Revisions in PI-RADS v2.1

Major Revisions in PI-RADS v2.1

- Image Data Acquisition: Technical Specifications
  - T2WI: recommended to perform in axial plane and at least one additional plane
  - DWI: clarification of b-values to use for purposes of DWI acquisition and for ADC map calculation
  - DCE: Temporal resolution ≤15 seconds is advised. 3D T1W GRE is preferred.
- Clarifications in Interpretation Criteria
  - Further description of assessment of lesions in CZ and AFMS
  - Revision in criteria for T2WI scores of 1 and 2 in TZ
  - Revision in determination of overall assessment category in TZ
  - Revisions in criteria for DWI scores of 2 and 3
  - Clarification of the distinction between positive and negative enhancement on DCE
  - Clarification in measurement of the prostate volume
  - Revision to sector map.
- Biparametric MRI
  - Discussion of the role of DCE-MRI and the implications of bpMRI for PI-RADS assessment categories

Learning Objectives

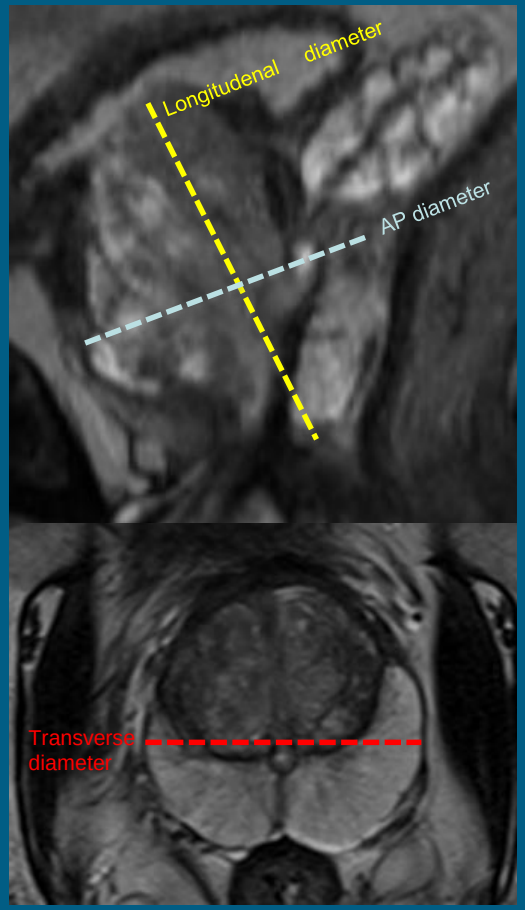
- To explain the motivation for changes introduced into the PI-RADS v2.1 system
- To summarize the changes made and how they are anticipated to improve the consistency of usage of mpMRI for planning MR-guided biopsy

PI-RADS v2.1 what's new

- Plane of T2W images
- DWI b-value uses & DCE temporal resolution
- DWI & DCE interpretations (including bpMRI statement)
- Special considerations: AFMS and CZ lesions
- Transition zone assessments for category 2 lesions including background assessments
- Other changes: sector map and prostate volume measurements

Image Acquisition: T2WI

- Axial plane (either straight axial to the patient or in an oblique axial perpendicular to the long axis of the prostate)
- At least one additional orthogonal plane (sagittal and/or coronal)



Prostate Volume Measurement

Ellipsoid formulation:

Maximum AP and longitudinal diameters on a mid-sagittal T2W image if obtained

Maximum transverse diameter on an axial T2W image

Image Acquisition: DWI

- ADC map calculation should be performed using a ***low b-value set at 0-100 sec/mm²*** (with preference for 50-100 sec/mm²), an ***intermediate b-value set at 800-1000 sec/mm²***, and optionally additional b-values in the range of 100-1000 sec/mm².

- ***A high b-value (≥1,400 sec/mm²) image set is also mandatory***

  (preferably should be obtained from a separate acquisition rather than from the above mentioned sequence (used for ADC map calculation), or calculated from the low and intermediate b-value images)

Image Acquisition: DCE

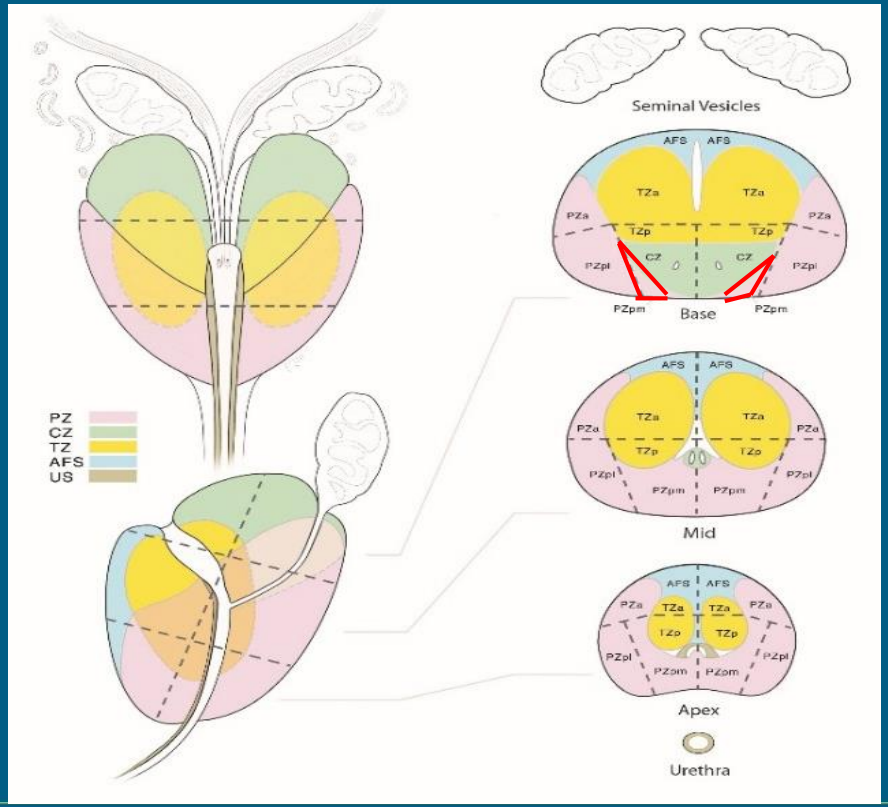
- Temporal resolution ≤15 seconds is advised.
- *3D T1W GRE is preferred.*

Image Interpretation: Anatomy

- Special considerations:
  - Central zone
  - Anterior Fibromuscular Stroma

- Asymmetry on T2WI, high b-value image, or ADC, as well as focal early enhancement, may help differentiate tumors from benign anatomy

Revisions in the Sector Map



*Two additional sectors added for the **right and left posterior medial PZ (PZpm) at the base***

Now 41 sectors total (38 prostate, 2 SV, 1 membranous urethra)

The prostate sector diagram was modified by David A. Rini, MFA, CMI, FAMI, Associate Professor in the Department of Art as Applied to Medicine at the Johns Hopkins University, based on previously published figures by Villers et al. (Curr Opin Urol 2009;19:274–82) and Dickinson et al. (Eur Urol 2011;59:477–94) with anatomical correlation to the normal histology of the prostate by McNeal JE (Am J Surg Pathol 1988 Aug;12:619–33).

Image Interpretation: DWI

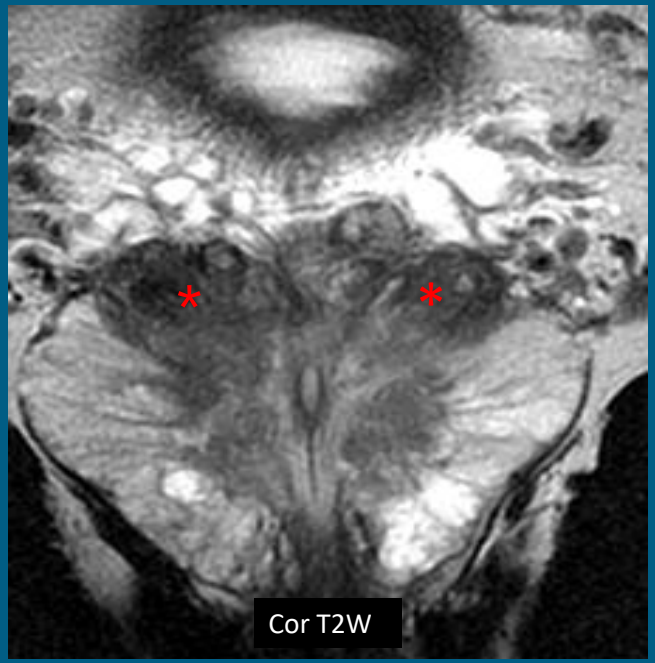
PI-RADS 2.0

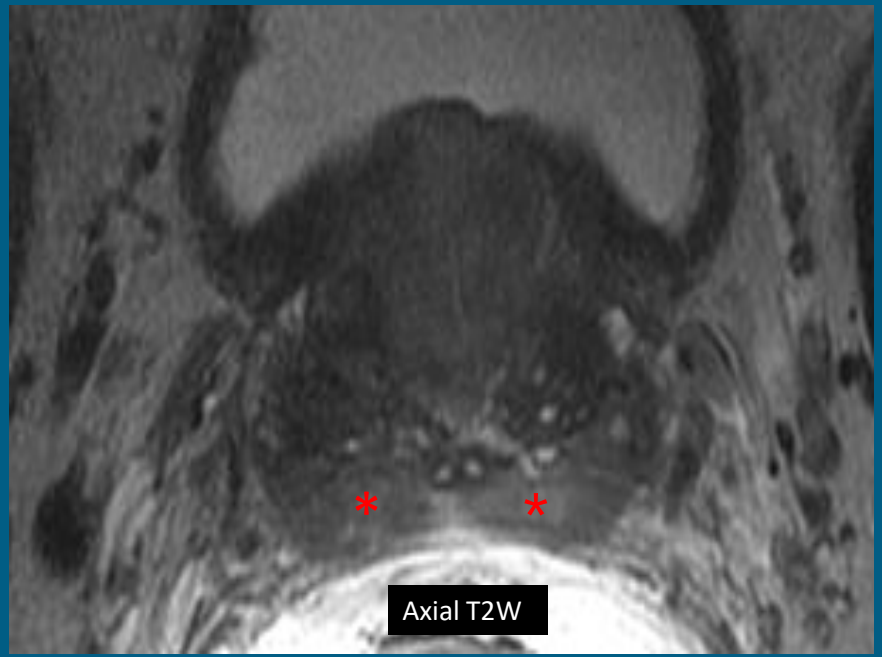
Score	Peripheral Zone (PZ) or Transition Zone (TZ)
1	No abnormality (i.e., normal) on ADC and high b-value DWI
2	Indistinct hypointense on ADC
3	Focal mildly/moderately hypointense on ADC and isointense/mildly hyperintense on high b-valueDWI.
4	Focal markedly hypointense on ADC and markedly hyperintense on high b-value DWI; <1.5cm in greatestdimension
5	Same as 4 but ≥1.5cm in greatest dimension or definite extraprostatic extension/invasive behavior

PI-RADS 2.1 Modifications

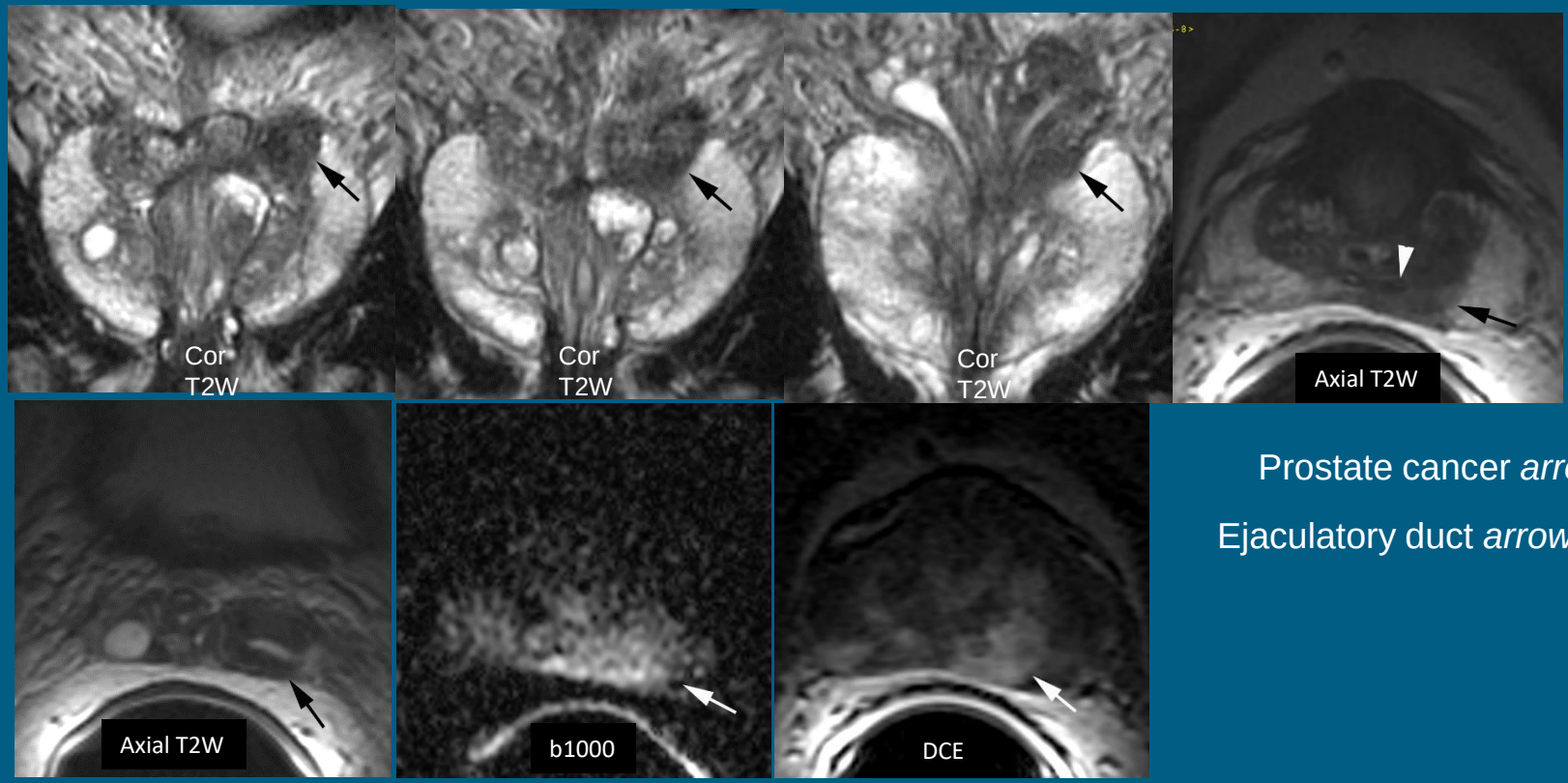
Score	Peripheral Zone (PZ) or Transition Zone (TZ)
1	No abnormality (i.e., normal) on ADC and high b-value DWI
2	Linear/wedge shaped hypointense on ADC and/or linear/wedge shaped hyperintense on high b-value DWI
3	Focal (discrete and different from the background) hypointense on ADC and/or focal hyperintense on high b-value DWI; may be markedly hypointense on ADC or markedly hyperintense on high b-value DWI, but not both.
4	Focal markedly hypointense on ADC and markedly hyperintense on high b-value DWI; <1.5cm in greatest dimension
5	Same as 4 but ≥1.5cm in greatest dimension or definite extraprostatic extension/invasive behavior

Normal Central Zone





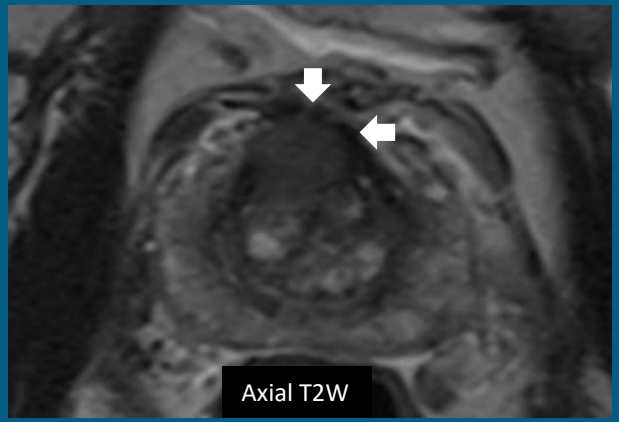
Central Zone Tumor

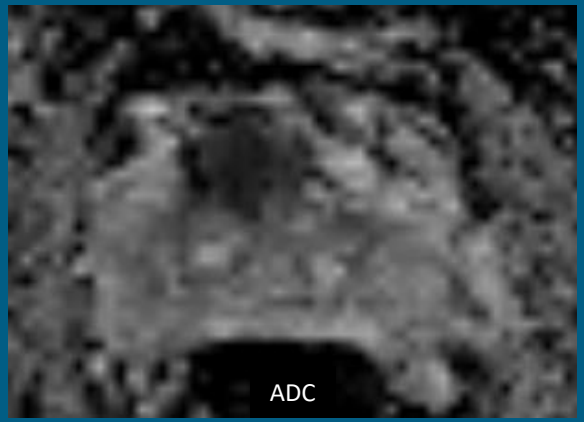


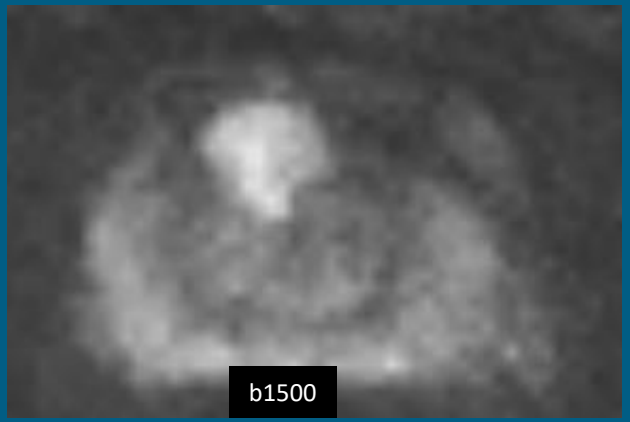
Prostate cancer *arrow*

Ejaculatory duct *arrowhead*

PCa involvement of Anterior Fibromuscular Stroma







Prostate cancer involves the anterior fibromuscular stroma, scored using transition zone criteria.

68-year-old man with PSA 6.2 ng/mL and Gleason score 8(4+4) prostate cancer confirmed on MRI targeted biopsy.

Assessment of T2W

PI-RADS v2.0

Score	Transition Zone (TZ)
1	Homogeneous intermediate signal intensity (normal)
2	Circumscribed hypointense or heterogeneous encapsulated nodule(s) (BPH)
3	Heterogeneous signal intensity with obscured margins Includes others that do not qualify as 2, 4, or 5
4	Lenticular or non-circumscribed, homogeneous, moderately hypointense, and <1.5 cm in greatest dimension
5	Same as 4, but ≥1.5cm in greatest dimension or definite extraprostatic extension/invasive behavior

PI-RADS v2.1

Score	Transition Zone (TZ)
1	Normal appearing TZ (rare) or a round, completely encapsulated nodule. (“typical nodule”)
2	A mostly encapsulated nodule OR a homogeneous circumscribed nodule without encapsulation. “atypical nodule”) OR a homogeneous mildly hypointense area between nodules
3	Heterogeneous signal intensity with obscured margins Includes others that do not qualify as 2, 4, or 5
4	Lenticular or non-circumscribed, homogeneous, moderately hypointense, and <1.5 cm in greatest dimension
5	Same as 4, but ≥1.5cm in greatest dimension or definite extraprostatic extension/invasive behavior

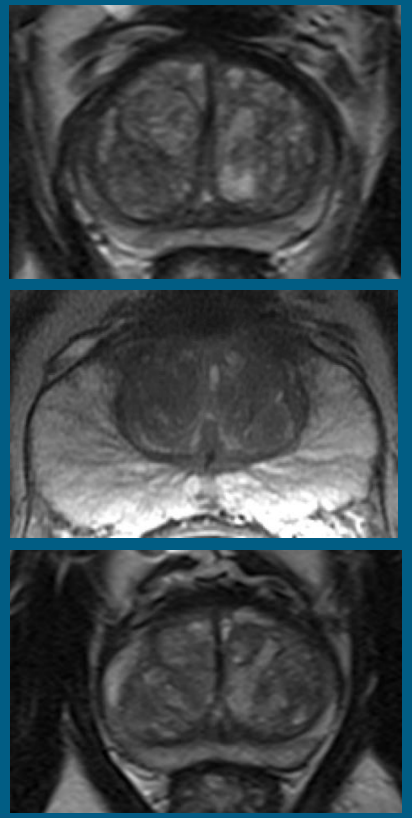
Image Interpretation: Transition Zone (TZ)

T2W score of 2:

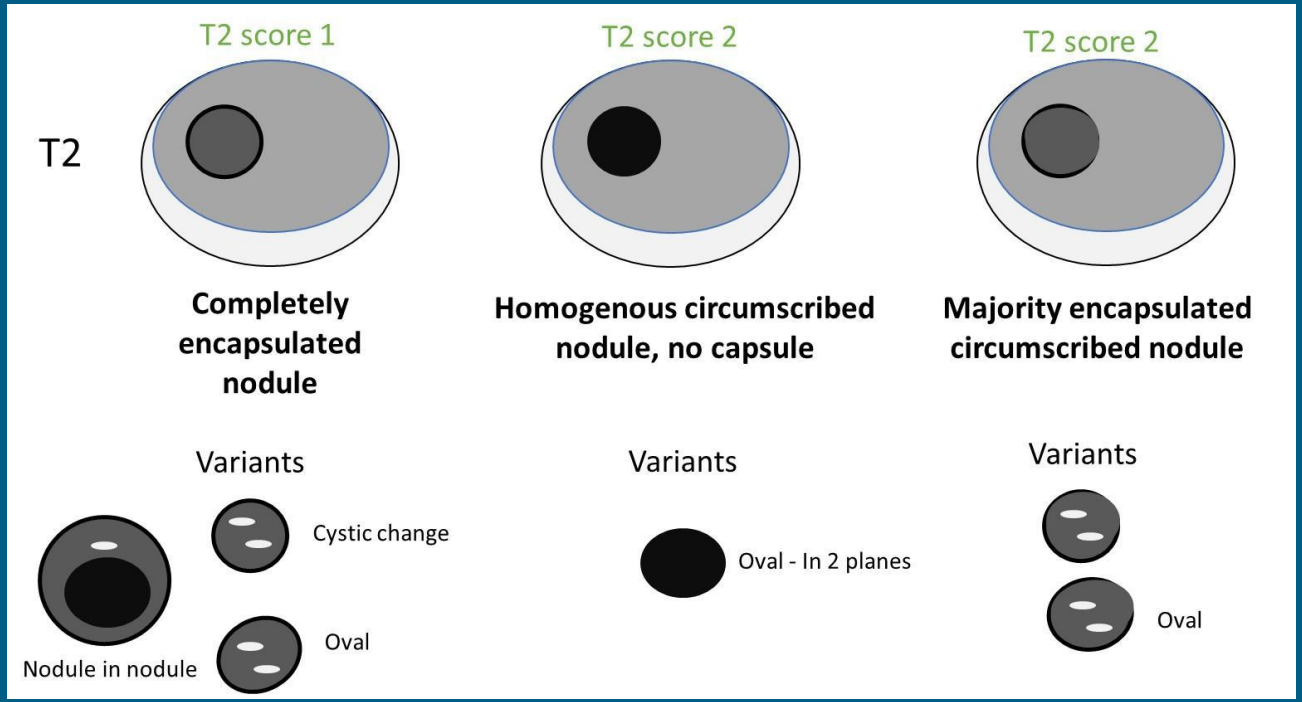
- A mostly encapsulated nodule
- A homogeneous circumscribed nodule without encapsulation
- A homogeneous mildly hypointense area between nodules

Image Interpretation: TZ

- Only score nodules or lesions/regions between nodules that differ from the background TZ.
- Findings similar to the background should ***NOT*** be scored.
- Typical BPH nodules (i.e., round, completely encapsulated nodules) are now ***NOT*** scored.



Schematic diagram of features of nodules in the TZ and their corresponding scores



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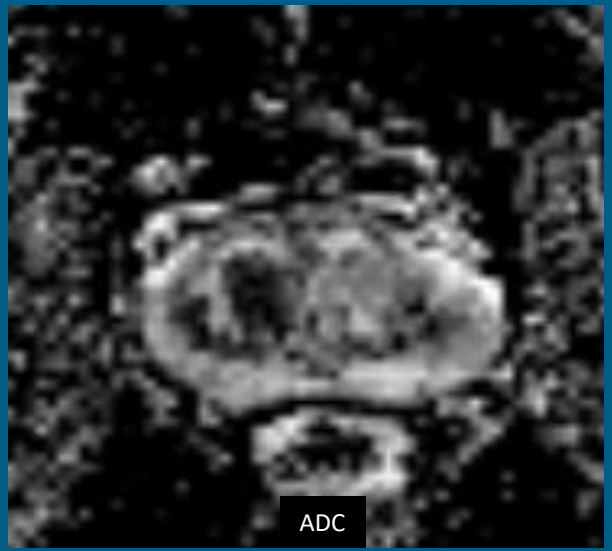
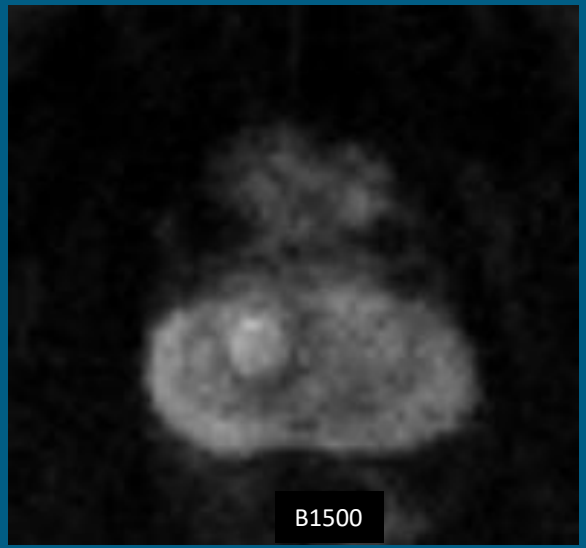
Encapsulated Nodule

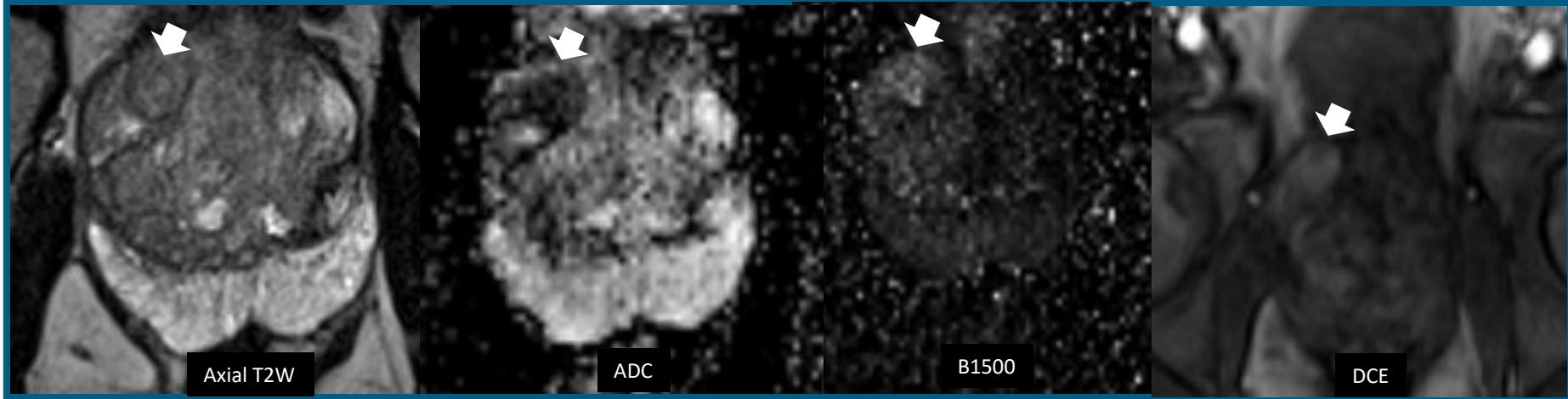
- PI-RADS 1





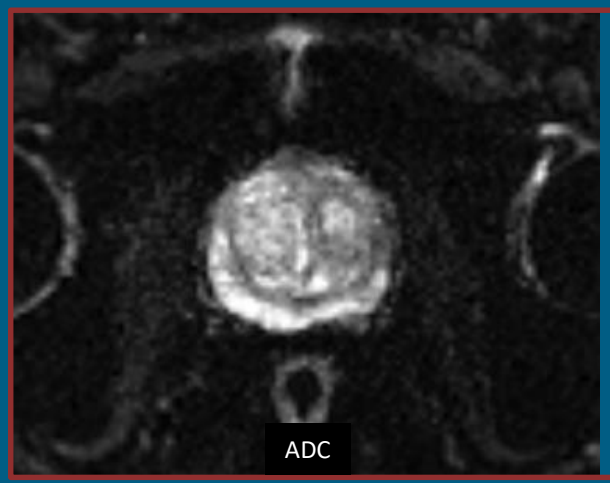
Encapsulated Nodule

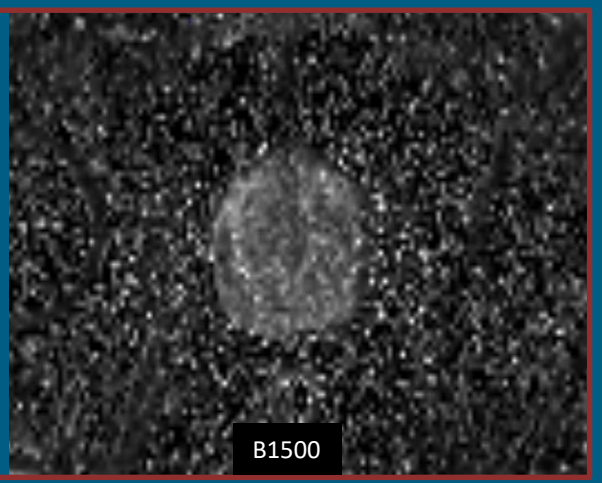
- PI-RADS 1



Homogeneous Hypointense Area Between Nodules

- PI-RADS 2





TZ: 2

DWI:1

Image Interpretation: Transition Zone

In TZ, ***DWI score of 4 or 5*** now ***elevates*** the overall PI-RADS assessment category from 2 to 3 for lesions receiving a T2W score of 2.

T2W	DWI	DCE	PI-RADS
1	Any*	Any	1
2	≤3	Any	2
	≥4	Any	3
3	≤4	Any	3
	5	Any	4
4	Any	Any	4

The only change in deriving the overall PI-RADS assessment category, compared to PI-RADS v2, concerns TZ lesions with a T2W score of 2.

Image Interpretation: Transition Zone

PI-RADS v2

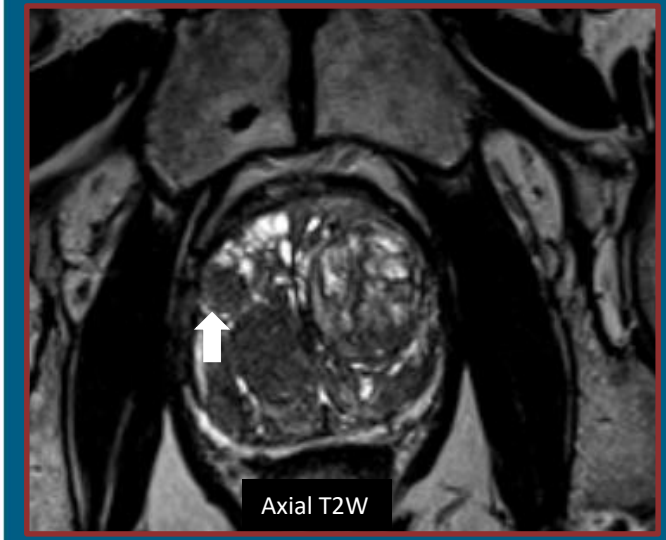
T2W	DWI	DCE	PI-RADS
1	Any*	Any	1
2	Any	Any	2
3	≤4	Any	3
	5	Any	4
4	Any	Any	4
5	Any	Any	5

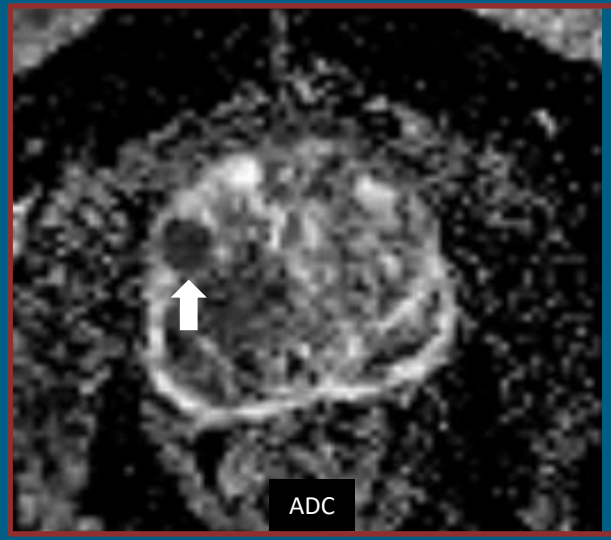
PI-RADS v2.1

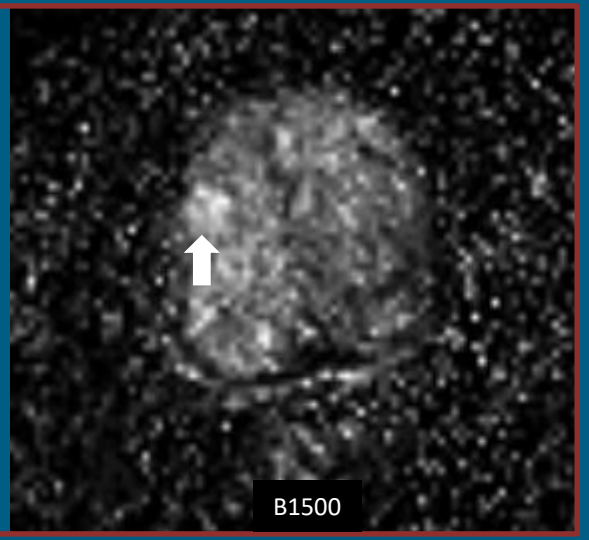
T2W	DWI	DCE	PI-RADS
1	Any*	Any	1
2	≤3	Any	2
	≥4	Any	3
3	≤4	Any	3
	5	Any	4
4	Any	Any	4
5	**Any**	**Any**	5

Atypical TZ Nodule

- PI-RADS 3







TZ: 2

DWI:4

Homogeneous mostly encapsulated nodule

Schematic diagram of PI-RADS v2.1

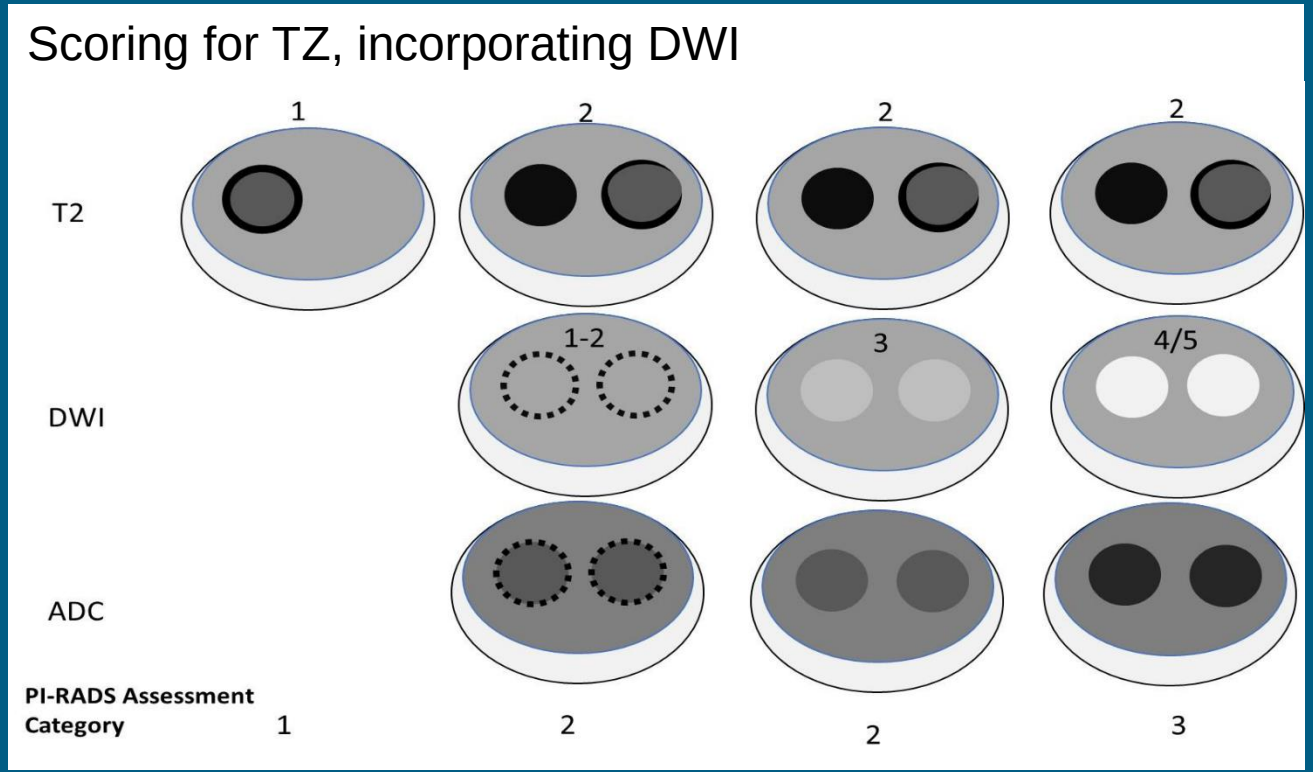


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Image Interpretation: DCE

Modified criteria for a ***negative*** score on DCE:

PI-RADS v2

Score	Peripheral Zone (PZ) or Transition Zone (TZ)
(–)	no early enhancement, or diffuse enhancement not corresponding to a focal finding on T2W and/or DWI or focal enhancement corresponding to a lesion demonstrating features of BPH on T2WI
(+)	focal, and; earlier than or contemporaneously with enhancement of adjacent normal prostatic tissues, and; correspnds to suspicious finding on T2W and/or DWI

PI-RADS v2.1

Score	Peripheral Zone (PZ) or Transition Zone (TZ)
(–)	no early or contemporaneous enhancement; or diffuse multifocal enhancement NOT corresponding to a focal finding on T2W and/or DWI or focal enhancement corresponding to a lesion demonstrating features of BPH on T2WI (including features of extruded BPH in the PZ)
(+)	focal, and; earlier than or contemporaneously with enhancement of adjacent normal prostatic tissues, and; corresponds to suspicious finding on T2W and/or DWI

Criteria for a positive score on DCE remains unchanged.

Biparametric MRI

- ***mpMRI recommended especially when***:
  - Clinical risk factors indicate the likely presence of significant disease that should not be missed (e.g., family history, prior negative biopsy, active surveillance, risk calculator)
  - Prior negative bpMRI – at persistent suspicion
  - Technical factors leading to suboptimal image quality of DWI

- No specific recommendations for use of bpMRI

PI-RADS v2.1

Prostate Imaging Reporting and Data System

PI-RADS v2.1 Assessment Category

1	very low	clinically significant cancer highly unlikely
2	low	clinically significant cancer unlikely
3	intermediate	clinically significant cancer equivocal
4	high	clinically significant cancer likely
5	very high	clinically significant cancer highly likely

Take home points

- PI-RADS remains primarily a prostate cancer detection and diagnosis system
- PI-RADS categories communicate the likelihood of clinically significant cancer
- PI-RADS system is a living document with adaptions being made as evidence accumulates in its use in practice
- Future developments will include further investigations in bpMRI, applications of AI and potential integration of circulating tumor cells or serum and/or urine biomarkers