

# Measurement of Glycine in Human Brain by PRESS at 7.0 Tesla In Vivo

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## INTRODUCTION

Glycine (Gly), an inhibitory neurotransmitter and co-agonist at N-methyl-D-aspartate receptors, has a singlet resonance at 3.55 ppm. Because of its low concentration and overlapping resonances of primarily *myo*-inositol (mI), detection of a small Gly signal by <sup>1</sup>H-MRS is a challenge. A PRESS (point-resolved spectroscopy) TE-averaging method was employed to measure Gly at 4T [1]. Improved suppression of the mI multiplet was achieved at 3T using long-TE triple refocusing [2]. Recently, a short-TE single spin echo scheme combined with ISIS localization has been proposed for 7T [3]. All the previously reported methods require modification of existing methodology in terms of sequence programming or post-acquisition data process. Given that PRESS and STEAM (stimulated-echo acquisition mode) sequences are readily available in most of the clinical MR systems, measurement of Gly by PRESS or STEAM would be valuable. Here, we propose an optimal PRESS echo time for detection of Gly in human brain at 7T.

## METHODS

Suppression of the strongly-coupled resonances of mI for detection of the Gly singlet can be achieved by exploiting signal degradation due to the effects of scalar coupling. The deleterious signal modulation of the coupled resonances with changing TE occurs more effectively in PRESS than in STEAM, because antiphase coherences that play a major role in signal degradation pass throughout PRESS while in STEAM only longitudinal and zero quantum coherences pass over the mixing period. Therefore, a PRESS sequence has been explored for detection of the Gly signal. Density-matrix simulation was employed to search for optimal TE<sub>1</sub> and TE<sub>2</sub> between 20 and 200 ms with 1 ms increments, using the published chemical shift and coupling constants [4]. It turned out that the mI multiplet at ~3.55 ppm is minimum at (TE<sub>1</sub>, TE<sub>2</sub>) = (100, 48) ms. Spatial localization was obtained with an 8.8-ms 90° RF pulse (BW = 4.7 kHz) and two 11.9-ms 180° RF pulses (BW = 1.4 kHz).

A preliminary *in vivo* test of the sequence was conducted on three brain regions of a healthy volunteer. A 25×30×30 mm<sup>3</sup> voxel was positioned in the medial prefrontal, fronto-parietal and occipital cortices (see Fig. 2). Experiments were carried out on a Philips 7T scanner (Philips Medical Systems, Cleveland, OH, USA). A quadrature birdcage head RF coil with 16 reception channels was used for RF transmission and reception. LC model fitting [5] was used for spectral analysis.

## RESULTS and DISCUSSION

Fig. 1 presents numerically-calculated spectra of Gly, mI, Cho (choline; 4 coupled spins) and threonine (Thr), for PRESS (TE<sub>1</sub>, TE<sub>2</sub>) = (100, 48) ms. The mI multiplet at ~3.55 ppm is suppressed drastically, allowing detection of the 3.55-ppm Gly singlet, as indicated in the sum of the spectra. For a concentration ratio of [Gly]:[mI]:[Cho]:[Thr] = 2:10:1:1, the peak amplitude and area ratios between 3.5 - 3.6 ppm are 100:18:2:10 and 100:8:2:8, respectively.

Fig. 2 displays *in vivo* spectra obtained from three brain regions as indicated in the images. A Gly peak at 3.55 ppm is clearly discernible in all spectra consistently. An mI peak at 3.62 ppm does not overlap with the Gly peak, in agreement with the calculation. With LC model fitting, the concentrations of Gly in the medial prefrontal, fronto-parietal and occipital cortices were estimated to be 0.6, 0.8 and 0.8 mM, respectively, with reference to Cr at 8 mM, assuming identical T<sub>1</sub> and T<sub>2</sub> between Gly and Cr. The fit standard deviation (SD) of Gly was ≤ 8% in all three spectra, which were obtained each with a 2.6-min measurement time. In addition, mI and glutamate were resolved with fit SD of 7% and 3%, respectively. In conclusion, we have demonstrated the feasibility of the optimized PRESS sequence for detection of Gly in human brain at 7T. Further *in vivo* studies are currently underway to study regional difference in Gly level in human brain.

## REFERENCES

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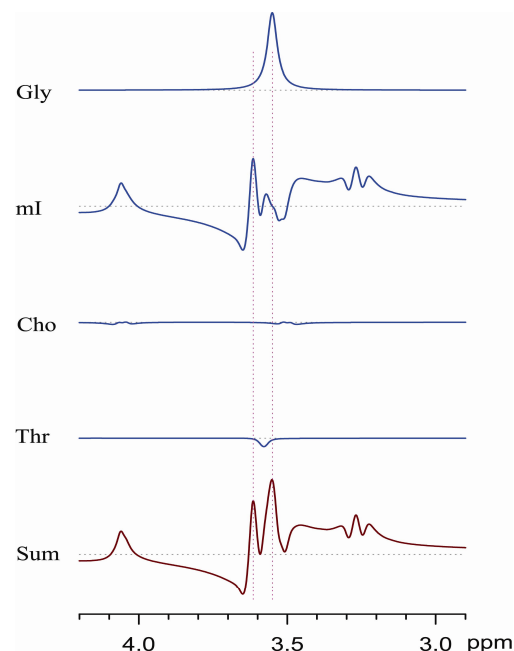


FIG 1. Density-matrix calculated spectra of Gly, mI, Cho and Thr for 90°-acquisition and optimized PRESS at 7T, for their concentration ratio of 2:10:1:1. PRESS echo times were (TE<sub>1</sub>, TE<sub>2</sub>) = (100, 48) ms. Spectra are broadened to 0.04 ppm (12 Hz). Vertical lines at 3.55 and 3.62 ppm indicate Gly and mI peaks, respectively.

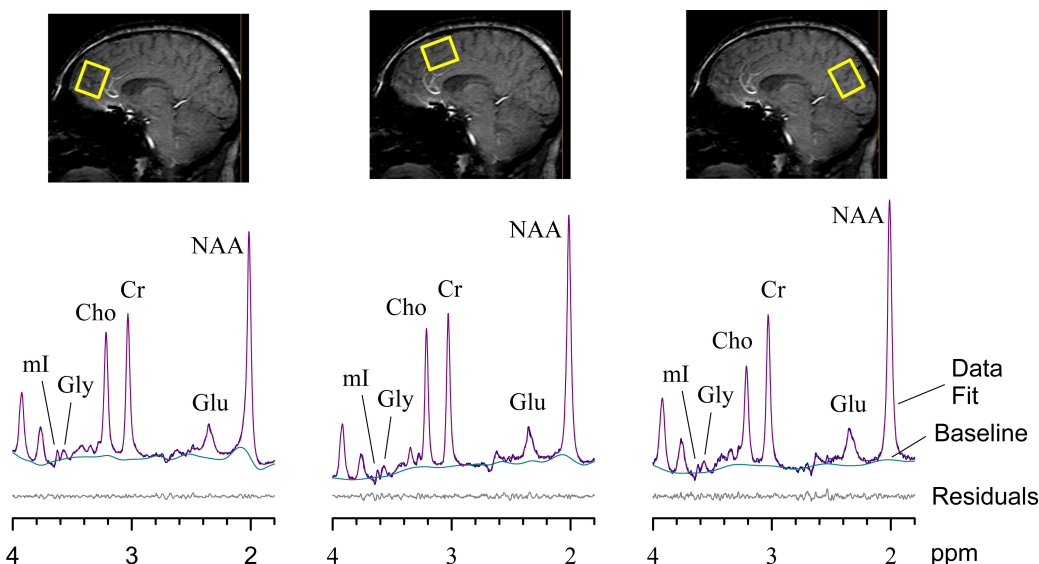


FIG 2. *In vivo* PRESS spectra obtained at 7T from the medial prefrontal (left), fronto-parietal (middle) and occipital (right) lobes are shown together with the LC model spectral fitting results. The voxel size was 25×30×30 mm<sup>3</sup>. TR = 2.5 s. NEX = 64. PRESS subecho times were (TE<sub>1</sub>, TE<sub>2</sub>) = (100, 48) ms.