EVALUATION OF ADVANCED MONOPOLAR AND BIPOLAR WHOLE BODY DIFFUSION WEIGHTED IMAGING AT 3T

Michael A. Jacobs[1], Li Pan[2], Doris G. Leung[3], and John A. Carrino[4]

[1]Russell H. Morgan Department of Radiology, The Johns Hopkins University School of Medicine, Baltimore, Maryland, United States, [2]Center for Applied Medical Imaging, Siemens Corporation Corporate Technology, Baltimore, MD, United States, [3]Center for Genetic Muscle Disorders, Kennedy Krieger Institute, Baltimore, MD, United States, [4]Russell H. Morgan Department of Radiology, The Johns Hopkins University School of Medicine, Baltimore, MD, United States

Purpose: To evaluate the performance of advanced monopolar and bipolar diffusion weighted imaging (DWI) sequences and establish the feasibility of performing whole body MRI (WB-MRI) at 3T.

Methods: Whole body-MRI was performed in 17 subjects, 14 with muscular dystrophy and 3 volunteers. at 3T (MAGNETOM Tim Trio, Siemens Healthcare, Erlangen, Germany). WB-MRI sequences including T1-weighted fat or nonfat saturated and T_2-weighted images were obtained in the axial and coronal planes with continuous table movement with powered by Tim technology (TimCT). For advanced DWI acquisition, two diffusion encoding schemes, a modified monopolar Stejskal-Tanner which uses the complete time between the two RF pulses for diffusion encoding and an improved bipolar variant which employs optimized spoiling, were used (TR/TE = 5600-7500/60-75ms, TI = 240ms, b=50 and 800s/mm^2, averages = 4, ST = 5mm, BW = 2706 Hz/pixel, echo spacing = 0.45 ms, acceleration factor=2). Conventional standard bipolar encoding scheme was used as reference for comparison (TR/TE=5700/82ms, TI = 240ms, b=50, 400 and 800 s/mm^2, averages = 4, ST = 5mm, BW = 1694 Hz/pixel, echo spacing = 0.69-88ms, acceleration factor=2). ADC maps were constructed from each of the DWI data sets for all three encoding schemes. Two readers reviewed four regions of the DWI and ADC maps (chest, abdomen, pelvis and lower extremities) to grade the diagnostic quality with a 4-point scale metric (1=artifacts>75%, 2=50-75% and 2.5=0-50 3=artifacts<25%, 4=no artifacts). The combined effect of artifacts as a percentage of the organ affected that degrades the diagnostic quality, such as, ghosting, susceptibility, and motion artifacts. Regions of interest were drawn on the ADC maps on the liver, spleen, kidney (left and right), anterior and posterior compartment of the lower extremities, and bladder to calculate mean and standard deviations (SD) of the ADC values from the ADC maps. A paired t-test was used to measure statistical significance. A p-value < 0.05 was defined as significant.
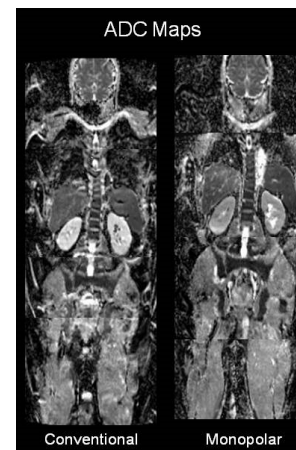

Figure 1. Example of WB-ADC maps constructed monopolar and conventional bipolar DWI.

Results: Representative WB-MRI ADC maps are shown in Figure 1. The mean diagnostic score from each location on the ADC maps is shown Table 1. Fig. 2 shows examples of the artifacts in the

Table 1 - Diagnostic Score	Chest	Abdominal	Pelvis	Thigh
Monopolar	2.52	2.41	2.10	2.94
Bipolar	2.50	2.67	2.75	2.25
Conventional	2.33	2.50	2.50	1.67**

thigh. There was no significance between the sequences (p>0.05) in each region, except for the abdomen(p=0.01). The ADC values from selected anatomical regions were: biceps fermoris monopolar (Right) 1.53±0.17x10^{-3}mm^2/s, (left) 1.45±0.15x10^{-3}mm^2/s, bipolar sequence: (Right) 1.42±0.15x10^{-3}mm^2/s, (left) 1.39±0.18x10^{-3}mm^2/s, and conventional (Right) 1.32±0.21x10^{-3}mm^2/s, (Left) 1.34±0.19x10^{-3}mm^2/s. Chest/Liver: monopolar,1.26±0.28x10^{-3}mm^2/s; bipolar:1.19±0.24x10^{-3}mm^2/s, and conventional,1.03±0.20x10^{-3}mm^2/s.
Bladder: monopolar,3.1±0.21x10^{-3}mm^2/s; bipolar:3.0±0.20x10^{-3}mm^2/s, and conventional,3.1±0.32x10^{-3}mm^2/s.

Conclusion: Advanced quantitative DWI using modified monopolar or biopolar encoding schemes in WB-MRI is feasible with high diagnostic quality and fewer artifacts are noted than conventional standard bipolar scheme. These data are consistent with previous reports[1]. The application of the advanced DWI in patients is promising and will advance the utility of WB-MRI in both lesion detection and providing additional metrics for lesion characterization [3-4].

References: [1] Morelli et al. Invest Radiol 2010;45: 29–35 [2] Antoch G, et al. JAMA 2003;290:3199-3206. [3] Schmidt GP, et al. EJR 2005;55:33-40 [4] Jacobs MA, et. al., Semin Roentgenol. 2009;111-22
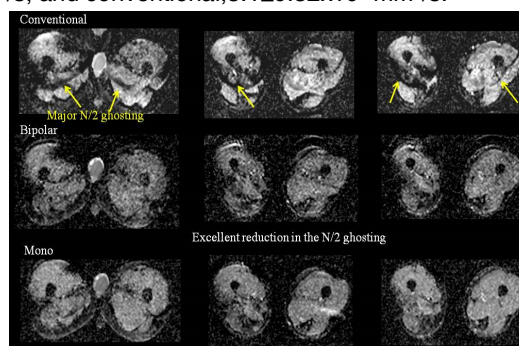
Figure 2. Examples of the DWI with ADC maps using three types of DWI sequences (monopolar and bipolar of advanced DWI and conventional bipolar DWI) in the thigh.