

# PI-RADS: Utility and Pitfalls

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# Objectives

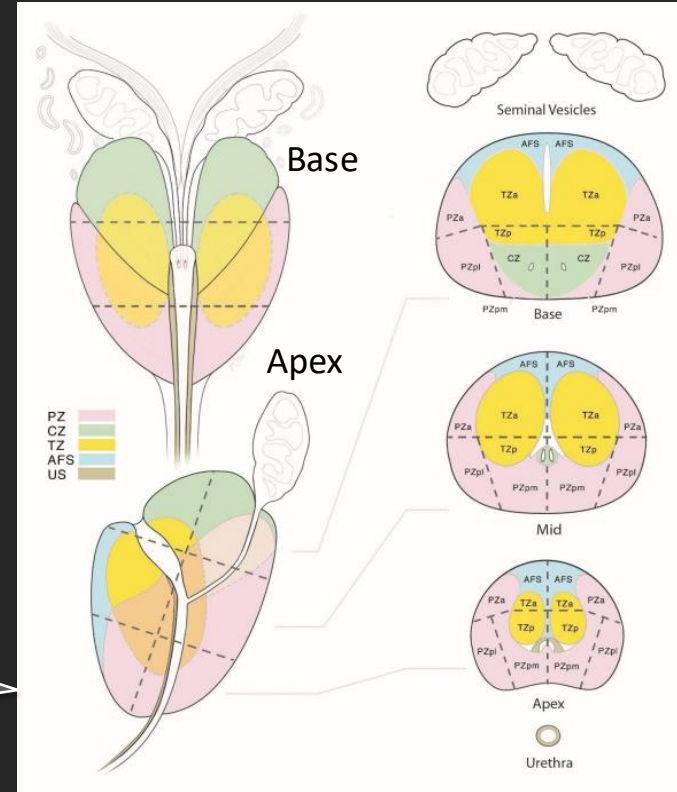
- Provide a basic review of prostate anatomy.
- Distill the key features of PI-RADS v2.1 using multiple case examples.
- Define the common pitfalls in prostate MRI to improve diagnostic specificity.

# Prostate Anatomy

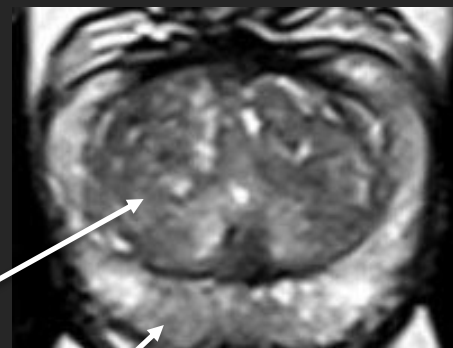
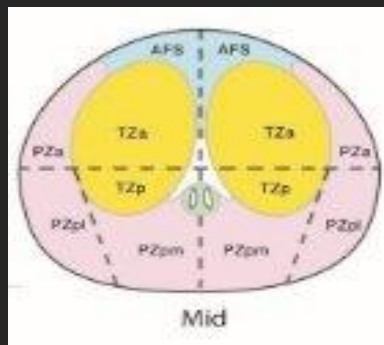
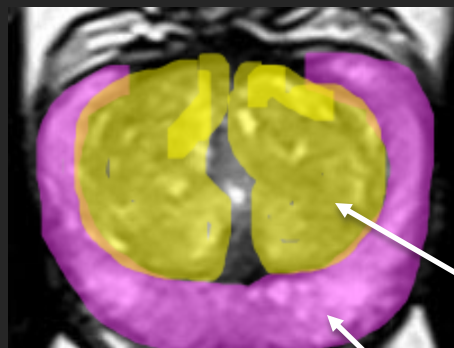
- Prostatic **base** is cranial and **apex** is caudal
- **Transition zone (TZ)** is bilobed, surrounds the prostatic urethra and enlarges in BPH
- **Peripheral zone (PZ)** occupies the posterior and lateral margins of the prostate and is the predominate tissue in the apex
- **Anterior fibromuscular stroma (AFS)** is a strip of tissue along the anterior prostate
- **Central zone (CZ)** (base) surrounds the bilateral ejaculatory ducts

PEARL:  
~75% of cancers  
originate in PZ.  
~25% in TZ.

[PIRADS-2019.pdf](#)



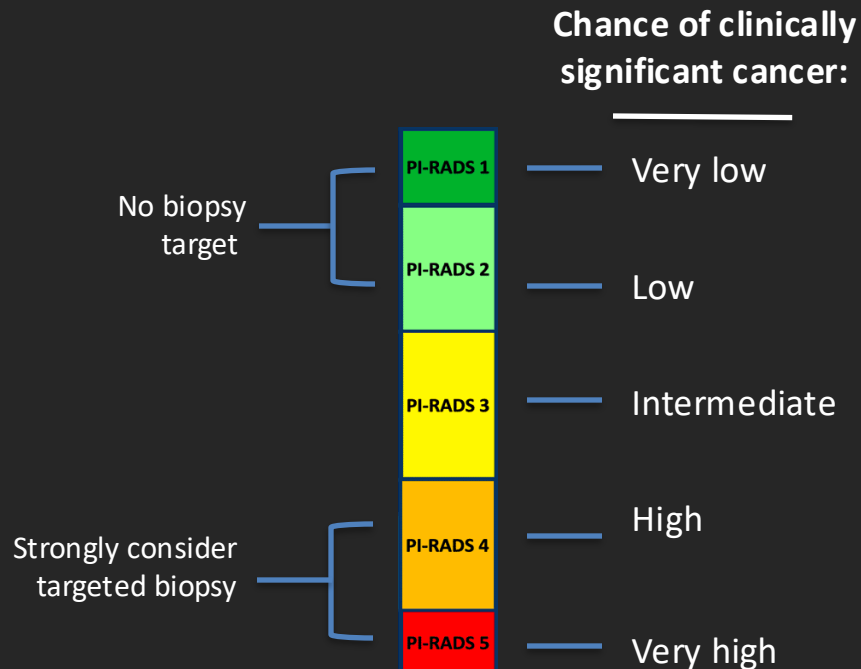
# Normal PZ and TZ



**TZ:** Entirely homogenous signal is rare.  
PI-RADS 1 includes round, completely encapsulated nodules.

**Normal PZ:** homogenous signal, T2 bright

# PI-RADS Assessment Categories



Pathologic definition of "Clinically Significant Cancer" =

- Gleason score  $\geq 7$
- Tumor volume  $\geq 0.5$  cc
- Extraprostatic extension (EPE)

# MRI Features of Assessment Categories

The table is based on the PI-RADS version 2.1.  
Changes from the old version 2.0 are indicated in light red.

Peripheral Zone		Transition Zone	
ADC / DWI		T2W	
1 Normal	PI-RADS 1	Normal appearing TZ (rare) or round, completely encapsulated nodule	1
2 ADC: Linear/wedge shaped hypointense and/or DWI: linear/wedge shaped hyperintense	PI-RADS 2	Mostly encapsulated nodule or Homogeneous circumscribed nodule without capsule or Homogeneous mildly hypointense area between nodules. <b>DWI ≤ 3</b>	2
3 ADC: Focal hypointense and/or DWI: focal hyperintense May be markedly hypointense on ADC or markedly hyperintense on high b-value DWI, but not both. <b>DCE -</b>	PI-RADS 3	Same as above but <b>DWI ≥ 4</b>	2
3 Same as above but <b>DCE +</b>		Heterogeneous signal intensity with obscured margins. Includes others that do not qualify as 2, 4, or 5. <b>DWI ≤ 4</b>	3
4 ADC: Focal markedly hypointense DWI: markedly hyperintense Diameter < 1.5cm	PI-RADS 4	Same as above but <b>DWI = 5</b>	3
5 Same as 4, but ≥ 1.5cm or extraprostatic extension	PI-RADS 5	Lenticular or non-circumscribed, homogeneous, moderately hypointense, < 1.5cm. <b>any DWI</b>	4
		Same as 4, but ≥ 1.5cm or extraprostatic extension. <b>any DWI</b>	5

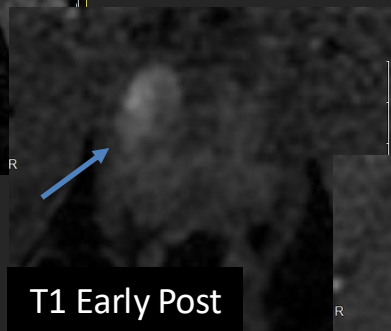
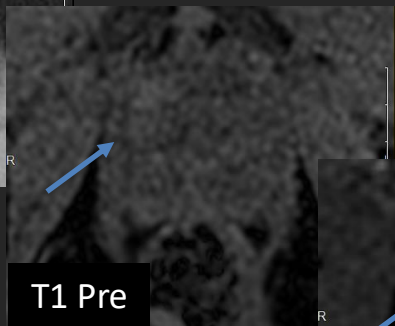
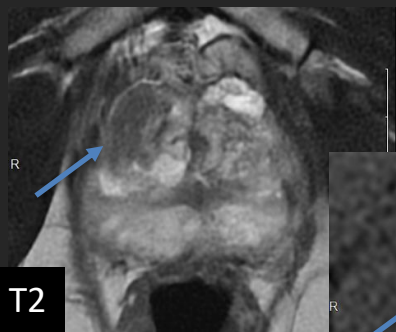
\*When DWI is PI-RADS 3 in the PZ, early dynamic contrast enhancement (DCE +) may upgrade to PI-RADS 4.

Predominant assessment sequences:

- TZ: ADC/DWI
- PZ: T2W

\*Extraprostatic extension (EPE) automatically upgrades to PI-RADS 5!

# Dynamic Contrast Enhancement (DCE)



- Criteria for (+) DCE:
  1. Focal and corresponding to suspicious finding on T2 and/or DWI.
  2. **Earlier enhancement than adjacent normal prostatic tissues.**

This category is commonly overcalled. Simple enhancement is not enough, it needs to be early relative to adjacent tissue!

REMEMBER:  
(+) DCE can upgrade  
a PZ lesion from PI-  
RADS 3 to 4

# Peripheral Zone: PI-RADS 3



[The Radiology Assistant - Prostate Cancer - PI-RADS v2.1](#)

## Primary features:

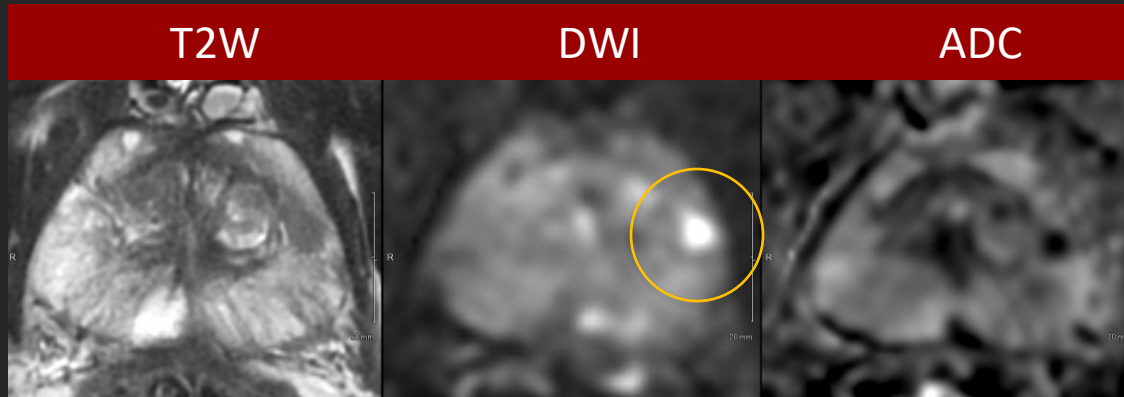
- Focal, **not** wedge shaped or linear
- Diffusion restriction is limited to mild/moderate on either DWI or ADC.

PZ

ADC / DWI	
1 Normal	PI-RADS 1
2 ADC: Linear/wedge shaped hypointense and/or DWI: linear/wedge shaped hyperintense	PI-RADS 2
3 ADC: Focal hypointense and/or DWI: focal hyperintense May be markedly hypointense on ADC or markedly hyperintense on high b-value DWI, but not both. <b>DCE -</b>	<b>PI-RADS 3</b>
3 Same as above but DCE +	PI-RADS 4
4 ADC: Focal markedly hypointense DWI: markedly hyperintense Diameter < 1.5cm	
5 Same as 4, but ≥ 1.5cm or extraprostatic extension	PI-RADS 5



# Peripheral Zone: PI-RADS 4



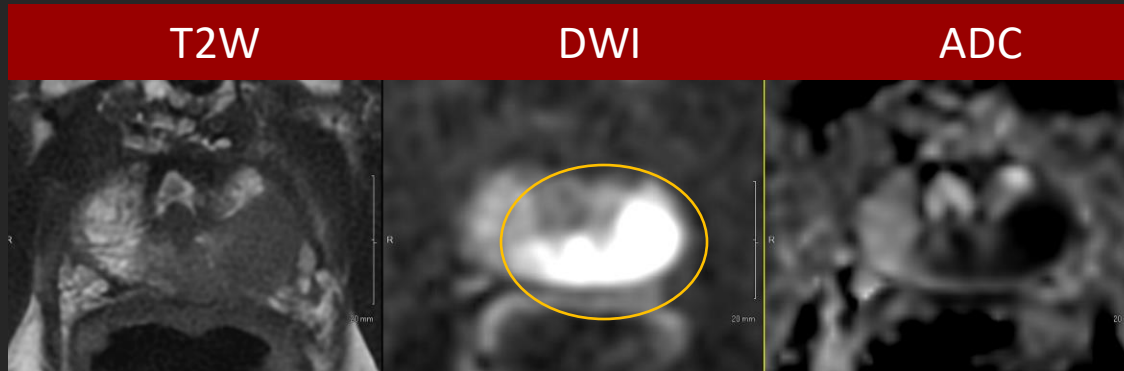
## Primary features:

- **Marked** diffusion restriction on both DWI and ADC
- Focal and **< 1.5 cm**

PZ

ADC / DWI	
1 Normal	PI-RADS 1
2 ADC: Linear/wedge shaped hypointense and/or DWI: linear/wedge shaped hyperintense	PI-RADS 2
3 ADC: Focal hypointense and/or DWI: focal hyperintense May be markedly hypointense on ADC or markedly hyperintense on high b-value DWI, but not both. DCE -	PI-RADS 3
3 Same as above but DCE +	PI-RADS 4
4 ADC: Focal markedly hypointense DWI: markedly hyperintense Diameter < 1.5cm	
5 Same as 4, but $\geq 1.5$ cm or extraprostatic extension	PI-RADS 5

# Peripheral Zone: PI-RADS 5



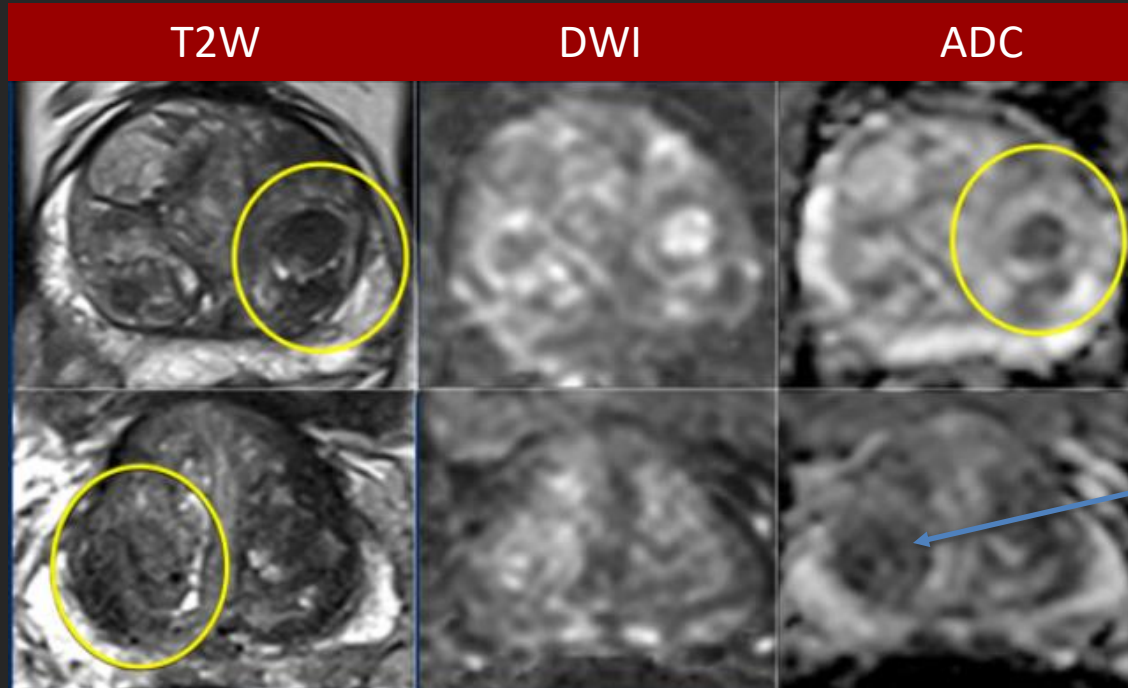
## Primary features:

- **Marked** diffusion restriction on both DWI and ADC
- Focal and **> 1.5 cm**

PZ

ADC / DWI	
1 Normal	PI-RADS 1
2 ADC: Linear/wedge shaped hypointense and/or DWI: linear/wedge shaped hyperintense	PI-RADS 2
3 ADC: Focal hypointense and/or DWI: focal hyperintense May be markedly hypointense on ADC or markedly hyperintense on high b-value DWI, but not both. DCE -	PI-RADS 3
3 Same as above but DCE +	PI-RADS 4
4 ADC: Focal markedly hypointense DWI: markedly hyperintense Diameter < 1.5cm	
5 Same as 4, but $\geq 1.5$ cm or extraprostatic extension	PI-RADS 5

# Transition Zone: PI-RADS 3



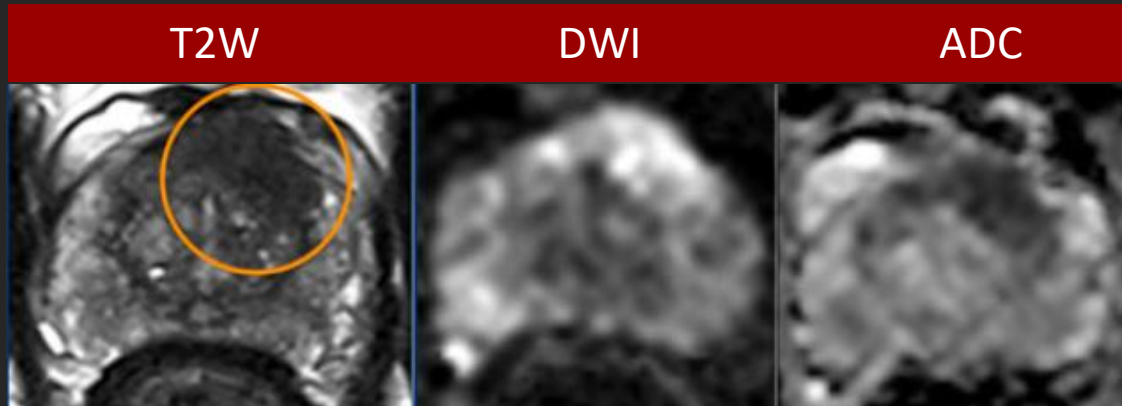
TZ



	T2W	
PI-RADS 1	Normal appearing TZ (rare) or round, completely encapsulated nodule	1
PI-RADS 2	Mostly encapsulated nodule or Homogeneous circumscribed nodule without capsule or Homogeneous mildly hypointense area between nodules. $DWI \leq 3$	2
	Same as above but $DWI \geq 4$	2
PI-RADS 3	Heterogeneous signal intensity with obscured margins. Includes others that do not qualify as 2, 4, or 5. $DWI \leq 4$	3
	Same as above but $DWI = 5$	3
PI-RADS 4	Lenticular or non-circumscribed, homogeneous, moderately hypointense, $< 1.5\text{cm}$ . any $DWI$	4
PI-RADS 5	Same as 4, but $\geq 1.5\text{cm}$ or extra-prostatic extension. any $DWI$	5

# Transition Zone: PI-RADS 4

TZ



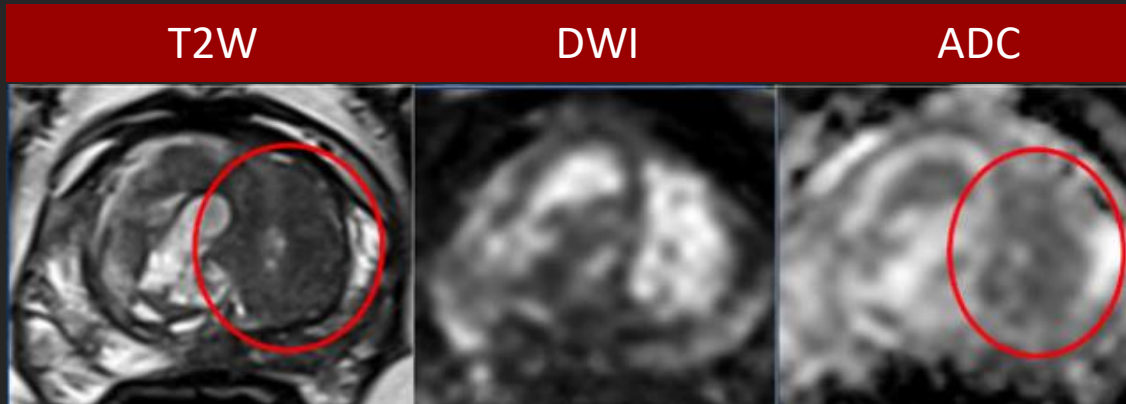
## Primary features:

- Differs from PI-RADS 3 in that the T2 signal is **homogenous** and **moderately** intense.
- < 1.5 cm

	T2W	
PI-RADS 1	Normal appearing TZ (rare) or round, completely encapsulated nodule	1
PI-RADS 2	Mostly encapsulated nodule or Homogeneous circumscribed nodule without capsule or Homogeneous mildly hypointense area between nodules. $DWI \leq 3$	2
	Same as above but $DWI \geq 4$	2
PI-RADS 3	Heterogeneous signal intensity with obscured margins. Includes others that do not qualify as 2, 4, or 5. $DWI \leq 4$	3
	Same as above but $DWI = 5$	3
PI-RADS 4	Lenticular or non-circumscribed, homogeneous, moderately hypointense, < 1.5cm. <b>any DWI</b>	4
PI-RADS 5	Same as 4, but $\geq 1.5$ cm or extra-prostatic extension. <b>any DWI</b>	5

# Transition Zone: PI-RADS 5

TZ



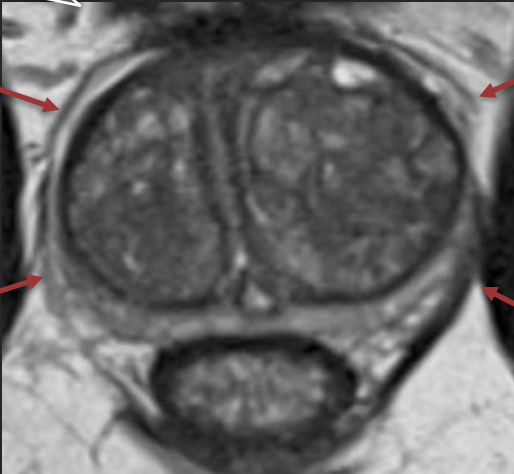
## Primary features:

- T2 signal is homogenous and moderately intense.
- >1.5 cm

	T2W	
PI-RADS 1	Normal appearing TZ (rare) or round, completely encapsulated nodule	1
PI-RADS 2	Mostly encapsulated nodule or Homogeneous circumscribed nodule without capsule or Homogeneous mildly hypointense area between nodules. $DWI \leq 3$	2
	Same as above but $DWI \geq 4$	2
PI-RADS 3	Heterogeneous signal intensity with obscured margins. Includes others that do not qualify as 2, 4, or 5. $DWI \leq 4$	3
	Same as above but $DWI = 5$	3
PI-RADS 4	Lenticular or non-circumscribed, homogeneous, moderately hypointense, < 1.5cm. any DWI	4
PI-RADS 5	Same as 4, but $\geq 1.5$ cm or extra-prostatic extension. any DWI	5

# Extra-prostatic extension (EPE)

REMEMBER:  
EPE automatically advances  
the lesion to PI-RADS 5 -->  
detection is critical!



- There is no true anatomic prostate capsule.
- On MRI however, the outer border is seen as a thin hypointense line (arrows)
- This line is used to assess extra-prostatic tumor growth.

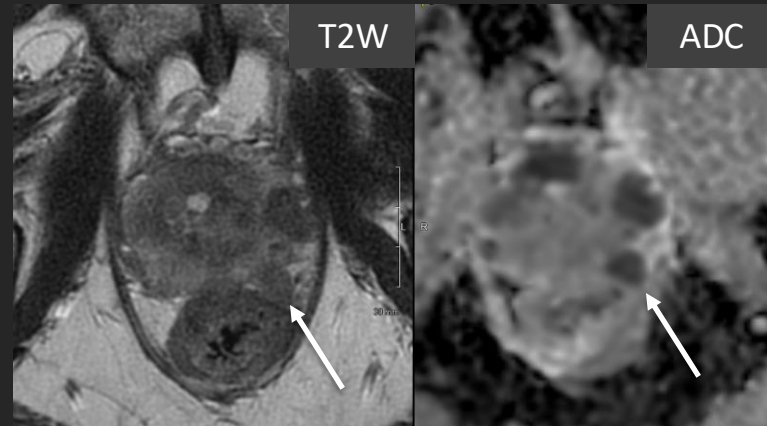
Nerve-sparing surgery is not possible when NV extension is seen.

## Neurovascular Bundles



Normal neurovascular bundles are located posterolaterally at 5 and 7 o'clock.

Multiple PI-RADS 5 lesions with probable extension into the left neurovascular bundle (arrows)



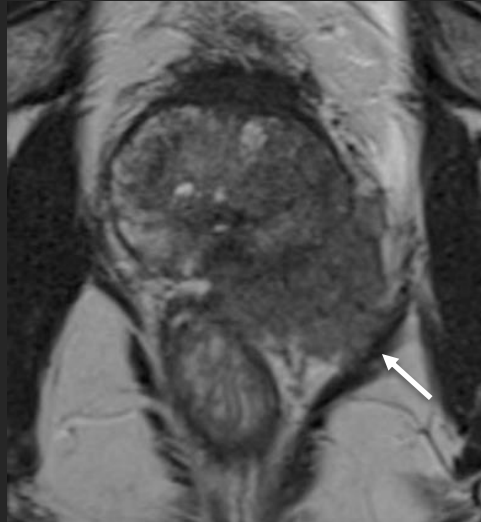
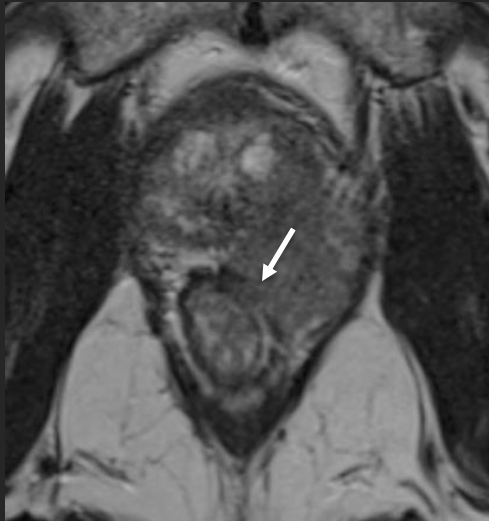


# Extra-Prostatic Invasion

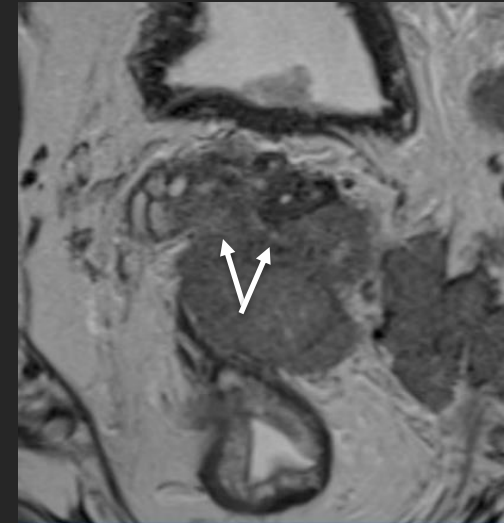
Tumor can invade adjacent structures including the:

Pelvic floor

Mesorectum and rectum

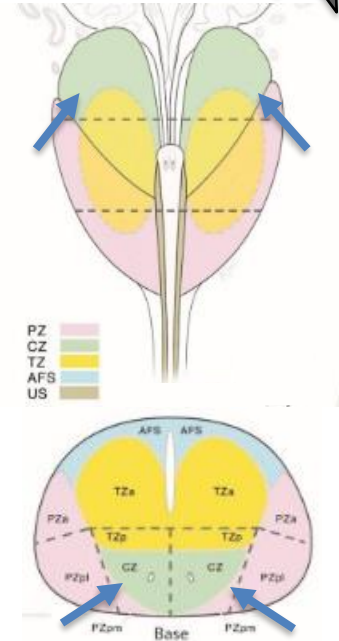


Seminal vesicles






PEARL:  
CZ will typically be  
symmetric, unlike  
cancer!

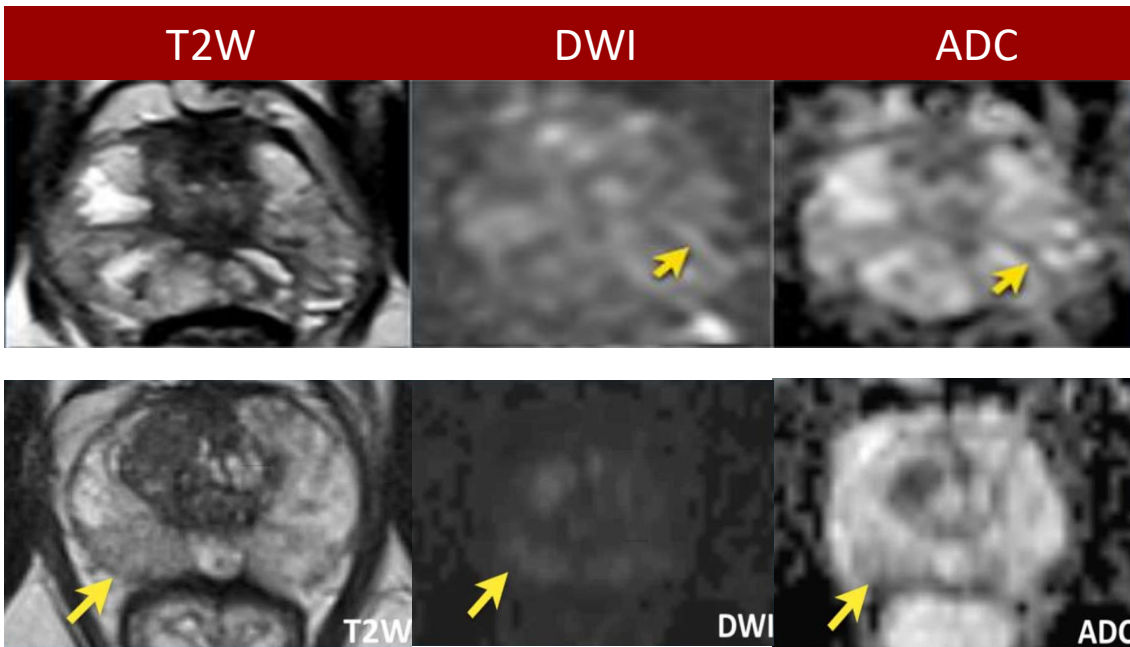


Normal central zone (solid arrows) has low T2 signal intensity and can resemble multifocal cancer (dash arrows).

## Acute and Chronic Prostatitis (PZ PI-RADS 2)



PEARL:  
Prostatitis can be  
asymptomatic!



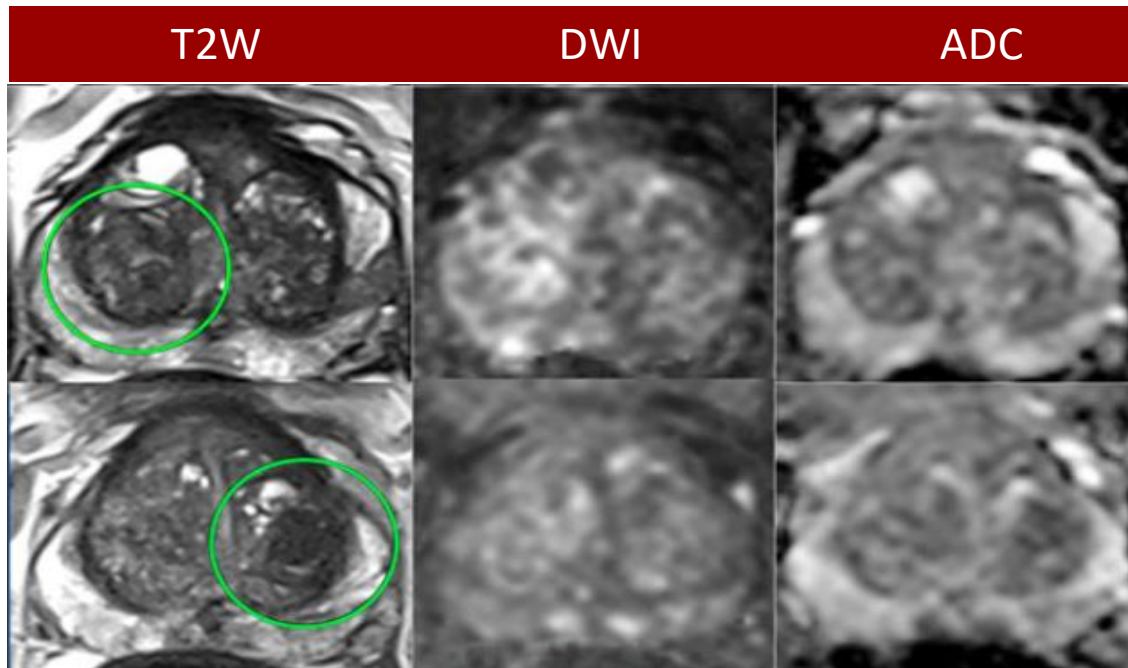
## Differential

	Prostatitis	PZ Prostate cancer
Focus	<u>Linear</u> (e.g. 1) or <u>Wedge shaped</u> (e.g. 2)	Round or droplet shaped
Border	Sharp	Ill-defined
Diffusion Restriction	Mild	Marked

# Pitfall #3

## Stromal BPH Nodule (TZ PI-RADS 2/3 )

PEARL:  
Shape and border are  
the primary  
distinguishing factors!



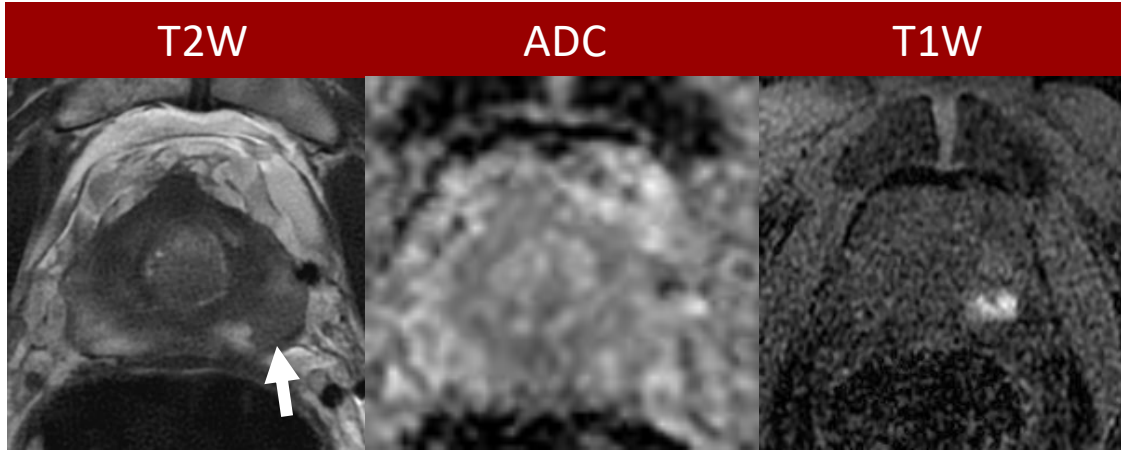
### Differential

	Stromal BPH Nodule	TZ Prostate cancer
Shape	Spherical	Lenticular or irregularly shaped
Border	Encapsulated (e.g. 1) or non-encapsulated (e.g. 2)	"Creeping" border w/ possible extension into PZ or AFS
Diffusion Restriction	Mild	Marked

# Pitfall #4

## Post Biopsy Hemorrhage

PEARL:  
Remember, evolving  
blood products change  
signal characteristics  
over time!



Subacute hemorrhage (arrow) has high T1W signal and no diffusion restriction while cancer has low T1W signal and restricts diffusion.

### Differential

	Hemorrhage	Prostate cancer
T1 Signal	High (subacute)	Low
T2 Signal	Heterogeneous	Low
Diffusion Restriction	None	Marked

# Summary

Transition Zone: Primarily assessed with T2.

Peripheral Zone: Primarily assessed with DWI.

- (+) DCE can upgrade PI-RADS 3 to 4

Dynamic Contrast Enhancement: **Early** enhancement of the lesion **relative to** the normal prostatic tissue.

Extraprostatic extension: Significant prognostic factor and upgrades lesion to PI-RADS 5.

## PITFALLS

1. Normal central zone
2. Acute/Chronic Prostatitis
3. Stromal BPH Nodule
4. Post Biopsy Hemorrhage

# References

- Rosenkrantz AB, Taneja SS. Radiologist, be aware: ten pitfalls that confound the interpretation of multiparametric prostate MRI. AJR Am J Roentgenol. 2014 Jan;202(1):109-20.
- American College of Radiology® Committee on PI-RADS®. PI-RADS 2019 v2.1. Available at: <https://www.acr.org/-/media/ACR/Files/RADS/PI-RADS/PIRADS-V2-1.pdf>. American College of Radiology. Accessed on Jan. 1, 2025.
- The Radiology Assistant : Prostate Cancer - PI-RADS v2.1, Georgios Agrotis<sup>1</sup>, Rhiannon van Loenhout<sup>2</sup>, Frank Zijta<sup>2</sup>, Robin Smithuis<sup>3</sup> and Ivo Schoots<sup>4</sup>.

