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Abdominal Imaging / Imagerie abdominale

Outcomes of Magnetic Resonance Imaging−Ultrasound Fusion Prostate Biopsy of PI-RADS 3, 4, and 5 Lesions

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Prostate cancer is the second most common cancer in men worldwide [1], and is the fifth leading cause of cancer death in men with 307,500 deaths in 2012 [1]. Approximately two-thirds of prostate cancer cases are disproportionately diagnosed in the developed world, largely due to prostate cancer screening practices [1]. However, some detected cancers are so low grade and slow growing that they are unlikely to affect the individual in his lifetime [2]. Treatment with radical prostatectomy, brachytherapy, or external bean radiotherapy carries risks including erectile dysfunction and urinary incontinence [2]. Differentiation of high-risk disease from indolent tumours can avoid unnecessary aggressive treatment for early stage screening-detected prostate cancers. Prostate cancer management should therefore be directed to the detection and treatment of clinically significant prostate cancer, to reduce mortality rates, while avoiding over-diagnosis and overtreatment.

The current widely accepted best means of detecting prostate cancer is the nontargeted or systematic transrectal ultrasound (TRUS) biopsy; however, this has a false negative rate of 10%-20% [2], particularly for lesions in the anterior gland, transition zone (TZ), and apex, which are likely to be undersampled. Furthermore, following radical prostatectomy, 30%-45% of patients are upgraded on final pathology to higher-grade tumours compared with their initial diagnoses by nontargeted TRUS [3]. Multiparametric prostate magnetic resonance (MRI) imaging has been shown to be effective in the detection of clinically significant prostate cancer, with improved sensitivity compared with systematic TRUS [4] and comparable results to template prostate mapping biopsies [5]. The multiparametric MRI Prostate Imaging-Reporting and Data System (PI-RADS) was introduced in 2012 [6] to standardize prostate MRI reporting across institutions and reduce the ambiguity of results amongst radiologists and urologists. These guidelines were revised and updated by a steering committee in 2014, with the release of PI-RADS version 2 [7]. A final PI-RADS score is assigned to reflect the likelihood of clinically significant cancer ranging from PI-RADS category 1 (clinically significant cancer is highly unlikely to be present) to category 5 (clinically significant cancer is highly likely to be present) [7], as detailed in Figure 1.

PI-RADS lesions can be targeted with MRI-US fusion biopsy or in-bore MRI biopsy for more accurate histological evaluation of the gland, with the overall aim of more appropriately directed prostate carcinoma management. MRI-TRUS fusion biopsy involves digital fusion of a previously performed multiparametric MRI with real-time TRUS scanning, allowing the user to biopsy MRI-detected target lesions that are often occult on TRUS. Although PI-RADS 4 and 5 lesions typically proceed for tissue diagnosis due to the high carcinoma likelihood, the decision tree

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Peripheral zone: **DWI** primary determining sequence		**Overall PI-RADS score**		**Transition zone:** **T2** primary determining sequence
No abnormality on ADC/high b-value DWI	→	**1** CSC highly unlikely	←	Homogenous intermediate signal intensity
Indistinct hypointensity on ADC	→	**2** CSC unlikely	←	Circumscribed hypointense/heterogenous encapsulated nodule(s) (BPH)
Focal mild/moderate ADC hypointensity & iso/mildly hyperintense on high b-value DWI	→ upgrade to **4** with positive DCE*	**3** equivocal for CSC	← upgrade to **4** with DWI score5	Heterogenous signal intensity with obscured margins.
Focal marked ADC hypointensity & markedly hyperintense on high b-value DWI	→	**4** CSC likely	←	Lenticular or non circumscribed/ homogenous moderate hypointensity
Same as (4) but ≥ 1.5cm or EPE/invasive behavior	→	**5** CSC highly likely	←	Same as (4) but ≥ 1.5cm or EPE/invasive behavior
***Positive DCE:** focal early or contemporaneous enhancement, compared with adjacent normal prostatic tissue.				

Figure 1. Summary of Prostate Imaging-Reporting and Data System (PI-RADS) version 2 scoring system, adapted from PI-RADS version 2 document from the American College of Radiology [7]. ADC = apparent diffusion coefficient; CSC = clinically significant carcinoma; DCE = dynamic contrast enhancement; DWI = diffusion-weighted imaging; EPE = extraprostatic extension.

involving category 3 lesions, which are equivocal for the presence of clinically significant carcinoma, is less clear. This study examines the characteristics and histological outcomes of biopsied lesions to assess the performance of the PI-RADS system at our institution, with an aim to direct future use, particularly regarding the management of equivocal PI-RADS 3 lesions.

Materials and Methods

Our institutional review board approved this retrospective study, with the requirement for written informed consent waived. Between January 2015 (time of incorporation of PI-RADS version 2 as the standard for reporting at our institution) and June 2016 (endpoint of available data at the time of data collection) all MRI-US prostate fusion biopsies were reviewed. Men with prior focal therapy or imaging which did not meet the PI-RADS version 2 technical standards were excluded. For those with multiple biopsied lesions that were PI-RADS category 3 or greater, each lesion was included in the study.

Multiparametric MRI studies were performed using pelvic phased array coils on 1.5T (144 of 194; 74.2%) or 3.0T (50 of 194; 25.8%) MRI systems, without the use of an endorectal coil. Sequences included axial, sagittal, and coronal T2-weighted images encompassing the entire prostate gland and seminal vesicles; axial diffusion-weighted imaging (DWI) with b strengths of 50, 500, 1000, and 1500 along with the corresponding apparent diffusion coefficient map; axial T1 images of the entire pelvis; and axial dynamic contrast enhanced (DCE) images with Gadovist (Bayer Healthcare Pharmaceuticals, Montville, NJ) along with subtraction images.

All images were interpreted according to PI-RADS version 2 by subspecialized abdominal radiologists, with experience in prostate MRI interpretation ranging between 2-15 years. MRI findings were again reviewed before performing fusion biopsy, with the documentation of a PI-RADS score for each sequence, dichotomous DCE result (positive or negative), and the overall PI-RADS score. External referrals were discussed at the monthly multidisciplinary prostate rounds, where consensus decisions were made regarding lesions requiring biopsy. Transrectal fusion biopsies were obtained via an MRI-TRUS