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 $T_2$'s 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.

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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