, the extent to which this assumption is valid in the case of young versus elderly human subjects is controversial[3-6]. The goal of this study was to take advantage of the high spectral dispersion and signal to noise ratio of data measured at a higher magnetic field than previously utilized to measure T_2 of metabolites in young and elderly subjects. In addition to their importance in addressing confounding of metabolite quantification, T_2 may also reflect the disease process and lead toward biomarkers.

METHODS: T_2 were measured from 29 young (age 18-22) and 32 elderly (age 70+) human subjects. STEAM spectra with VAPOR water suppression outer volume suppression were measured at several echo times (TE = 10-180 ms) from the occipital cortex (volume of interest, VOI = 27 cm^3) at 4T (Oxford/Varian) using a surface quadrature transceiver[7]. Four excitations were executed at each TE at a TR of 4.5 s. First- and second- order shims were adjusted using FASTMAP[8]. Contributions from metabolites were quantified using LCModel with simulated basis sets for each TE. The same macromolecule basis spectrum (TE<10 ms) was used in all basis sets. The T_2 of each metabolite was quantified by fitting signals at all TE to the well known transverse relaxation equation: $SI(TE) = SI(0)\exp(-TE/T_2)$, where SI(0) and T_2 were fitted.

RESULTS: Artifact free spectra were measured at all TEs (fig. 1), which allowed for reliable determination of signal strengths via LCModel. Signal strengths fit well to the transverse relaxation equation (fig. 2). Table 1 lists the mean and standard deviation (SD) of the T_2 fitted from all of the subjects in each age group. The T_2's were different in young versus old subjects ($p < 0.01$) for all of the metabolites listed.

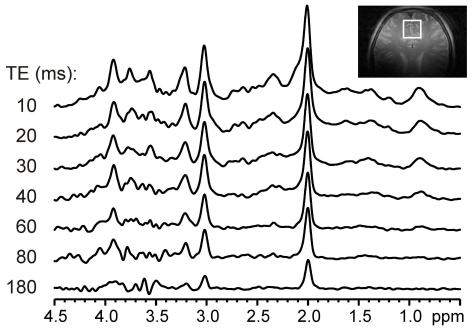

Fig. 1. Spectra measured at all echo times from a representative elderly subject. Inset: illustration of VOI placement.

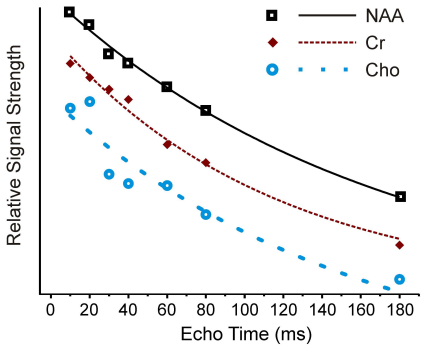

Fig. 2. Signals measured at discrete echo times and fitted T_2 curves.

Table 1. Transverse relaxation time constant (mean ± SD) for NAA, Cr and Cho measured in 29 young and 32 elderly subjects.

Metabolite	Young T_2 (ms)	Elderly T_2 (ms)
NAA	220 ± 23	170 ± 18
Cr	130 ± 8	112 ± 11
Cho	186 ± 47	143 ± 41

DISCUSSION: The T_2 measured in the young subjects agree with previously published values[9-11], attesting accuracy of measured T_2 values. The T_2 measured in our large cohort indicate that relaxation is faster in elderly subjects. Spectral acquisition time for calculation of T_2 in each subject was short enough (i.e. 2 minutes) to accommodate quantification of single human subject T_2 on a routine basis. As such, this approach has potential to increase accuracy of metabolite quantification, to better understand normal and diseased aging, and to progress toward discovery of biomarkers.

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