

Reduced FOV Decreases Susceptibility Artifact in Diffusion-Weighted MRI for Prostate Cancer Detection

Natalie Korn¹, John Kurhanewicz^{1,2}, Suchandrima Banerjee³, Emine Saritas⁴, and Susan Noworolski^{1,2}

¹Radiology and Biomedical Imaging, University of California, San Francisco, San Francisco, CA, United States, ²Graduate Group in Bioengineering, University of California, Berkeley, Berkeley, California, United States, ³GE Healthcare, San Francisco, California, United States, ⁴Bioengineering, University of California, Berkeley, Berkeley, California, United States

Target Audience: This research will benefit researchers and clinicians in prostate imaging.

Purpose: Diffusion-weighted imaging (DWI) increases both sensitivity and specificity in detecting prostate cancer in multiparametric MR studies¹. However, DWI images suffer from high susceptibility artifact near interfaces between air, blood, or fecal matter in the rectum, distorting the peripheral zone (PZ) of the prostate, where 70% of cancers are located. The aim of this study was to determine if the severity of visually-assessed image distortion is less in prostate ADC maps generated from a novel, reduced FOV diffusion imaging technique² (rFOV) than from a standard diffusion sequence (STD) and to determine if the ADC contrast between untreated tumors and healthy-appearing tissue within subjects is as high as or better than the standard sequence.

Methods: Twenty-seven untreated patients with biopsy-proven prostate cancer underwent 3T MRI of the prostate with a fluid-filled endorectal coil probe. STD (128x128, phase FOV factor=1, FOV=24, NEX=4) and rFOV (128x64, FOV=18-24, phase FOV factor=.5, NEX=6) sequences were acquired using a 2D single-shot EPI spin-echo with TR/TE=5000/min, b=600 and 0, and 3-4mm slices. The rFOV employs a 2D RF pulse, limiting the excitation FOV in the phase-encoding direction. This shortens the echo-train length for a given resolution, reducing off-resonance effects in the image.

The incidence and severity of distortion (changes in the contour of the prostate by the rectal wall) on the rFOV and STD ADC maps were scored 0 for no distortion, and 1-4 for increasing distortion. Regions of interest (ROIs) were placed in areas of reduced ADC which corresponded to positive biopsy findings and to radiologist-identified tumor regions (n=15) and areas of healthy PZ tissue in these patients and controls (n=25). Tumor contrast was calculated as: $[ADC_{tumor} - ADC_{healthy}] / ADC_{tumor}$.

Results: Sixteen of the twenty-seven patients scanned showed rectal wall distortion. See an example in Figure 1. Twelve of the sixteen distortion cases (75%) showed visibly-decreased distortion in the rFOV ADC map. One patient showed severe artifact due to a hip implant, which was not improved by the rFOV sequence.

Distortion scores were significantly reduced with the rFOV sequence ($p < 0.0003$, Wilcoxon signed-rank test) (Fig 2). For the fifteen patients with suspected tumor, the rFOV sequence provided significantly higher contrast between tumor and healthy tissue as shown in Table 1 ($p < 0.02$).

Discussion: The rFOV sequence yielded significantly decreased rectal wall susceptibility artifact and provided significantly higher contrast between tumor and healthy tissue. This technique shows great promise for improving DWI quality thereby potentially improving the detection and assessment of prostate cancer volume and grade.

References:

1. Turkbey, B, et al. Current Opinion in Urology; (22)4;310-315 2012
2. Saritas E.U. et al, MRM 468-473, 2008

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1. R01 CA137207
2. R01 CA148708

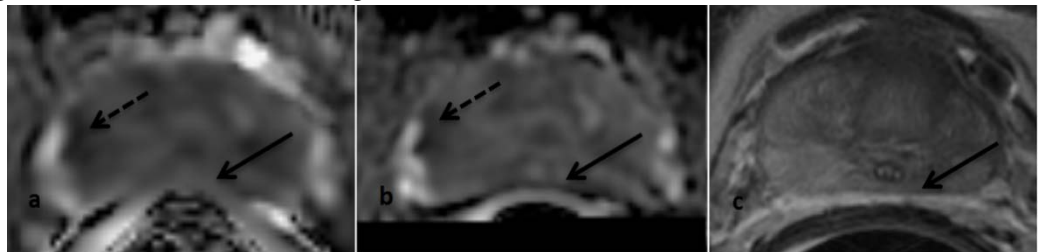


Fig. 1 Rectal wall/peripheral zone distortion (solid arrows): pronounced in (a) STD, minimal in (b) rFOV, and none on (c) T2-weighted image. Note reduced ADC in the suspected tumor region (dashed arrow) on both ADC maps.

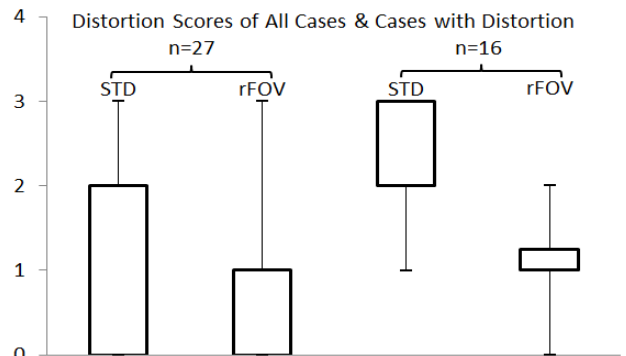


Fig 2. Observable distortion is lower in rFOV than STD for all cases, $p < 0.0003$ (left) and for cases with observable distortion, $p < 0.0001$ (right).

Sequence	Healthy (n=25)	Tumor (n=15)	Contrast (n=15)
STD	1708 ± 234	950 ± 81	-41.7 ± 0.1
rFOV	1710 ± 244	906 ± 103	-45.2 ± 0.1
Significance	$p < 0.96$	$p < 0.05$	$p < 0.02$

Table 1. Paired t-test results for ADC values [$\times 10^{-3} \text{mm}^2/\text{s}$] and contrast [%] showing significant differences between STD and rFOV.