Title: Validation of AI-Enhanced 0.55T MRI for Quantitative Prostate Imaging: Comparison with 1.5T MRI

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Abstract

Introduction:
Multiparametric MRI is essential for prostate cancer diagnosis, surveillance, and treatment planning. Apparent diffusion coefficient (ADC) measurements are increasingly used as quantitative biomarkers for lesion characterization and assessment of tumor aggressiveness. This study evaluated minimal ADC (ADCmin) measurements obtained using an AI-enhanced 0.55T MRI system and compared them with those derived from a contemporary 1.5T MRI platform to assess the feasibility of quantitative prostate imaging at low field strength.

Methods:
To directly evaluate the effect of the MRI platform on quantitative prostate imaging, a same-day, back-to-back within-subject comparison was performed. A single subject underwent prostate MRI examinations on both an AI-enhanced Siemens Healthineers MAGNETOM Free.Max (0.55T) system and a contemporary Siemens Healthineers MAGNETOM Altea (1.5T). system within one hour, using matched imaging protocols and identical diffusion-weighted imaging b-values in B0_100_800_1400_c2000 s/mm², (B2000) as well as B50_1000 s/mm² (B1000) protocols. Qualitative image assessment was performed using PI-RADS v2.1 criteria, including evaluation of lesion conspicuity, zonal anatomy, and overall lesion categorization. Quantitative ADCmin measurements were subsequently compared between platforms to assess the consistency of diffusion-derived imaging biomarkers across field strengths. Descriptive analyses were performed to characterize ADCmin distributions on the 0.55T and 1.5T platform. Comparative analyses, including Wilcoxon signed-rank testing, percent-difference calculations, and Bland-Altman assessment, were used to contextualize observed ADCmin measurements relative to the 0.55 T and 1.5T scanner. IBM SPSS Statistics version 29.0.2.0 software was used.

Results:
Qualitative inspection of respective intra- and extraprostatic structures appeared similar between scanners. No suspicious lesions were identified on either platform, with both examinations demonstrating a PI-RADS assessment category of 1–2, indicating concordant qualitative interpretation between MRI systems. The AI-enhanced 0.55T platform demonstrated reproducible ADCmin measurements with protocol-dependent behavior. Two voxels in the

B2000 and one voxel in the B1000 protocols for the 0.55T MRI dataset demonstrated possible artifacts with low ADCmin values and were excluded from analysis; the second lowest ADCmin was used in its place. Mean ADCmin values at B1000 were similar between scanners (842.2 vs 860.5 $\mu m^2/s$; $p=0.490$), whereas B2000 acquisitions demonstrated lower ADC values on the 0.55T platform (763.5 vs 1011.0 $\mu m^2/s$; $p<0.001$). Mean percent differences increased from 3.5% at B1000 to 34.7% at B2000 ($p<0.001$). Bland-Altman analysis demonstrated minimal bias at B1000 (18.3 $\mu m^2/s$ lower on average for 0.55T) and greater systematic divergence at B2000 (247.6 $\mu m^2/s$ lower on average for 0.55T), (Figure 2). The lower ADC values observed on the AI-enhanced 0.55T platform are an expected finding and likely reflect reduced signal-to-noise ratio at high b-values, resulting in systematic ADCmin underestimation despite identical diffusion-weighting parameters. Similar field-strength-dependent ADCmin variability between 1.5T and 3T has been reported in other organs, supporting the need for platform-specific validation of quantitative prostate MRI measurements.

Conclusion :

AI-enhanced 0.55T prostate MRI demonstrated preserved anatomic visualization and good qualitative concordance with 1.5T MRI, with both platforms yielding comparable overall prostate assessment and PI-RADS categorization. Quantitative analysis likewise demonstrated strong concordance between systems; however, ADCmin measurements obtained using high b-value DWI were consistently lower on the 0.55T platform. These findings suggest that low-field ADCmin measurements may represent a distinct scanner-specific quantitative signature rather than a direct equivalent of higher-field values. As ADCmin increasingly informs lesion characterization and risk stratification, future studies should establish platform-specific ADCmin reference ranges and validate the relationship between 0.55T ADCmin measurements, histopathology, and prostate cancer grade.

Figures:

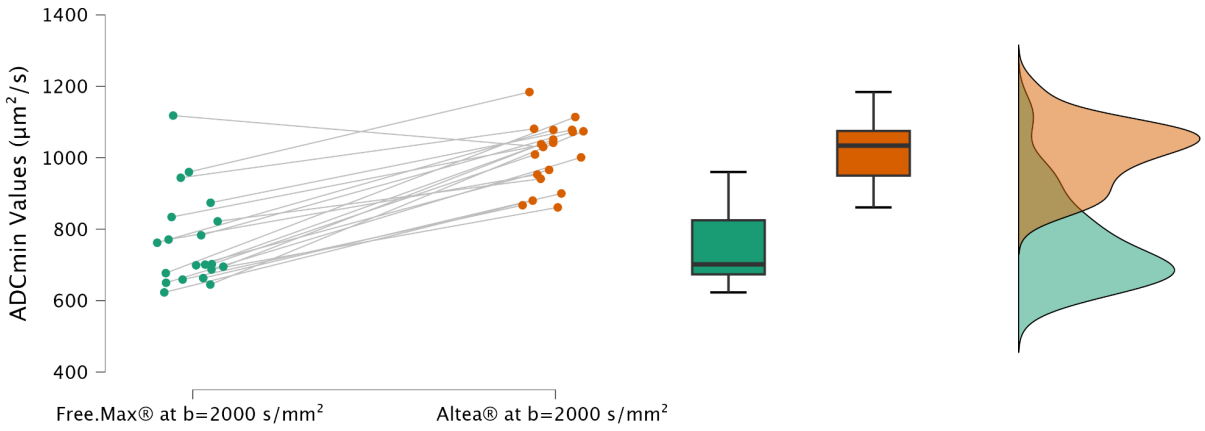

Figure 1: Comparison of ADCmin values derived from B0_100_800_1400_c2000 s/mm² Protocol: Green figures correspond to the Siemens Healthineers MAGNETOM Free.Max (0.55T) and orange figures represent the Siemens Healthineers MAGNETOM Altea (1.5T). Open Bore system.

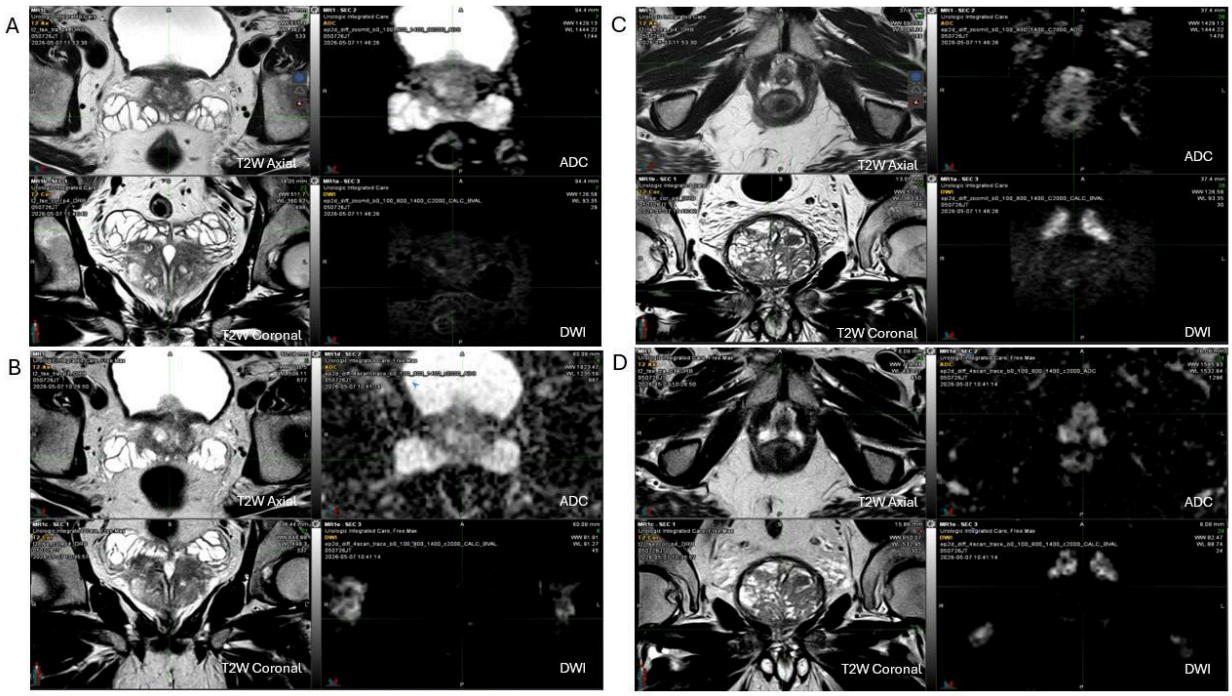

Figure 2 : Visualization of intra and extraprostatic structures in T2W Axial and Coronal views. DWI and ADCmin series displayed. A and C demonstrate Siemens Healthineers MAGNETOM Altea (1.5T) imaging and B and D demonstrate Siemens Healthineers MAGNETOM Free.Max (0.55T) imaging with series including T2W Axial, T2W Coronal, ADC and DWI.

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