Reproducibility Evaluation of Spatially Resolved Liver ³¹P Metabolism Using a Dual Tuned 8-channel ³¹P/¹H Coil

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Introduction: A multi-channel phased-array ³¹P coil can be used to acquire regional changes in the ³¹P metabolite concentration of the whole liver [1]. This information can then be used for diagnosis and follow-up of various liver diseases [2]. However, changes in the placement of the coil position, separation between the anterior and posterior coils, and spectroscopic grid placement during the scan can significantly affect the acquired

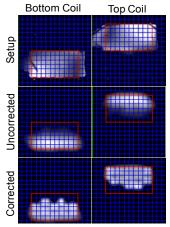


Figure 1: Uncorrected and corrected sensitivity maps for the top and bottom coil.

data [3]. In this abstract we present a preliminary investigation on quality and coverage of a dual-tuned 8-channel phased-array ³¹P/¹H coil presented in [1]. The aim of this work was to examine the methods (acquisition and processing) to minimize data variability from coil placement and spectroscopic imaging setup, correct for coil sensitivities, and evaluate variability in the data from one scan to another for whole liver ³¹P 2D MRSI.

Methods: A dual tuned 8-channel ³¹P/¹H coil was used for ³¹P MRSI on a Siemens 3T TIM Trio whole body MRI scanner (Siemens Healthcare, Germany). Water filled fiduciary markers were placed on both anterior and posterior coil plates around the coil diameter to be used as reference points for acquisition planning and post-processing alignment. Permanent markers on the scanner bed were used to ensure that the coil is placed reproducibly at the exact location on the scanner bed every time.

A 10 liter plastic carboy filled with 10 mM potassium phosphate monobasic solution was used for the initial pulse sequence development and RF transmitter calibration. The following parameters were used for data acquisition using a slice-selective MRSI

sequence: TE 2.3ms, TR 1s, FOV 400x400x30 mm³, nominal voxel size 25x25x30 mm³. Each FID was acquired with 2048 points and a bandwidth of 5000 Hz. The acquisition took about 24 min for 30 weighted averages. The first point of each FID was used to determine the relative phases of each coil and to phase adjust the data before combining the signal. An exponential filter of 25 Hz line-broadening and first order phase correction was applied to the combined signal.

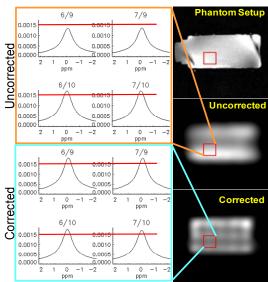


Figure 2: Uncorrected and corrected MRSI for a Phantom.

Coil sensitivity correction maps for both the anterior and posterior coil plates (each containing four ³¹P channels) were computed individually by calculating the area under the peak from the ³¹P spectrum of a homogenous 10 liter 25 mM potassium phosphate monobasic phantom. An empty 10

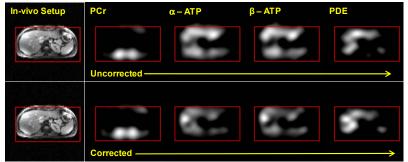


Figure3: Uncorrected and Corrected MRSI in-vivo data.

liter plastic carboy was placed above or below the filled phantom while acquiring the data for both coil plates, respectively. Any signal below 30% of the maximum was considered noise and was removed from the correction maps. These maps were then used to correct for the variations in the coil sensitivity in the acquired phantom and in vivo ³¹P data. Finally, the data was quantified using the AMARES routine in jMRUI. For in vivo data six metabolites were quantified: β-ATP, α-ATP, γ-ATP, PCr, Pi, PME, and PDE. The relative ratio of metabolites to β-ATP was used to measure data variability between two scans. Scans were performed on two different days on the same subject with the same protocol.

Results/Discussions: Figure 1 shows the original uncorrected and corrected sensitivity maps obtained for the anterior and posterior plates of the coil. Figure 2 shows the results of this sensitivity correction on the full phantom data. The sensitivity map analysis shows that usable data can be obtained for a maximum depth of 18 cm. Figure 3 shows the results of coil sensitivity correction on in vivo data. We see a moderate increase in the signal at the middle and decrease in the noise at the edges after the correction. From data variability analysis it was concluded that within 5 cm of either of the coils the relative concentrations are within 20% of each other. However, farther away the variability increases to about 40% between two scans. Correction of coil sensitivities seems to have little to no effect on correcting for the variability.

Conclusion: Various techniques that have worked successfully in minimizing the data variability from coil placement and spectroscopic planning are presented. Effects of coil sensitivity and a possible algorithm to correct for it are discussed. Correction of sensitivity had a moderate improvement on signal for in vivo data, but did not change the variability between two scans. The metabolite concentration data from voxels closer to the coil showed less variability than voxels farther away in longitudinal scans, due to the higher SNR of spectra closer to the coil. Improving the SNR with 3D CSI might give a better reproducibility between scans.

References: [1] A. Panda et.al., Proc. ISMRM 2009, 17:475; [2] S. Solga et. al. Liver International, Vol. 25, 2005; [3] J. James et.al., Proc. ISMRM 2009, 17:615.