Geometrical Distortion on Diffusion Weighted Imaging of Prostate: Comparison of Single-Shot Echo-Planar and Readout-Segment Echo-Planar Techniques

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Introduction: Current guidelines suggest acquisition of prostate diffusion-weighted imaging (DWI) using single-shot Echo-Planar Imaging (ssEPI) technique, which is highly susceptible to T2* blurring and geometrical distortion, most notably at higher magnetic fields.

Objective and Specific Aims: To compare the image quality between two techniques for acquiring prostate DWI: ssEPI and Readout-Segment Echo-Planar Imaging (rsEPI).

Rationale and background: As DWI is an essential part of risk assessment in multiparametric MRI (mpMRI) of prostate; improvement in the image acquisition technique is essential to decrease geometrical distortion.

Methods and materials: This single-center, HIPAA-compliant study assessed data of 69 consecutive patients who underwent 3 Tesla prostate mpMRI between January and March 2019. Non-cooperative patients and patients with history of prior pelvic surgery or radiation therapy were not included. Two radiologists, blinded to the clinical information, evaluated each MRI separately for qualitative scoring. A five-point Likert scale was used to assess the geometrical distortion on ssEPI and rsEPI as followed: 1= no perceptible artifact, 2= minimal susceptibility artifact, which did not interfere with diagnosis 3= mild susceptibility artifact, obscuring <50% of the peripheral zone, 4= moderate susceptibility artifact, obscuring >50% of the peripheral zone, and 5= severe susceptibility artifact, affecting the peripheral and transition zones. The degree of rectal gas/ rectal distention was also assessed using a five-point scale. All statistical analysis were performed using SPSSv.16 to run two-tailed Wilcoxon signed rank test to compare the rankings between two techniques and weighted Kappa test to assess inter-rater agreement.

Results: The inter-reader agreement for scoring image distortion in ssEPI and rsEPI were 0.82 and 0.78, respectively. Mean scores for image distortion were 1.71 and 1.33 in ssEPI and rsEPI techniques, respectively. A significant correlation was observed between increment in rectal distention grading and geometrical distortion on both ssEPI and rsEPI (R_s: 0.53 and 0.40, respectively, $P<0.001$). The geometrical distortion was significantly less observed in rsEPI compared to ssEPI, regardless of the rectal gas degree ($P<0.01$) and when stratified based on rectal gas scoring ($P<0.05$). Geometrical distortion scores of 3 higher were observed in nine individuals in ssEPI, with all having scores < 3 on rsEPI.

Discussion and Conclusion: rsEPI performed significantly better in producing DWI with higher image quality and less geometrical distortion compared to ssEPI. Compared to ssEPI, readout-segment EPI uses a higher bandwidth per pixel with shorter effective TE, leading to reduced T2 shine-through effect. Using rsEPI for DWI acquisition may augment or replace ssEPI on 3T prostate mpMRI.