Correlation time diffusion coefficient mapping of the abdomen with respiratory triggered mixed-TSE: a non-pulsed field gradient technique

H. Jara[1], R. Diaz Garbizu[2], J. A. Soto[3]

[1]Radiology and Biomedical Engineering, Boston University Medical Center, Boston, MA, United States, [2]Biomedical Engineering, Boston University, Boston, MA, United States, [3]Boston University Medical Center, Boston, MA, United States

Purpose: Develop a diffusion coefficient mapping technique for abdominal imaging with reduced sensitivity to non-diffusional motions. Specifically to use the mixed-turbo spin-echo pulse sequence with respiratory triggering and adapt a Bloembergen-Purcell-Pound (**Ref.** 1) mathematical algorithm for mapping the diffusion coefficient using as input self-coregistered maps of the relaxation times (T1, T2) and of the absolute proton density (PD). This approach does not rely on pulsed-field-gradient encoding and is therefore much less vulnerable from artifacts caused by non-diffusional motions normally occurring in the abdomen: respiration, pulsations, flow, peristalsis, and gross patient motion.

Methods: Imaging at 1.5T was performed with standard MRI clinical scanners (Philips Medical Systems) with the mixed turbo spin echo (**Ref.** 2) (mix-TSE) pulse sequence; this is a multislice 2D pulse sequence that combines the principles of T1-weighting by inversion recovery and T2-weighting by multi-echo sampling into a single mixed MRI acquisition. Standard quadrature body coils were used for both excitation and signal reception. Respiratory triggering with respiratory bellows was utilized to reduce respiratory motion artifacts. Imaging occurred during the expiratory portion of the respiration cycle with nominal scan times of two minutes and forty seconds. Actual scan times can be up to twice as long depending upon the patient's breathing pattern. Directly acquired images were initially post-processed with quantitative MRI algorithms to generate the PD, T1, and T2 maps. PD maps were generated by reversing the T1 and T2 weightings of one of the mixed-TSE directly acquired images. PD and T1 maps were then used to calculate the correlation time diffusion coefficient maps using a mathematical model based on the Bloembergen-Purcell-Pound relaxation theory.

Results: Representative PD, T1, T2 and D maps are shown in Fig 1. A proton density weighted image is shown next to the PD map to illustrate the effectiveness of the quantitative PD algorithm to reduce artifactual intensity variations throughout the field of view. Note that the spatial resolution of the diffusion coefficient maps equals that of the directly acquired maps. ROI diffusion coefficient measurements were performed on 10 healthy subjects, who were imaged as part of an IRB-approved study, and the results are shown in Figure 2.

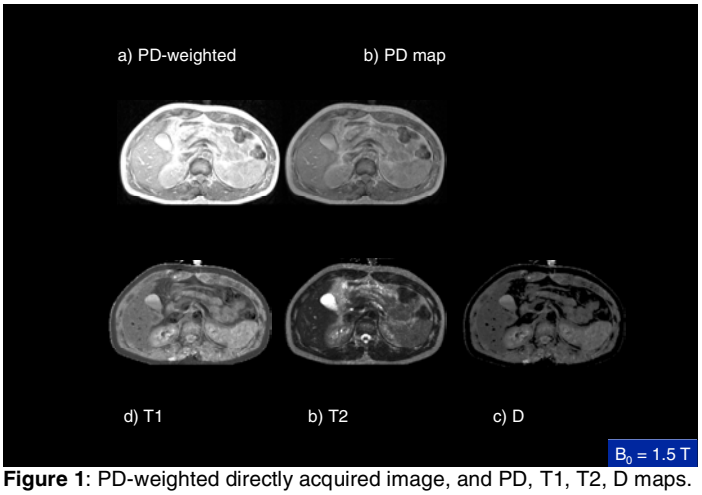

Figure 1: PD-weighted directly acquired image, and PD, T1, T2, D maps.

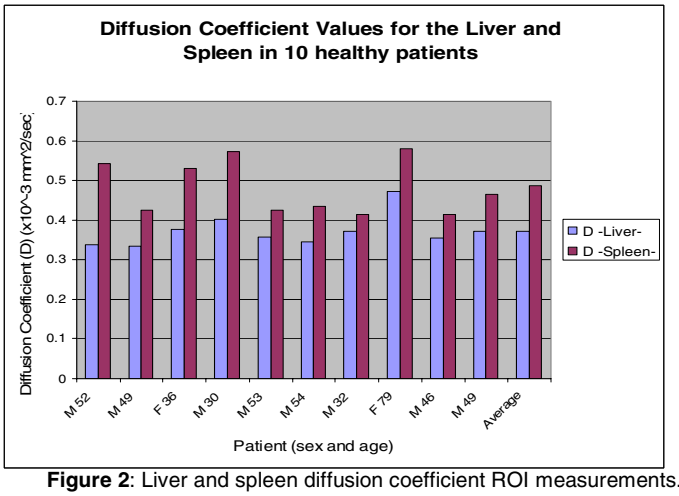

Figure 2: Liver and spleen diffusion coefficient ROI measurements.

Conclusion: A non-PFG technique for high resolution mapping of the diffusion coefficient in the body has been developed. The technique does not use diffusion-encoding gradient pulsed field gradients and is therefore much less vulnerable to image quality degradation caused by the concomitant non-diffusional motions of the abdominal organs.

References

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