HIGH RESOLUTION 2D CTPRESS WITH 2D SPIRAL ENCODING

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INTRODUCTION: J-coupling causes spectral splitting and complicated signal modulation that limit the detection of important brain metabolites such as glutamate (Glu) and glutamine (Gln) in proton spectroscopic imaging. Glu is an important excitatory neurotransmitter in the brain and changes in Glu and Gln are an indication for metabolic ailments such as hepatic encephalopathy [1, 2] and Rett’s syndrome [3]. While 2D spectroscopy, e.g. CTPRESS [4], has been demonstrated to successfully improve signal detection of coupled spins, it carries a heavy penalty in scan time over conventional chemical shift spectroscopy. To mitigate the scan time constraints, Mayer et al [5] exploited the diagonal feature of 2D CTPRESS spectra to achieve eight-fold undersampling with a 17-step 2D MRS experiment and demonstrated the method for a voxel size of 4.5cc at 3T with a quadrature birdcage head coil within a total scan time of 4:40min for two averages with fast spiral spectroscopic image encoding.

METHODS: The pulse sequence for the 17-step CTPRESS experiment shown in Fig. 1 was implemented and applied in vivo on two human subjects on a 3.0 T MRI scanner (Siemens AG, Erlangen, Germany) using a 32 channel head coil. The last refocusing pulse of the PRESS selection module was shifted in increments of Δt = 6.4ms corresponding to a spectral bandwidth of 78.125Hz in f₁. For optimal SNR from Glu, the average TE of the 17-step CTPRESS experiment was chosen to be 151 ms [5]. The bandwidth in the f₂ dimension was 1.2 kHz.

RESULTS: SNR of the 0.85cc and 4.5cc 2D CTPRESS experiments were calculated from the NAA peaks centered at 2.01ppm and averaged over the excitation volume. The reduction in SNR by a factor of approximately 2.5 of the 0.85cc experiment is consistent with a 5.29 factor decrease in voxel size and a 4.64 factor increase in acquisition time. Fig. 3a and b is a map of the central 3x6 = 18 voxels of the excitation volume, demonstrating successful reduction of line splitting for the multiplets of NAA, Glu, and Gln. Fig. 4a and b show the 1D diagonal spectra for the 0.85cc 2D CTPRESS experiment from voxels with predominant gray matter and white matter, corresponding to the red crosses in Fig. 2a and 2b. Glu and Gln signal that are typically obscured in 1D spectroscopic imaging manifest as peaks between 2.25ppm-2.50ppm and 3.50-3.80ppm. Relative metabolite amplitudes in gray-matter and white-matter voxels demonstrate signal pattern variations similar to [5].

CONCLUSION & DISCUSSION: We have demonstrated the application of a spatially-resolved 2D CTPRESS acquisition at a resolution of 0.85cc. Peaks from Glu, Gln, mI and NAA are well distinguished and can be reliably measured at this resolution. An immediate extension is to enable 3D spectroscopic imaging by incorporating phase-encoding in k₁ space. Without scan time penalty or SNR tradeoffs, four slices can be encoded within a 4-cm thick slab for the same voxel size of 0.85cc.


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