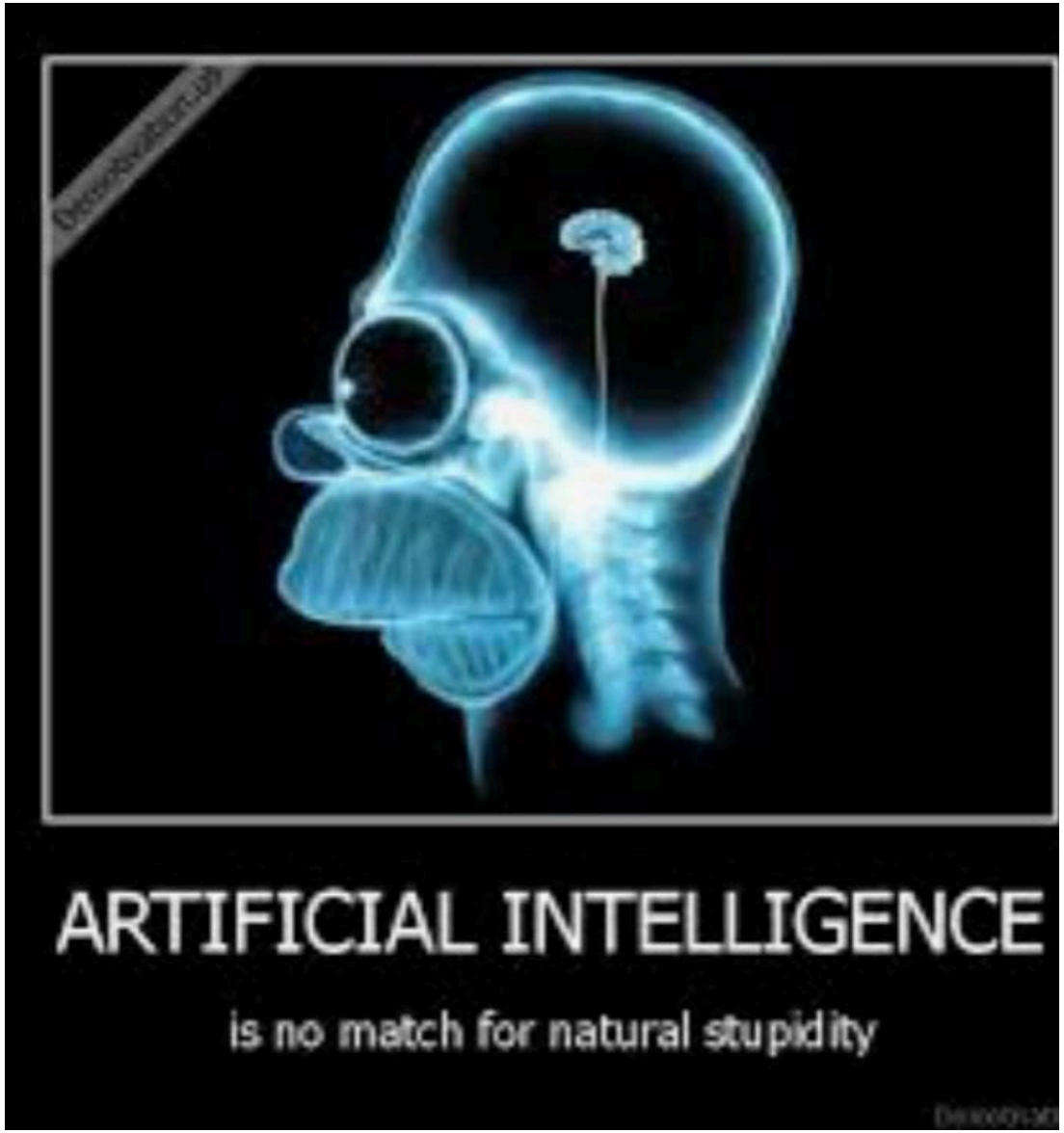
Advances in Radiology

OVERVIEW

- Artificial Intelligence in Radiology
- Multiparametric Prostate MRI


ARTIFICIAL INTELLIGENCE
is no match for natural stupidity

Case No. 1

Differential diagnosis of aortic dissection from CT scan

A 36-year-old male with hypertension is admitted to the Emergency Department with heart murmur, acute chest pain, and acute abdominal pain. The patient underwent a CT which is shown here. Which is most likely?

You answered

a. Aortic Dissection

b. Esophagitis

c. Penetrating Atherosclerotic Ulcer

d. Acute Myocardial Infarction

A 36-year-old male with hypertension is admitted to the Emergency Department with **heart murmur**, **acute chest pain**, and acute abdominal pain. The patient underwent a CT which is shown here. Which is most likely?

Patient Case Analysis

Image Analysis

Watson Inference

Aortic Dissection

Esophagitis

Penetrating Atheroscl...

Acute Myocardial Inf...

Eyes of **Watson**

Analyzing Text › › › Analyzing Images › › › Reasoning › › › Selecting Answer

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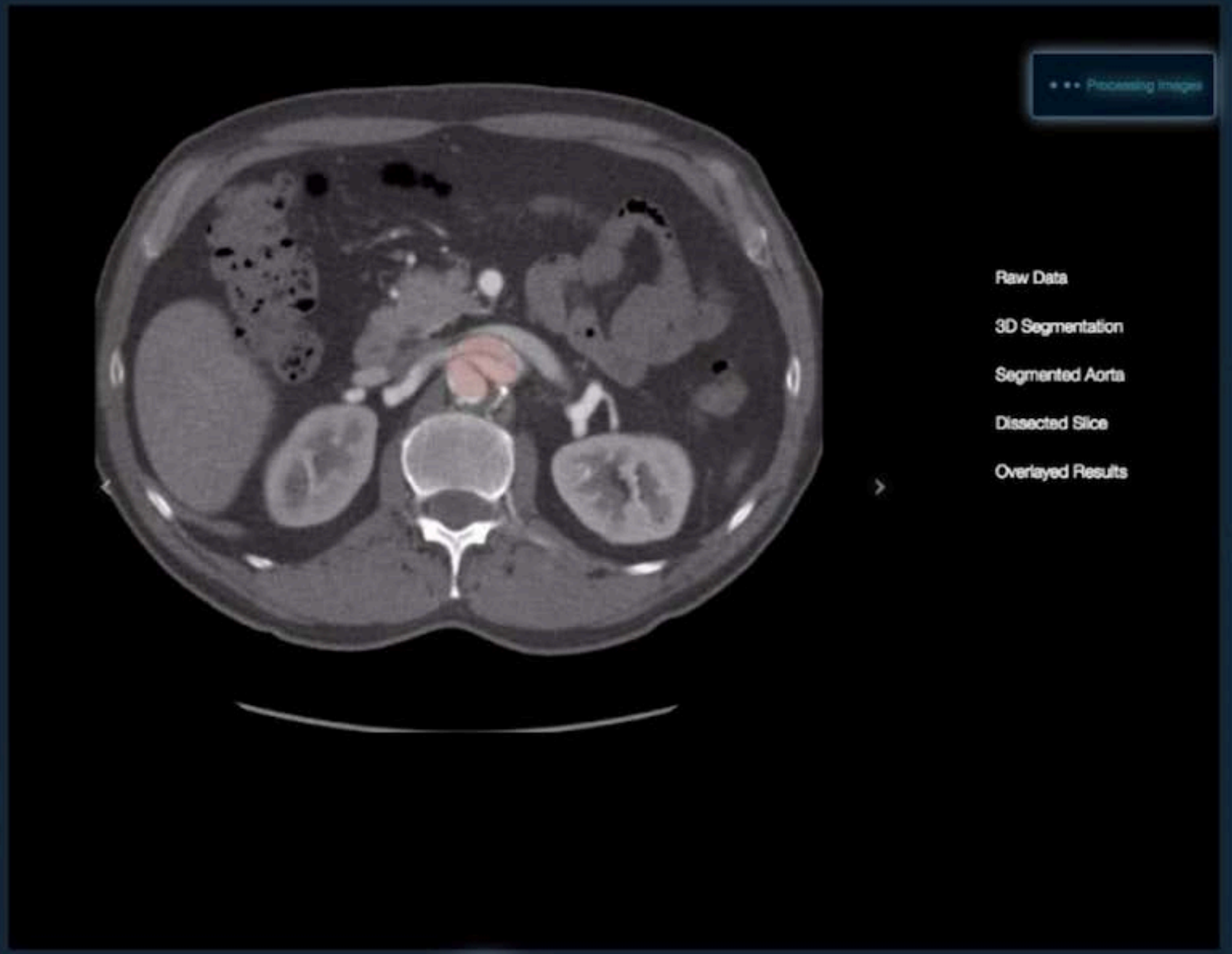

You answered

a. Aortic Dissection

b. Esophagitis

c. Penetrating Atherosclerotic Ulcer

d. Acute Myocardial Infarction

Patient Case Analysis

Age: **36 years**
Gender: **male**
Sign or Symptom: **heart murmur**
Sign or Symptom: **pain abdominal**
Sign or Symptom: **acute chest pain**
Modality: **CT scan**
Question Type: **Differential Diagnosis**

Image Analysis

Watson Inference

Eyes of **Watson**

Analyzing Text ››› Analyzing Images ››› Reasoning ››› Selecting Answer

HOME

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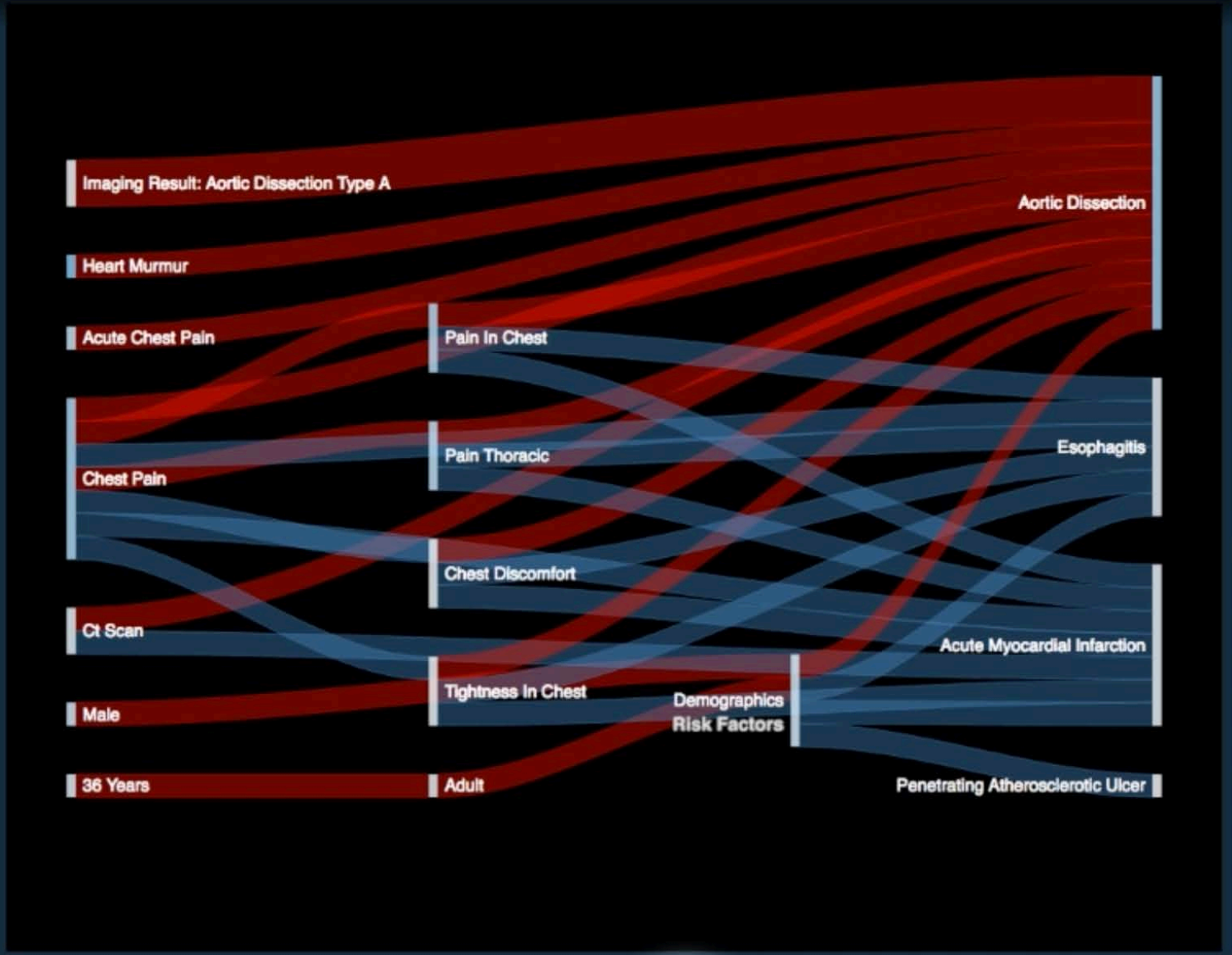

You answered

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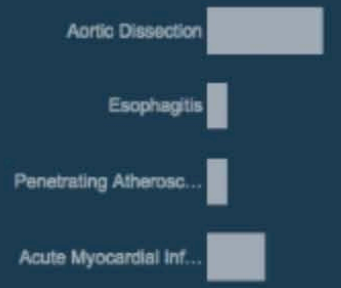
Patient Case Analysis

Age: **36 years**
Gender: **male**
Sign or Symptom: **heart murmur**
Sign or Symptom: **pain abdominal**
Sign or Symptom: **acute chest pain**
Modality: **CT scan**
Question Type: **Differential Diagnosis**

Image Analysis

Disease: **Aortic Dissection Type A**

Watson Inference



Eyes of **Watson**

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You answered

a. Aortic Dissection

b. Esophagitis

c. Penetrating Atherosclerotic Ulcer

d. Acute Myocardial Infarction

Watson answers:

Aortic Dissection

Next Case

Evaluate Watson

Patient Case Analysis

Age: **56 years**

Gender: **male**

Sign or Symptom: **heart murmur**

Sign or Symptom: **pain abdominal**

Sign or Symptom: **acute chest pain**

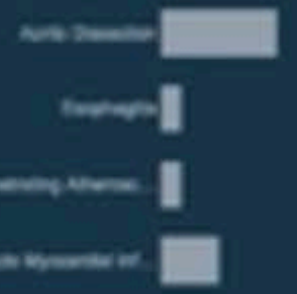
Modality: **CT scan**

Question Type: **Differential Diagnosis**

Image Analysis

Disease: **Aortic Dissection Type A**

Watson Inference



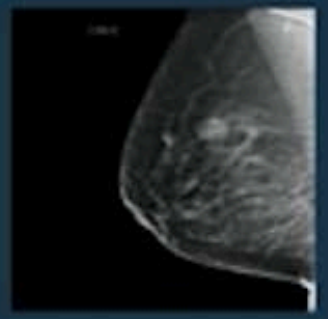
Eyes of Watson

Analyzing Text ··· Analyzing Images ··· Reasoning ··· Selecting Answer

Case No. 2

Differential diagnosis of fibroadenoma of the breast from mammogram

A 62-year-old woman presents for diagnostic mammography with a palpable mass in her right breast. Describe the finding.



You answered

a. Infiltrating duct carcinoma of breast

b. Lipoma of breast

c. Fibroadenoma of breast

d. Fat necrosis of breast

• • • Processing Text

A **62-year-old** woman presents for diagnostic mammography with a palpable mass in her right breast. Describe the finding.

Patient Case Analysis

Image Analysis

Watson Inference

Infiltrating duct carcin...

Lipoma of breast

Fibroadenoma of bre...

Fat necrosis of breast

Eyes of **Watson**

Analyzing Text ››› Analyzing Images ››› Reasoning ››› Selecting Answer

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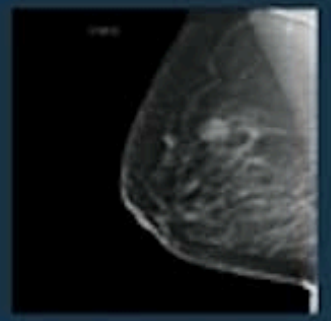

You answered

a. Infiltrating duct carcinoma of breast

b. Lipoma of breast

c. Fibroadenoma of breast

d. Fat necrosis of breast

Patient Case Analysis

Age: **62 years**

Indication: **Diagnostic Mammography**

Physical exam: **Breast lump present**

Image Analysis

Watson Inference

Eyes of **Watson**

Analyzing Text ››› **Analyzing Images** ››› Reasoning ››› Selecting Answer

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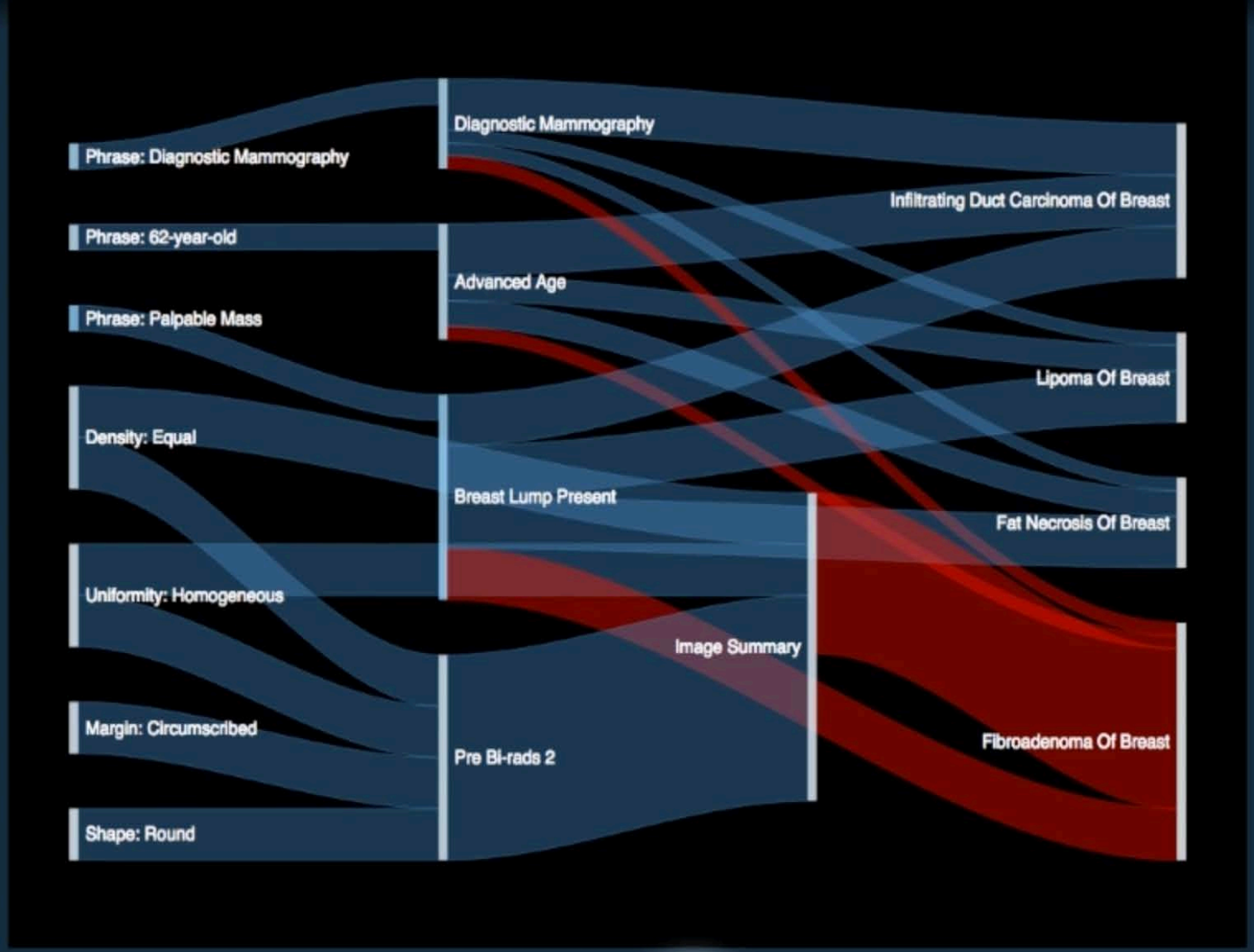


Patient Case Analysis

Age: **62 years**

Indication: **Diagnostic Mammography**

Physical exam: **Breast lump present**

Image Analysis

Pre BI-RADS: **2**

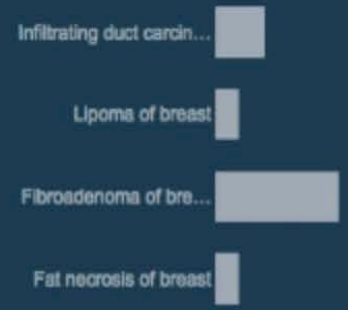
Density: **Equal**

Margin: **Circumscribed**

Shape: **Round**

Uniformity: **Homogeneous**

Watson Inference



Eyes of **Watson**

Analyzing Text ››› Analyzing Images ››› Reasoning ››› Selecting Answer

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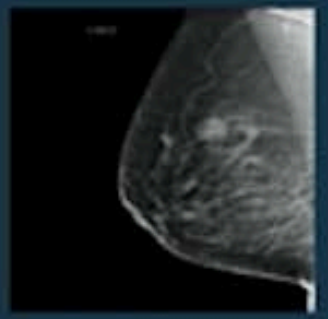


You answered

a. Infiltrating duct carcinoma of breast

b. Lipoma of breast

c. Fibroadenoma of breast

d. Fat necrosis of breast

Watson answers:

Fibroadenoma of breast

Next Case

Evaluate Watson

Patient Case Analysis

Age: **62 years**

Indication: **Diagnostic Mammography**

Physical exam: **Breast lump present**

Image Analysis

Pre BI-RADS: **2**

Density: **Equal**

Margin: **Circumscribed**

Shape: **Round**

Uniformity: **Homogeneous**

Watson Inference

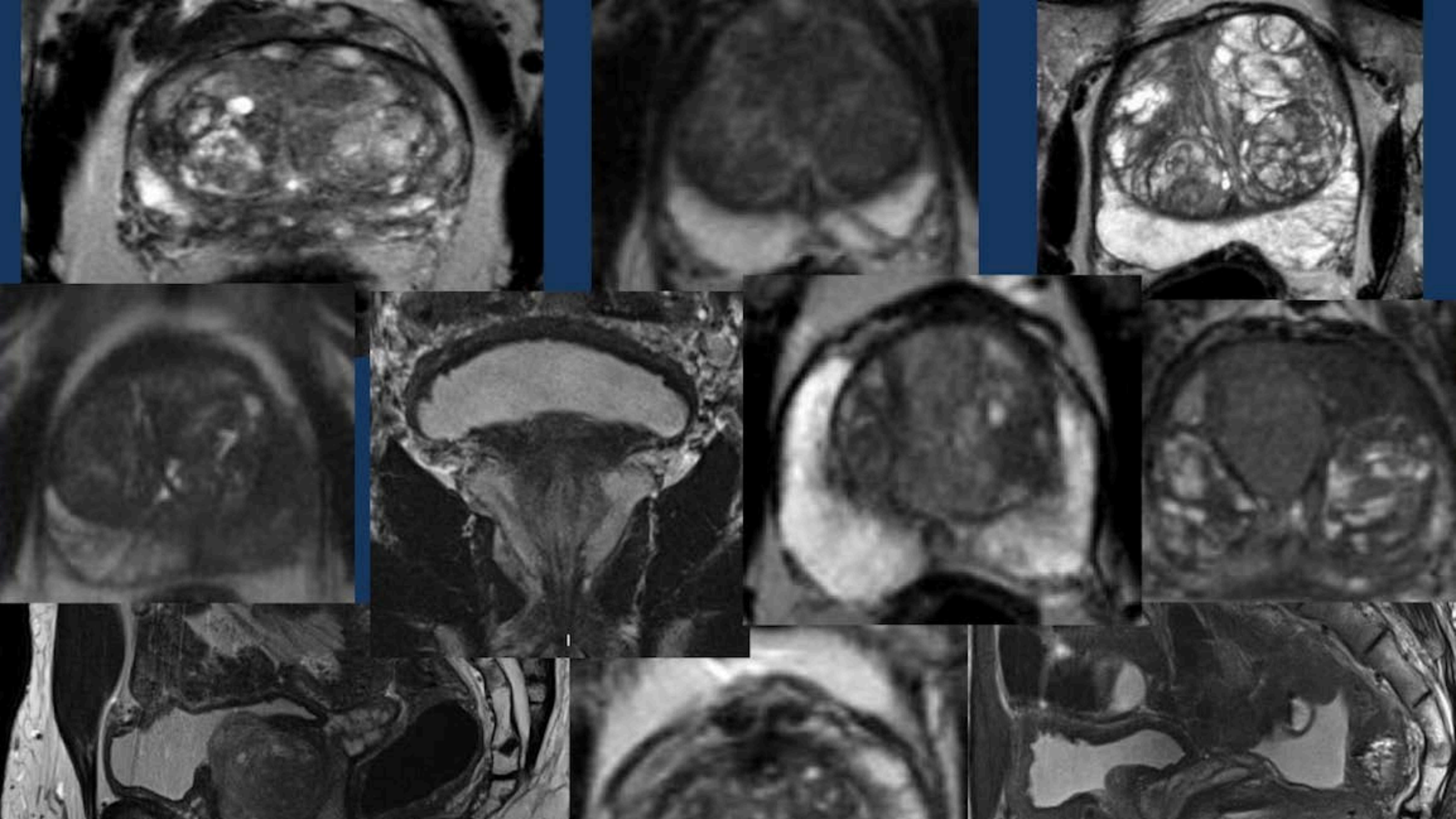
Eyes of **Watson**

Analyzing Text ››› Analyzing Images ››› Reasoning ››› Selecting Answer

Multiparametric Prostate MRI

Multiparametric Prostate MRI (mpMRI)

- Includes both:
  - a) morphological imaging
    - T2-weighted - T2WI
  - b) functional imaging
    - diffusion-weighted (DWI)
    - dynamic contrast-enhanced MRI (DCE-MRI)
    - MR spectroscopy (MRS)
- Yields qualitative and quantitative biomarkers



Why PI-RADS v2?

- Limitations of PI-RADS v1
- Rapid progress in the field
- Simplify to encourage widespread adoption
- Single international standard for prostate mpMRI

Aims of PI-RADS v2

- Establish minimum acceptable technical parameters for prostate MRI
- Simplify and standardize the terminology and content of radiology reports
- Facilitate the use of MRI data for targeted biopsy
- Develop assessment categories that summarize levels of suspicion or risk and can be used to triage patients to appropriate management
- Enable data collection and outcome monitoring
- Educate radiologists on prostate MRI reporting and reduce variability in imaging interpretations
- Enhance communication with referring clinicians
- Promote quality assurance and research
- Improve patient outcomes

PI-RADS v2 Assessment Categories

Each lesion is assigned a PI-RADS Assessment Category using 5-point scale based on the likelihood (probability) that a combination of findings on T2W, DWI, & DCE correlates with the presence of a clinically significant cancer at a particular location

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

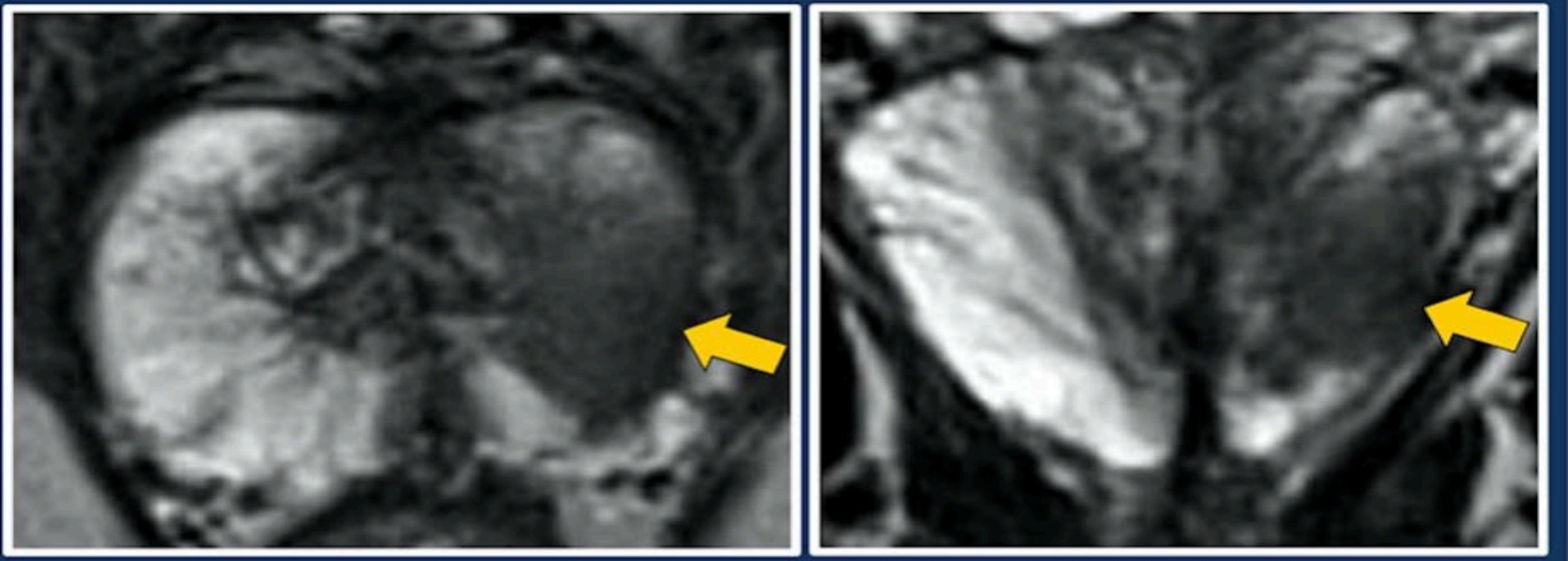
PI-RADS v2: Clinically Significant Cancer

- Gleason score ≥ 7 (including 3+4 with prominent but not predominant Gleason 4 component), and;
- Volume ≥ 0.5cc, and/or;
- Extraprostatic extension (EPE)

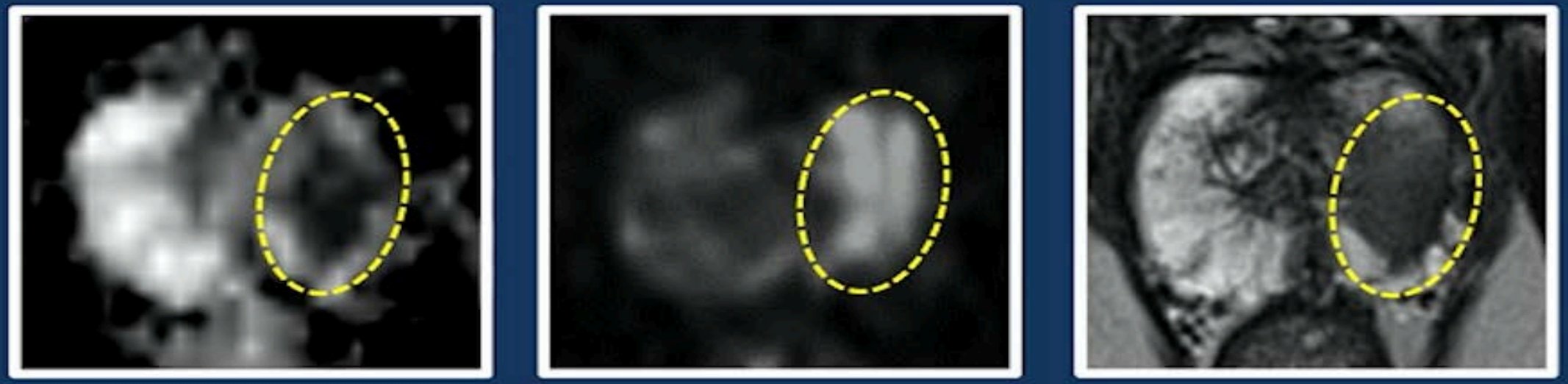
Wolters T, et al. J Urol 2011;185:121-5

Prostate Cancer: T2-weighted Imaging

- T2 dark



Diffusion-Weighted Imaging (DWI)



ADC

DWI
High b-value 1400

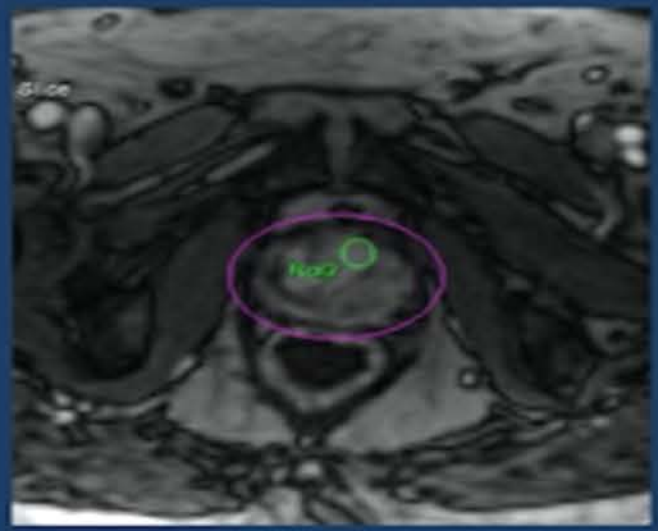
T2WI

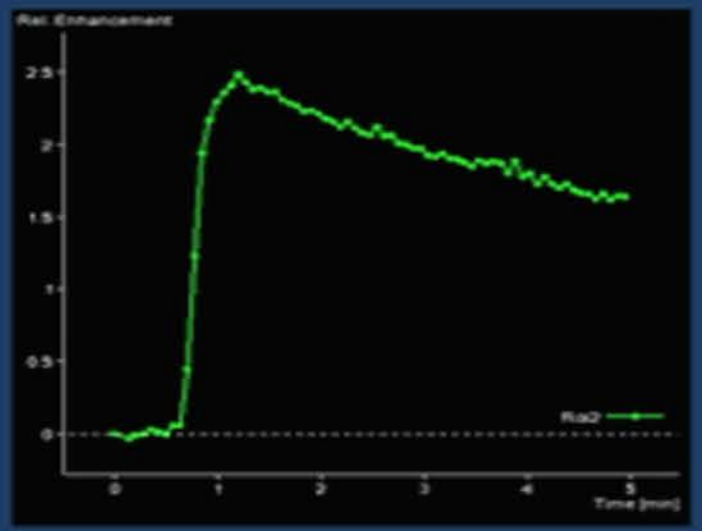
- ADC dark
- DWI high b value bright

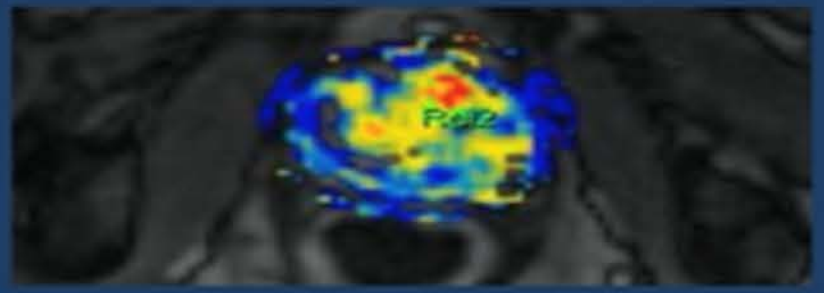
Dynamic Contrast Enhanced MRI (DCE-MRI)

- **Quantitative analysis**
  - **TTP (time to peak)**
  - **Washout characteristics**

  Tracer Kinetic Compartmental Modeling
  - **Permeability (K^{Trans})**
  - **Extracellular Volume Fraction (EVF)**
- **Qualitative analysis**





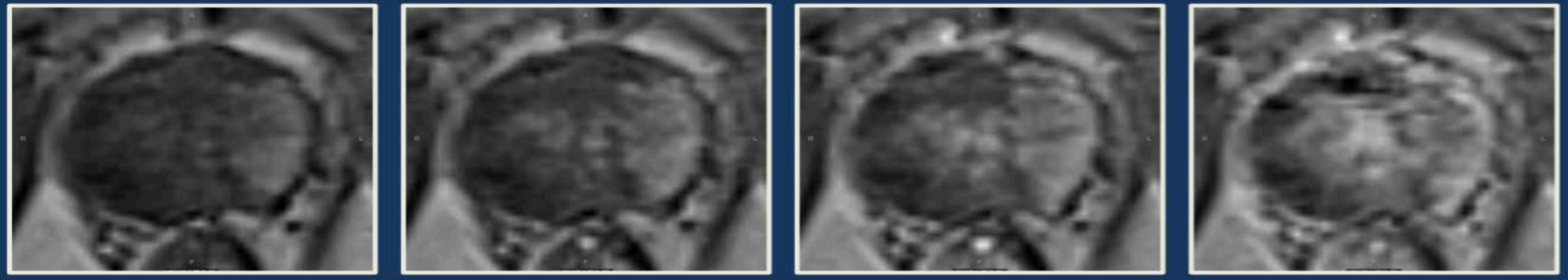


MRI at 3.0T: Parametric map of K^{Trans}

Dynamic Contrast Enhanced MRI (DCE-MRI): Limitations

- Enhancement kinetics of prostate cancers are variable
- Enhancement may be seen with:
  - Inflammation
  - High grade PIN (prostate intra-epithelial neoplasia
  - ASAP (atypical small acinar proliferation)
  - Following biopsy
  - Sparse Gleason 3+3 with inflammatory focus
- Marginal incremental value to T2W and DWI
- DCE critical for recurrence after prostatectomy or radiation therapy

Dynamic Contrast Enhanced MRI (DCE-MRI)



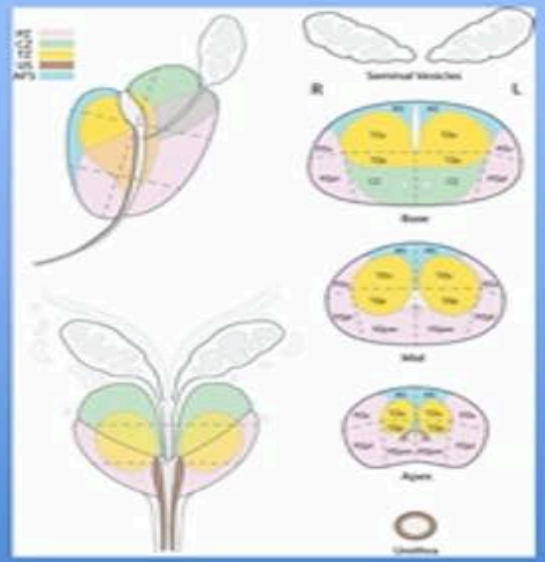
time

Qualitative assessment
Positive: focal, early enhancement
Negative: non-enhancing, diffuse

Step-by-step Assessment

1

Anatomical Localization



2

Qualitative Evaluation on T2WI, DWI (1-5 score) and DCE (positive/negative)

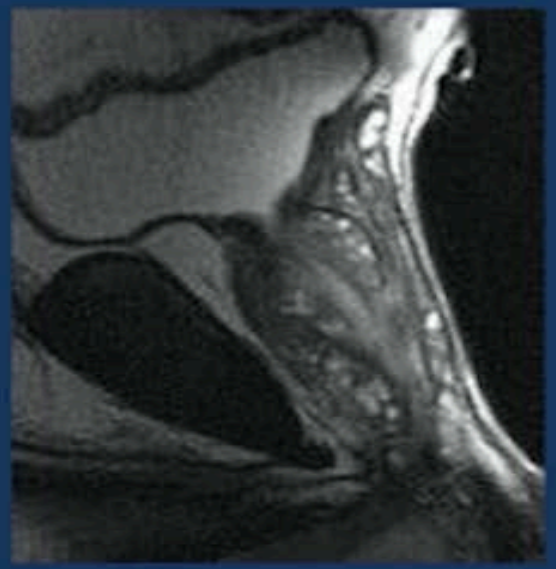
Score	Peripheral Zone (PZ)
1	Uniformly hyperintense (normal)
2	Linear, wedge-shaped, or diffuse **mild** hypointensity, usually indistinct margin
3	Non-circumscribed, rounded, **mild** hypointensity
4	Circumscribed, homogenous **moderate** hypointense focus/mass confined to prostate and <1.5 cm in greatest dimension
5	Same as 4 **but** ≥1.5cm in greatest dimension **or** definite extraprostatic extension/invasive behavior

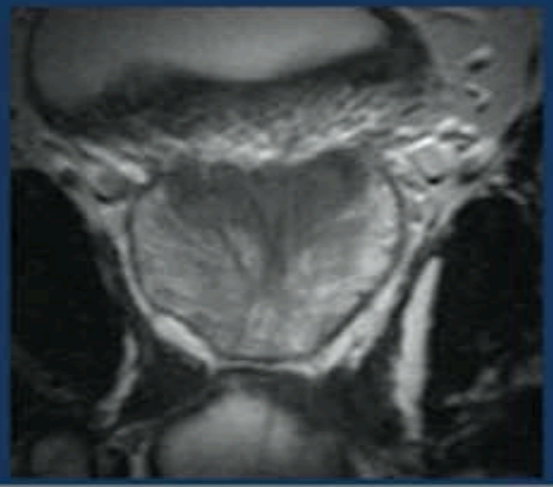
3

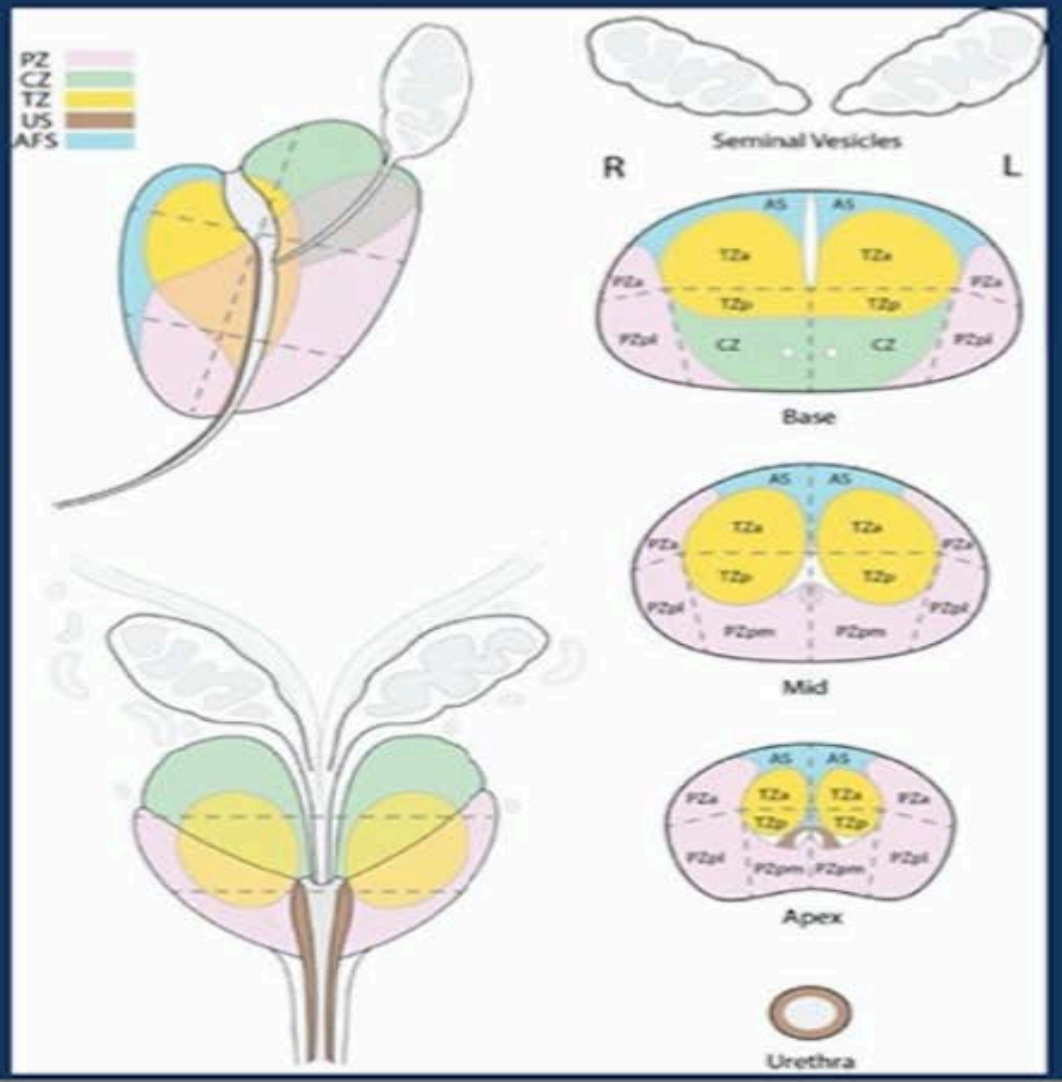
Overall PI-RADS Assessment

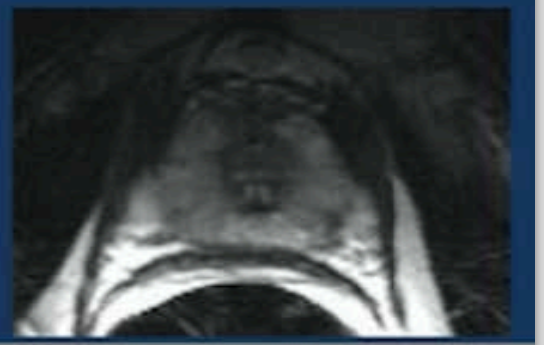
DWI	T2W	DCE	PIRADS Category
1	Any	Any	1
2	Any	Any	2
3	Any	-	3
		+	4
4	Any	Any	4
5	Any	Any	5

Prostate Zonal Anatomy









Prostate Zonal Anatomy: Cancer Origin

- 70%-75% of prostate cancers originate in the PZ and 20%-30% in the TZ
- Cancers originating in the CZ are uncommon < 5% and most are secondary to invasion by PZ tumors
- Primary CZ cancers are significantly more aggressive than PZ or TZ cancers with greater risk of extracapsular extension, seminal vesicle invasion and positive surgical margins

Lesions graded 1 through 5 based on:

- Size
- Border
- Shape
- Signal
- Enhancement

PI-RADS Peripheral Zone T2WI

Score	Peripheral Zone (PZ)
1	Uniformly hyperintense (normal)
2	Linear, wedge-shaped, or diffuse **mild** hypointensity, usually indistinct margin
3	Non-circumscribed, rounded, **mild** hypointensity
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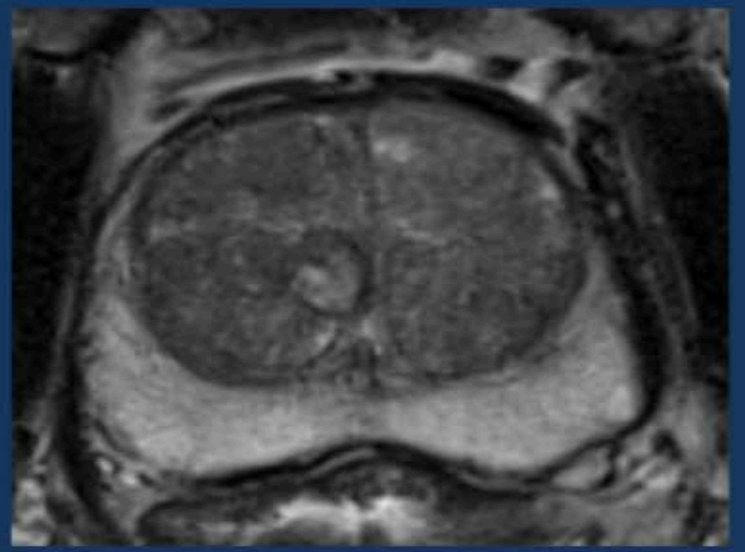
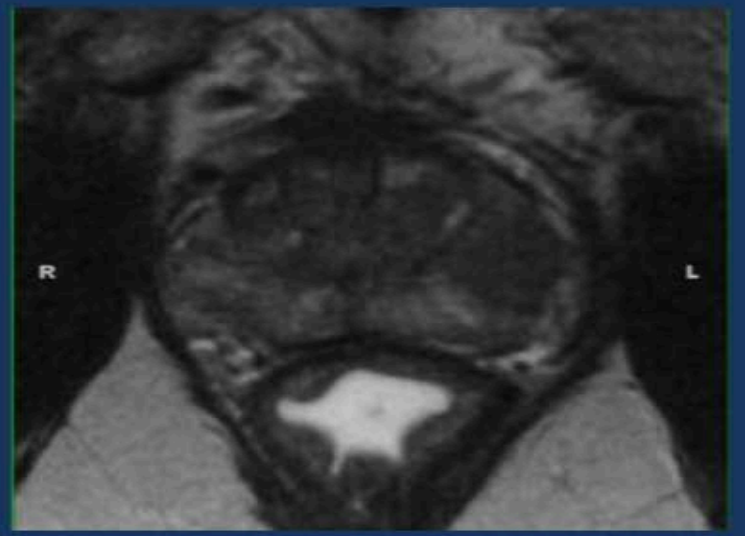
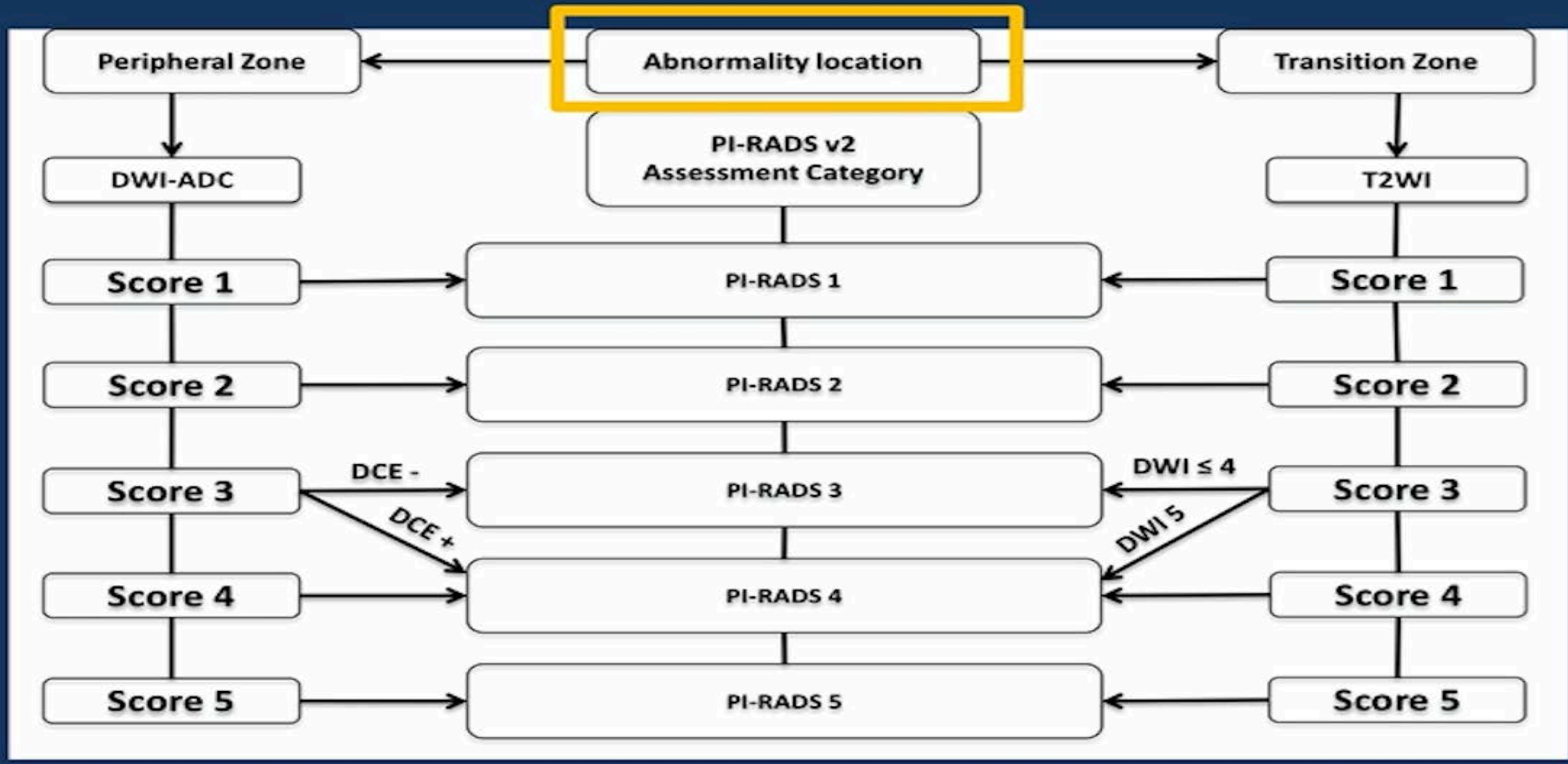




PI-RADS v2 Assessment Categories



Purysko AS. et al. Radiographics 2016

"We're trying to give our patients more incentive."