Evaluation of the impact of computed high b-value diffusion-weighted imaging on prostate cancer detection

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Abstract

Purpose: The purpose of this study was to compare high b-value (b = 2000 s/mm(2)) acquired diffusion-weighted imaging (aDWI) with computed DWI (cDWI) obtained using four diffusion models-mono-exponential (ME), intra-voxel incoherent motion (IVIM), stretched exponential (SE), and diffusional kurtosis (DK)-with respect to lesion visibility, conspicuity, contrast, and ability to predict significant prostate cancer (PCa).

Methods: Ninety four patients underwent 3 T MRI including acquisition of b = 2000 s/mm(2) aDWI and low b-value DWI. High b = 2000 s/mm(2) cDWI was obtained using ME, IVIM, SE, and DK models. All images were scored on quality independently by three radiologists. Lesions were identified on all images and graded for lesion conspicuity. For a subset of lesions for which pathological truth was established, lesion-to-background contrast ratios (LBCRs) were computed and binomial generalized linear mixed model analysis was conducted to compare clinically significant PCa predictive capabilities of all DWI.

Results: For all readers and all models, cDWI demonstrated higher ratings for image quality and lesion conspicuity than aDWI except DK ($p < 0.001$). The LBCRs of ME, IVIM, and SE were significantly higher than LBCR of aDWI ($p < 0.001$). Receiver Operating Characteristic curves obtained from binomial generalized linear mixed model analysis demonstrated higher Area Under the Curves for ME, SE, IVIM, and aDWI compared to DK or PSAD alone in predicting significant PCa.

Conclusion: High b-value cDWI using ME, IVIM, and SE diffusion models provide better image quality, lesion conspicuity, and increased LBCR than high b-value aDWI. Using cDWI can potentially provide comparable sensitivity and specificity for detecting

significant PCa as high b-value aDWI without increased scan times and image degradation artifacts.

Keywords: Diffusional kurtosis model; High b-value diffusion-weighted imaging; IVIM model; Mono-exponential model; Prostate cancer; Stretched exponential model.