ECHO PLANAR DIFFUSION-WEIGHTED MRI OF THE ABDOMEN AND PELVIS: COMPARISON OF FREE-BREATHING MONOPOLAR AND BIPOLAR SPIN-ECHO SEQUENCES IN IMAGE QUALITY AND GEOMETRIC DISTORTIONS

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Introduction: Diffusion-weighted magnetic resonance imaging (DWI) exploits the random, thermally induced displacement of water molecules in biological tissue. Most DWI applications in the abdomen and pelvis employ single-shot spin-echo-planar imaging (ssEPI) due to its fast acquisition times and resultant robust performance against motion artifacts. Nevertheless, EPI-based DWI suffers from increased sensitivity to magnetic field inhomogeneities, which ensue from susceptibility differences at soft tissue interfaces and eddy currents generated by the high-amplitude diffusion-weighting gradients [1-3]. Geometric distortion results when image readout takes place in the presence of eddy currents, whereby the current-associated residual magnetic field is misread as a spatial encoding gradient field. A bipolar double spin-echo sequence with alternating polarity diffusion sensitising gradients has been employed to counteract the effect of eddy currents [4]. The purpose of this study was to compare artifacts, signal-to-noise ratios (SNR), fat suppression and apparent diffusion coefficient values (ADCs) using monopolar (conventional Stekjal and Tanner) and bipolar ssEPI-DWI on abdominal and pelvic images.

Method: Seven healthy female volunteers underwent abdominal and pelvic DWI imaging on a 1.5T scanner (Siemens Medical Solutions, Erlangen, Germany). Diffusion-weighted imaging was performed with a bipolar EPI sequence with SPAIR fat suppression (TR/TE=6300/69, 40 slices, 5mm thickness, 5 averages, 128x128 matrix interpolated to 256x256, 380mm FOV, Grappa = 2, 30 reference lines, three scan trace with all b-values using scanner software). ADC maps were generated with all b-values using scanner software. Artifacts were assessed in consensus by two radiologists using multi-planar reformatting on a 5 point-scale, ranging from 1 (excessive artifact) to 5 (no artifact). ADCs were determined by positioning five circular regions of interest (ROIs, area 0.97 cm2) with an inherent low TS, such as muscle.

Results: Both radiologists agreed that monopolar sequences (including the minimum TE technique) suffered from distortion, with a zipper-like artefact along the phase-encoding direction (Figure 1). SNR was significantly higher in monopolar compared to bipolar sequences in all tissues irrespective of b value (Tables 1-2, except kidney at b=600 s/mm2). With the reduced TE in the pelvis, SNR of the monopolar sequence continued to be better than in the corresponding bipolar sequence. FMR did not change significantly between mono- and bipolar acquisitions (for b=600, 0.87±0.08 monopolar, 0.92±0.15 bipolar; b=900, 1.17±0.11 monopolar, 1.05±0.13 bipolar; b=1050, 1.3±0.11, monopolar, 1.02±0.22 bipolar). Except for psoas muscle, ADCs were significantly higher in the bipolar dataset (Tables 1 and 2).

Discussion & Conclusion: Although the bipolar EPI-DWI exhibits a worse SNR than the monopolar technique, its relative insensitivity to geometric distortion enhances the overall image quality. Fat suppression appears to be equally effective in both techniques. ADC values demonstrate (excessive artifact) to 5 (no artifact). ADCs were determined by positioning five circular regions of interest (ROIs, area 0.97 cm2) with an inherent low TS, such as muscle.

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