Diffusion-weighted MRI of the prostate at 3-T: Comparison of endorectal coil (ERC) MRI and phased-array coil (PAC) MRI – The impact of SNR on ADC measurement

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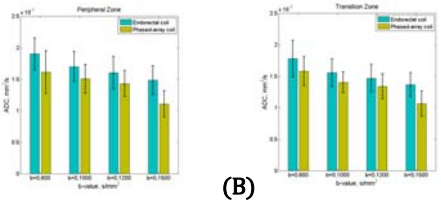
Introduction: Prior studies have found that, compared to the use of a phased-array coil (PAC) alone, the use of both an endorectal coil (ERC) and a PAC to acquire T2-weighted fast spin-echo images of the prostate at 1.5 Tesla results in greater visibility of anatomical details and more accurate prostate cancer staging (1, 2). The use of both a PAC and an ERC (a combination referred to hereafter as ERC+PAC) improves prostate imaging by providing greater signal-to-noise ratio (SNR) and thus increased spatial resolution. However, the insertion of the ERC causes patient discomfort, is expensive, and can lead to complications such as proctitis and diverticulitis (3). Recently, the availability of higher field strength magnets, increased numbers of phased-array receiver coils, and improved pulse-sequence techniques has generated interest in the possibility of performing prostate MRI using only a PAC.

Currently, DW-MRI is used in clinical practice for the detection of prostate cancer and is usually evaluated by a radiologist qualitatively or quantitatively with the help of apparent diffusion coefficient (ADC) maps. To our knowledge, no prior studies have compared ADC values obtained with a PAC alone to those obtained with an ERC and a PAC. The purpose of the present work was to compare ADC values from DW-MR images of the prostate obtained with an ERC and a PAC to ADC values from DW-MR images obtained with only a PAC at 3.0 T.

Methods: The institutional review board issued a waiver of informed consent for this HIPAA-compliant retrospective study. Twenty-five patients with biopsy-proven prostate cancer underwent standard 3-Tesla MRI using 2 different coil arrangements (ERC+PAC and PAC only) in the same session. DW-MRI at five b-values (0, 600, 1000, 1200, and 1500 s/mm^2) were acquired using both coil arrangements. On b=0 images, SNRs were measured as the ratio of the mean signal from peripheral zone (PZ) and transition zone (TZ) ROIs to the standard deviation from the mean signal in an artifact-free ROI in the rectum. Matching regions-of-interest (ROIs) were identified in the peripheral zone and transition zone on ERC-MRI and PAC-MRI. For each ROI, mean ADC values for all zero and non-zero b-value combinations were computed.

Results: Mean SNR with ERC-MRI at PZ (66.33±27.07) and TZ (32.69±12.52) was 9.27 and 5.52 times higher than with PAC-MRI ((7.32±2.30) and (6.13±1.56), respectively) ($P < 0.0001$ for both). ADCs from DW-MR images obtained with all b-values in the PZ and TZ were significantly lower with ERC-MRI than with PAC-MRI ($P < 0.001$ for all).

Conclusion: Lower SNR of DW-MR images of the prostate obtained with a PAC can significantly decrease ADC values at higher b-values compared to similar measurements obtained using the ERC. To address these requirements, clinical MR systems should have image processing capabilities which incorporate the noise distribution.



(A) (B)

Fig. 1: Comparison of mean ADC values (derived from the standard monoexponential model) between PAC and ERC, for all b-value combinations for ROI (**A**) PZ and (**B**) TZ for all patients.

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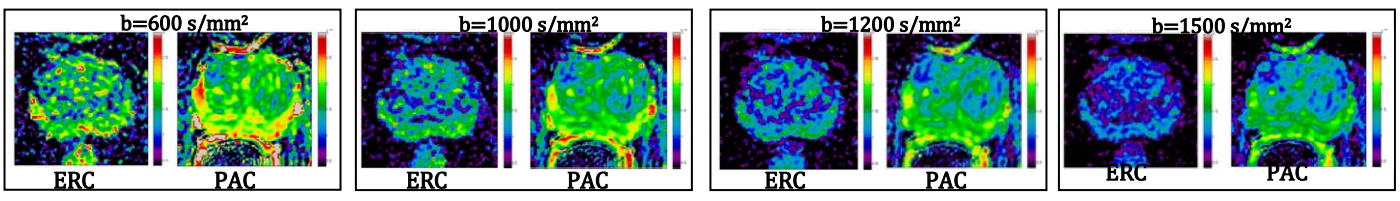

Fig. 2: Data from a 64-year-old patient, PSA level 11.5 ng/mL, clinical stage T1c, and Gleason 6. Imaging parameters: TR/TE=3500/76.8 ms, 128×128, FOV=160×160 mm^2.ADC maps obtained using, PAC and ERC. Dynamic range (min-max: 0.8×10^{-3} - 3.2×10^{-3} mm^2/s) was the same for all maps.