

Detection and localization of unfavorable-histology prostate cancer using MRI and whole-mount histopathology

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ABSTRACT

Background. Detecting localized prostate cancer (PC) with metastatic potential—defined as unfavorable-histology PC (uhPC: Grade Group [GG] ≥ 3 or GG2 with cribriform/intraductal features)—is critical for guiding appropriate intervention. We evaluate the utility of Prostate Imaging Reporting Data System (PI-RADS) and automated Restriction Spectrum Imaging restriction score (RSIs; biophysics-based quantitative MRI biomarker) for uhPC detection and localization.

Methods. We evaluated patient-level detection of uhPC in a multi-center cohort with biopsy as reference, and lesion-level localization in a separate cohort with whole-mount histopathology [WMHP] from radical prostatectomy (Figure 1). Area under the Receiver Operating Characteristic curve (AUC) was calculated to compare patient-level detection of uhPC with PI-RADS and RSIs. PI-RADS and RSIs were used to evaluate sensitivity for the most aggressive tumor within the prostate (index tumor) and all uhPC tumors in WMHP.

Results. Patient-level detection of uhPC did not differ significantly between PI-RADS and RSI in 1,022 patients from five centers ($p=0.13$). At the lesion-level ($n=103$ patients, Figure 2), sensitivity for the index tumor was: PI-RADS=87% [79-94], RSIs=85% [78-93], and 93% [86-98] with both combined. For all uhPC tumors, sensitivity was: PI-RADS=81% [73-90], RSIs=86% [78-93], and 90% [82-97] with both combined. A limitation in lesion-level analyses is that only patients who opted for surgery could be included.

Conclusions. MRI demonstrated high detection of uhPC, reinforcing its value in identifying biologically aggressive disease. Both PI-RADS and automated RSIs are useful for targeted biopsy and tumor-focused treatment, such as focal radiation dose escalation to aggressive intraprostatic lesions.

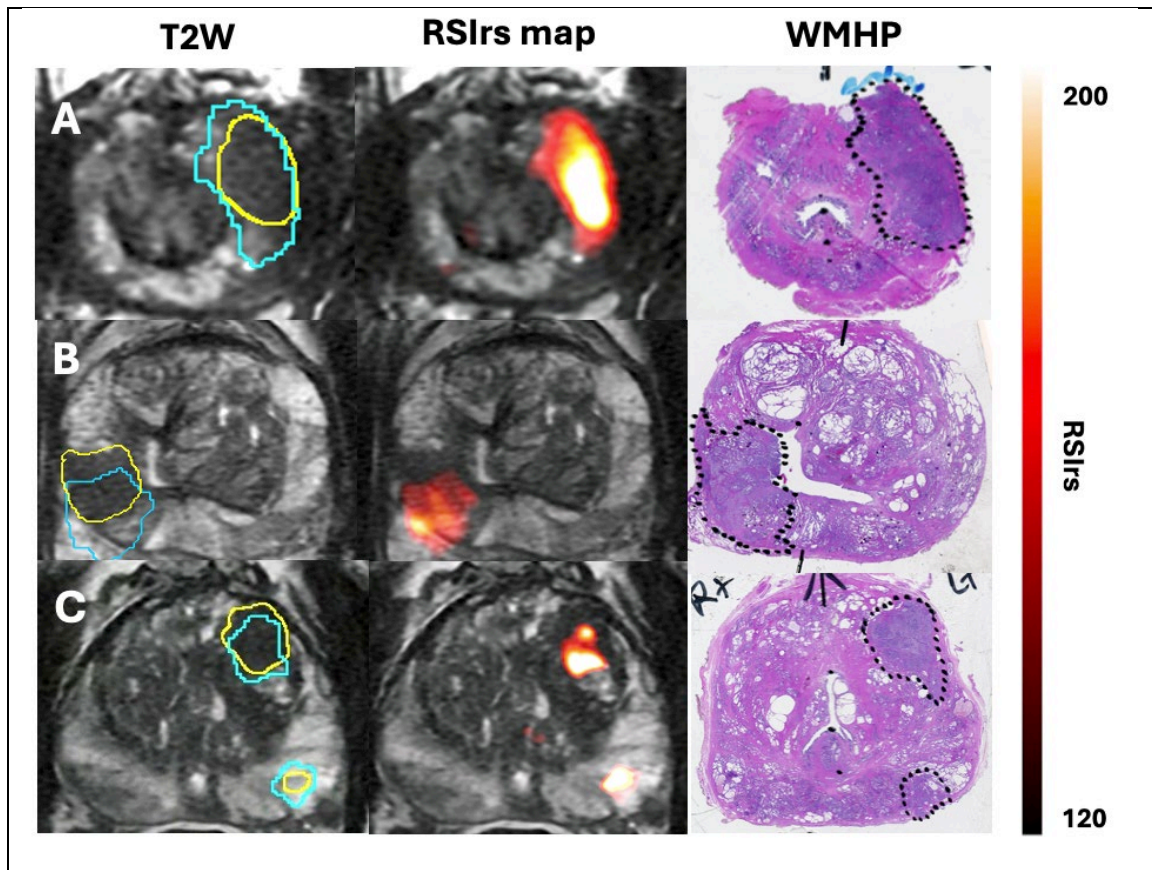


Figure 1. Axial images of anatomical T2-weighted (T2W) MRI and Restriction Spectrum Imaging restriction score (RSIrs) maps overlaid on the T2W images, as well as whole-mount histopathology (WMHP) slices from three patients that underwent radical prostatectomy as treatment for prostate cancer. Patients A and B had Grade Group (GG) 3 disease on WMHP, while patient C had a GG 3 tumor (left anterior) and a GG 4 tumor (left posterior). The axial MRI images show the automated RSI lesions in blue (the most suspicious lesions derived from the RSIrs maps) and the PI-RADS lesions in yellow, which were delineated by an expert radiologist blinded to the clinical history of the patient.

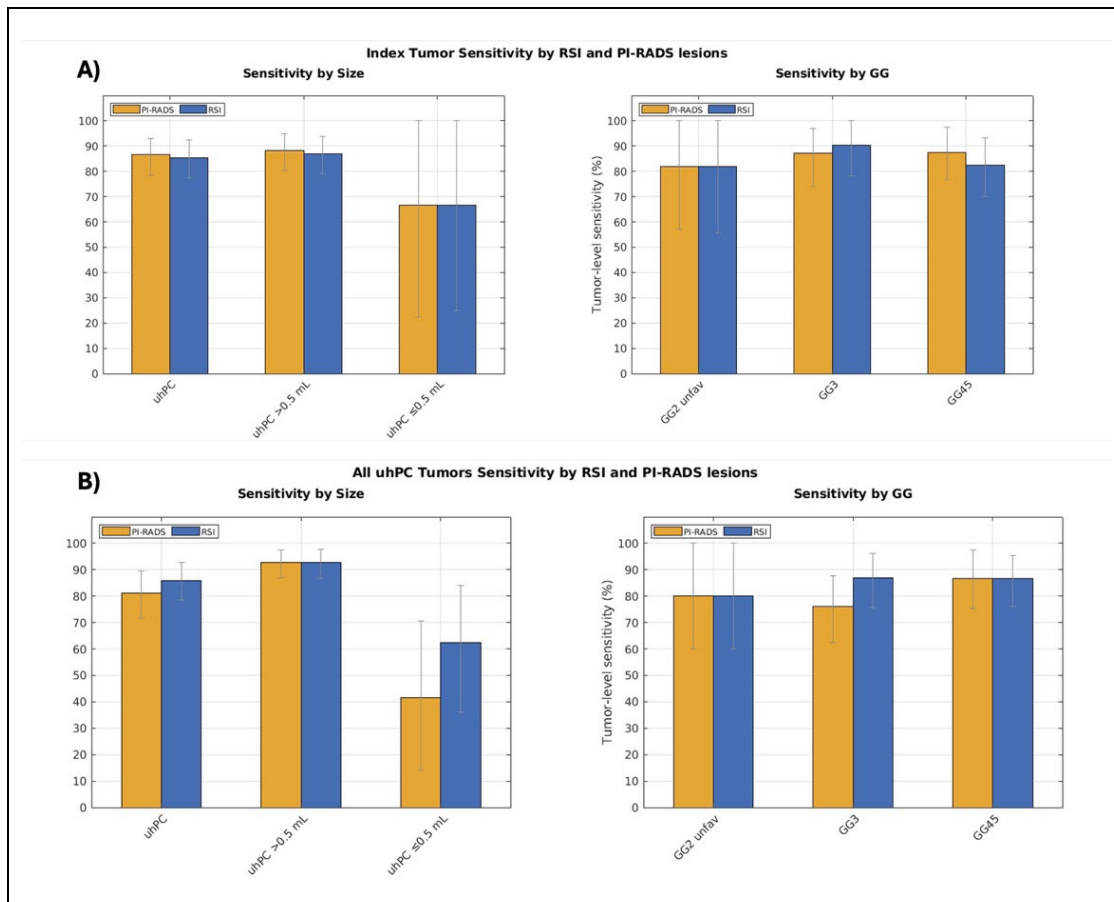


Figure 2. Lesion-level sensitivity for detection of the index tumor and all unfavorable histology prostate cancer (uhPC) tumors in the prostate in the whole-mount histopathology cohort. Detection performance was evaluated both by Grade Group (GG) and by tumor size (tumors >0.5ml vs tumors ≤0.5ml). Small tumors were missed more often than larger tumors, both with PI-RADS and Restriction Spectrum Imaging (RSI), suggesting that tumor size is an important factor for detection of uhPC on MRI.

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Conflicts of Interest Disclosure Statement

Dr. Tyler Seibert reports honoraria or consulting fees from Varian Medical Systems, WebMD, MJH Life Sciences, MD Education USA, GE Healthcare, Blue Earth Diagnostics, Janssen, CorTechs Labs, and MyOme. He has stock options in CorTechs Labs, MyOme, and Open Medicine for serving on their scientific advisory boards. He receives research funding and/or in-kind research support from GE Healthcare, Blue Earth Diagnostics, Quibim, AIRA Matrix, Veracyte, and Lantheus, all through the University of California San Diego. These companies might potentially benefit from the research results. The terms of this arrangement have been reviewed and approved by the University of California San Diego in accordance with its conflict-of-interest policies. Dr. Anders Dale is a Founding Director and holds equity in CorTechs Labs, Inc. (DBA Cortechs.ai), Precision Pro, Inc., and Precision Health and Wellness, Inc. AMD is the President and a Board of Trustees member of the J. Craig Venter Institute (JCVI). He is a Professor II at Oslo University in Norway. Dr. Rebecca Rakow-Penner receives research funding from GE Healthcare. She is also a consultant for GE and Imagination Biosystems. She is a shareholder in Cortechs. She receives Honoraria from Efficiency Learning Systems. She serves on the Scientific Advisory Board for Imagine Scientific. Dr. Michael Liss is the founder of Oncobiomix. Dr. Sean Woolen has paid grants to institution from Siemens Healthineers. Dr. Jeff Simko owns stock in Alpenglow biosciences, Triopsy Medical and Protean Biosciences. Advisory board for astra-zeneca.