Qualitative and Quantitative effects of Gadoxetate Disodium on DWI/ADC in a Healthy, Liver Donor Population

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Introduction: Diffusion weighted imaging (DWI) is becoming a routine for abdominal MRI and is usually performed either before or after intravenous contrast injection [1]. Several studies have shown that DWI can be performed immediately after gadolinium (Gd) administration without any significant impact on qualitative appearance or ADC measurements in the liver compared with the pre-contrast DWI [2-4]. However, our observation contradicts the findings presented in these studies. A significant variation – consistent over a year-long trial with over 25 healthy liver donor patients – in the pre- and post-contrast (gadoxetate disodium) ADC values was observed. The goal of this study was to determine the causes of signal loss and ADC variations in the pre- and post-contrast DWI for the liver. In particular, we investigated the effect of inversion time (TI) used for fat suppression and contrast administration on ADC measurements.

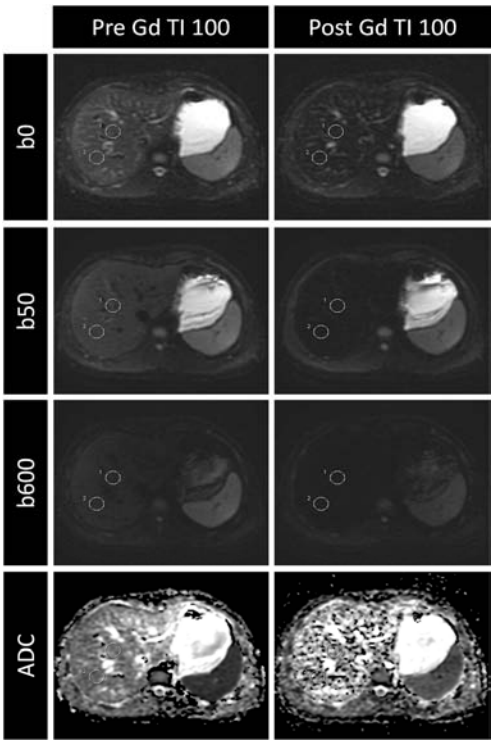

Figure 1: Pre- and post-gadolinium b-maps and ADC maps for a liver donor patient.

Methods: An 8-channel body array coil was used for DWI on a 1.5T whole body MRI scanner (GE Healthcare, Waukesha, WI, USA). The data was acquired from 20 patients with a modified protocol to perform pre- and post-contrast DWI. Additionally, 5 patients were scanned with multiple TIs pre- and post-contrast. The standard respiratory triggered spin-echo single-shot echo-planar sequence with the following parameters was used for DWI: TR/TE (variable – based on respiration), approx. 10000/75 ms; FOV, 400 × 400 mm; matrix, 128 × 128; slice thickness, 6 mm; NEX, 4; b = 0, 50, 600, 1200 mm^2/s along 3 diffusion directions; and acquisition time ~ 2 min. A 0.1 mmol/kg gadoxetate disodium (EOVIST, Bayer HealthCare) administration was used as the contrast agent. Fat suppressed DWI was acquired using the short-tau inversion-recovery (STIR) technique with the TI of 0 (no fat suppression), 100, and 120 ms. The mean signal for b0 and ADC were calculated from two non-overlapping regions of interest (ROI), approximate area: 400 mm^2, placed in the right lobe of the liver.

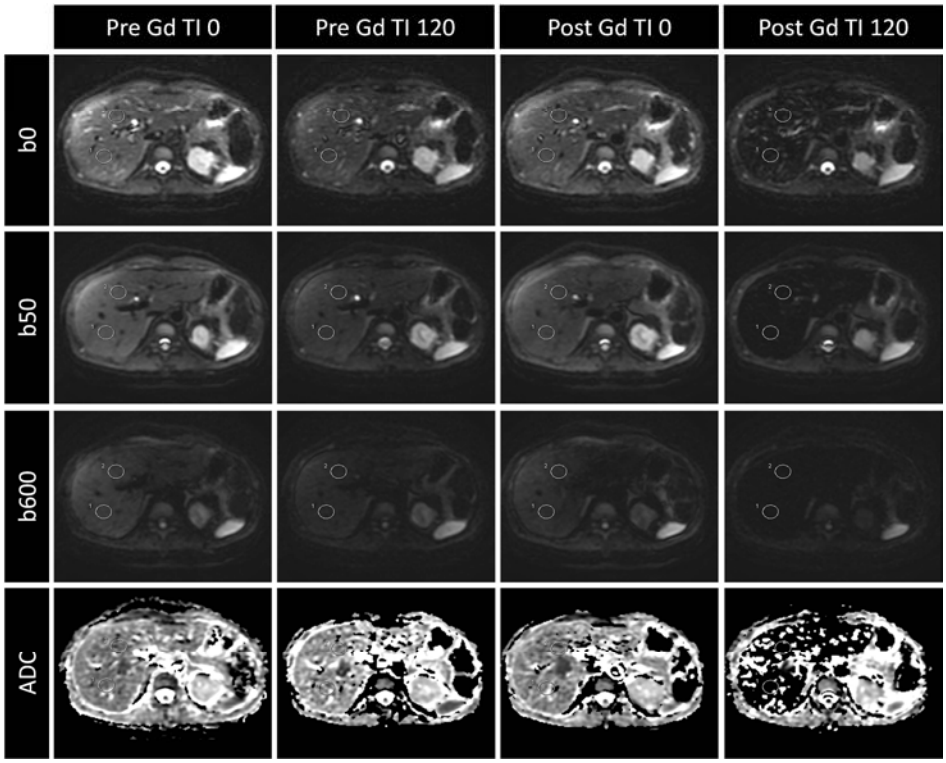

Figure 2: Effect of gadolinium contrast and inversion time on b-maps and ADC maps of liver.

Results/Discussions: Figure 1 shows the pre- and post-contrast b-maps and ADC maps for a TI=100 from a liver donor patient. The mean b0 value over the two ROI pre- and post-contrast was calculated as 108 and 27 (74% signal drop), respectively. A similar reduction in the b-map signal was observed for all other patients across all the b values. Figure 2 shows the b-maps and ADC maps for a patient acquired with the TIs of 0 and 120 pre- and post-contrast. The mean b0 value of 266, 147, 146, 31 and ADC of 1.2, 1.4, 1.1, 0.5 $\times 10^{-3}$ mm^2/s was observed for pre-Gd TI=0, pre-Gd TI=120, post-Gd TI=0, and post-Gd TI=120, respectively. A similar trend was observed for all 5 patients.

Conclusion: A pre vs. post contrast ADC signal loss was observed for both TI=0 and TI=120, which contradicts the published studies that Gd-contrast does not have significant impact on DWI of the liver. As expected, signal loss was observed when an inversion pulse was used in both the pre- and post-contrast DWI, however, the signal loss was significantly higher when a TI pulse was added to the post-contrast DWI. Thus, when using a hepatobiliary agent, liver DWI should be performed pre-contrast. If post-contrast DWI of the liver is preferred or necessary, caution regarding the use of a TI pulse is advised.

References: [1] Qayyum A, RadioGraphics 2009. 29:1797–1810; [2] Gulani V et al., J Magn Reson Imaging. 2009. 30(5): 1203–1208; [3] Chu F et al., J Comput Assist Tomogr. 2005 Mar-Apr;29(2):176-80.; [4] Colagrande S et al., J. Magn. Reson. Imaging 2013. 38:365–370.