TUMOR SIZE ESTIMATION USING AN ARTIFICIAL INTELLIGENCE PROSTATE CANCER MAPPING ALGORITHM

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Introduction and Background: Accurate estimation of prostate cancer tumor size is critical for assessing risk and selecting treatment strategies. Since conventional clinical and imaging estimates are weakly correlated with tumor size, an artificial intelligence (AI) model was used to map clinically significant prostate cancer (csPCa, i.e. Gleason grade group ≥ 2) risk in 3D and estimate tumor volume.

Specific Aims: Compare AI to conventional methodology for prediction of tumor volume.

Methods and Materials: Cases with at least one csPCa-bearing MRI-visible lesion and no ablative treatment prior to prostatectomy were retrospectively selected for study inclusion. Whole mount (WM) pathology slides were registered to preoperative MRI, and pathologist-defined csPCa contours were interpolated to define ground-truth tumor volume (Fig B,D). MRI and simulated biopsy was then used to generate a 3D cancer map (Fig A,C) for each case using AI software (Unfold AI, K221624). The sum of estimated csPCa probability for voxels throughout the prostate was correlated to WM tumor volume using linear regression. For comparison, 6 conventional metrics derived from prostate serum antigen (PSA), biopsy results, and PI-RADS regions of interest (ROIs) were likewise correlated to tumor volume. The accuracies of linear regression fits were compared using Wilcoxon signed-rank tests with $\alpha = 0.05$.

Results: 97 patients met study eligibility criteria. AI cancer maps were strongly correlated to WM tumor volume with $R^2 = 0.81$ (Fig E). Using a linear regression model to predict tumor volume, all conventional metrics were significantly less accurate than AI including: PSA ($R^2 = 0.27$, $p < 0.001$), PSA density ($R^2 = 0.26$, $p < 0.001$), number of csPCa-positive cores ($R^2 = 0.57$, $p < 0.001$), maximum csPCa core length ($R^2 = 0.51$, $p < 0.001$), total length of csPCa in all cores ($R^2 = 0.69$, $p = 0.005$), and PI-RADS ROI volume ($R^2 = 0.33$, $p < 0.001$).

Discussion and Conclusion: AI was highly predictive of tumor volume, outperforming conventional clinical measures. More accurate tumor volume assessments may improve risk assessment and treatment strategy selection, particularly when defining margins for focal ablation or radiation dosing. This promising technique warrants further study, with the potential to improve prostate cancer management and treatment outcomes.

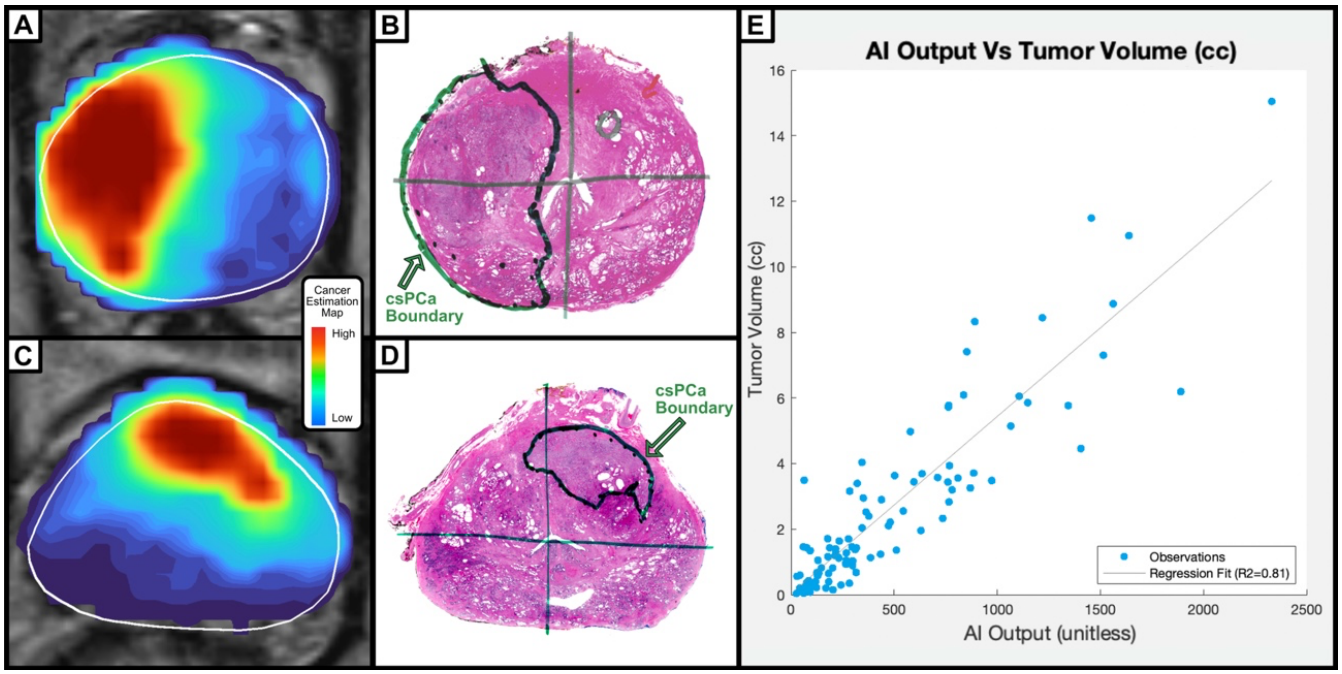

Figure: (A,C) Cancer estimation maps and (B,D) Ground-truth whole mount histopathology slides for a large tumor (top row) and a smaller tumor (bottom row). (E) plots the correlation between AI model output (the sum of estimated cancer probability in voxels throughout the prostate) and ground-truth tumor volume, $R^2 = 0.81$