MRI: Prostate, PI-RADS v2.1

Image quality in the multicenter setting can be greatly influenced by variances in acquisition protocols. These variances may be related not only to equipment manufacturer and model, but also technique.

The study may permit imaging per institutional standard-of-care. However, aligning image acquisition to established standards is essential for robust quality data.

Prostate MRI exams should be acquired on a 1.5T or 3.0T MRI scanner. *3T imaging is preferred*.

With some 1.5T MRI systems, especially older ones, use of an endorectal coil (ERC) is considered indispensable for achieving the high-resolution diagnostic quality imaging needed to stage prostate cancer.

The patient should evacuate the rectum, if possible, just prior to the MRI exam.

Prostate MRI acquisition protocols should always be tailored to specific patients, clinical questions, management options, and MRI equipment.

The tables below are provided as a guideline and overview for MRI Prostate exams. Please refer to your site's specific MRI manufacturer's imaging protocols for the optimal scanning protocol.
The Prostate MRI examination should be acquired according to the PIRADSv2.1 standard. The exam should contain, at a minimum, the following series:

Pre-Contrast

1. 3-plane localization scan
2. T1-weighted sequence
3. T2-weighted sequence
4. Diffusion weighted sequence
5. Generated ADC map from DWIs

Post-Contrast

6. Dynamic Contrast-enhanced T1-weighted sequence

Exam and Patient Preparation

Magnet Strength	1.5T or 3T	Low-field magnets are not acceptable
Coil	Phased Array Coil Endorectal Coil (ERC) as necessary	ERC as needed, particularly at 1.5T
FOV	Smallest FOV that encompasses the prostate gland and seminal vesicles	For all sequences
Patient Position	Supine	
Contrast Injection	Dual-chamber power injector recommended Contrast Bolus = 0.1 mmol/kg Bolus Rate = 2–3 mL/s Saline Flush = 20 mL	Insertion of intravenous catheter in upper extremity prior to the start of contrast imaging.
Slice Plane	Axial [Plus orthogonal plane(s) for T2w]	May be oblique to match long axis of prostate.

Additional Considerations	Antispasmodic agent may be administered to reduce motion artifacts. Patient should evacuate rectum just prior to the MRI exam	Diminishes bowel peristalsis and improves quality of imaging. Reduces DWI artifact, can facilitate use of ERC.

Image Acquisition and Map Generation

Localization Scan	3-plane localization scan	
T1-Weighted (T1w) Sequence	Per site's standard acquisition parameters	Performed prior to contrast
Pre-Contrast T2-Weighted (T2w) Sequence	Slice thickness = 3.0 mm FOV = 120–200 mm Resolution ≤ 0.7 mm (phase) ≤ 0.4 mm (frequency) Gap = 0 mm	Typical pulse sequences are 2D RARE, e.g., FSE or TSE. To avoid blurring, excessive echo train lengths should be avoided. T2w images should always be obtained in the axial plane (either straight axial to the patient or in an oblique axial plane matching the long axis of the prostate) and a minimum of one additional orthogonal plane (i.e., sagittal and/or coronal).
Pre-Contrast Diffusion-Weighted Imaging (DWI) with ADC mapping	Slice thickness ≤ 4.0 mm Gap = 0 mm TR ≥ 3000 ms TE ≤ 90 ms Resolution ≤ 2.5 mm phase and frequency *b*-values minimum 2 **see ADC Maps**	DWI image set must include a *b*-value ≥1400 s/mm^2. This can be calculated from other *b*-values (and resultant ADC map) or physically acquired.
ADC Maps	<u>Generated from DWIs at multiple *b*-values</u> For only 2 *b*-values: Low *b* = 0–100 s/mm^2 (Preferred low *b* = 50–100 s/mm^2) Intermediate *b* = 800–1000 s/mm^2 For all ADC maps: Max *b* ≥ 1000 s/mm^2	For ADC maps, if only two *b*-values can be acquired due to time or scanner constraints, use one low *b*=0–100 s/mm^2 (preferably 50–100 s/mm^2) and one intermediate *b*=800–1000 s/mm^2. A high *b*-value (≥1400 s/mm^2) image set is also mandatory and preferably should be obtained from a separate acquisition or calculated from the low and intermediate *b*-value images. To calculate ADC, use *b*≤1000 s/mm^2 to avoid diffusion kurtosis effect that have been described at higher *b*-values. An acquired *b*≥1400 s/mm^2 should **not** be used to generate ADC maps.

Dynamic Contrast Enhanced (DCE) T1-Weighted (2D or 3D technique)	Slice thickness = 3.0 mm FOV = 120–200 mm Resolution ≤ 2.0 mm phase and frequency Gap = 0 mm TR < 100 ms TE < 5 ms Temporal Resolution ≤ 15 s Observation Time ≥ 120 s	FOV should encompass the entire prostate gland and seminal vesicles. While both 2D or 3D T1w gradient echo (GRE) sequences have been described in the literature, 3D T1w GRE is generally available using modern systems and is preferred. Scan should be carried out for several minutes and temporal resolution should be ≤15 seconds per acquisition to depict focal early enhancement.

References

1. ACR–SAR–SPR Practice Parameter for the Performance of Magnetic Resonance Imaging (MRI) of the Soft-Tissue Components of the Pelvis, Res. 4 – 2015. https://www.acr.org/-/media/ACR/Files/Practice-Parameters/MR-SoftTissue-Pel.pdf, accessed March 26, 2021
2. PI-RADS: Prostate Imaging– Reporting and Data Systems, v2.1, 2019. https://www.acr.org/-/media/ACR/Files/RADS/PI-RADS/PIRADS-V2-1.pdf, accessed June 10, 2021.