ARTIFICIAL INTELLIGENCE FOR AUTOMATED SEGMENTATION OF PROSTATE CANCER AND PELVIC ANATOMY

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BACKGROUND, INTRODUCTION, AND AIMS: A reliable distinction of anatomy within and adjacent to the prostate is critical for diagnosing and treating prostate cancer (PCa). Manual localization of pelvic anatomy and PCa is tedious, subjective, and often inaccurate due to variability in prostate MRI scans. Hence, we developed artificial intelligence (AI) models to segment pelvic anatomy and cancer automatically and effectively.

METHODS AND MATERIALS: AI-based PCa region of interest (ROI) and pelvic anatomy segmentation was performed using a nnUNet architecture. The PCa ROI segmentation model was trained using 1500 mpMRI cases (obtained from the 2022 "PI-CAI" challenge) and their corresponding AI-predicted zonal anatomy labels as inputs. All PCa ROI labels had a PI-RADS score ≥ 4. Four additional AI models were trained individually using 912, 89, 833, and 332 T2W MRI cases for automated segmentation of prostate zones, pelvic bone, urethra, and other structures, respectively. Prostate zones consisted of the peripheral zone (PZ), central zone (CZ), and anterior fibromuscular stroma (AFS). Other structures included the rectum, bladder, and seminal vesicles (SV). Training labels for pelvic anatomy were manually defined using ITK-SNAP and 3D Slicer. All models were trained using 5-fold cross-validation and independently tested on 25 "Prostate158" challenge cases. ROI, PZ, and CZ test set labels were derived from Prostate158, and all others were manually generated by three imaging scientists. Another senior imaging scientist reviewed all test data.

RESULTS: AI models achieved DICE score and max Hausdorff distance (mm) means of [84%, 2.5] for PZ, [91%, 3.0] for CZ, [63%, 3.4] for AFS, [97%, 2.0] for bladder, [99%, 0.2] for bone, [96%, 3.8] for rectum, and [77%, 4.4] for SV. Mean and max centroid distances (CD, mm) for urethra segmentation were 1.92 and 7.42. Lastly, the AI model segmented PCa ROIs with an AUC of 0.83 and 42% average precision.

DISCUSSION AND CONCLUSION: AI can accurately and automatically segment pelvic anatomy and prostate cancer, potentially streamlining prostate cancer management. Among many potential applications, this could improve cancer diagnostic accuracy and help clinicians avoid damage to critical structures during interventions.

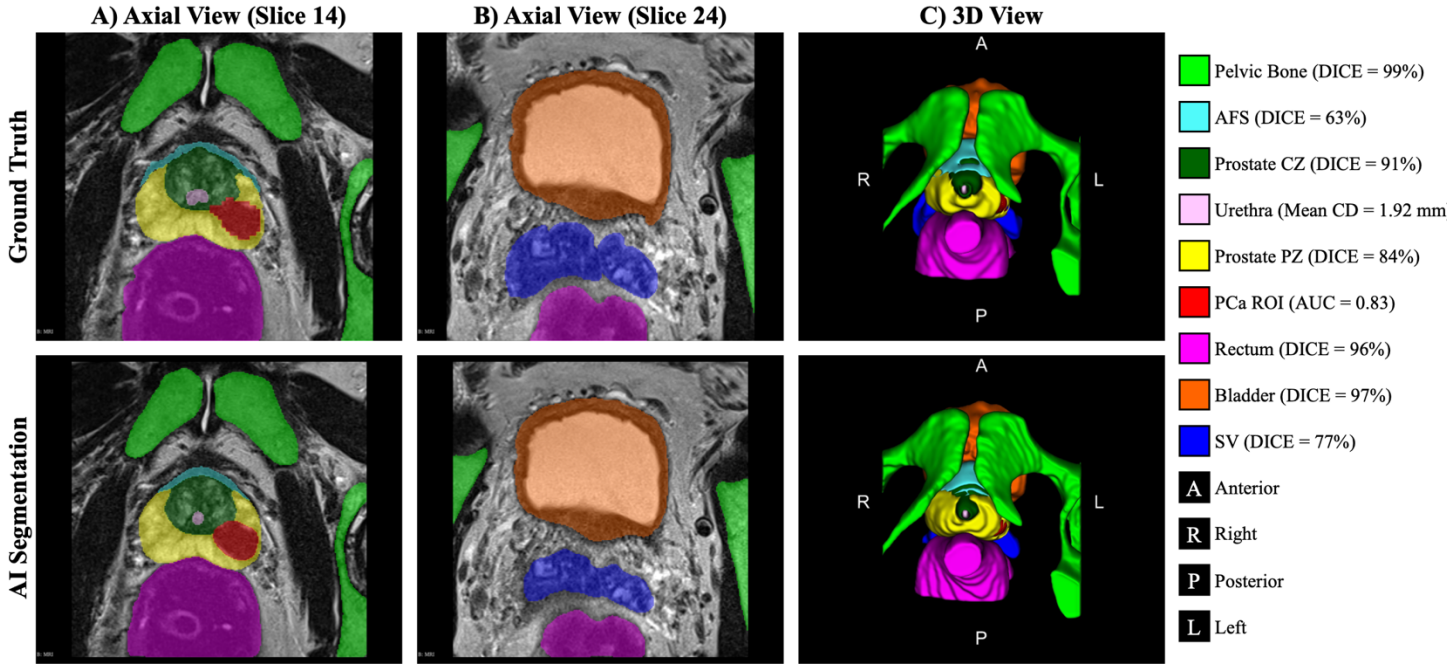

Figure: Exemplary image (test case 11) showing AI performance for automated segmentation of PCa and pelvic anatomy (prostate zones, pelvic bone, urethra, rectum, bladder, and SV) compared to ground truth.

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