Reliable GABA Spectral Editing BASING-PRESS MRS at 7T

Yan Li[1], Bian Wei[2], Peder Larson[2], Jason C Crane[2], Srikantan Nagarajan[2], and Sarah J Nelson[2,3]

[1]*University of California, San Francisco, California, United States,* [2]*Department of Radiology and Biomedical Imaging, University of California, San Francisco, California, United States,* [3]*Department of Bioengineering and Therapeutic Sciences, University of California, San Francisco, California, United States*

Target audience: MRS sequence developers, and clinicians, such as neuroscientists and psychiatrists, who are interested in GABA and Glx.

Introduction: γ-aminobutyric acid (GABA) is the main inhibitory neurotransmitter in the brain, and has been widely studied using Magnetic Resonance Spectroscopy (MRS) in many diseases, such as schizophrenia and epilepsy. The disturbance in GABA found in these diseases suggests the detection of GABA could provide useful information in understanding the mechanisms of the diseases and monitoring treatment efficacy. It is difficult to isolate the GABA resonances from other components in a single echo time MRS acquisition. Spectral editing methods that take advantage of the coupling pattern of protons of GABA have been applied to separate these signals from partially overlapping resonance of creatine (Cr). The most common acquisition method being applied is an editing sequence called MEGA-PRESS. The purpose of this study was to evaluate acquisition parameters that are important for obtaining reliable GABA signals from volunteers in the regions that are frequently used for clinical studies (auditory cortex, superior temporal gyrus and caudate) at 7T using a single-voxel BASING-PRESS sequence that was similar to MEGA-PRESS [1].

Methods: Five healthy volunteers (3M and 2F) were studied to establish the feasibility of the methodology. All MR studies were performed using a 32-channel receive-only array with a volume transmit head coil on a GE 7 Tesla scanner (GE Healthcare, Waukesha, WI). Anatomic images consisted of a T1-weigthed sagittal scout and T1-weigthed fast spoiled gradient echo images. GABA-editing BASING-PRESS MRS was obtained with TE/TR=68/2000ms, voxel size=20x20x20mm^3 or 30x30x20mm^3, phase encoding array=8x8x1 and two editing cycles or 1x1x1 and 64 editing/64 non-editing. The editing pulse (Figure 1) was designed to be placed symmetrically at 2.0 ppm and 1.4 ppm in the two cycles to reduce the co-editing of macro-molecules (MM). The total acquisition time was about 4.5 min. The volunteers had a repeat acquisition either in the later part of the scan or another visit. The spectra were processed with phase/frequency correction and coil combination. The difference spectra, the subtraction of edited from non-edited spectra was quantified using LCModel [2], which used a basis-set generated by individual metabolite phantoms. The concentration GABA was referenced to NAA.

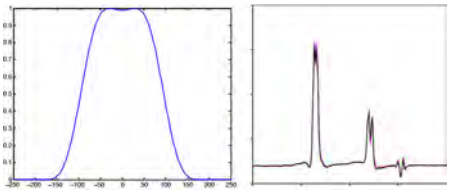

Figure 1. Editing pulses (left) and difference spectra (right) with the editing pulses placed symmetrically to 1.7ppm (black) and water (red) from a GABA phantom.

Results: The difference spectra with the editing pulses that were placed symmetrically to 1.7 ppm and water were plotted in Figure 1, and showed no difference. Chemical shift artifacts caused by PRESS excitation were more significant at 7T. An overpress factor of 1.9 was applied in the spectral acquisition as shown in Figure 2. The placement of editing pulses at 2.0 and 1.4 ppm removed the effect of GABA overestimation (GABA+). Figure 3 shows an example of unedited spectra in each individual channel using 1x1 and 8x8 phase encoding. The levels of GABA/NAA from 5 volunteers are shown in Table 1. The mean coefficient of variance was 6.6%.

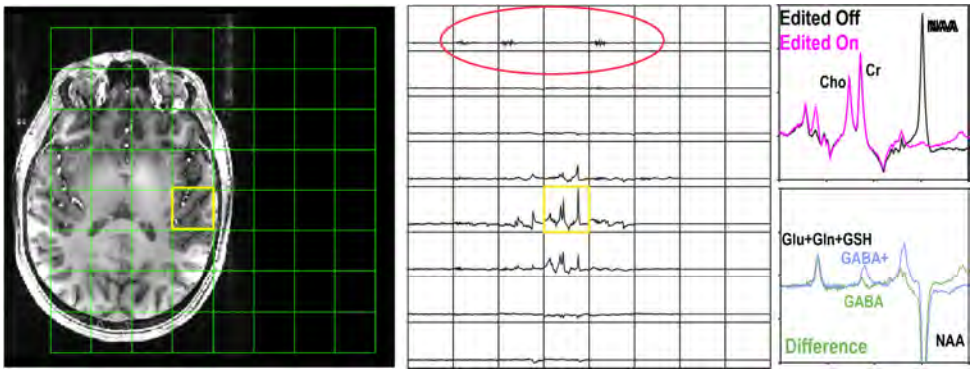

Figure 2. GABA-editing BASING-PRESS from a volunteer. GABA+ = GABA+MM when using editing pulses symmetrically to water. Note that there were no in-plane saturation bands applied.

Table 1. GABA/NAA in volunteers

Subject	ROIs	Scan 1	Scan 2	Scan 3
1	Auditory	0.100	0.106	
2	Auditory	0.146	0.129	
3	STG	0.149	0.126	
4	STG	0.123	0.113	0.118
5	Caudate	0.133	0.141	

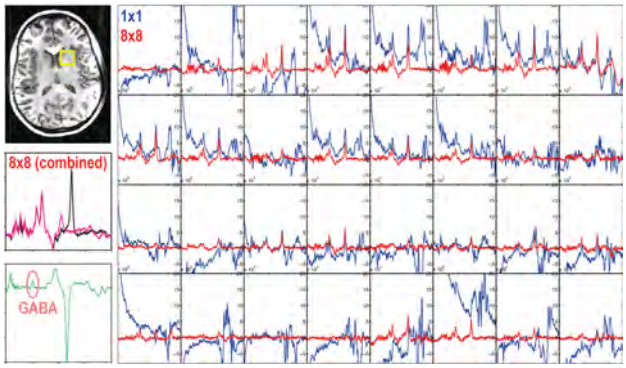

Figure 3. GABA-editing BASING-PRESS spectra from a volunteer in the region of caudate. Unedited spectra obtained with 1x1 (64 averages in each cycle, blue) and 8x8 (red) phase encoding arrays were plotted for each individual channel.

Discussion/Conclusion: The increased SNR and improved spectral resolution from the 7T scanner could also benefit GABA spectral editing; however, it also brought up complications when using the PRESS sequence. Three regions of interested were selected in this study that are in general difficult to achieve B0 homogeneity. A large overpress factor was needed to reduce the chemical shift artifacts at 7T, however, the inefficiency of saturation bands and unspoiled coherence could interfere the quality of data. The 8x8 phase encoding steps with a spatial resolution defined by the size of the selected volume were able to successfully remove these effects without compromising on total acquisition time, and even without using in-plane saturation bands. The variability of GABA/NAA within subjects was relatively small. More subjects will be recruited, and tissue segmentation applied in further analysis.

Reference: [1] Star-Lack J. et al. J Mag Res 1998; 133:243-254. [2] Provencher SW. Mag Res Med 1993; 30:672-679.

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