In-vivo detection of GABA using short-TE MRS at 3 Tesla

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Introduction. Gamma-aminobutyric acid (GABA) is the primary inhibitory neurotransmitter in the mammalian brain. In-vivo detection of GABA is most commonly performed using magnetic resonance spectroscopic (MRS) editing techniques [1, 2]. Recently, GABA detection was demonstrated at 3T without spectral editing by employing a short-TE MRS method in combination with LCModel analysis [3]. This method may be advantageous because it enables the simultaneous measurement of a large number of metabolites (including GABA) simultaneously. It was recently shown using Monte-Carlo simulations that this approach can provide reliable measurements of GABA under normal experimental conditions at 3T [4]. The purpose of this study is to experimentally assess the reliability of short-TE MRS measurements of GABA in the human brain at 3T through a) comparison of short-TE GABA measurements with gold-standard edited GABA measurements in the same voxel in-vivo, and b) measurement of within-session reproducibility of short-TE GABA measurements.

Methods. In-vivo experiments. All volunteers (n=14, age=23.3±5.4 yrs, 8 female, 6 male) provided informed, written consent and were scanned on a 3T Siemens TIM Trio scanner (Erlangen, Germany) with a body coil transmitter and a 32-chanel receive head array. Both short-TE and edited GABA spectra were acquired from a localized region measuring 2.5 x 2.5 x 2.5 cm^3 in the primary visual cortex. Short-TE MR spectra were acquired using the SPECIAL sequence [3] (4096 points, spectral width = 4000 Hz, TR/TE=3000/8.5 ms, 192 averages) and edited GABA spectra were acquired using the MEGA-SPECIAL sequence [5] (2048 points, spectral width = 2400 Hz, TR/TE=3000/68 ms, 192 averages,). Post-processing and analysis**.** For all spectra, a semi-automated processing chain was applied which involved the removal of motion corrupted averages, and frequency and phase drift corrections prior to signal averaging. Following spectral processing, short-TE MRS data were analysed in LCModel using a basis set that consisted of 21 simulated metabolite basis spectra. Edited MEGA-SPECIAL MRS data were analyzed by peak fitting using AMARES [6] according to the method described previously [5]. Within-session reproducibility was assessed by splitting the acquired short-TE SPECIAL data into four equal and consecutive blocks, each containing 48 averages. Each of these blocks was then processed identically, as described above. Each of the four processed datasets was then analysed using LCModel and the coefficient of variation of the GABA estimates across the four scan blocks was calculated for each subject.

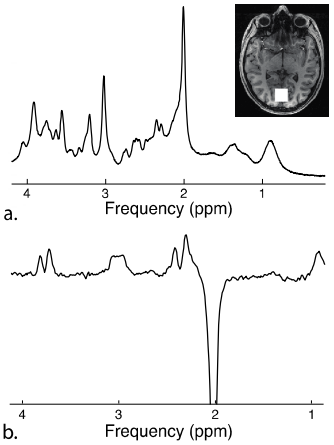

Figure 1. Typical short-TE spectrum (a) and GABA-edited spectrum (b) acquired in the primary visual cortex.

Results and Discussion. Results. Figure 1 shows typical short-TE (a) and edited (b) spectra from a single subject. Figure 2 shows the Short-TE GABA concentration estimates in all 14 subjects, plotted against the gold-standard edited GABA measurements. A significant positive relationship was observed between the two measures (R=0.58, p<0.05). Within-session reproducibility is illustrated in Figure 3 using a box plot, with each box representing a single subject. The average coefficient of variation across all 14 subjects was 8.7 ± 4.9%. Discussion. The observed significant positive relationship between short-TE GABA measurements and gold-standard edited GABA measurements suggests that short-TE MRS can detect individual differences in GABA concentrations with reasonable reliability and that short-TE MRS can be used as an alternative to the more conventional GABA-editing techniques. From the study of within-session reproducibility, the coefficient of variation of repeated short-TE measurements of GABA is small, and compares favourably with previously published reproducibility values for edited measurements of GABA at the same field strength [1,2].

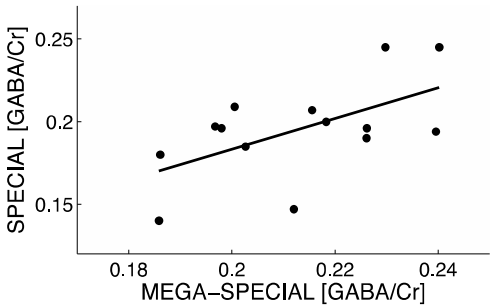

Figure 2. Comparison of GABA/Cr concentration estimates obtained using both short-TE SPECIAL (x-axis) and edited MEGA-SPECIAL (y-axis). A significant relationship was observed (R=0.58, p<0.05).

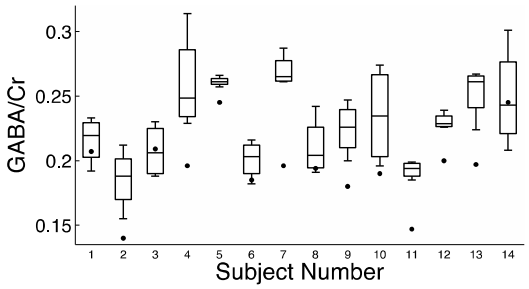

Figure 3. Illustration of within-session reproducibility for short-TE GABA MRS. Four measurements were obtained by breaking the acquisition into four consecutive blocks and analyzing each separately.

References. [1] Rothman DL et al. PNAS (1993); 90:5662. [2] Mescher M et al. NMR Biomed (1998); 11:266. [3] Mekle R et al. Magn Reson Med (2009); 61(6):1279. [4] Near J. Proc Intl Soc Magn Reson Med (2011); 19:3440. [5] Near J et al. NMR Biomed (2011); In press. [6] Vanhamme L et al. J Magn Reson (1997); 129(1):35.