Correlation of architectural patterns of prostate cancer histology with multiparametric MRI appearance

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Background: Pathologic growth patterns, such as cribriform and stromogenic carcinomas, have implications for prostate cancer (PCa) prognosis beyond Gleason grading. Multiparametric magnetic resonance imaging (mpMRI) is an attractive tool for non-invasive detection and characterization of PCa; however, preliminary work suggests some aggressive histologic patterns may be particularly difficult to visualize on mpMRI. The goal of this work is to investigate the association of architectural patterns on histology with mpMRI appearance.

Methods: PCa patients underwent prostate mpMRI (T2W, DWI, DCE MRI) with endorectal coil followed by robotic-assisted radical prostatectomy at a single institution. Whole-mount prostate specimens were processed with patient-specific MRI-based 3D-printed molds for optimal image-pathology correlation. Suspicious lesions were prospectively identified at mpMRI by an experienced genitourinary radiologist blinded to pathology. Histologic patterns were manually annotated by an experienced genitourinary pathologist blinded to imaging. Twenty-one previously described patterns[‡] representing reactive stroma, cribriform (including expansile, large, and small caliber), expansile sheets, single cells, patterns of early intraluminal complexity, mucin rupture patterns, and well-formed glands of varying sizes were identified on digital pathology. Patterns were characterized by incidence and proportion (%) contained within regions correlating to imaging findings.

Results: In a preliminary cohort of 7 patients, 12/14 lesions prospectively identified on mpMRI were positively correlated to 8 regions of PCa on pathology (MRI+). Four cases harbored additional regions of PCa that did not correlate with imaging findings (MRI-). In total, 2835 patterns were annotated on digital pathology, with 20% representing various cribriform patterns identified in 6/7 patients. Small gland cribriform patterns were identified in 7/8 MRI+ regions compared to 2/4 MRI- regions, notably at a higher proportion (average proportion 16% vs 4%) within each region. Conversely, expansile cribriform and large caliber glands with complex intraluminal papillae were each observed at a higher proportion within MRI- regions (average proportion 44% and 33%) compared to MRI+ regions (average proportion 10% and 1%). Reactive stromal patterns were observed in one patient (MRI+).

Conclusions: Variations in architectural patterns of PCa histology could influence prospective visibility/detection on mpMRI. Reproducibility of these high-level histologic patterns of prostate cancer will be critical for accurate prognostication. This preliminary work is part of an ongoing study to develop machine learning approaches for identification and characterization of histologic sub-patterns of prostate cancer on digital pathology.

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