Detailed diffusion measurements of the liver and spleen over extended b-factor ranges

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Introduction: With the use of EPI and parallel imaging techniques, diffusion-weighted MRI of the abdominal organs has become feasible with clinical scanners. Several studies of water diffusion measurements in abdominal organs have been performed in recent years (1-3), though data has been restricted to b-factors less than 1300 s/mm^2. In this study, we have made detailed diffusion measurements of the liver and spleen using multiple b-factors ranging up to 4000 s/mm^2, allowing us to determine whether the signal decay in these organs at high b-factors shows a monoexponential behavior or not.

Materials and Methods: Eight healthy volunteers (six males and two females aged 22 - 48 years) with no fatty liver were examined with a 1.5T Signa Excite system (General Electric Medical Systems, Milwaukee, WI) using an 8 channel body coil. Diffusion measurements of the liver and spleen were performed with a line scan diffusion imaging approach (4). A single 15mm column passing through liver and spleen was chosen for interrogation. The amplitude of the diffusion gradients, sampled along three orthogonal directions, was exponentially incremented every TR period to cover b-factors from 0 - 4000 s/mm^2 in 16 steps. A scan time of 38 s with TR/TE=2000/91 ms allowed for breath-hold studies. For the data analysis, the first b-factor was excluded to decrease the contamination of perfusion fraction.

Results: Figure 1a shows a T2-weighted liver and spleen image with a saturation band outlining the 15 x 15mm^2 column targeted for diffusion interrogation. Figure 1b shows this tissue column as a function of b-factor from 0 - 4000s/mm^2 (top to bottom). The signal decay versus b-factor over the extended range demonstrates a biexponential rather than a monoexponential decay in both organs (Fig. 2). The fast diffusion coefficients for the liver and spleen were 1.76±0.41 and 1.50±0.36 x 10^{-3} mm^2/s, respectively. The slow diffusion coefficients for the liver and spleen were 0.39±0.14 and 0.31±0.11 x 10^{-3} mm^2/s, respectively. The fast ADC fractions for the liver and spleen were 59.9±14.2 and 54.8±13.4 %, respectively. The interindividual mean biexponential parameters characterizing the decays in liver and spleen were not statistically different.

Discussion: Detailed measurements of diffusion decay including high b-factors show no significant differences between the liver and spleen, leading to the conclusion that the reason spleen appears brighter than the liver on diffusion-weighted images is due to a T2 shine-through rather than a diffusion effect. The water signal decay due to diffusion in the liver and spleen is well suited to biexponential fits over extended b-factor ranges. The clinical utility of the biexponential parameterization is unclear, though clearly offers new and unique information for tissue characterization in the liver and spleen.

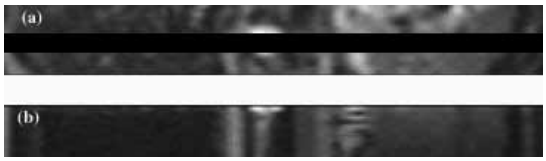

Figure 1: (a) T2-weighted scout image with a saturation band passing through the liver and spleen. (b) A line scan diffusion image of the column. The horizontal axis is spatial and the vertical axis is b-factors from 0 - 4000 s/mm^2 (top to bottom).

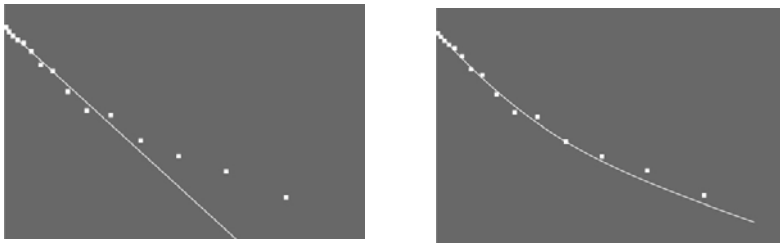

Figure 2. Typical signal decay in the liver with extended b-factors. Semi-log plots of the signal decay is biexponential (right) rather than monoexponential (left).

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