Effect of Field Strength and Software on Apparent Diffusion Coefficient Measurements in Diffusion-Weighted Imaging of the Abdomen at 1.5 and 3 Tesla.

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Background: Diffusion Weighted Imaging (DWI) has been used in the abdomen for the *qualitative* evaluation of tumors and *quantitative* analysis of tumor response to treatment [1, 2, 3]. Up to this point, the vast majority of studies have been performed using data acquired only from 1.5 T magnets. With the emergence of high field strength magnets used in clinical practice, it would be useful to determine if there is any difference in ADC measurements at 3 T compared to the standard 1.5 T. If ADC values are indeed independent of field strength, then the monitoring of tumor response to treatment can be performed at both 1.5 T and 3 T.

Materials and Methods: During a two month period, 20 healthy male volunteers (mean age: 34.7 years) were imaged on both a 1.5 T and a 3 T MR system (MAGNETOM Avanto and Trio, Siemens Medical Solutions, Germany) with the 1.5 T system running the B11 software package and the 3 T system running the B13 software package. A single dedicated body matrix coil positioned over the abdomen and the spine array coils were used for signal reception at each MR system. The imaging protocol included 5 axial DWI scans of the abdomen (trace b-value 0/400, TR 3200ms, TE 76ms, ST 6mm, NEX 4, TA 62s, Matrix 108 x 128, iPAT 2) acquired during free breathing. Each volunteer was scanned using this standardized protocol at both field strengths in random order on the same day. ADC values were calculated automatically for each DWI series by the MR system and displayed as corresponding ADC maps. Sixteen of the original 20 volunteers (80%) returned for a two month Fall Session. The sessions were separated by a 5 month period. Each volunteer was scanned using the same standardized protocol on the same 1.5 and 3 T MR systems. In the interval the software package on the 1.5 T system was upgraded from B11 to B13. The 3 T system remained at B13.

Quantitative analysis was performed by a senior radiology resident, with four years of experience in body MR imaging, on a multi-modality imaging workstation (Leonardo, Siemens Medical Solutions) in a blinded fashion regarding the magnetic field strength. Region-of-interest (ROI) mean values were obtained in five anatomical locations (posterior right hepatic lobe, pancreatic head, body, and tail, and spleen). For each location, 3 circular ROIs with a standardized size of 21 pixels were placed on the b-value = 0 images at homogeneous, artifact-free areas without including large blood vessels. Identical ROI positions were pasted on the corresponding ADC maps (Figure 1). The data were analyzed with multi-factor repeated-measures ANOVA using SPSS 13.0.

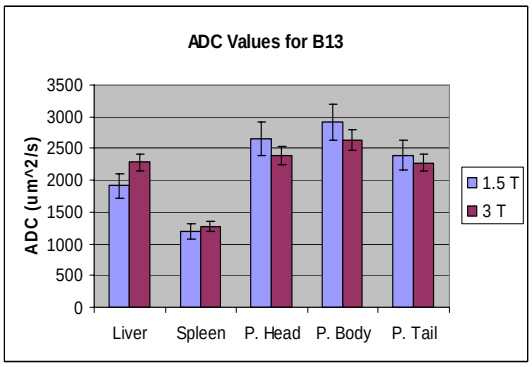

Chart 1: ADC values in various anatomic locations at both, 1.5T and 3T acquired on the identical software platform B13.

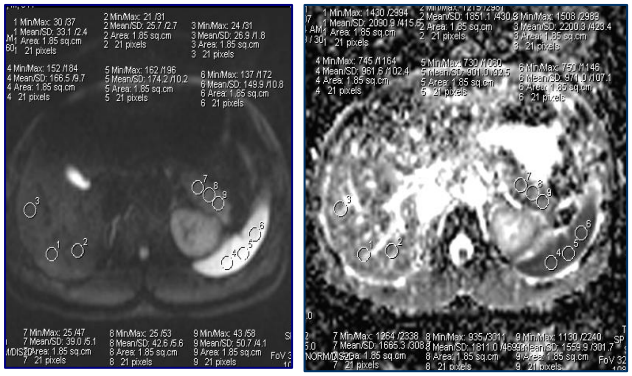

Figure 1: Axial DWI with a b-value of 0 illustrates ROI placement in liver, spleen, and pancreatic tail. These ROIs are copied onto the ADC map (right image) to ensure identical position.

Results: The B11 ADC values acquired during the spring session were significantly ($p<.001$) lower than the B13 values acquired at 1.5T during the fall session with a mean difference of about 25%. However, there was no significant difference when comparing the B13 3T spring session with the B13 3T fall session. There was a significant ($p<.001$) main effect of tissue type (Chart 1). After removing the B11 ADC values there was no significant ($p=.605$) main effect of field strength nor was there a significant ($p=.485$) difference between spring and fall, but there was a significant ($p=.001$) interaction between field strength and tissue type on ADC with Liver and Spleen being higher at 3T and Pancreas being lower and with the difference being statistically significant ($p<.001$) for liver (Chart 1).

Conclusions: ADC values in abdominal organs are stable over 5 months but are highly sensitive to changes in post processing or sequences such as those that can occur during routine software upgrades. Longitudinal studies will need to incorporate some calibration methods to properly compare data across such inevitable changes. The ADC values in some tissues, such as liver, are sensitive to changes in field strength. For those tissues care must be taken that follow-up studies are performed at the same field strength.

References:

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3. Koh DM et al. AJR 2007; 188:1001-1008