MULTI-PARAMETRIC MRI PROSTATE PI-RADS Scoring. V2.1 02 MAY 2025

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FELLOWSHIP OF BODY IMAGING

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AUA Guidelines for mpMRI Prostate

- Biopsy-naïve in high PSA/ +DRE
- Biopsy–negative + high suspicion
- Active surveillance
- Biopsy decision-making

AUA: Clinical Scenarios Where PSMA PET is Recommended After mpMRI:

1. *Biopsy-Proven High-Risk or Very High-Risk Prostate Cancer*
2. *Biochemical Recurrence After Definitive Treatment*
3. *Equivocal or Indeterminate Lesion on mpMRI*
4. *Prior Negative Biopsy but Persistent Suspicion*
5. *Incomplete MRI Evaluation*

.

SNMMI & EANM Recommendations

PSMA PET/CT + mpMRI enhances diagnostic accuracy by offering superior local and metastatic disease in Pca for;

- Initial staging (PSMA for intermediate / high risk patient)
- BCR (after definite therapy to look for source of PSA)
- Planning for salvage RT (by accurately localizing recurrent disease post-prostatectomy.)

ACR: Role of MRI in Prostate Malignancy

- Enhances lesion detection and characterization
  →differentiation btw Indolent vs Clinically Significant lesions

- Aid in Targeted Biopsies

- Pivot role in Extraprostatic Extensions/ Local Invasion/
  & Nodal involvement

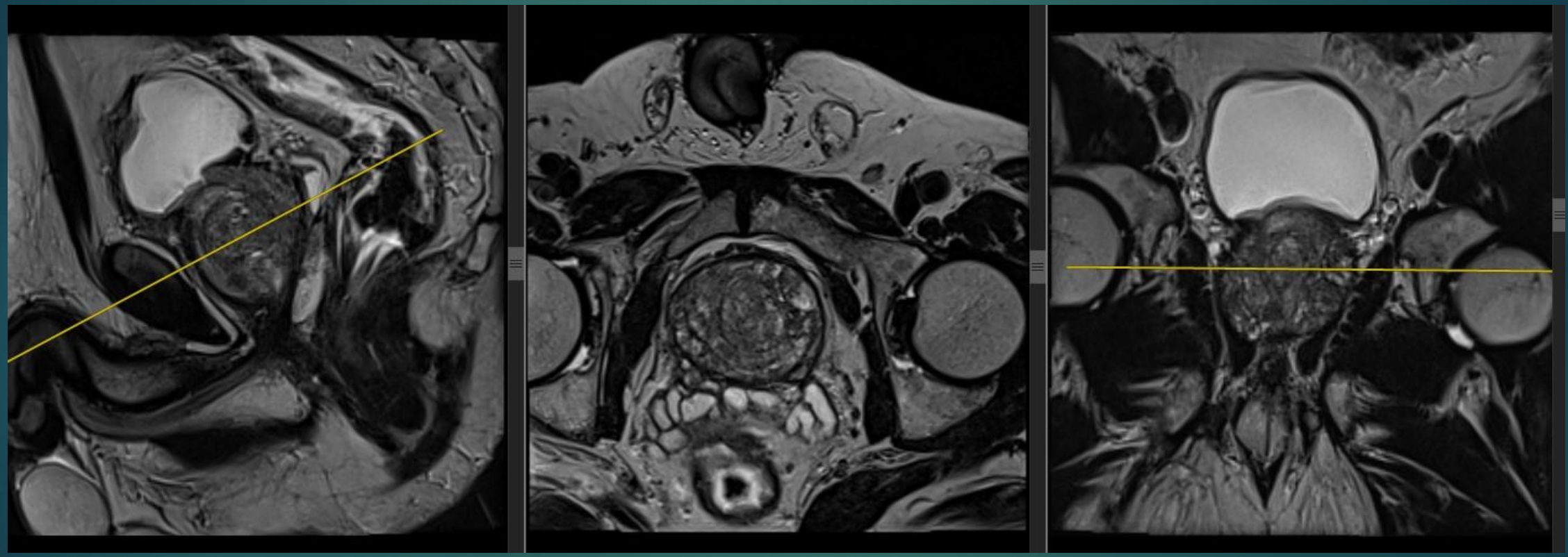
ACR; Definition of a Clinically Significant Lesion in PIRADS V2.1

- *Gleason score ≥ 7 - including 3+4 with prominent but not predominant Gleason 4 component*
- *Tumor volume > 0.5cc*
- *Extraprostatic extension (EPE)*

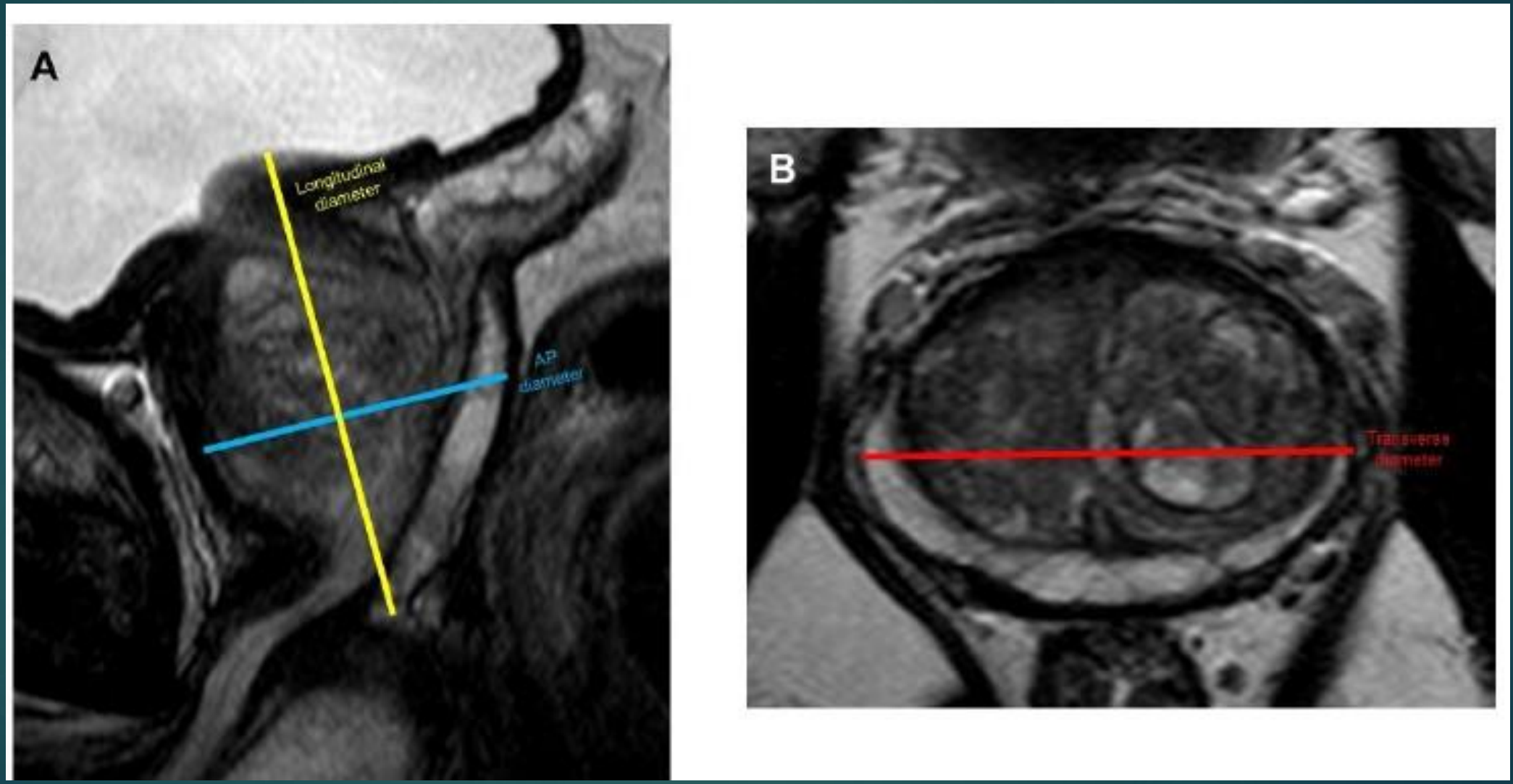
Components of a Multiparametric MRI Prostate

- T2 Sequences- Axial, Sagittal, Coronal Series
- Diffusion Weighted Imaging sequences/ DWI
- Dynamic Contrast Enhanced Sequences
- T1 Sequence
- Magnetic Resonance Spectroscopy
- Intravoxel Incoherent Motion/ IVIM/ A substitute for DCE

T2 Sequence

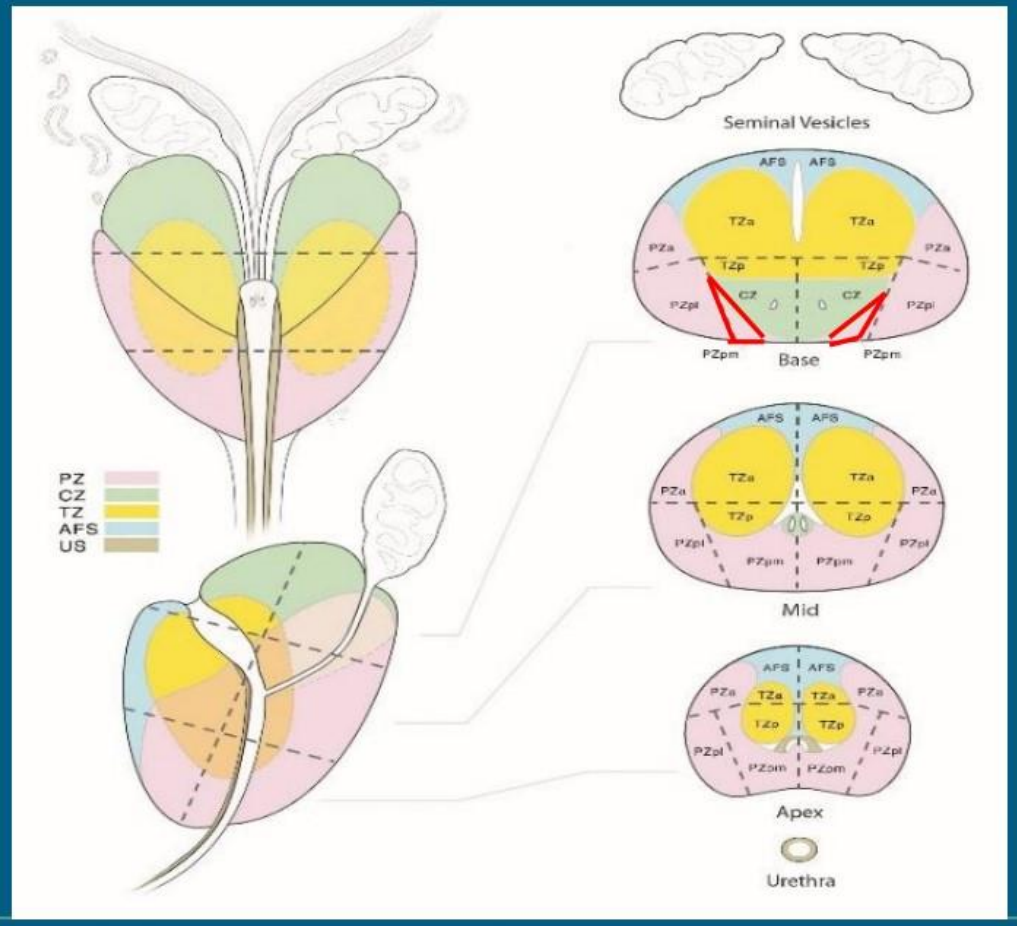


T2 Sequence


A
Longitudinal diameter
AP diameter
B
Transverse diameter

PI-RADS Assessment Table for TZ

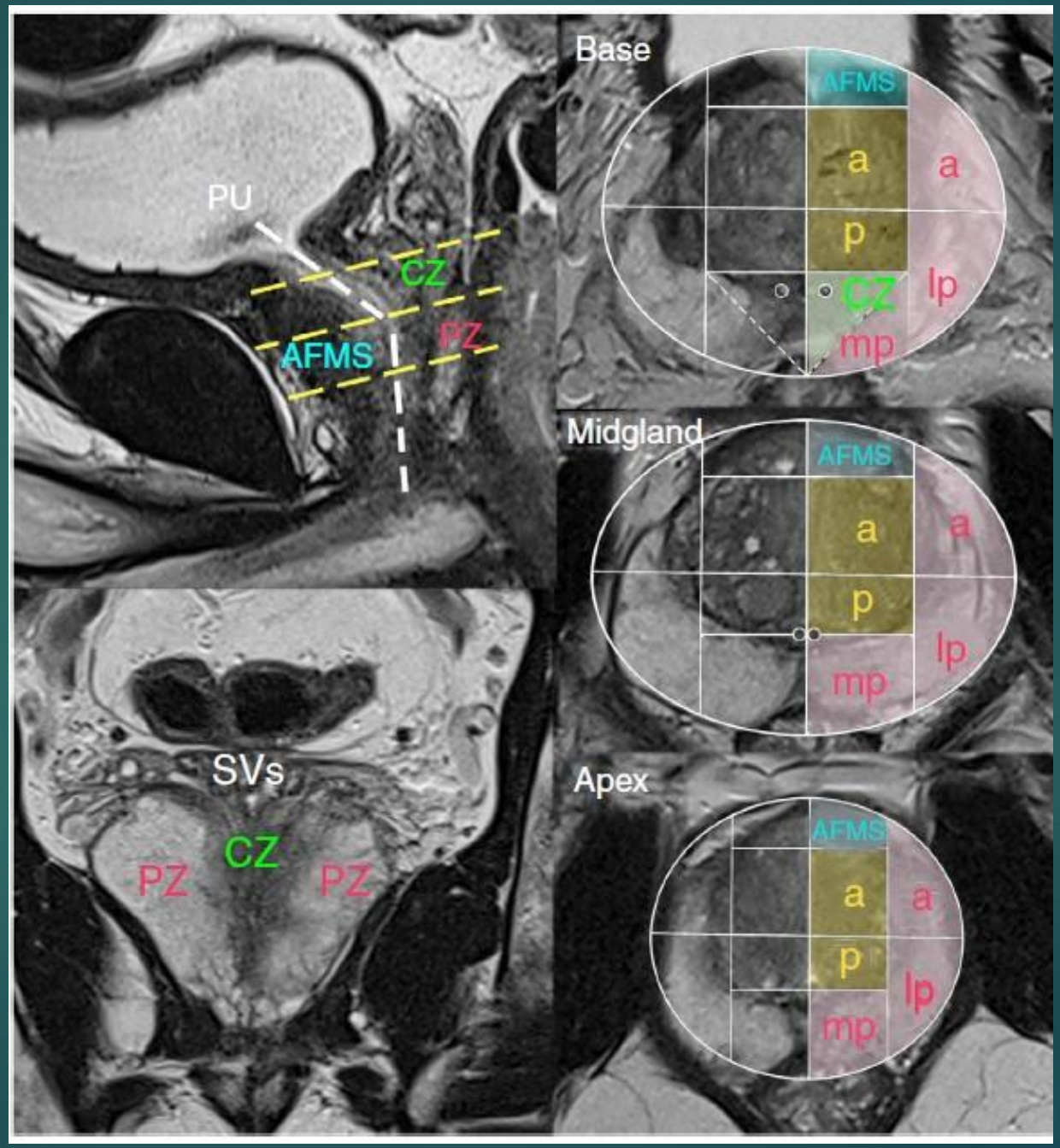
Revisions in the Sector Map

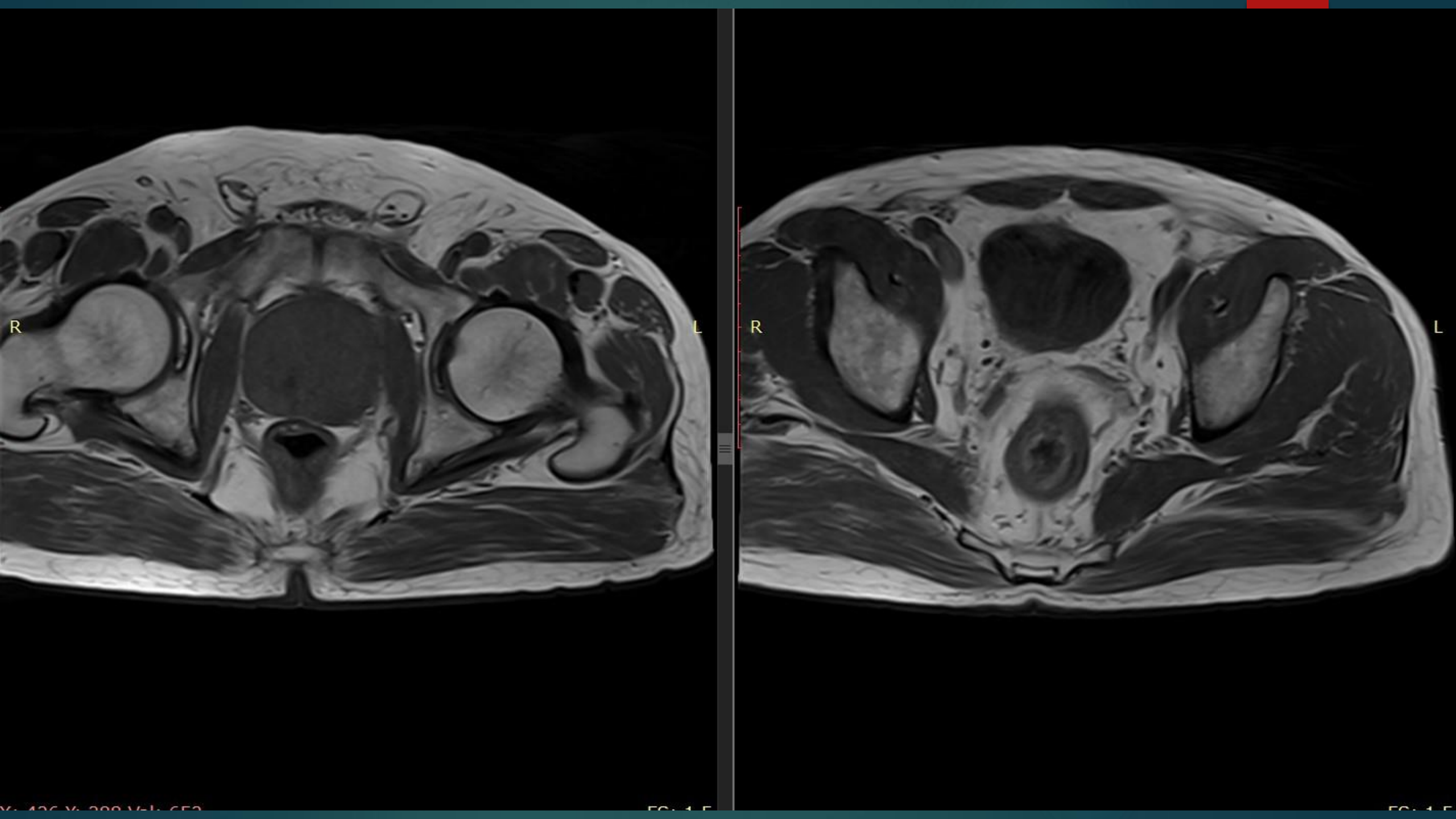


*Two additional sectors added for the **right and left posterior medial PZ (PZpm) at the base***

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).

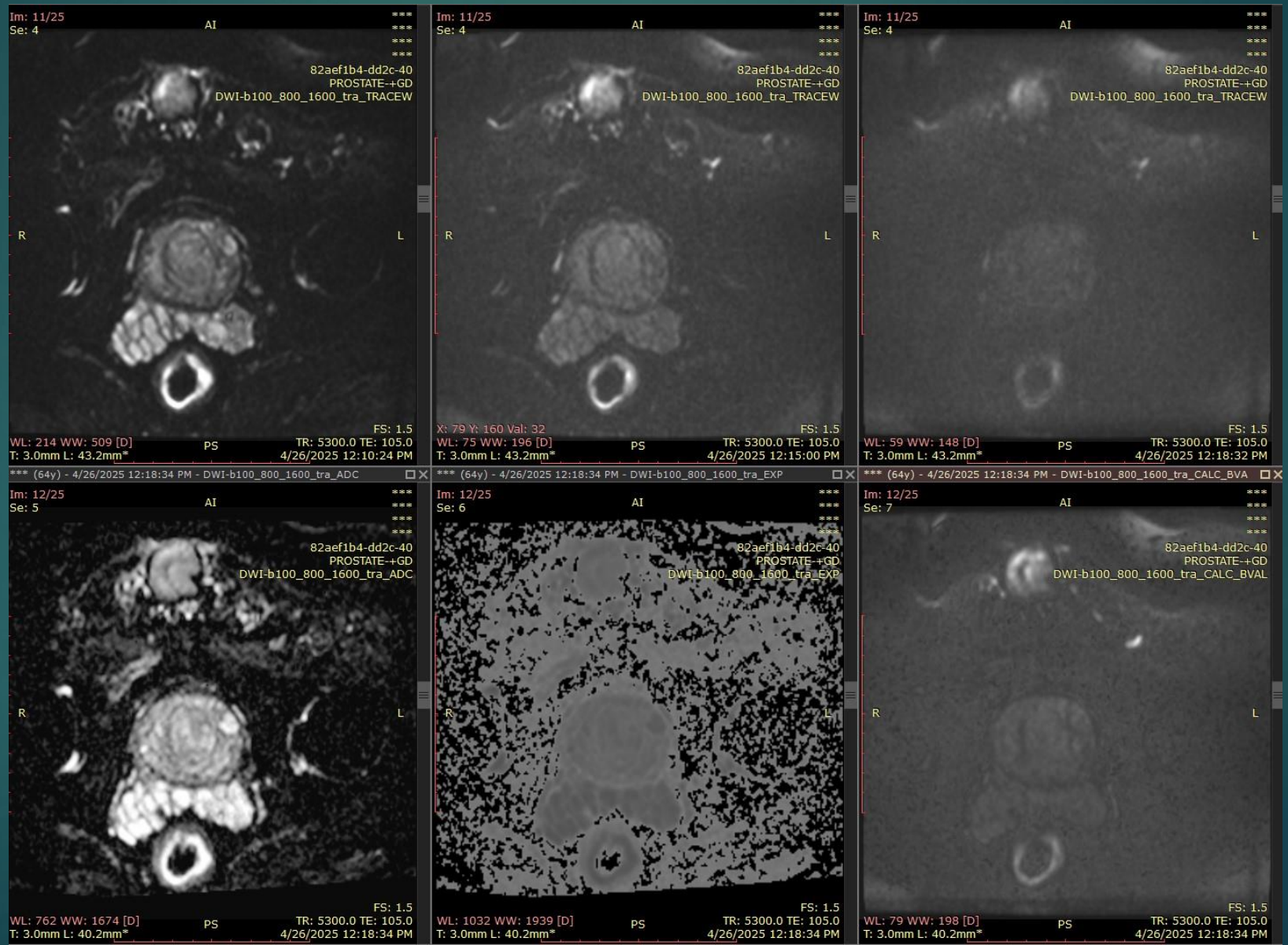

PU
CZ
PZ
AFMS
SVs
CZ
PZ
PZ
Base
AFMS
a
a
p
lp
CZ
mp
Midgland
AFMS
a
a
p
lp
mp
Apex
AFMS
a
a
p
lp
mp


R
L
R
L

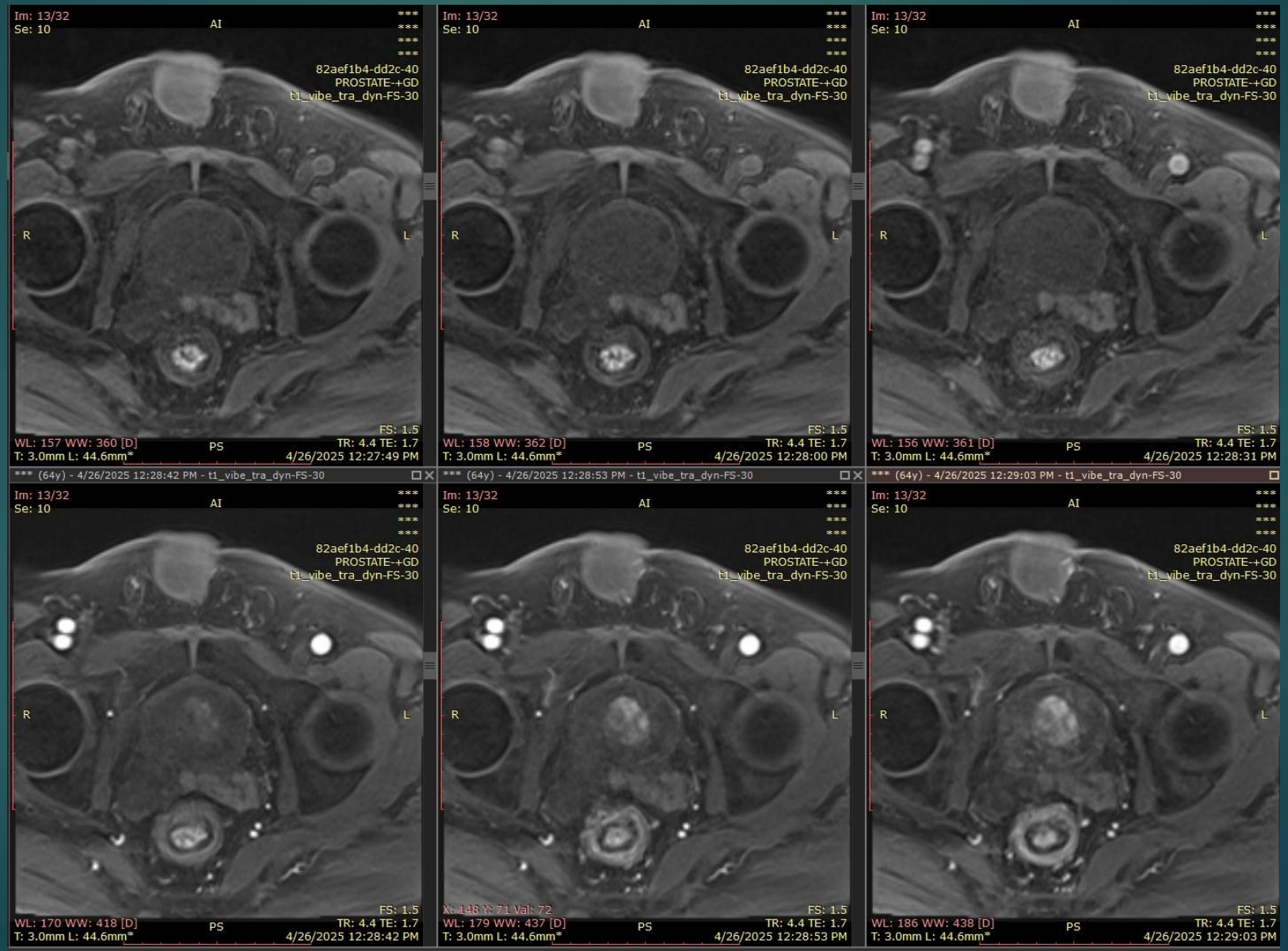
Diffusion Weighted Imaging

- Assessing the random motion of water molecules
- Malignant cells are packed, → restricting motion
- In a constant, large magnetic field, different small magnetic fields are produced (different b-values)
- Higher b-values→ more sensitive to motion restrictions
- Two types of images:
  - A series with different b-values (DWI)
  - One image showing Apparent Diffusion Coefficient (ADC)

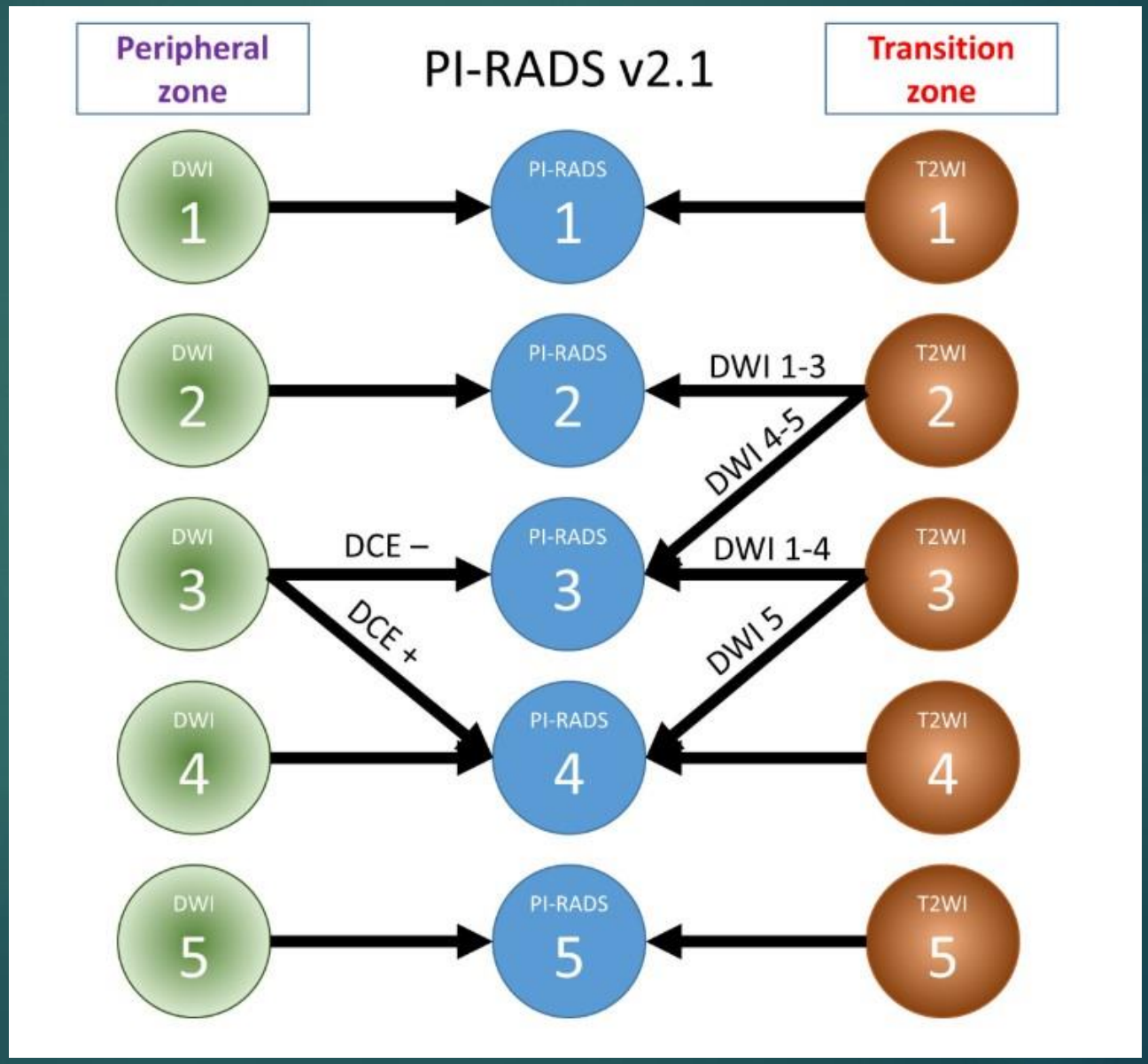
DWI/ ADC


Im: 11/25
Se: 4
AI
82aef1b4-dd2c-40
PROSTATE-+GD
DWI-b100_800_1600_tra_TRACEW
R
L
FS: 1.5
WL: 214 WW: 509 [D]
T: 3.0mm L: 43.2mm*
PS
TR: 5300.0 TE: 105.0
4/26/2025 12:10:24 PM
Im: 11/25
Se: 4
AI
82aef1b4-dd2c-40
PROSTATE-+GD
DWI-b100_800_1600_tra_TRACEW
R
L
X: 79 Y: 160 Val: 32
FS: 1.5
WL: 75 WW: 196 [D]
T: 3.0mm L: 43.2mm*
PS
TR: 5300.0 TE: 105.0
4/26/2025 12:15:00 PM
Im: 11/25
Se: 4
AI
82aef1b4-dd2c-40
PROSTATE-+GD
DWI-b100_800_1600_tra_TRACEW
R
L
FS: 1.5
WL: 59 WW: 148 [D]
T: 3.0mm L: 43.2mm*
PS
TR: 5300.0 TE: 105.0
4/26/2025 12:18:32 PM
*** (64y) - 4/26/2025 12:18:34 PM - DWI-b100_800_1600_tra_ADC
Im: 12/25
Se: 5
AI
82aef1b4-dd2c-40
PROSTATE-+GD
DWI-b100_800_1600_tra_ADC
R
L
FS: 1.5
WL: 762 WW: 1674 [D]
T: 3.0mm L: 40.2mm*
PS
TR: 5300.0 TE: 105.0
4/26/2025 12:18:34 PM
*** (64y) - 4/26/2025 12:18:34 PM - DWI-b100_800_1600_tra_EXP
Im: 12/25
Se: 6
AI
82aef1b4-dd2c-40
PROSTATE-+GD
DWI-b100_800_1600_tra_EXP
R
L
FS: 1.5
WL: 1032 WW: 1939 [D]
T: 3.0mm L: 40.2mm*
PS
TR: 5300.0 TE: 105.0
4/26/2025 12:18:34 PM
*** (64y) - 4/26/2025 12:18:34 PM - DWI-b100_800_1600_tra_CALC_BVA
Im: 12/25
Se: 7
AI
82aef1b4-dd2c-40
PROSTATE-+GD
DWI-b100_800_1600_tra_CALC_BVAL
R
L
FS: 1.5
WL: 79 WW: 198 [D]
T: 3.0mm L: 40.2mm*
PS
TR: 5300.0 TE: 105.0
4/26/2025 12:18:34 PM

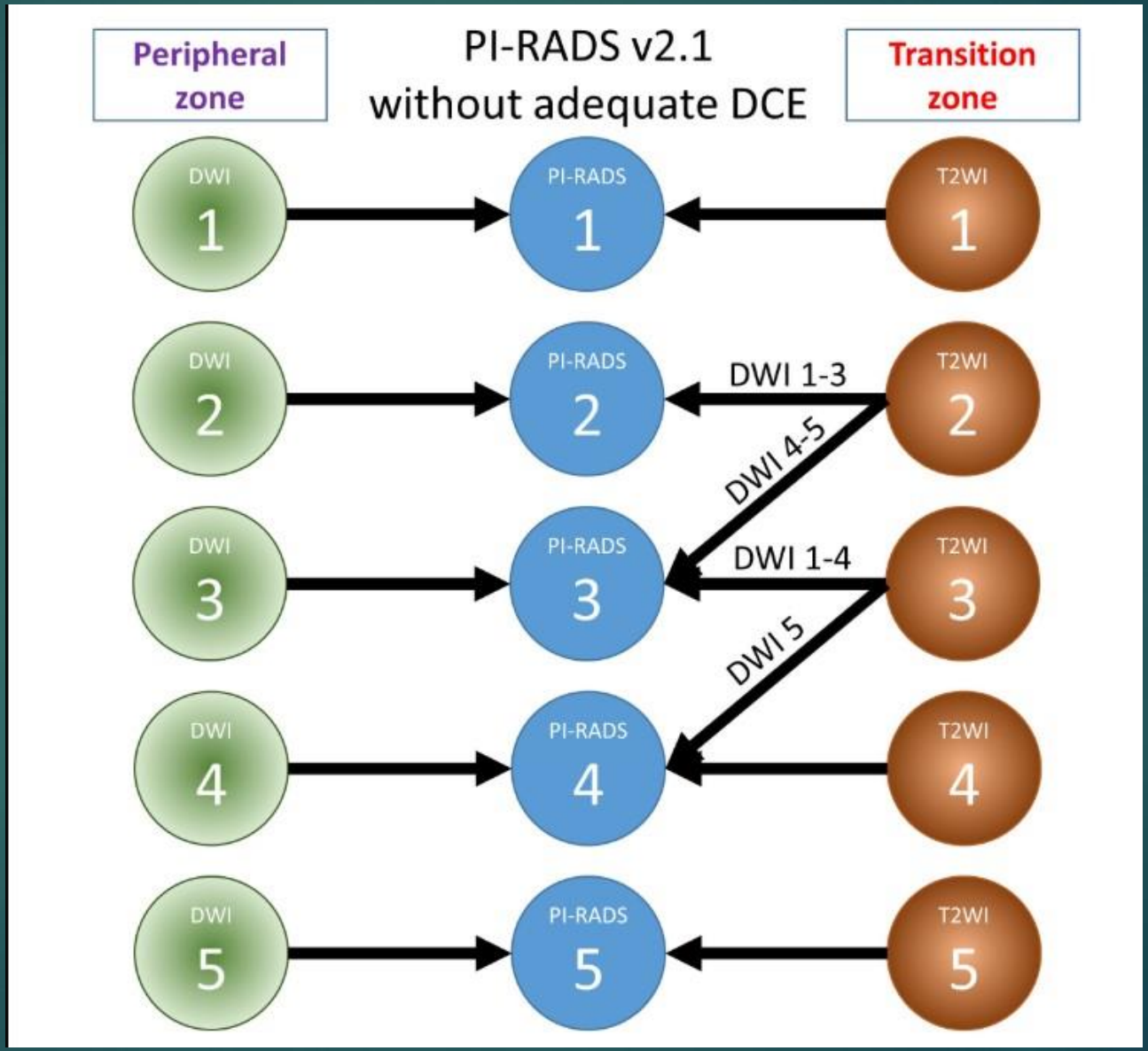
Dynamic Contrast Enhancement Series/ DCE



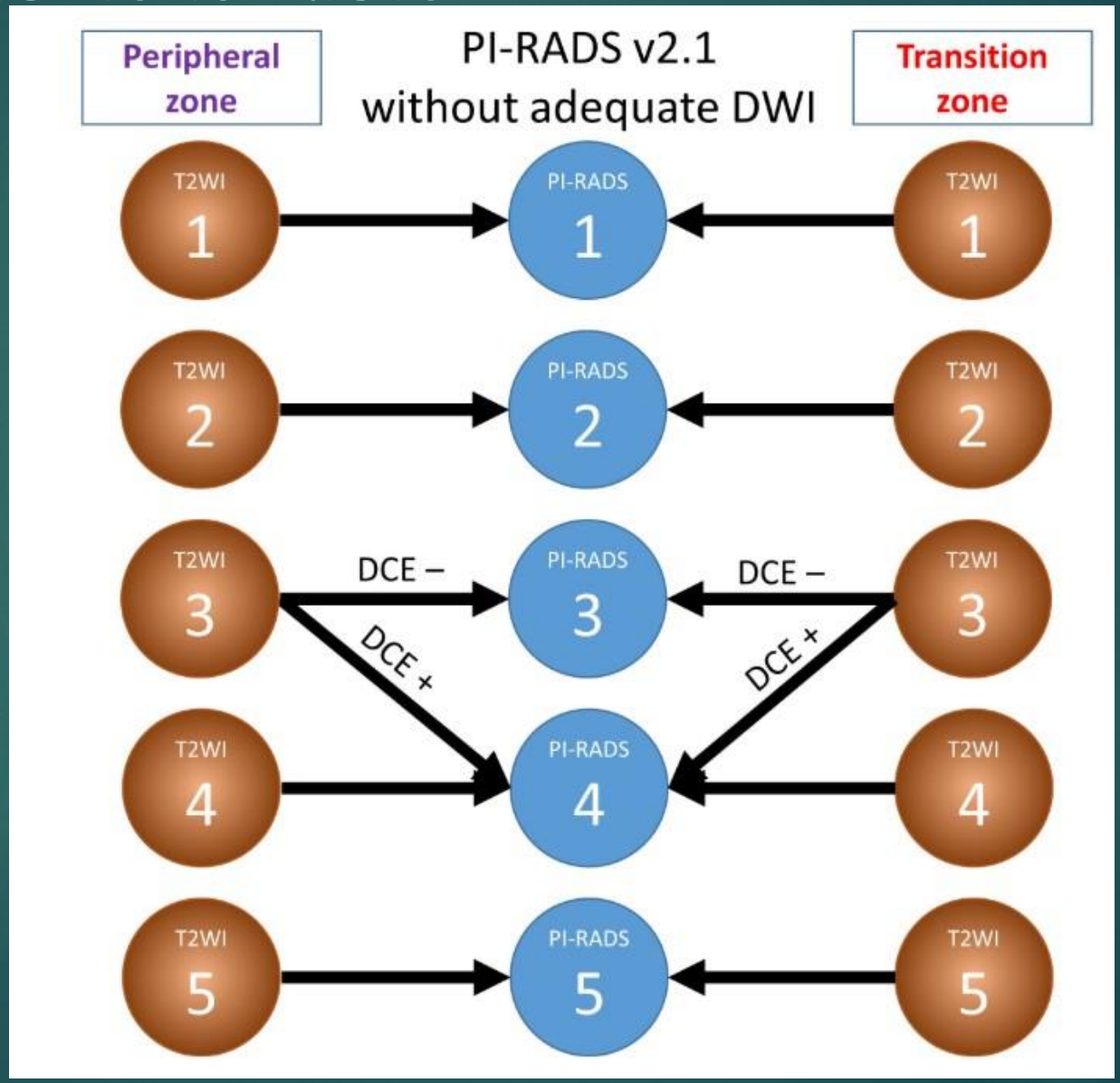
PI-RADS Assessment Table



PI-RADS Assessment Table

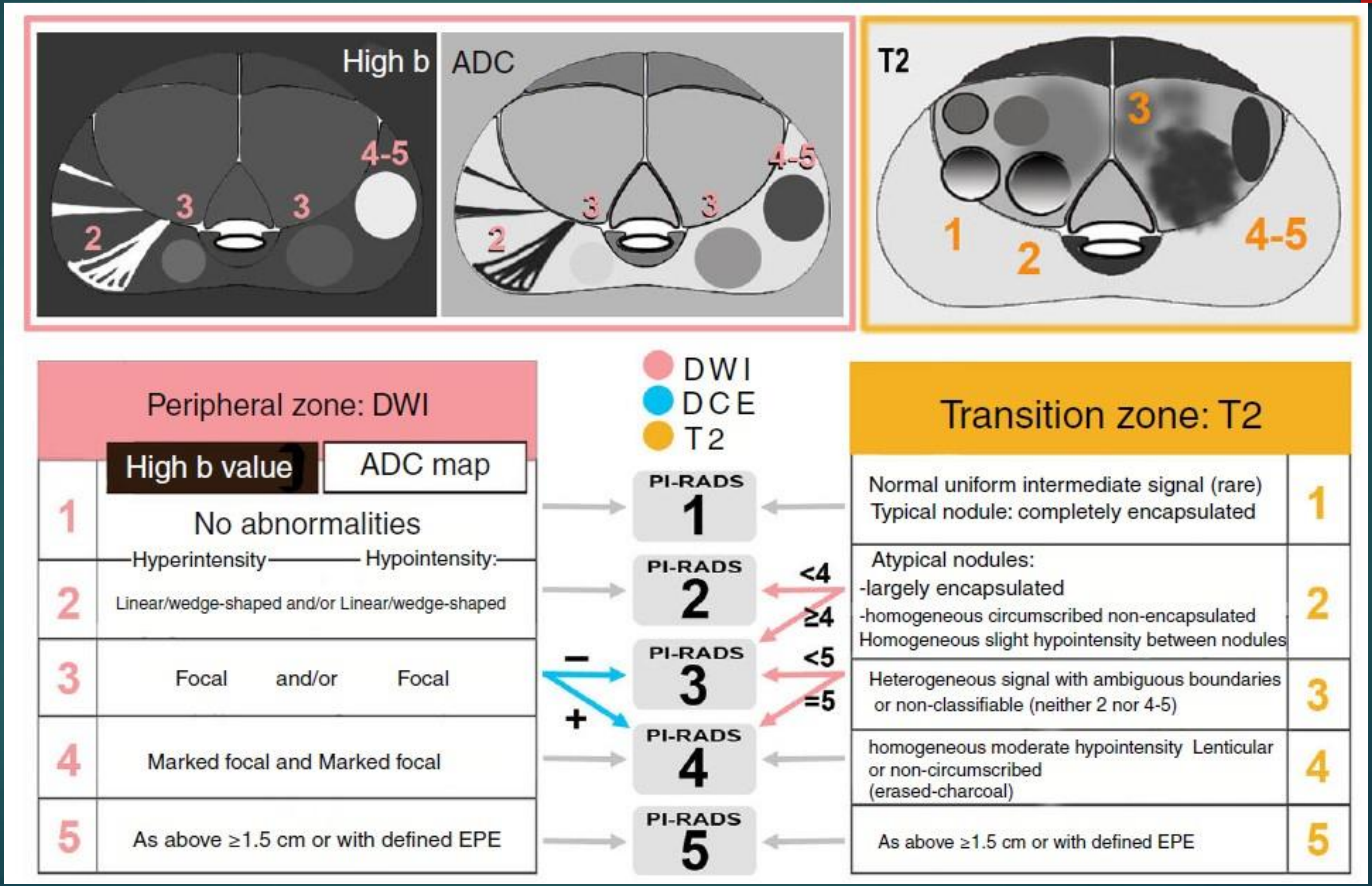


PI-RADS Assessment Table



PI-RADS v2.1

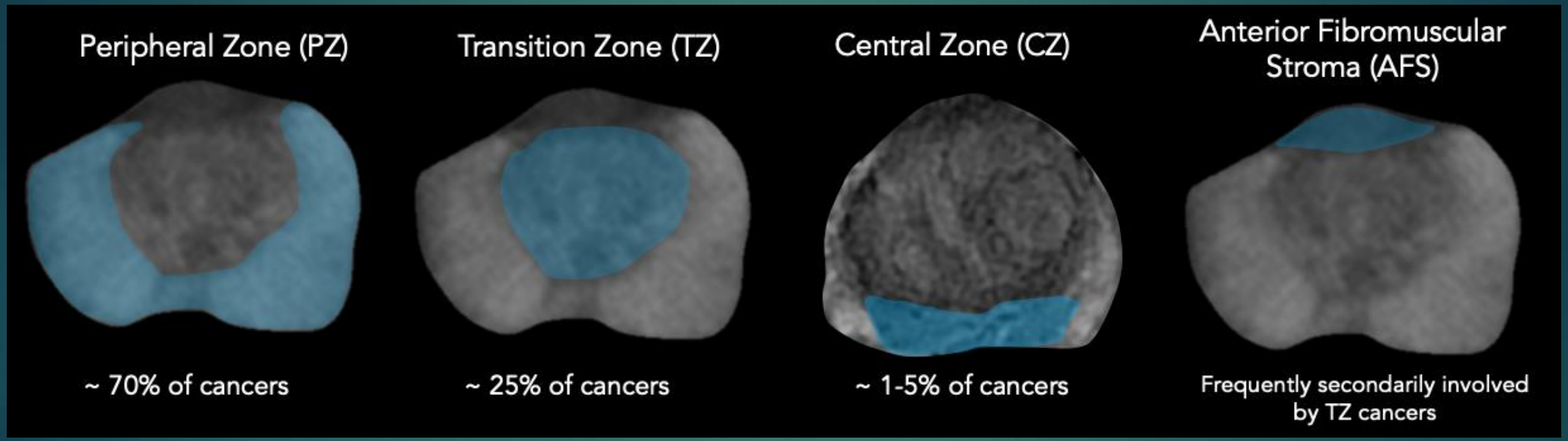
B


High b
ADC
T2
4-5
3
3
2
1
Peripheral zone: DWI
High b value
ADC map
1
No abnormalities
2
Hyperintensity
Hypointensity:
Linear/wedge-shaped and/or Linear/wedge-shaped
3
Focal and/or Focal
4
Marked focal and Marked focal
5
As above ≥1.5 cm or with defined EPE
DWI
DCE
T2
PI-RADS 1
PI-RADS 2
PI-RADS 3
PI-RADS 4
PI-RADS 5
−
+
<4
≥4
<5
=5
Transition zone: T2
Normal uniform intermediate signal (rare)
Typical nodule: completely encapsulated
1
Atypical nodules:
-largely encapsulated
-homogeneous circumscribed non-encapsulated
Homogeneous slight hypointensity between nodules
2
Heterogeneous signal with ambiguous boundaries
or non-classifiable (neither 2 nor 4-5)
3
homogeneous moderate hypointensity Lenticular
or non-circumscribed
(erased-charcoal)
4
As above ≥1.5 cm or with defined EPE
5

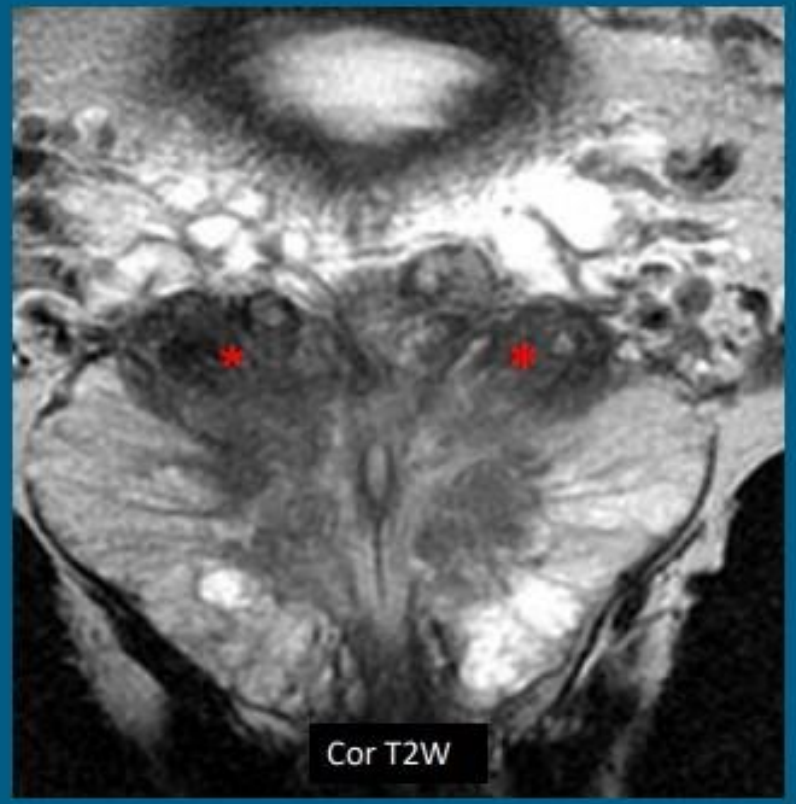
PI-RADS V2.1 Assessment Categories

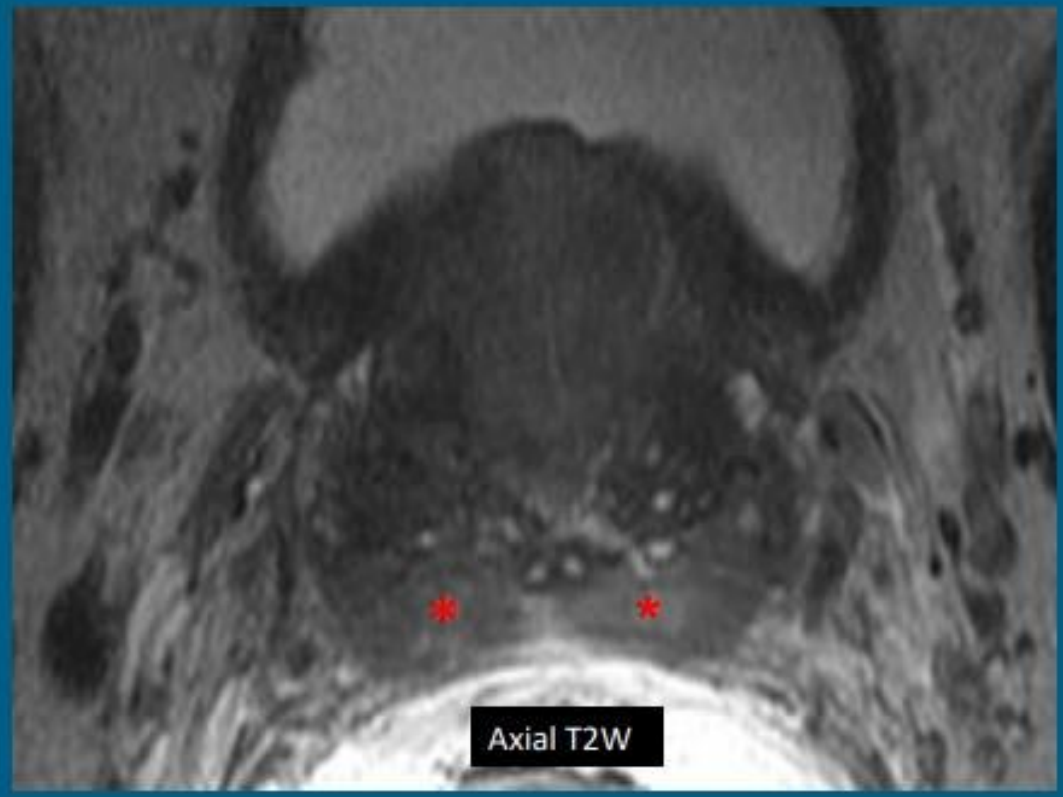
- PIRADS 1 – Very low (clinically significant cancer is highly unlikely to be present)
- PIRADS 2 – Low (clinically significant cancer is unlikely to be present)
- PIRADS 3 – Intermediate (the presence of clinically significant cancer is equivocal)
- PIRADS 4 – High (clinically significant cancer is likely to be present)
- PIRADS 5 – Very high (clinically significant cancer is highly likely to be present)

Zonal Differentiation

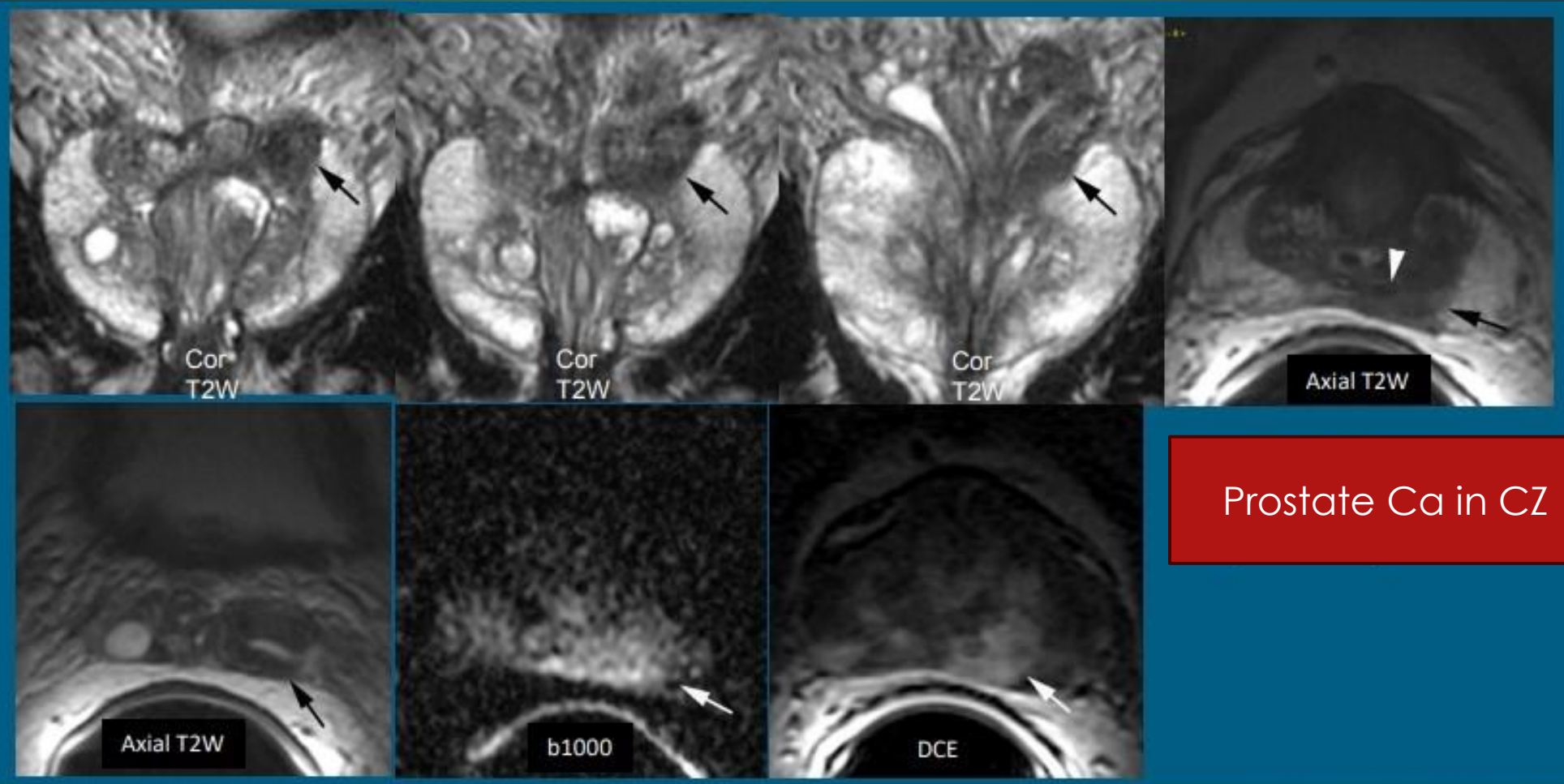


CZ Normal





CZ Tumor

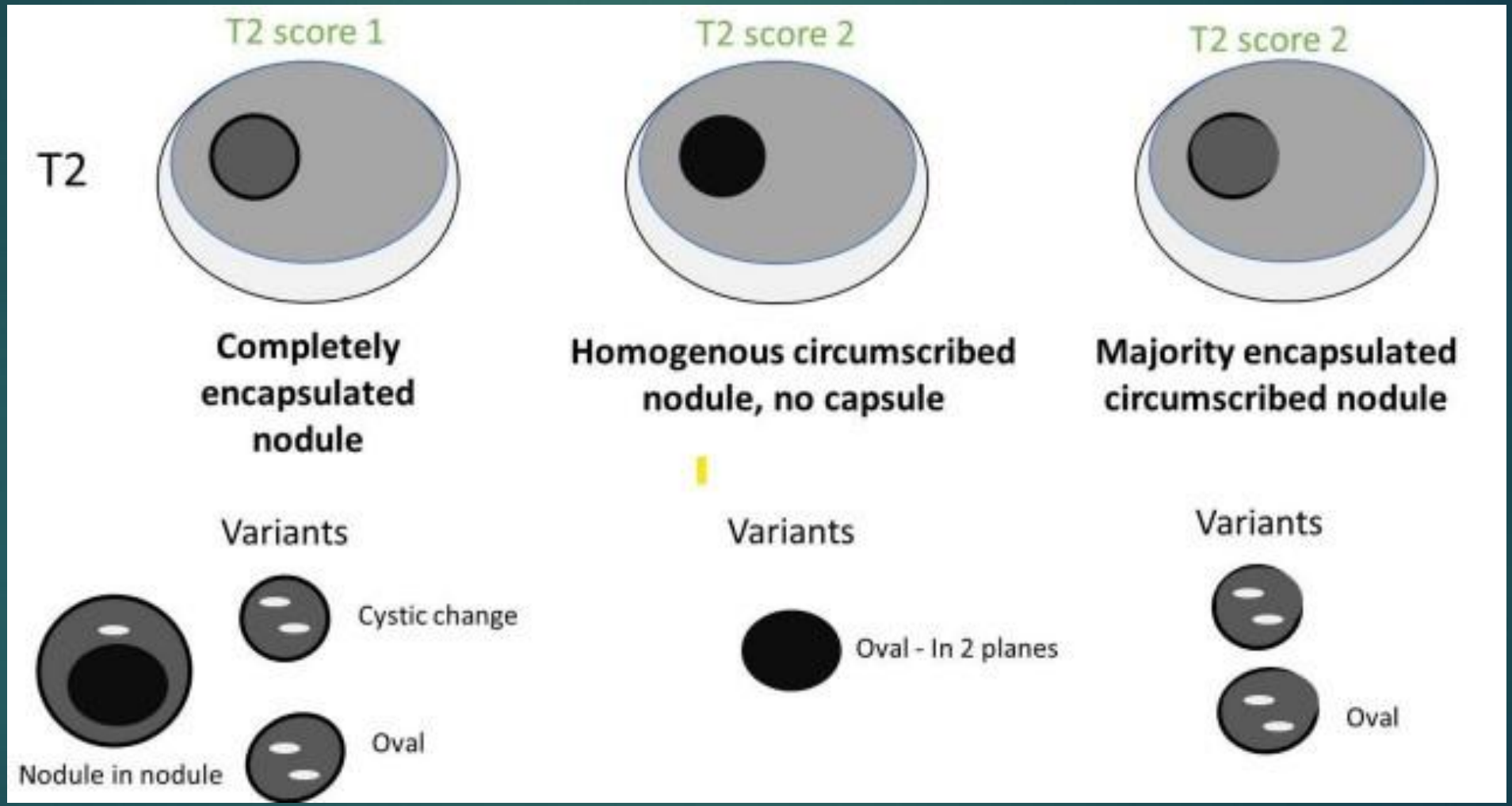


Prostate Ca in CZ

T2 Assessment 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

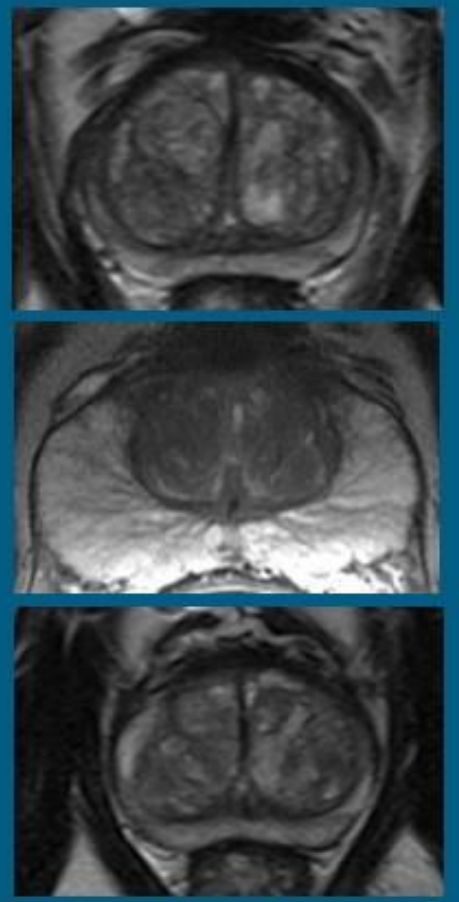
T2 sequence for Nodules in PI-RADS 1 and 2



TZ Pitfalls

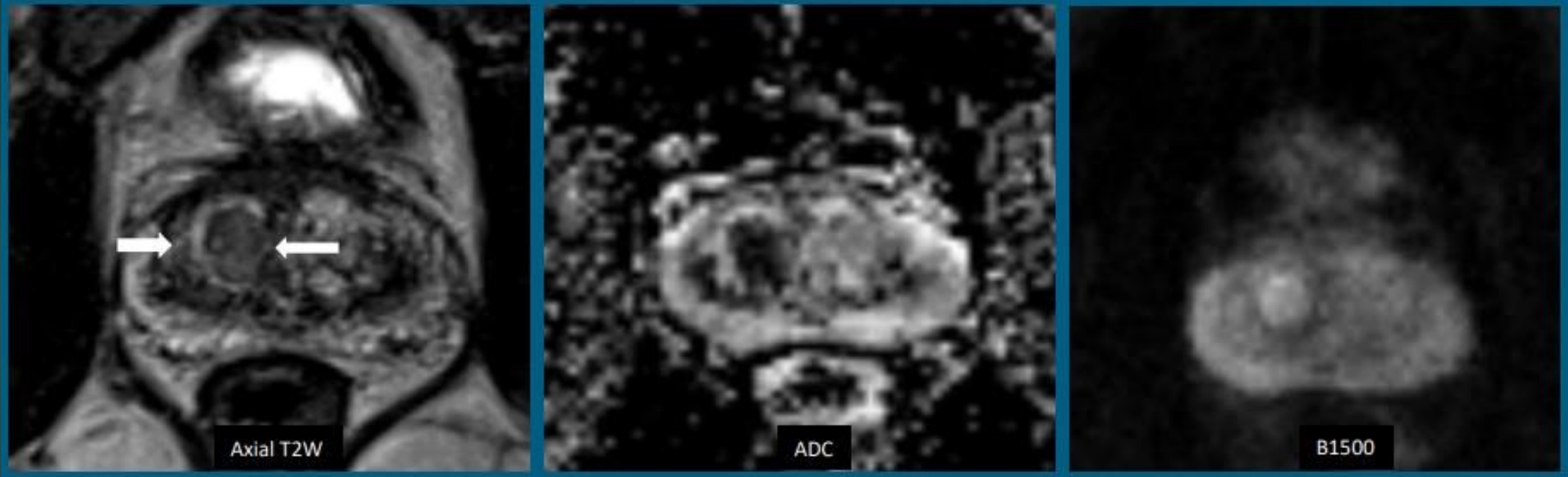
Image Interpretation: TZ

- 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.



T2 TZ Encapsulated Nodule

T2 Score 1 **PIRADS 1**



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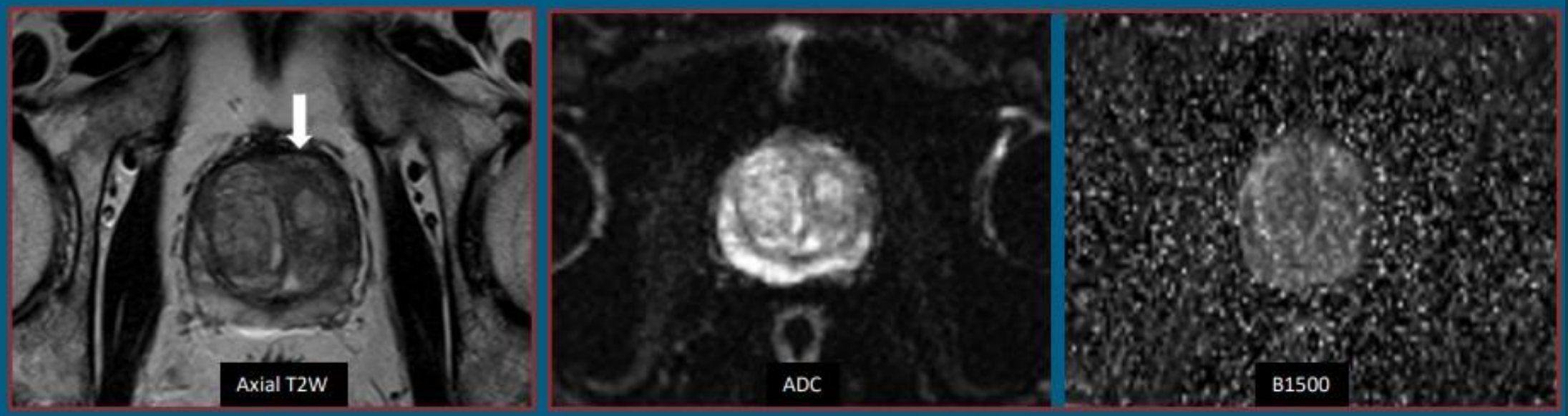
T2 TZ – Homogeneous Low T2 Between Nodules

T2 Score 2 PIRADS 2

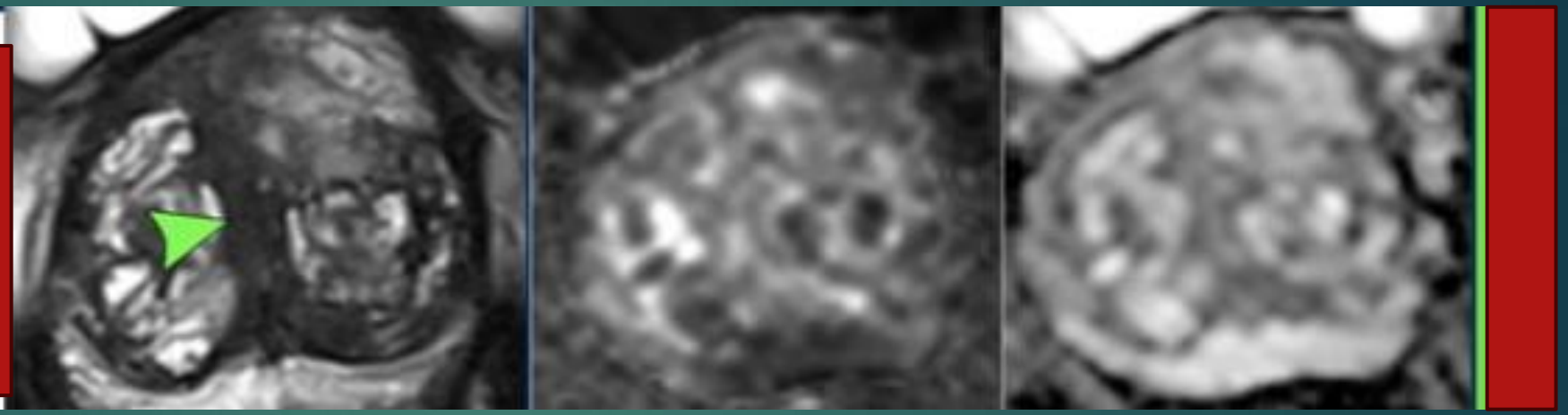


TZ: 2

DWI:1

T2 TZ

Mild low T2, homogeneous, btw Nodules



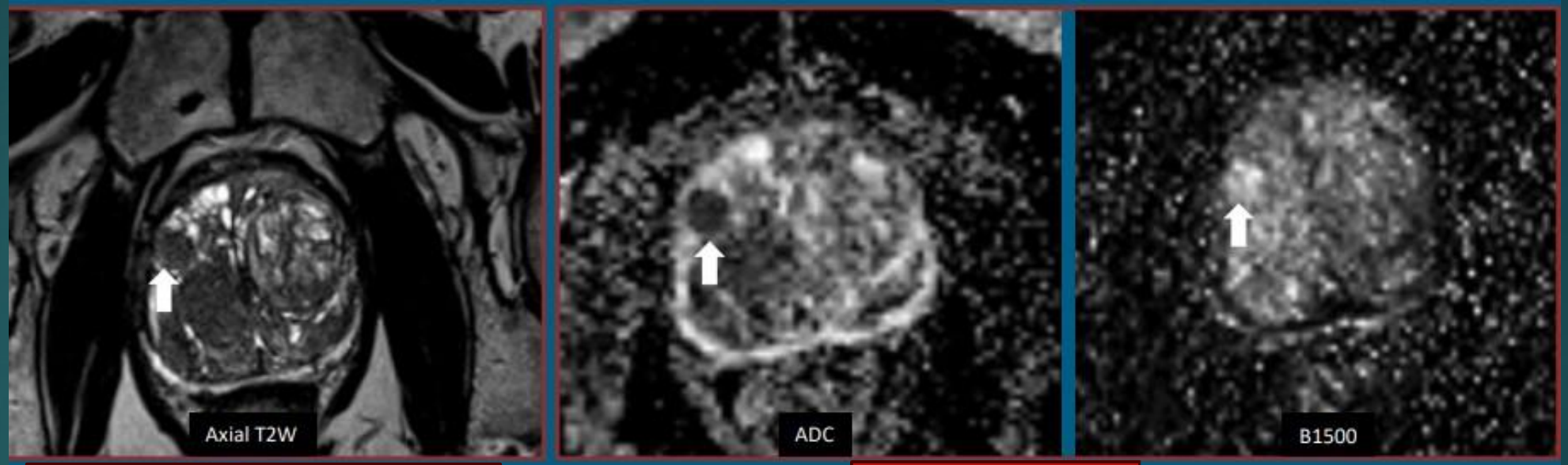
T2 Score 2

PIRADS 2

CZ Nodule

Atypical Nodule

PIRADS 3



T2 score: 2

DWI Score 4

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A

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.

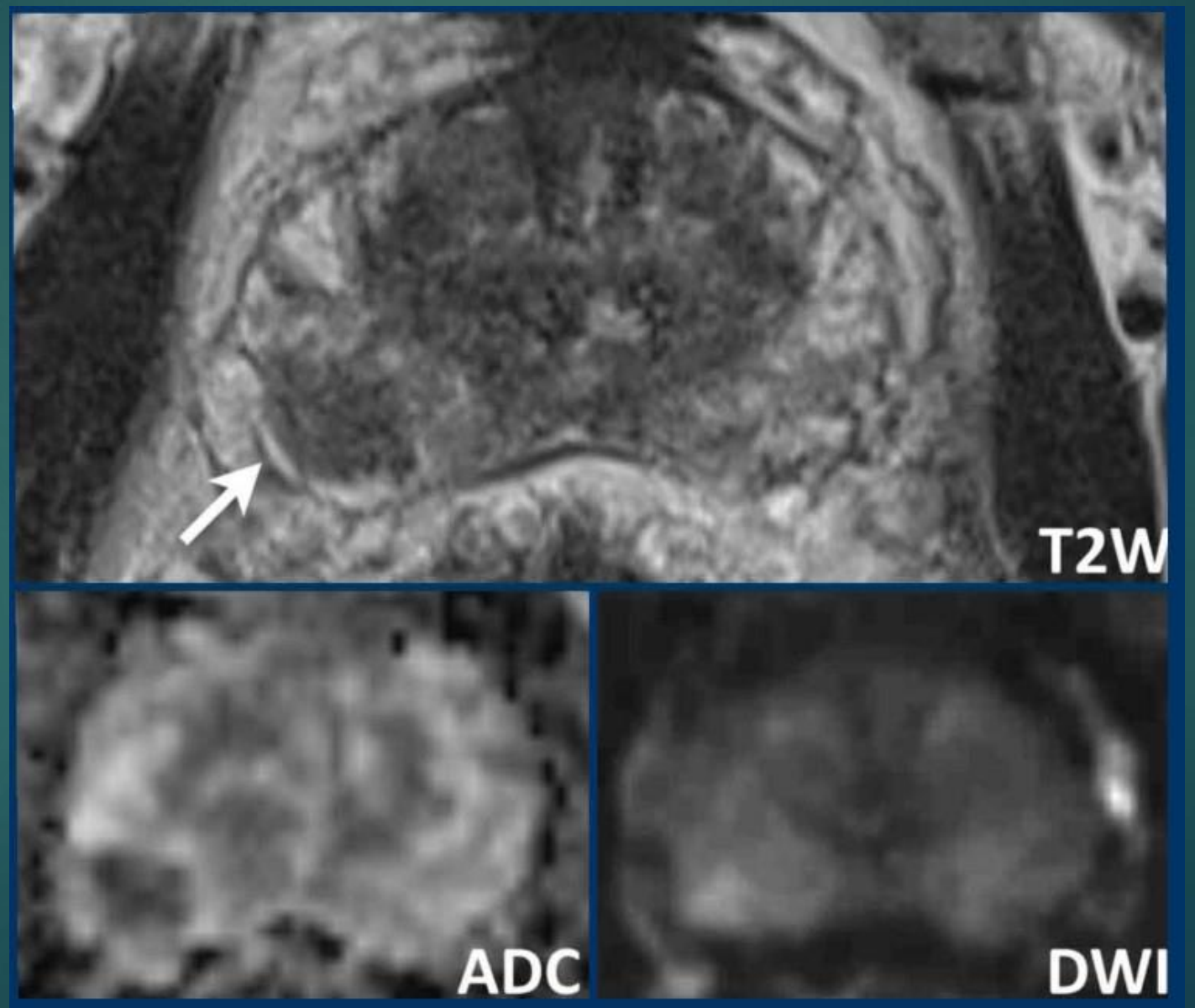
PZ Nodule

Marked ADC
+
Marked DWI

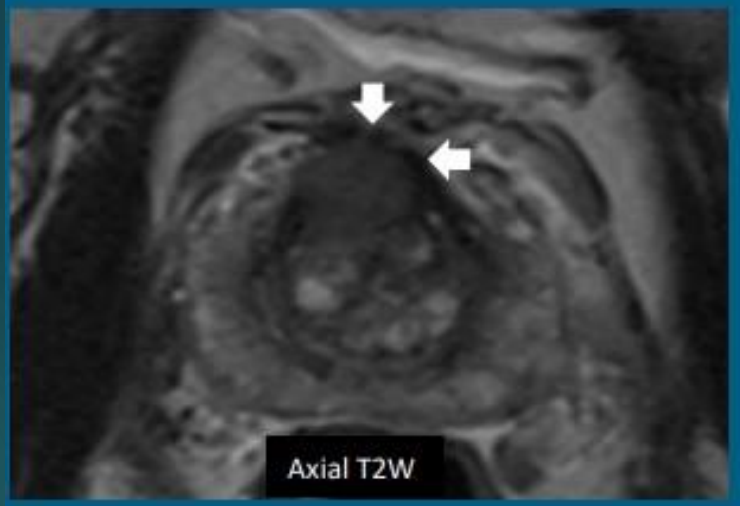
DWI Score 4-5

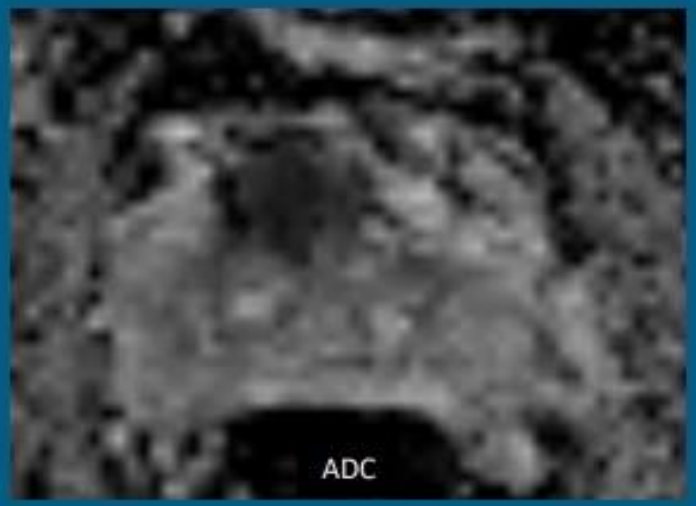
DCE: N/A

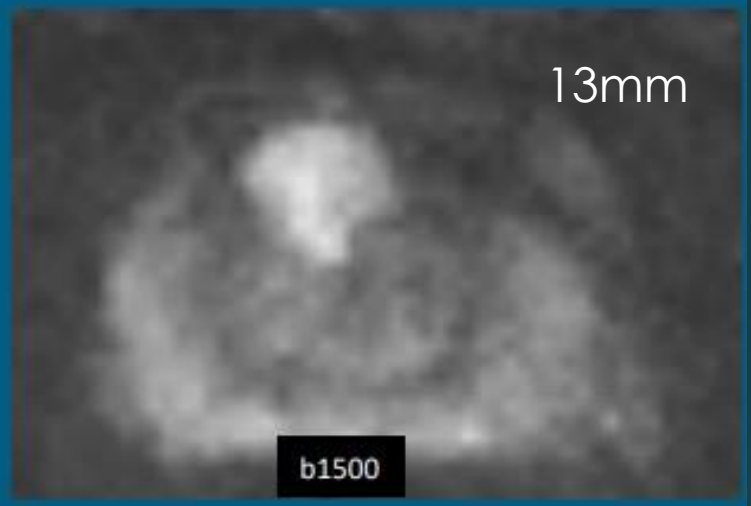
PIRADS 4-5



AFM Tumor







T2 score: erased-charcoal appearance → 4

Restriction does not affect upgrading the T2 score of 4 in TZ
Just size >15mm, and EPE can upgrade the score to 5

PIRADS 4-5 based on size

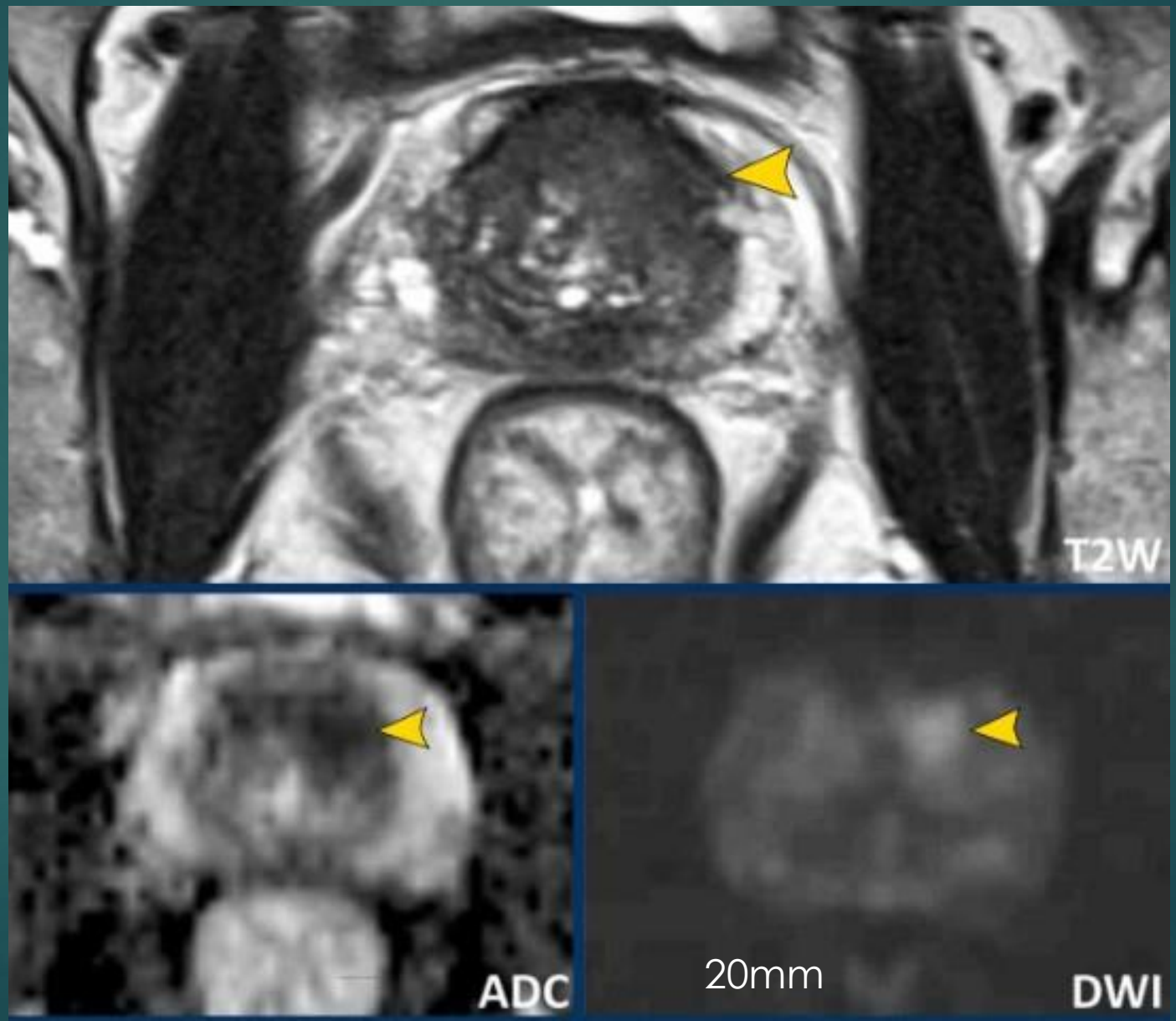
TZ Apex

EUS

T2 score 5

No help from DWI, just better visualization

PIRADS 5



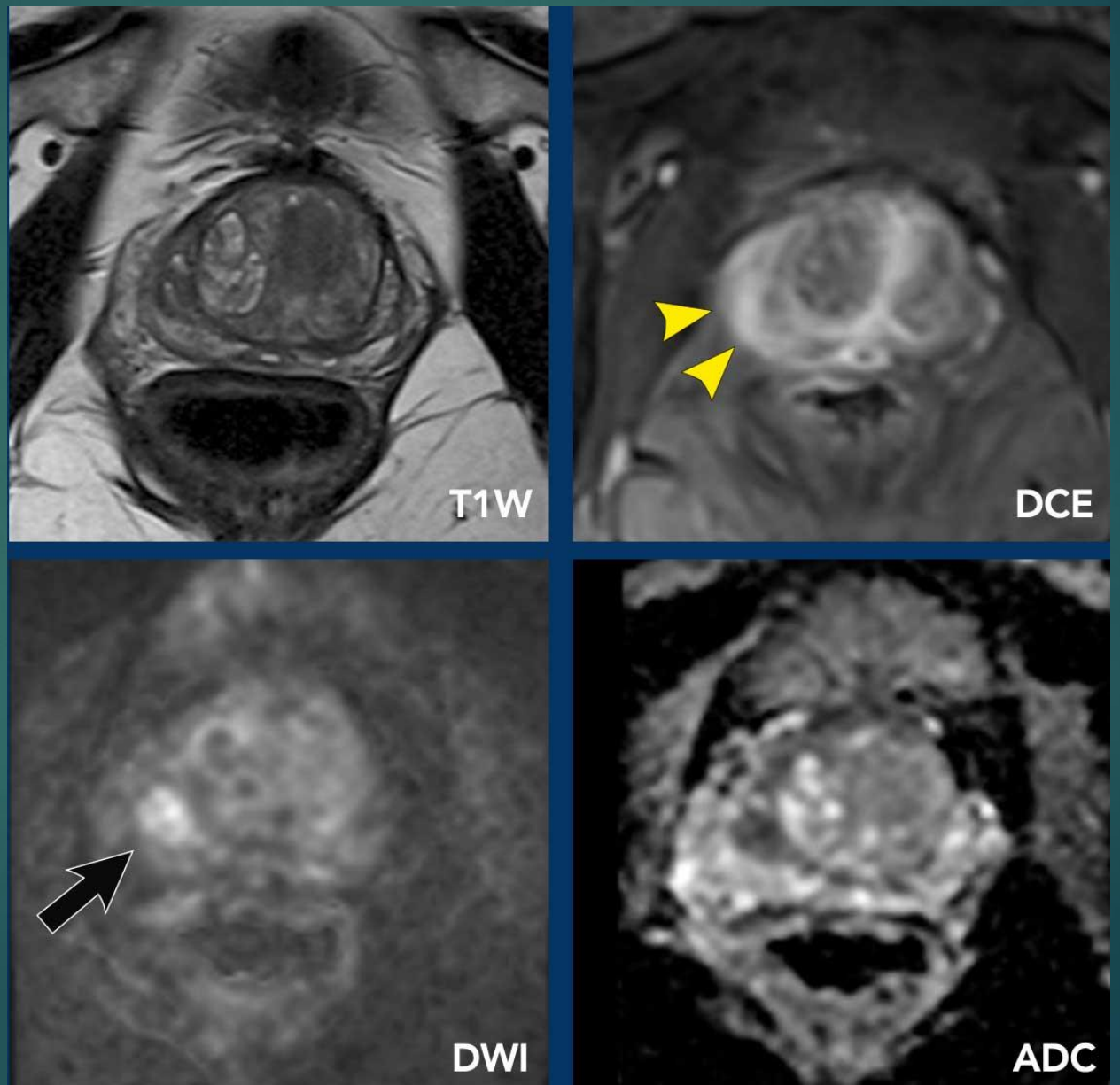
PZ

Marked white DWI
Marked dark ADC

Avid enhancement

DWI Score 4
PIRADS 4

Wrong
It is an Abscess



Thank you

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A

B

A

B

A

B

A

B

EAU Risk Stratification:

- **Low-Risk:**
  - **≤ cT2a, PSA < 10 ng/mL, Gleason ≤ 6**
- **Intermediate-Risk:**
  - **cT2b or PSA 10–20 or Gleason 7 (3+4)**
- **High-Risk:**
  - **≥ cT3 or PSA > 20 or Gleason ≥ 8**

NCCN Risk Stratification

NCCN Risk :

- *Low-Risk:*
  - *PSA < 10 ng/mL*
  - *Gleason ≤ 6*
  - *Clinical Stage ≤ T2a*
- *Intermediate-Risk:*
  - *PSA 10–20 ng/mL or*
  - *Gleason 3+4 or 4+3 or*
  - *Clinical Stage T2b-T2c*
- *High-Risk:*
  - *PSA > 20 ng/mL or*
  - *Gleason ≥ 8 or*
  - *Clinical Stage ≥ T3*

AUA & NCCN; Situations Where mpMRI Remains Essential:

1. *Initial evaluation of biopsy-naïve patients for lesion detection and targeted biopsy planning.*

2. *PI-RADS scoring and local prostate lesion characterization.*

3. *Detailed assessment of local recurrence post-treatment.*

AUA & NCCN; when PSMA PET without mpMRI

1. *Biochemical Recurrence After Definitive Treatment*
2. *High-Risk Newly Diagnosed Prostate Cancer (Staging)*
3. *Contraindications or Limitations to MRI*
4. *Clinical Trial Enrollment or PSMA-Targeted Therapy Planning*

AUA Stratification for localized Pca

TABLE 3: Risk Group Classification for Clinically Localized Prostate Cancer	
Low-Risk	PSA <10 ng/mL AND Grade Group 1 AND clinical stage T1-T2a
Intermediate-Risk	PSA 10-<20 ng/mL OR Grade Group 2-3 OR clinical stage T2b-c
	• Favorable: Grade Group 1 with PSA 10-<20 ng/mL or clinical stage T2b-c and <50%* biopsy cores positive OR Grade Group 2 with PSA<10 ng/mL and clinical stage T1-2a and <50% biopsy cores positive
	• Unfavorable: Grade Group 1 with PSA 10-<20 ng/mL and clinical stage T2b-c OR Grade Group 2 with PSA 10-<20 ng/mL and/or clinical stage T2b-c and/or ≥50%* biopsy cores positive OR Grade Group 3 with PSA <20 ng/mL
High-Risk	PSA ≥20 ng/mL OR Grade Group 4-5 OR clinical stage T3

Tumor (T) Staging

- T1: Clinically inapparent tumor, not palpable or visible on imaging.
  - T1a: Found incidentally in ≤5% of resected tissue.
  - T1b: Found incidentally in >5% of resected tissue.
  - T1c: Identified by needle biopsy due to elevated PSA.
- T2: Tumor confined within the prostate.
  - T2a: Involves ≤50% of one lobe.
  - T2b: Involves >50% of one lobe but not both.
  - T2c: Involves both lobes.
- T3: Tumor extends beyond the prostate capsule.
  - T3a: Extraprostatic extension (unilateral or bilateral).
  - T3b: Invades seminal vesicles.
- T4: Tumor invades adjacent structures (bladder neck, rectum, levator muscles, pelvic wall).

Nodal (N) Staging

- N0: No regional lymph node involvement.
- N1: Metastases in regional lymph nodes.

Metastasis (M) Staging

- M0: No distant metastasis.
- M1: Distant metastasis present.
  - M1a: Involvement of non-regional lymph nodes.
  - M1b: Spread to bones (common metastatic site).
  - M1c: Spread to other organs (lungs, liver, brain).

AUA Guidelines: when to use PSMA PET after mpMRI

High-Risk Prostate Cancer Staging

Biochemical Recurrence (BCR) Detection

Equivocal mpMRI Findings (e.g., PI-RADS 3)

Negative mpMRI but High Clinical Suspicion

Planning for Salvage Therapy

ACR Guidelines for Pca metastasis

Bone Metastases

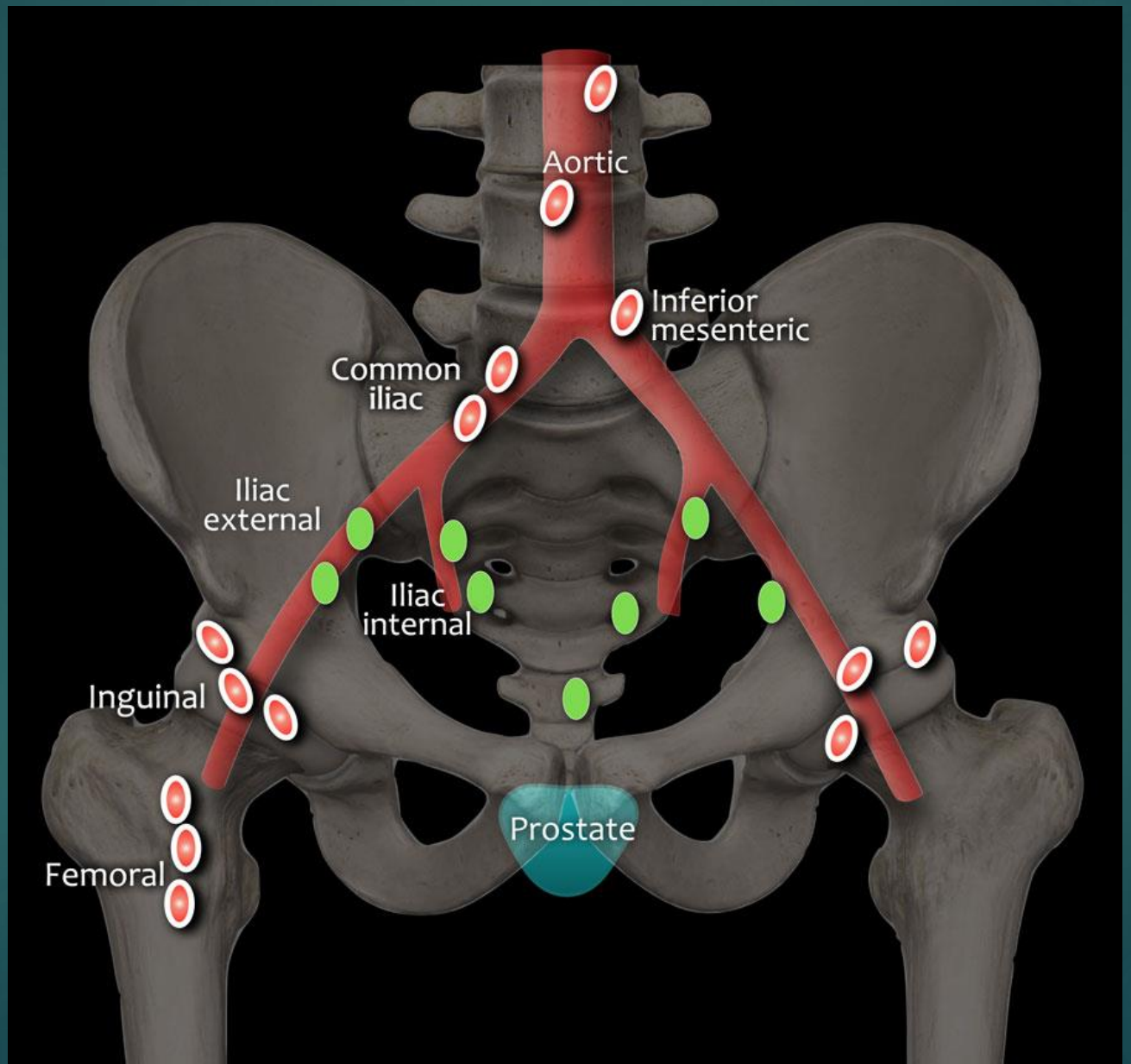
Primary Modality: Radionuclide bone scintigraphy.
Advanced Imaging: PSMA PET/CT (higher sensitivity and specificity), and MRI (superior for bone marrow involvement).

Liver Metastases

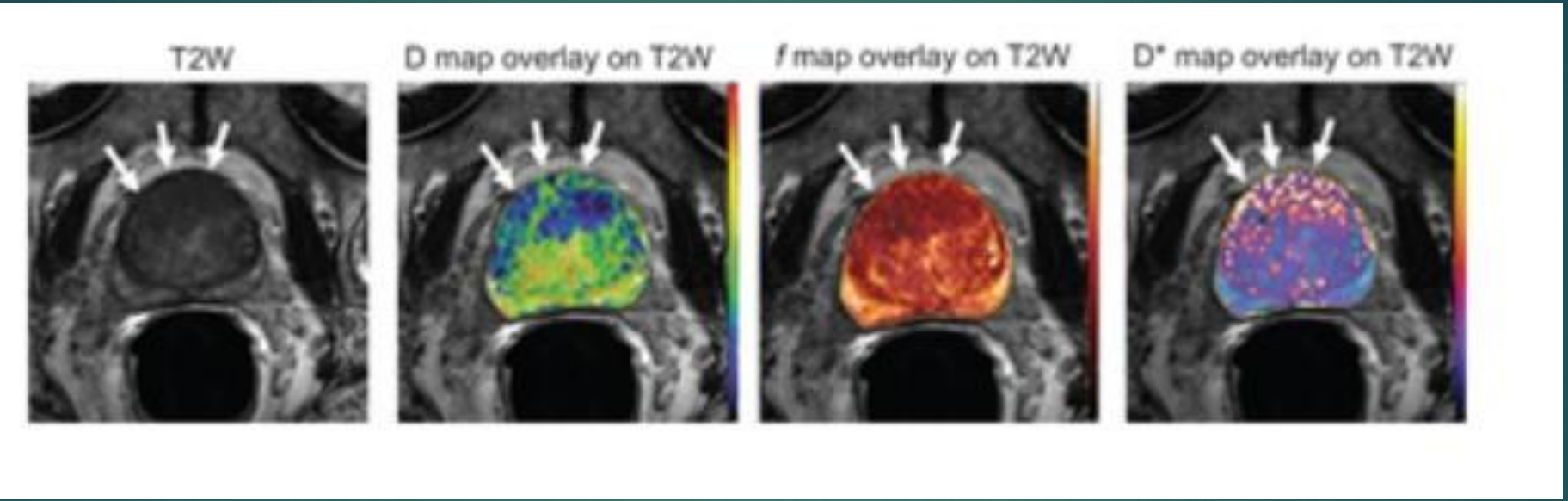
Primary Modalities: Contrast-enhanced multiphase CT (arterial, portal venous, delayed phases) and multiparametric MRI (mpMRI) for superior soft tissue contrast.

Lung Metastases

Primary Modality: Chest CT with intravenous contrast for evaluation of pulmonary metastases.


Aortic
Inferior mesenteric
Common iliac
Iliac external
Iliac internal
Inguinal
Prostate
Femoral

Intravoxel Incoherent Motion (IVIM)



AI in mpMRI

Table 2 Potential applications for artificial intelligence algorithms in prostate imaging

Steps	Tasks
Image Acquisition	**Automated sequence acquisition and quality assessment**
	• Automatically identifying key anatomical landmarks to guide and refine the selection of imaging planes
	• Automated and reproducible assessment of image quality
Image Interpretation	**Organ Segmentation**
	• Precise delineation of prostate boundaries and compartments
	Lesion Segmentation
	• Automated identification and delineation of suspicious lesions
	Lesion Detection
	• Detection of subtle lesions, reducing false negative MRIs
	PI-RADS Scoring
	• Automated assignment of Prostate Imaging Reporting and Data System (PI-RADS) scores
	Staging
	• AI-driven assessment of tumor stage based on imaging features
Reporting	**Automated Reporting**
	• Generation of structured reports based on AI-driven analysis
	Translation to Lay Language
	• Summarization of complex findings in understandable language
Management	**Decision-Making Models**
	• Integration of radiomics, demographic data, and serum markers
	• Personalized risk assessment for informed clinical decision-making
	Biopsy and Treatment Planning
	• AI-guided recommendations for biopsy site selection
	• Treatment planning assistance for optimal therapeutic strategies

AI artificial intelligence, *MRI* magnetic resonance imaging