

# Prostate MRI

# PI-RADS™ v2 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)
- 
- Clinically significant cancer: for PI-RADS™ v2 clinically significant cancer is defined on pathology/histology as Gleason score  $\geq 7$  (including 3+4 with prominent but not predominant Gleason 4 component), and/or volume  $\geq 0.5\text{cc}$ , and/or extra prostatic extension (EPE).

# Changes to PI-RADS version 2 from v1

- Only DWI-ADC and T2W are scored using 5-point scale
- Now has specific descriptors for scores of 3
- Dynamic contrast-enhanced now scored as positive or negative; no longer receive a 1-5 score based on enhancement pattern
  - Kinetic curves not included in guidelines
- MR spectroscopy removed
- 1.5 cm is used as cutoff between PI-RADS 4 and PI-RADS 5 lesions

# Scoring: Peripheral zone lesions

- For peripheral zone lesions, the score is assigned based on the lesion's appearance on the ADC map and high b-value DWI.
- Dynamic contrast-enhanced MRI assumes a secondary role and is used as an ancillary parameter
  - Specifically for peripheral zone lesions that receive a score of 3 at DWI-ADC, a dynamic contrast-enhanced MR imaging score of “positive” (as described subsequently) may result in an overall assessment category of 4.
- If DWI is diagnostic and repeating doesn't help or isn't possible, use T2W score with DCE as ancillary parameter

# Scoring: Transition zone lesions

- For abnormalities in the transition zone, the overall assessment category is based primarily on the score assigned at T2-weighted MR imaging.
- DWI-ADC assumes a secondary role in these cases and is considered an ancillary feature solely for transition zone lesions that are deemed equivocal for clinically significant cancer based on T2-weighted MR imaging.
  - Specifically, for transition zone lesions that receive a score of 3 at T2-weighted MR imaging, a DWI-ADC score of 5 results in an overall assessment category of 4.

# Peripheral zone descriptors

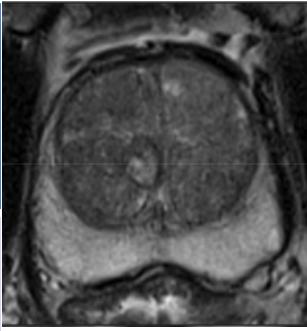
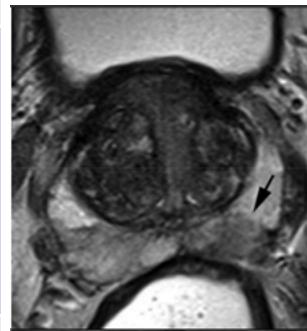
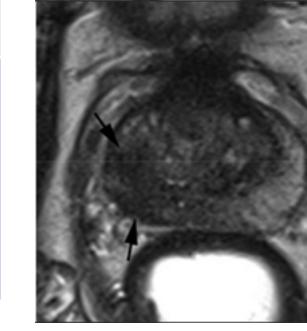
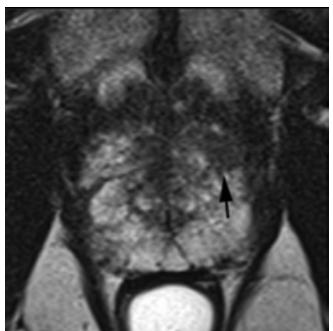
PI-RADS Score	DWI	T2
1	No abnormality (i.e., normal) on ADC and high b-value DWI	Uniform hyperintense signal intensity (normal)
2	Indistinct hypointense on ADC	Linear or wedge-shaped hypointensity or diffuse mild hypointensity, usually indistinct margin
3	Focal mildly/moderately hypointense on ADC and isointense/mildly hyperintense on high b-value DWI	<ul style="list-style-type: none"><li>- Heterogeneous signal intensity or non-circumscribed, rounded, moderate hypointensity</li><li>- Includes others that do not qualify as 2, 4, or 5</li></ul>
4	Focal markedly hypointense on ADC and markedly hyperintense on high b-value DWI $<1.5\text{cm}$ in greatest dimension	Circumscribed, homogenous moderate hypointense focus/mass confined to prostate and $<1.5\text{ cm}$ in greatest dimension
5	Same as 4 but $\geq 1.5\text{cm}$ in greatest dimension or definite extraprostatic extension/invasive behavior	Same as 4 but $\geq 1.5\text{cm}$ in greatest dimension or definite extraprostatic extension/invasive behavior

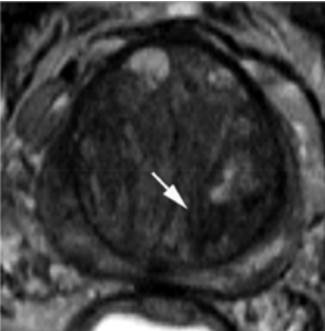
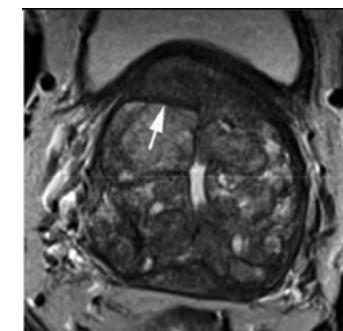
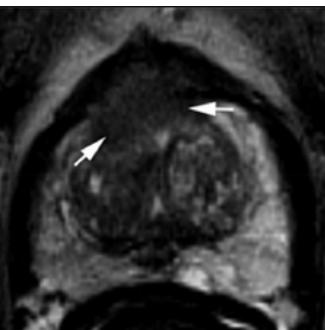
# Transition zone descriptors

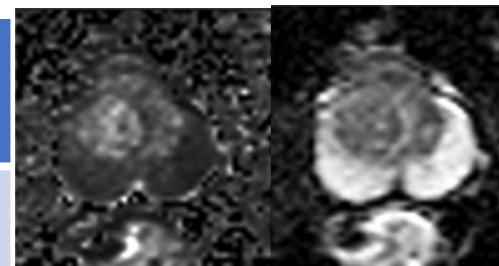
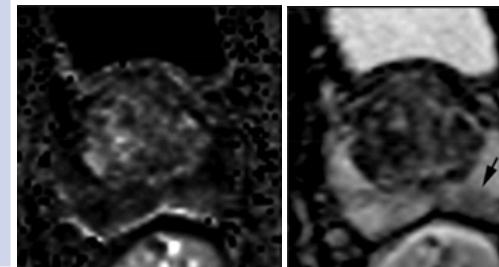
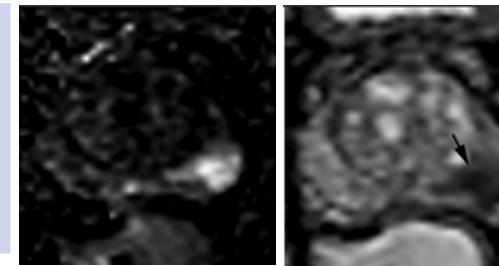
Score	DWI	T2
1	No abnormality (i.e., normal) on ADC and high b-value DWI	Homogeneous intermediate signal intensity (normal)
2	Indistinct hypointense on ADC	Circumscribed hypointense or heterogeneous encapsulated nodule(s) (BPH)
3	Focal mildly/moderately hypointense on ADC and isointense/mildly hyperintense on high b-value DWI.	Heterogeneous signal intensity with obscured margins Includes others that do not qualify as 2, 4, or 5
4	Focal markedly hypointense on ADC and markedly hyperintense on high b-value DWI; <1.5cm in greatest dimension	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	Same as 4, but ≥1.5cm in greatest dimension or definite extraprostatic extension/invasive behavior

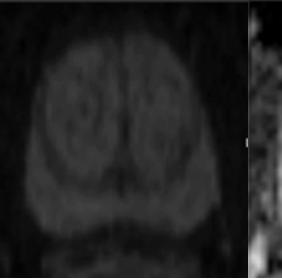
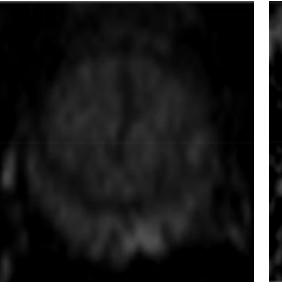
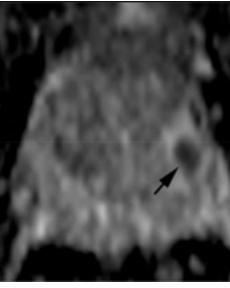
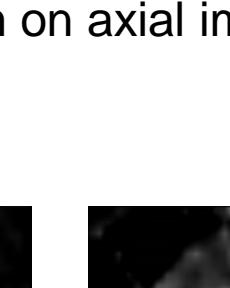
# Dynamic contrast-enhanced descriptors (PZ or TZ)

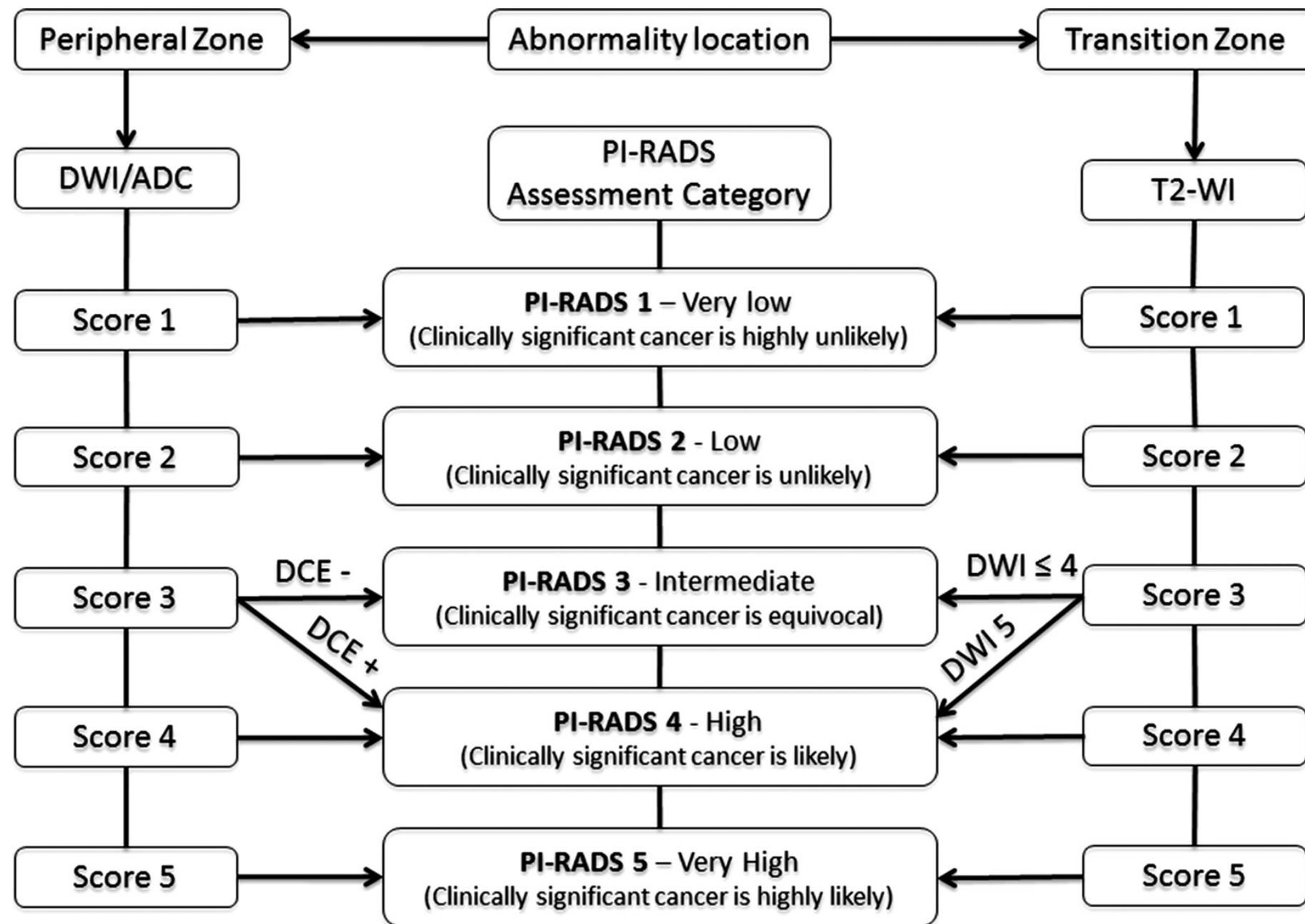
PI-RADS Score	PZ or TZ
-	no early enhancement, or diffuse enhancement not corresponding to a focal finding on T2W and/or DWI or focal enhancement corresponding to a lesion demonstrating features of BPH on T2WI
+	focal, and; earlier than or contemporaneously with enhancement of adjacent

Score	T2 in peripheral zone		
1	Uniform hyperintense signal intensity (normal)		Uniform hyperintense signal intensity (normal).
2	Linear or wedge-shaped hypointensity or diffuse mild hypointensity, usually indistinct margin		Linear (arrow), wedge-shaped, or diffuse mild hypointensity, usually indistinct margin.
3	Heterogeneous signal intensity or non-circumscribed, rounded, moderate hypointensity Includes others that do not qualify as 2, 4, or 5		Heterogeneous signal intensity or non-circumscribed, rounded, moderate hypointensity (arrow)
4	Circumscribed, homogenous moderate hypointense focus/mass confined to prostate and <1.5 cm in greatest dimension		Circumscribed, homogenous moderate hypointense focus/mass confined to prostate and <1.5 cm in greatest dimension (arrow).
5	Same as 4 but ≥1.5cm in greatest dimension or definite extraprostatic extension/invasive behavior		Same as 4 but ≥1.5cm in greatest dimension (arrows) or definite extraprostatic extension/invasive behavior.

Score	T2 in transition zone		
1	Homogeneous intermediate signal intensity (normal)		Homogeneous intermediate signal intensity (normal).
2	Circumscribed hypointense or heterogeneous encapsulated nodule(s) (BPH)		Circumscribed (arrows) 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		Heterogeneous signal intensity with obscured margins (arrow). 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		Lenticular (arrow) 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		Same as 4, but ≥1.5cm in greatest dimension (arrows) or definite extraprostatic extension/invasive behavior.

Score	DWI peripheral zone lesions		No abnormality (i.e. normal) on ADC and high b- value DWI.
1	No abnormality (i.e., normal) on ADC and high b-value DWI		
2	Indistinct hypointense on ADC		Indistinct hypointense on ADC (arrow).
3	Focal mildly/moderately hypointense on ADC and isointense/mildly hyperintense on high b-value DWI		Focal mildly/moderately hypointense on ADC (arrow) and isointense/mildly hyperintense on high b-value DWI.
4	Focal markedly hypointense on ADC and markedly hyperintense on high b-value DWI; <1.5cm in greatest dimension		Focal markedly hypointense on ADC (arrow) and markedly hyperintense on high b-value DWI; <1.5cm on axial images.
5	Same as 4 but ≥1.5cm in greatest dimension or definite extraprostatic extension/invasive behavior		Same as 4 but ≥1.5cm in greatest dimension (arrow) or definite extraprostatic extension / invasive behavior.

Score	DWI transition zone lesions		
1	No abnormality (i.e., normal) on ADC and high b-value DWI		No abnormality (i.e. normal) on ADC and high b-value DWI.
2	Indistinct hypointense on ADC		Indistinct hypointense on ADC.
3	Focal mildly/moderately hypointense on ADC and isointense/mildly hyperintense on high b-value DWI.	 	Focal mildly/moderately hypointense on ADC (arrow) and isointense/mildly hyperintense on high b-value DWI.
4	Focal markedly hypointense on ADC and markedly hyperintense on high b-value DWI; <1.5cm in greatest dimension		Focal markedly hypointense on ADC (arrow) and markedly hyperintense on high b-value DWI; <1.5cm on axial images.
5	Same as 4 but ≥1.5cm in greatest dimension or definite extraprostatic extension/invasive behavior		Same as 4 but ≥1.5cm in greatest dimension (arrow) or definite extraprostatic extension / invasive behavior.



## PI-RADS Assessment

Peripheral Zone (PZ)

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

\* "Any" indicates 1-5

Transition Zone (TZ)

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

\* "Any" indicates 1-5

## Assessment Without Adequate DCE

Peripheral Zone (PZ): Determined by DWI Assessment Category

Transition Zone (TZ)

T <sub>2</sub> W	DWI	DCE	PI-RADS
1	Any	X	1
2	Any	X	2
3	≤4	X	3
	5	X	4
4	Any	X	4
5	Any	X	5

## Assessment Without Adequate DWI

Peripheral Zone (PZ) and Transition Zone (TZ)

T <sub>2</sub> W	DWI	DCE	PI-RADS
1	X	Any	1
2	X	Any	2
3	X	-	3
		+	4
4	X	Any	4
5	X	Any	5

# Caveats

- Symmetric bilateral findings are often normal anatomic structures or benign processes
  - Ex: Central zone at the base of the prostate gland
- Prostatitis can show abnormal signal on all pulse sequences
  - Tend to be more indistinct, linear, lobar, or diffuse whereas cancer is usually more discrete
- In the TZ, round circumscribed encapsulated nodules usually represent BPH and rarely represent clinically significant cancer, despite showing pronounced changes at DWI-ADC and DCE.
  - These lesions do not need to be assigned a PI-RADS category
- In the PZ, a round circumscribed encapsulated lesion likely represents extruded benign prostatic hyperplasia and warrants an overall assessment category of 2, regardless of the presence of reduced ADC
- Benign lesions including prostatitis can mimic prostate cancer; cancer tends to have a lower ADC (750-900 mm<sup>2</sup>/sec or lower on ADC map)
- Changes from prostatitis (including granulomatous prostatitis) can cause signal abnormalities in the PZ with all pulse sequences. Morphology and signal intensity may be helpful to stratify the likelihood of malignancy. In the PZ, mild signal changes on T2W and/or DWI that are not rounded but rather indistinct, linear, lobar, or diffuse are less likely to be malignant
- For the PZ, DWI is the primary determining sequence (dominant technique). Thus, if the DWI score is 4 and T2W score is 2, PI-RADS Assessment Category should be 4.
- For the TZ, T2W is the primary determining sequence. Thus, if the T2W score is 4 and DWI score is 2, PI-RADS Assessment Category should be 4.

# Invasion on MRI

- Imaging features used to assess for EPE include asymmetry or invasion of the neurovascular bundles, a bulging prostatic contour, an irregular or spiculated margin, obliteration of the rectoprostatic angle, a tumor-capsule interface of greater than 1.0 cm, breach of the capsule with evidence of direct tumor extension or bladder wall invasion.
- Seminal vesicle invasion: Tumor extension into seminal vesicle There are 3 types:
  - 1) Tumor extension along the ejaculatory ducts into the seminal vesicle above the base of the prostate; focal T2 hypointense signal within and/or along the seminal vesicle; enlargement and T2 hypointensity within the lumen of seminal vesicle; Restricted diffusion within the lumen of seminal vesicle; Enhancement along or within the lumen of seminal vesicle; Obliteration of the prostate-seminal vesicle angle
  - 2) Direct extra-glandular tumor extension from the base of the prostate into and around the seminal vesicle
  - 3) Metachronous tumor deposit –separate focal T2 hypointense signal, enhancing mass in distal seminal vesicle

# Nodes

- Nodal groups that should be evaluated include: common femoral, obturator, external iliac, internal iliac, common iliac, pararectal, presacral, and paracaval, and para-aortic to the level of the aortic bifurcation

# Benign findings in prostate

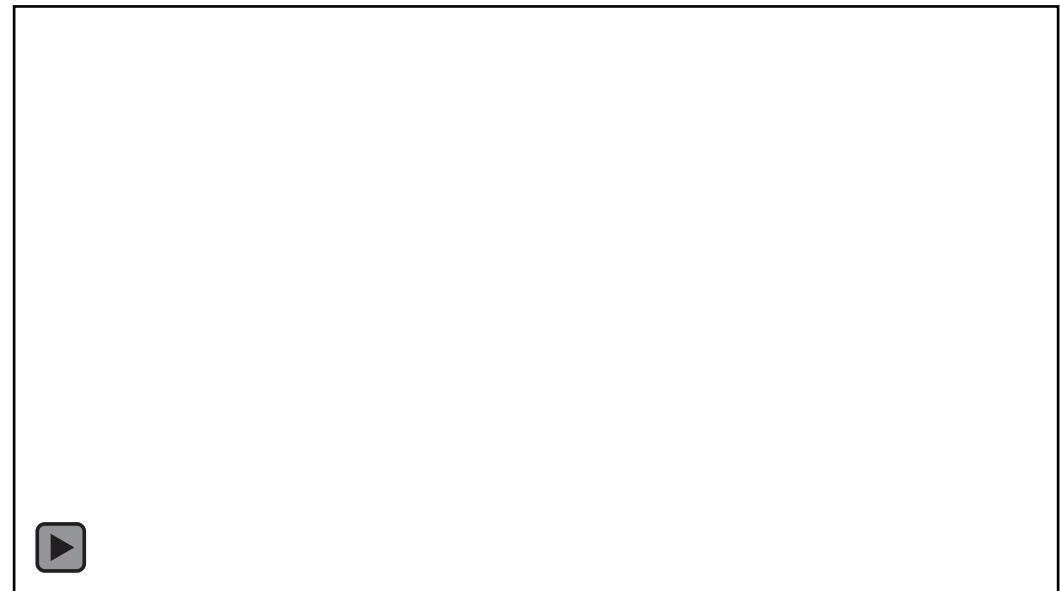
- Benign prostatic hyperplasia: arises in the TZ.
  - May appear as band-like areas and/or encapsulated round nodules with circumscribed margins
  - Glandular BPH nodules and cystic atrophy moderate-marked T2 hyperintensity
  - Stromal nodules have T2 hypointensity
  - May be highly vascular on DCE and can demonstrate a range of signal intensities on DWI
- Hemorrhage
  - Common in the PZ and/or seminal vesicles after biopsy
  - Focal or diffuse hyperintense on T1W and iso-hypointense on T2W
  - Chronic blood may appear hypointense on all MR sequences
- Cysts
  - Markedly hyperintense on T2w, dark on T1.
  - Can contain blood products or proteinaceous fluid, causing hyperintense signal on T1W
- Calcifications
  - Hypointense on all sequences
- Prostatitis
  - Decreased signal on PZ on both T2W and ADC
    - Decrease on ADC is generally neither as great or as focal as cancer
  - Can also increase perfusion
  - Morphology commonly band-like, wedge-shaped or diffuse rather than focal, round, oval or irregular
- Atrophy
  - wedge-shaped areas of low signal on T2W and mildly decreased signal on the ADC map from loss of glandular tissue. The ADC is generally not as low as in cancer, and there is often contour retraction of the involved prostate
- Fibrosis
  - Can occur after inflammation
  - Wedge- or band-shaped areas of low T2W

# DynaCAD: If trouble loading study

- If study not in Dynacad
  - 1) Go to study in PACS
  - 2) Right click on any image from the study
  - 3) Transmit → Study → new pop-up window comes up, scroll down to DynaCAD and click Transmit

# DynaCAD: Gland Segmentation

- 1) Click Gland Segment icon at top
- 2) New 2x2 window comes up. On top left window, if it's a coronal or sagittal (it usually loads this way)
  - Right click → Reference series → select axial T2
- 3) Move contours (thin green line) to outline the prostate
  - Top icon moves the contour
  - Middle icon changes the size of the line the mouse pulls
  - Bottom icon is a smoothing tool
- 4) When fully contoured, click Approve at top.
  - On the top left of each screen, you can see the size in 3 planes and prostate volume
  - Bottom right shows 3D model urologists will see
- 5) After approved, click Cancel to exit



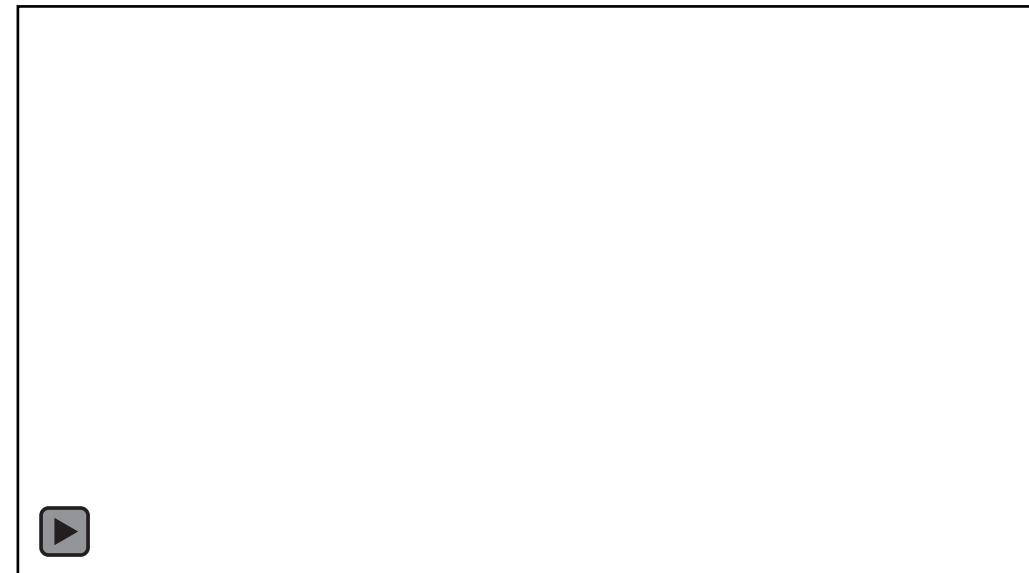
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# DynaCAD: Contouring lesions

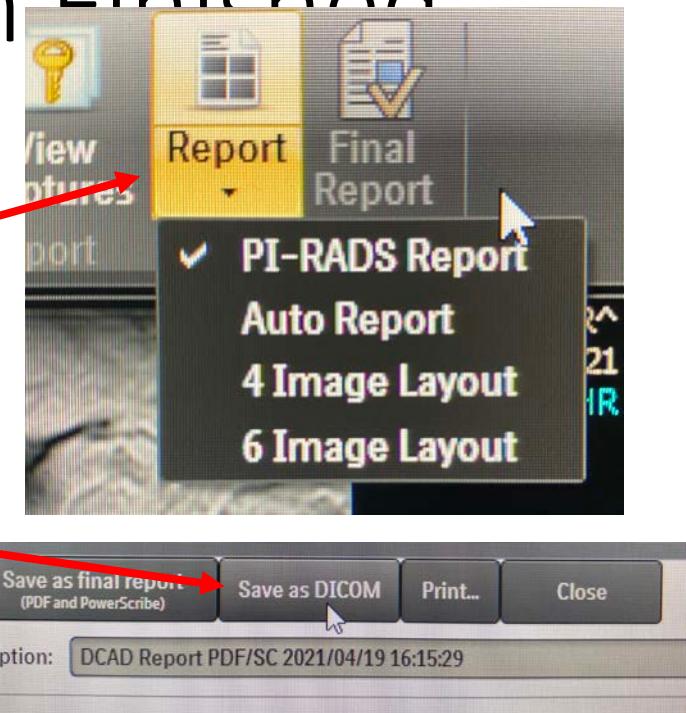
- F2 → Windows are now 2x1
  - Usually a T2 and DWI. If other sequences are preferred, right click and top row pulls up other sequences
- Right click → Free Hand ROI → circle lesion with wand
  - Right click → Edit/Make 3D ROI → scroll up and down and continue circling nodule on other slices until done
  - When done: Right click nodule → End Edit
  - Right click measurements → Edit PI-PIRADS Info → Fill in locations on the prostate map, Extraprostatic Extension, T2W/DWI/DCE/overall assessment scores → OK
- If you need to fix / delete a slice, while editing Right Click → Remove Slice

# DynaCAD: Contouring lesions

- If lesion not seen on T2, or better seen on another sequence
- Contour it on the DWI [or whatever preferred seq] on right half of screen the way you would on axial t2
- When done, right click → Associate to → axial T2
  - The contour should now pop-up onto the axial T2 sequence

# DynaCAD: When Finished

- When done, click Save All and Mark Read in top row
- Click little arrow below report → PI-RADS Report → continue → Save as DICOM at top → wait a couple minutes → Click arrow below Send → one of the last sequences will be called DCAD Report SC with date and time → click the check box next to this, make sure destination at top is ACPAX / Summa PACS and click send



■	201:	3 Axis locator			
■	501:	AX T1 whole pelvis (T1)			
■	601:	SAG T2 HR (T2)			
<input checked="" type="checkbox"/>	701:	AX T2 HR (T2)			
■	901:	AXIAL DWI (DIFFUSION)			
■	902:	AXIAL DWI (DIFFUSION)			
■	903:	AXIAL DWI (DIFFUSION)			
■	904:	AXIAL DWI (DIFFUSION)			
■	905:	AXIAL DWI (DIFFUSION)			
■	1001:	AXIAL DWI 1400B (DIFFUSION)			
■	1002:	AXIAL DWI 1400B (DIFFUSION)			
■	1003:	AXIAL DWI 1400B (DIFFUSION)			
■	1101:	COR T2 HR (T2)			
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