Altered Macromolecular Pattern in Aging Brain

Malgorzata Marjanska[1], J. Riley McCarten[2], Laura S Hemmy[2], and Melissa Terpstra[1]
[1]*Center for Magnetic Resonance Research, University of Minnesota, Minneapolis, MN, United States,* [2]*Minneapolis VA Medical Center, Geriatric Research and Clinical Center, MN, United States*

Target Audience: MR spectroscopists, and aging and dementia researchers

Purpose: The resonances originating from high-molecular weight macromolecules (MM) underlie those of metabolites in brain ^{1}H NMR spectra. These resonances have different physical properties from those of metabolites such as shorter T_1 and T_2. It has been shown using 1.5 T in humans that MM content can depend on age of the subject (1). The purpose of this study was to utilize a uniquely high field of 7 T to investigate differences in the MM pattern in the aging brain.

Methods: Cognitively normal subjects, 4 young (age: 22-31, 2 M) and 3 elderly (age: 69-75, 2M), were studied using a 7-T, 90-cm horizontal bore magnet equipped with a Siemens console and body gradients. A home-built 16-element transmit-receive transmission line head array (2) was used and transmit phase of each channel was optimized via individual 1 kW CPC amplifiers (3).

In vivo ^{1}H NMR spectra were acquired from voxel a positioned in the occipital cortex (OCC) (volume of interest, VOI = 8 cm^3) using a STEAM sequence with VAPOR water suppression and outer volume suppression (4) (T_R = 5 s, T_E = 8 ms, NA = 64). The metabolite-nulled macromolecule spectra were acquired using the inversion-recovery technique (T_R = 2 s, T_E = 8 ms, T_I = 0.68 s, NA = 384) with analogous STEAM localization. First- and second-order shims were adjusted using FASTMAP (5).

Results: Figure 1 shows: the region of the spectra in which MM resonances can be easily identified because they are not obscured by strong metabolite resonances and VOI placement. The most pronounced age associated difference is the more intense MM resonance at 1.7 ppm in the elderly. Figure 2 shows MM spectra underlying the entire ppm range. The cool colored (blue) arrows point to the lower intensities of MM resonances at 1.2 and 1.4 ppm in the elderly brain. The warm colored (orange) arrow points to the higher intensity of MM resonance at 1.7 ppm. Additionally, the MM resonance at 2 ppm was more intense in the elderly brain.

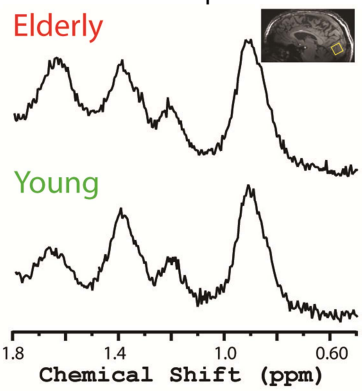

Figure 1. The 0.5 to 1.8 ppm region of representative short-echo time STEAM spectra from one young and one elderly subject measured from the OCC. The vertical scale has been adjusted such that the MM resonance at 0.9 ppm for young and elderly subjects has the same intensity.

Discussion: Previously, an age associated increase of MM content (0.6 to 3.3 ppm) was reported for a group of 25-55 year olds compared to a group of < 25 year old subjects (1). In this work, we included an elderly cohort and focused on the spectral pattern of MM. We observed differences in the MM pattern with some MM resonances more intense (1.7 and 2 ppm) and some MM resonances less intense (1.2 and 1.4 ppm) in the elderly brain compared to the young.

Conclusion: The MM pattern is clearly different in elderly compared to young human subjects. This important finding suggests that when a measured MM spectrum is used in the basis set for metabolite quantification, it should be measured from an age matched cohort. The strong difference in the MM pattern at 2.0 ppm is interesting because of the affiliation of this resonance with the glutamate resonances of protein amino acids (7).

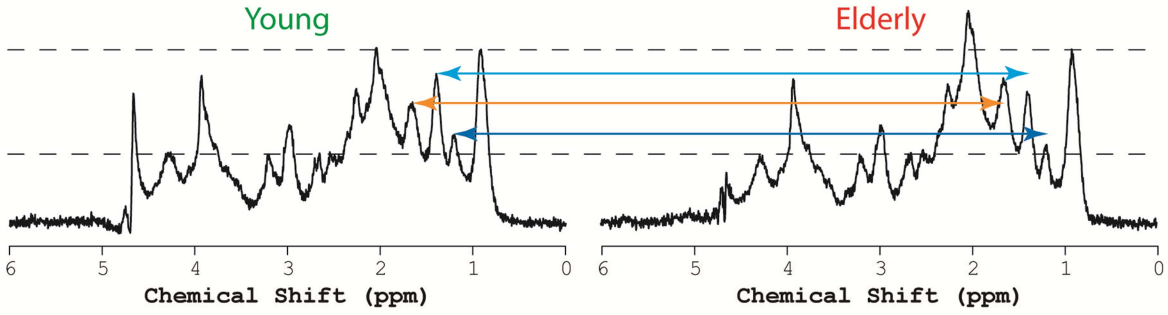

Figure 2. Representative metabolite-nulled MM spectra from one young and one elderly subject measured from the OCC. The vertical scale has been adjusted such that the MM resonance at 0.9 ppm for young and elderly subjects has the same intensity. Horizontal dashed lines are visual guides to indicate the same intensity of the MM resonances at 0.9, and 3.2 and 4.3 ppm.

References: **1.** L. Hofmann *et al.*, MRM 2001, **2.** G Adriany *et al.* MRM 2008, **3.** GJ Metzger *et al.* MRM 2008, **4.** I Tkac *et al.* MRM 2001, **5.** R Gruetter, I Tkac MRM 2000, **6.** I. Mader *et al.* JMRI 2002, **7.** K.L. Behar *et al.* MRM 1994.

Acknowledgements: R01AG039396, P41 EB015894, P30 NS076408, S10 RR026783 and WM Keck Foundation.