Comparison of GABA+ and Macromolecular-suppressed GABA Measurements

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OBJECTIVE: To examine the relationship between measurements of the 3.0 ppm GABA resonance with and without macromolecule suppression using GABA-edited MRS of the human brain at 3 T.

BACKGROUND: The standard implementation of MEGA-PRESS to edit GABA applies an editing pulse at 1.9 ppm, but is subject to contamination by macromolecules (MM) due to inversion of the MM resonance at 1.7 ppm. For this reason, this measure of GABA is often referred to as GABA+. MM-suppressed methods[1,2] have been developed to detect GABA with minimal MM contributions.

METHODS: MEGA-PRESS data were collected at 3 T (Philips Achieva) in 12 healthy, young, male participants. The standard GABA+ acquisition parameters were: TR/TE 2s/68 ms; 14 ms editing pulses at 1.9 ppm in editing-ON scans and at 7.5 ppm in OFF scans; 40 blocks of 8-step phase cycles; 2048 points, spectral width 2 kHz; VAPOR water suppression. MM-suppressed GABA data were acquired with the same parameters, except for TE = 80 ms to permit 20 ms editing pulses, which were applied at 1.9 ppm in the ON condition and at 1.5 ppm in the OFF condition. All other parameters were the same. Both standard GABA+ and MM-suppressed GABA measurements were performed using 3×3×3 cm^3 voxels in the occipital lobe (OCC) and the sensorimotor cortex (SM).

Data were analyzed using Gannet[3] and GABA was quantified relative to water; however, the correction factor of 0.45 (that aims to remove the MM contribution in the GABA estimate) was not included any of the quantification (GABA+ or MM-suppressed measures). For this reason, all concentration estimates are approximately double the typical values. Initially, all data (from both voxel locations) was pooled to increase statistical power and the correlation between GABA+ and MM-suppressed GABA was quantified. Subsequently, the two different voxel locations were examined independently.

RESULTS: Table 1 shows the average measured GABA for both methods and voxel locations and acquisitions. Figure 1a shows the relationship between the MM-suppressed GABA and the GABA+. A moderate correlation was found, correlation coefficient = 0.48, p = 0.02. When analyzed by region, Figures 1b and 1c, this correlation loses significance in the SM voxel, and the correlation disappears in the OCC voxel (Table 2). The average tissue proportions of the OCC voxel were 28% ± 2% white matter, 57% ± 4% grey matter and 15% ± 4% CSF where as the SM voxel was 53% ± 4% white matter, 32% ± 2% grey matter and 15% ± 3% CSF.

DISCUSSION: A significant correlation between GABA+ and MM-suppressed GABA exists when all data is pooled. When examining the two voxels independently, a correlation remains in the SM voxel, however it looses significance. In the OCC voxel, the correlation no longer exists. MM-suppressed GABA measures are expected to more specifically correlate with measures of brain function; however, it is surprising there is not a greater correlation between MM-suppressed GABA and the standard GABA+ measurements. This may indicate MM-suppressed measures are less stable, for example MM-suppressed measure are particularly susceptible to frequency drifts, or there are greater inter-individual differences in MM than originally expected.[4]

Table 1. Measured GABA+ using the standard acquisition and GABA with MM-suppressed.

	GABA+ (i.u.)	MM-suppressed GABA (i.u.)
All data	6.5 ± 1.3	3.2 ± 1.0
OCC	7.2 ± 0.9	3.5 ± 0.7
SM	5.8 ± 1.1	2.9 ± 1.1

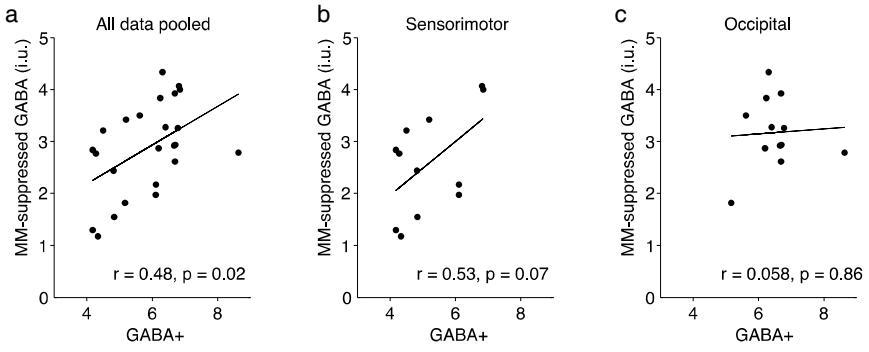

Figure 1. Relationship between GABA+ and MM-suppressed GABA. Across all data (a) a significant correlation is observed. The SM voxel (b) shows a non-significant correlation, but the OCC voxel (c) does not show a correlation.

References:
1. Edden et al. Magn Reson Med 2012; 68: 657.
2. Henry et al. Magn Reson Med 2001; 45: 517.
3. Edden et al. J Magn Reson Imag 2014, DOI 10.1002/jmri.24478.
4. Terpstra et al. Magn Reson Med 2012; 46: 1009

Acknowledgments: NIH grants: R21 NS077300 and R01 EB 016089