COMPUTED DIFFUSION-WEIGHTED IMAGING OF THE PROSTATE AT 3T: IMPACT ON IMAGE QUALITY AND TUMOR DETECTION

Andrew B Rosenkrantz[1], Nicole Hindman[1], Hersh Chandarana[1], Fang-ming Deng[2], James S Babb[1], Samir S Taneja[3], and Christian Geppert[4]

[1]Radiology, NYU Langone Medical Center, New York, New York, United States, [2]Pathology, NYU Langone Medical Center, New York, New York, United States, [3]Urologic Oncology, NYU Langone Medical Center, New York, New York, United States, [4]Siemens Medical Solutions MR R&D, New York, New York, United States

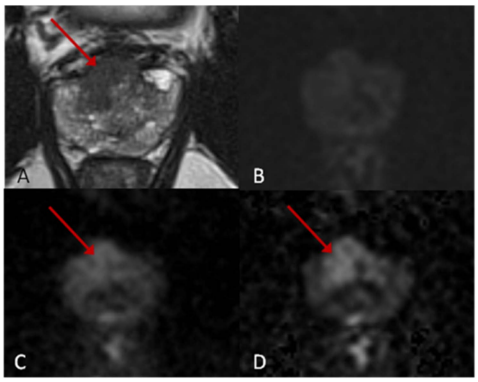
Target Audience: Radiologists and physicists involved in the performance and interpretation of prostate MRI.

Purpose: DWI is a critical technique for prostate cancer (PCa) detection and localization. While recent work has shown improved performance for tumor detection when using b-values over 1,000 sec/mm^2 given incomplete suppression of benign prostate tissue at lower b-values[1], use of very high b-values is challenged by greater distortion and decreased SNR. Computed-DWI is a newly described technique in which very high b-value images are mathematically extrapolated from the acquired lower b-value images, thereby providing high b-value images without additional scan time and potentially avoiding limitations of directly acquired high b-value images[2]. Thus, our aim was to investigate the utility of computed-DWI on image quality and tumor detection for 3T MRI of the prostate.

Methods: 49 PCa patients undergoing 3T MRI (MAGNETOM Trio, Siemens Healthcare) using pelvic phased-array coil before prostatectomy were included. Scans included SS-EPI DW with b-values 50 and 1,000 mm^2/s; ADC values from these images were used to generate computed b-1,500 images; 38 of the scans also included directly acquired b-1,500 images. A uropathologist recorded the location of the dominant tumor in all cases. Two radiologists independently scored three separate image sets (direct b-1000, direct b-1500, computed b-1500), blinded to sequence and clinical details, on a 1-5 scale (5=highest quality) for suppression of benign prostate tissue, distortion, ghosting, and overall image quality (IQ). Then, the readers recorded the location of the dominant lesion on each image set and scored that lesion's visual conspicuity and their confidence in the diagnosis (also on 1-5 scale); the readers were allowed to note if no lesion was visible. A third radiologist, aware of pathologic findings, placed ROIs to record contrast between tumors and benign peripheral zone (PZ). Image sets were compared using logistic regression, ANOVA, Wilcoxon tests, and McNemar tests.

Results: The Table shows results for all image sets. For both readers, computed b-1,500 had significantly better sensitivity for all tumors, sensitivity for high grade tumors, and PPV for tumor detection than direct b-1,000 ($p \leq 0.0.020$) and no significant difference in these parameters than direct b-1,500 ($p \geq 0.180$). Compared with direct b-1000, computed b-1,500 had significantly better confidence in diagnosis, visual tumor conspicuity, benign prostate suppression, distortion, ghosting, and overall IQ for reader 1 ($p<0.001$), and significantly better confidence in diagnosis, visual tumor conspicuity, benign prostate suppression, and distortion for reader 2 ($p \leq 0.039$). Aside from significantly better distortion and ghosting for both readers and overall IQ for reader 1 for computed b-1,500 compared with direct b-1500 ($p \leq 0.059$), there was no significant difference between direct b-1,500 and computed b-1,500 for any measure for either reader ($p \geq 0.104$). Tumor-to-PZ contrast was significantly better on computed b-1,500 than on direct b-1,000 or direct b-1,500 ($p \leq 0.001$).

Parameter	Reader	Direct b-1,000	Direct b-1,500	Computed b-1,500
Sensitivity (all tumors)	*1*	46.9%	65.8%	69.4%
	2	46.9%	60.5%	67.3%
Sensitivity (high grade tumors)	*1*	54.8%	76.9%	80.6%
	2	58.1%	69.2%	80.6%
PPV for tumor detection	*1*	59.0%	66.7%	70.8%
	2	60.5%	71.9%	78.6%
Confidence in diagnosis	*1*	3.5±0.7	4.4±0.9	4.3±0.8
	2	3.8±0.9	4.0±1.0	3.8±0.9
Conspicuity of dominant lesion	*1*	3.6±0.8	4.5±0.7	4.6±0.7
	2	3.9±0.9	4.4±1.0	4.2±1.0
Suppression of benign prostate	*1*	3.4±0.6	3.9±0.7	4.2±0.7
	2	2.9±0.9	3.3±0.9	3.5±0.8
Distortion	*1*	3.9±0.9	4.0±0.8	4.5±0.6
	2	3.7±0.8	3.7±0.7	4.0±0.8
Ghosting	*1*	4.5±0.6	4.7±0.5	4.9±0.3
	2	3.9±0.7	3.9±0.7	4.2±0.8
Overall image quality	*1*	3.7±0.7	4.1±0.7	4.5±0.7
	2	3.1±0.7	3.3±0.7	3.3±0.9
Tumor-to-PZ Contrast	-	0.22 ±0.11	0.32 ±0.10	0.37 ±0.10



Dominant Gleason 4+3 tumor in right transition zone (red arrow). *(A)* T2WI. *(B)* Direct b-1,000. *(C)* Direct b-1,500. *(D)* Computed b-1,500. Tumor is visible on direct and computed b-1,500 DWI, but not conspicuous on direct b-1,000 DWI.

Discussion: Computed DWI is a simple mathematical technique for achieving very high b-values that requires no additional acquisition time. In our study, it achieved better IQ and performance for tumor detection than direct b-1,000 images, and was comparable to computed b-1,500 images. We attribute the performance of computed DWI to its offering the improved background suppression of direct b-1,500 images without suffering from the decreased SNR and artifacts of such images.

Conclusion: For 3T prostate MRI, computed-DWI improves IQ, as well as sensitivity and PPV for tumor detection, compared with directly acquired DWI, without requiring additional scan time.

References: [1] Metens T, Miranda D, Absil J, Matos C. Eur Radiol 2012;22(3):70-9. [2] Blackledge MD, Leach MO, Collins DJ, Koh DM. Radiology 2011;261(2):573-581.