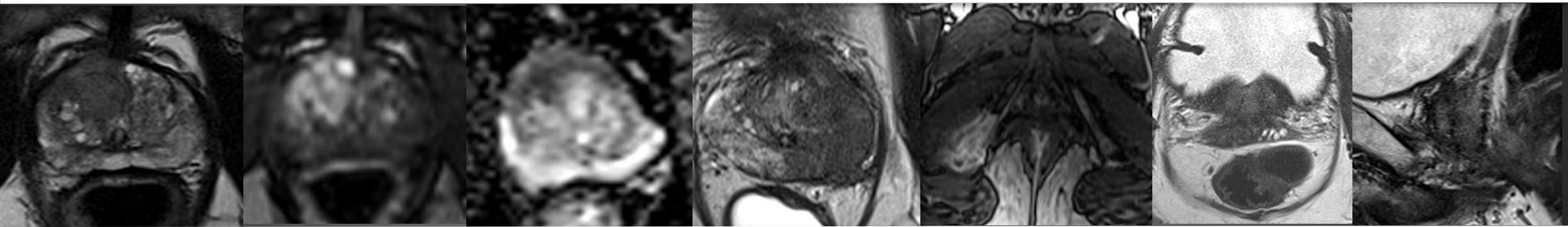


ACR Prostate MR course

Evidence-based Clinical Indications for Prostate mpMRI



Andrei S Purysko, M.D.

Abdominal Imaging Section &
Nuclear Radiology Department

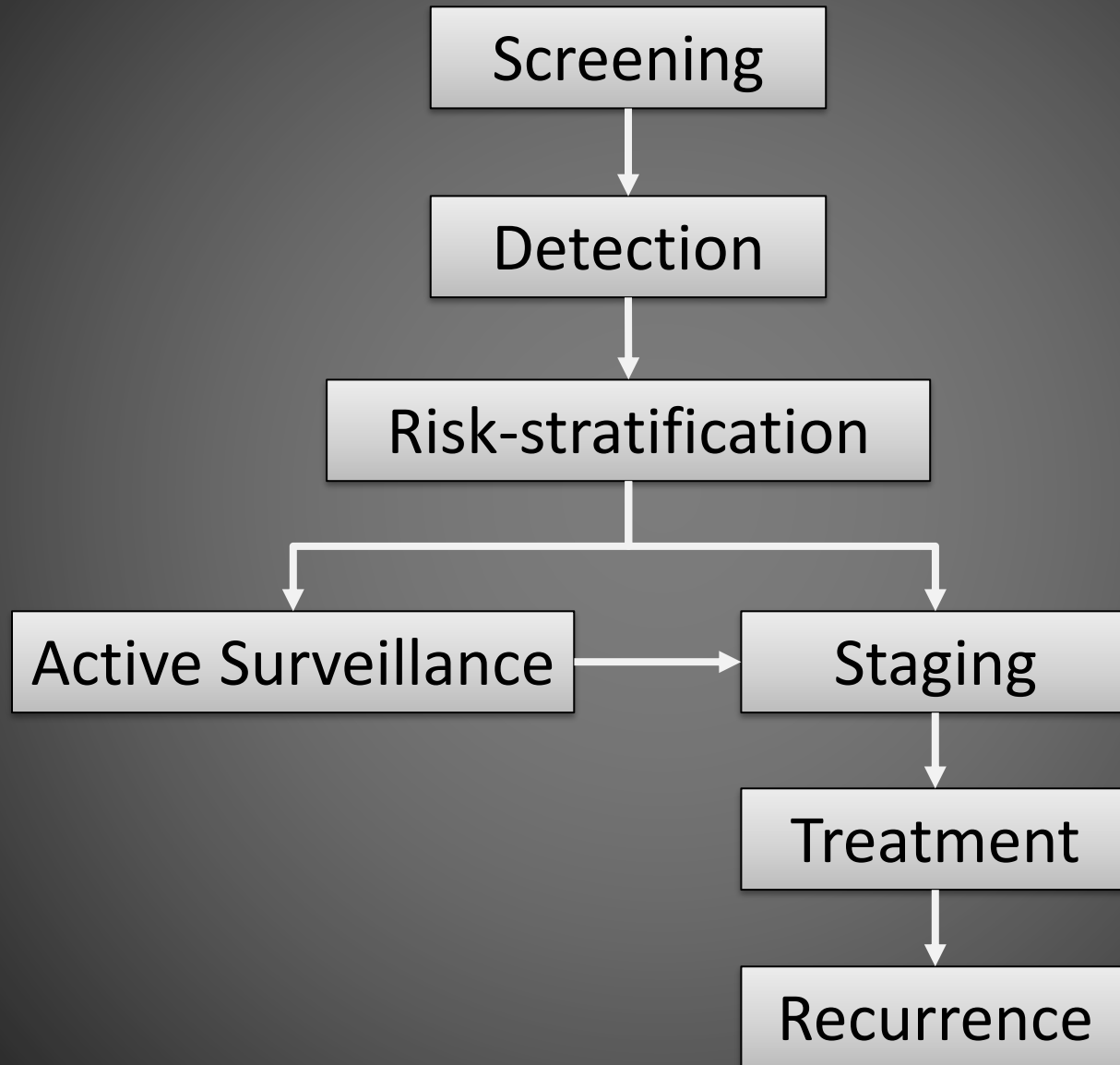
Disclosures

- Consulting agreement – Koelis
- Research support and consulting agreement with Blue Earth Diagnostics

Objective

- To review current indications for mpMRI in the diagnosis and management of prostate cancer.

Prostate Cancer



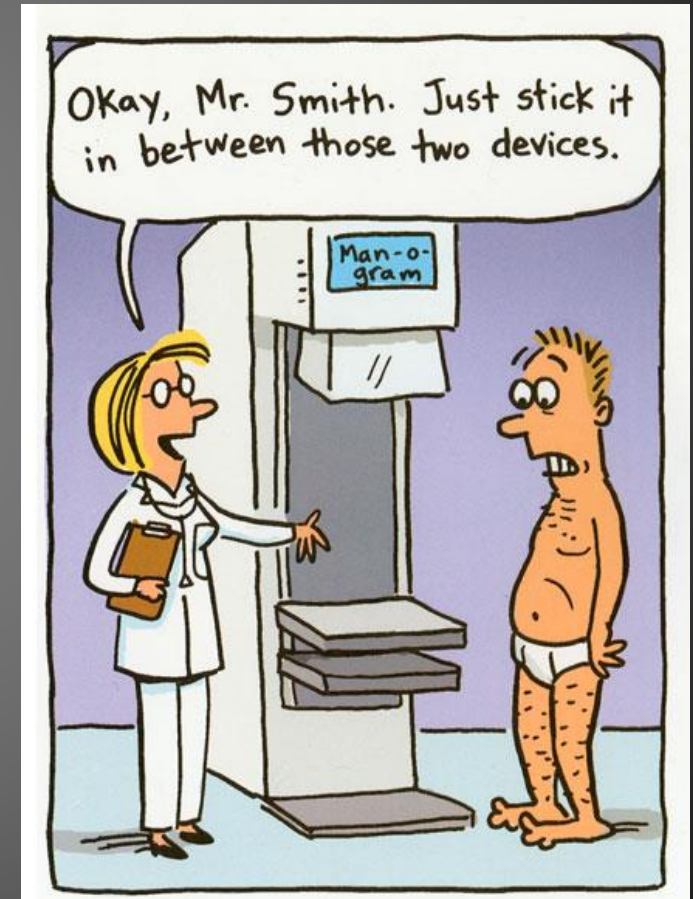
PCa Screening

- **Early detection** increases chance of successful treatment
- Digital rectal examination (DRE)
 - 70-80% of the Bx based on DRE are negative
- Serum Prostate-Specific Antigen (PSA)
 - Only $\frac{1}{4}$ of the patients with elevated PSA have PCa
 - $\uparrow$ over detection of indolent disease $\rightarrow$ over treatment
- Alternative approaches
 - **PSA density:** PSA/gland volume (> 0.15 – higher risk for csPCa)
 - PSA isoforms (isoPSA), 4K score



PCa Screening

- MRI is currently not considered a screening tool
- Pilot study* (n = 47 unselected men)
- OR for PCa detection:
 - MRI: 2.7, (95% CI 1.4-5.4)
 - PSA: 1.1 (95% CI 0.9-1.4)
- OR for PCa GS $\geq 3+4$:
 - MRI: 3.5 (95% CI 1.5-8.3)
 - PSA: 1.0 (95% CI 0.9-1.2)



*Nam, et al. J Urol. 2016 PMID: 26880413

PCa Screening

The NEW ENGLAND JOURNAL of MEDICINE

MRI-Targeted or Standard Biopsy in Prostate Cancer Screening

- 49118 men invited, 12570 enrolled – 1532 had PSA > 3ng/ml
- MRI + MRI-guided bx (n = 929) vs Standard bx (n = 603)
- GG ≥ 2: 21% vs 18%
- GG 1: 4% vs 12%

JAMA Oncology | Original Investigation

Cost-effectiveness of Prostate Cancer Screening Using Magnetic Resonance Imaging or Standard Biopsy Based on the STHLM3-MRI Study

- MRI + MRI-guided bx is more cost-effective than Standard bx

Eklund, et al. NEJM. 2021 PMID: 34237810

Hao, et al. JAMA Oncol 2022 PMID: 36355382

Prostate Cancer

Screening

DRE and PSA

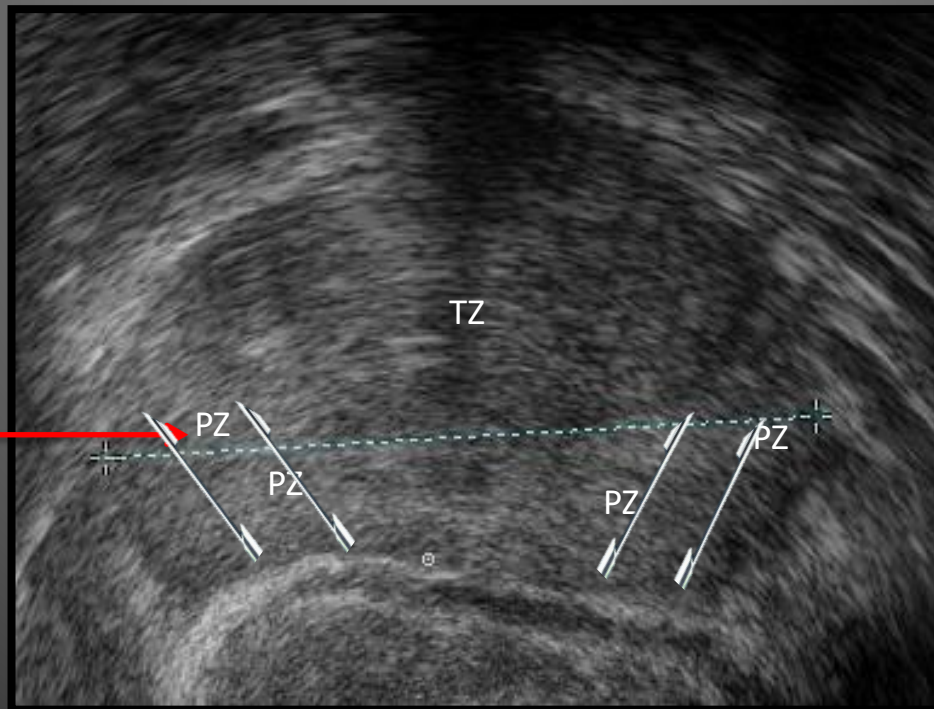


Detection

PCa Detection

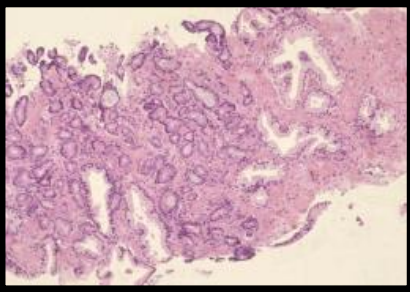
- Transrectal or transperineal ultrasound-guided biopsy
 - **Systematic** but non-targeted
 - Detects a large number of indolent tumors
 - Misses a large number of clinically significant (CS) PCa

75-80%

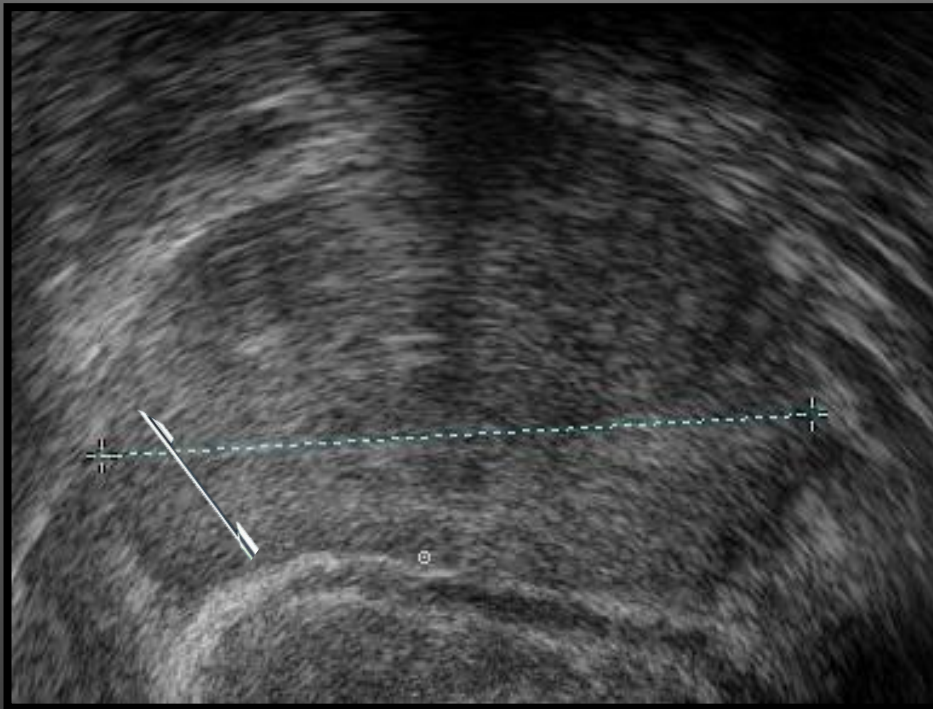


PCa Detection

- Transrectal or transperineal ultrasound-guided biopsy
 - Systematic but **non-targeted**
 - **Detects many indolent tumors**
 - Misses many clinically significant (CS) PCa

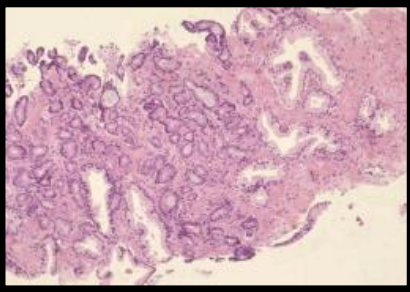


Gleason 3 + 3

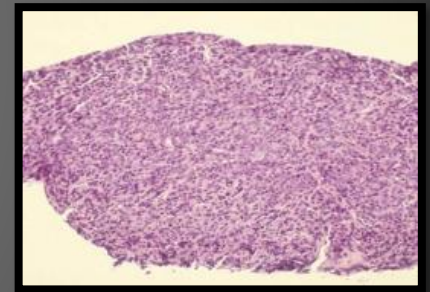
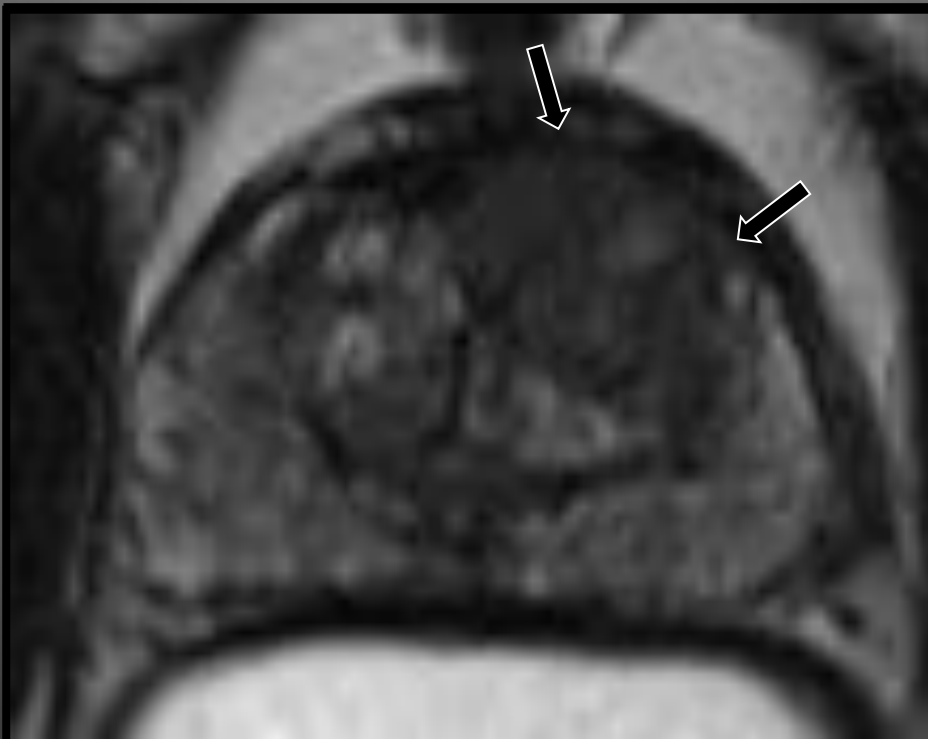


PCa Detection

- Transrectal or transperineal ultrasound-guided biopsy
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 - Misses many clinically significant (CS) PCa



Gleason 3 + 3



Gleason 4 + 3

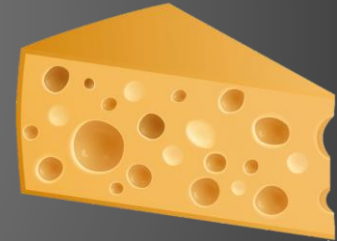


PCa Detection

Diagnostic accuracy of multi-parametric MRI and TRUS biopsy in prostate cancer (PROMIS): a paired validating confirmatory study

Lancet 2017; 389: 815-22

- Multicenter prospective trial; N= 576 biopsy naïve men
- 1.5 T with PPAC
- MRI vs. TRUS-bx for detection of PCa $GS \geq 4 + 3$ or ≥ 6 mm
- Reference: transperineal template prostate mapping bx
- Results:
 - Sensitivity MRI: 93% - TRUS-bx: 48%
 - Specificity MRI: 41% - TRUS-bx: 96%
- If MRI was used for triage:
 - 27% men could have avoided a biopsy
 - 5% fewer insignificant PCa detected



Detection of Individual Prostate Cancer Foci via Multiparametric Magnetic Resonance Imaging

EUROPEAN UROLOGY 75 (2019) 712–720

David C. Johnson^{a,b,*}, Steven S. Raman^c, Sohrab A. Mirak^c, Lorna Kwan^b, Amirhossein M. Bajgirani^c, William Hsu^c, Cleo K. Maehara^c, Preeti Ahuja^c, Izak Faiena^b, Aydin Pooli^b, Amirali Salmasi^b, Anthony Sisk^d, Ely R. Felker^c, David S.K. Lu^c, Robert E. Reiter^{b,*}

- n = 588; 1213 tumor foci in RP specimens
- MRI detected:
 - 45% of all PCa
 - 65% of csPCa (GG ≥ 2)
 - 83% solitary; 58% multifocal
 - 80% of high-grade PCa
- Size of missed lesions:
 - 61.1% <1 cm
 - 28.3% 1-2 cm
 - 10.4% >2 cm.

Smaller, low-grade, multifocal, non-index tumors were more likely to be missed.

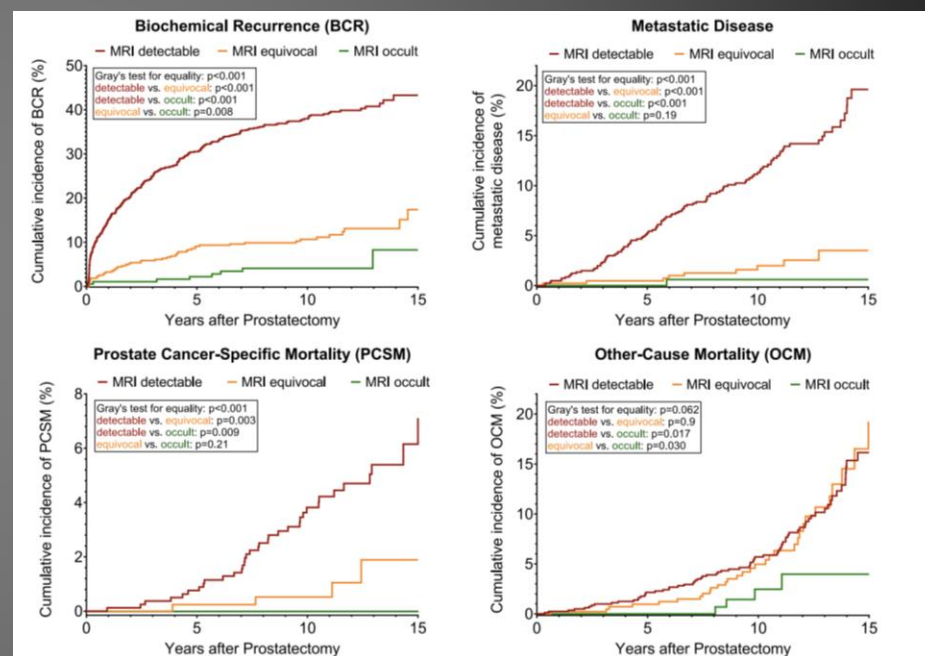
PCa MRI Visibility and Outcomes

MRI-Detectability of Clinically Significant Prostate Cancer Relates to Oncologic Outcomes After Prostatectomy

Clinical Genitourinary Cancer, Vol. 20, No. 4, 319-325

Andreas G. Wibmer,¹ Robert A. Lefkowitz,¹ Yulia Lakhman,¹ Joshua Chaim,¹
Ines Nikolovski,¹ Evis Sala,^{1,*} Samson W. Fine,² Timothy F. Donahue,³
Michael W. Kattan,⁴ Hedvig Hricak,^{1,†} Hebert Alberto Vargas^{1,†}

- N = 1449 patients with GG ≥ 2 PCa on RP
- MRI invisible cancers were less likely to have BCR (8% vs. 43%), metastasize (0.6% vs. 20%), or lead to PCa mortality (0% vs. 7%) than MRI-detectable cancers ($P < .001$).



MRI-invisible cancers constitute a prognostically distinct subgroup among higher-grade PCa

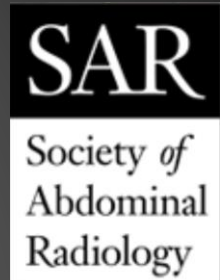
PCa Detection

Update of the Standard Operating Procedure on the Use of Multiparametric Magnetic Resonance Imaging for the Diagnosis, Staging and Management of Prostate Cancer

of THE JOURNAL
UROLOGY®

Marc A. Bjurlin ✉, Peter R. Carroll, Scott Eggener, Pat F. Fulgham, Daniel J. Margolis, Peter A. Pinto, Andrew B. Rosenkrantz, Jonathan N. Rubenstein, Daniel B. Rukstalis, Samir S. Taneja, and Baris Turkbey

23 Oct 2019



Use of prostate magnetic resonance imaging in the risk stratification, diagnosis and treatment pathway of men with prostate cancer is expanding. When quality prostate imaging is obtained, current evidence now supports its use in men at risk of harboring prostate cancer and who have not undergone a previous biopsy, as well as in men with an increasing prostate specific antigen following an initial negative standard prostate biopsy procedure.

Prostate Cancer

Screening

DRE and PSA

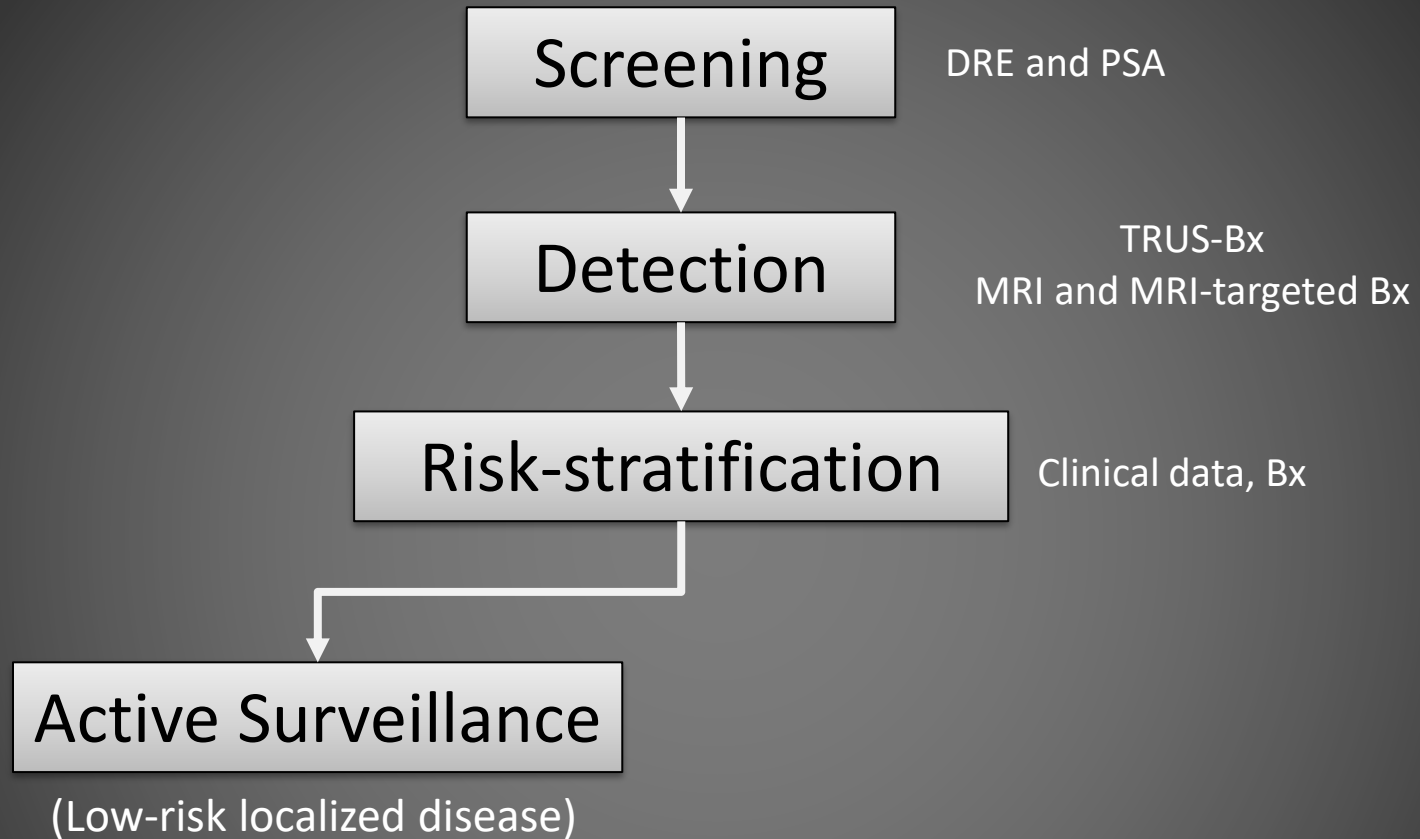
Detection

TRUS-Bx
MRI and MRI-targeted Bx

Risk-stratification



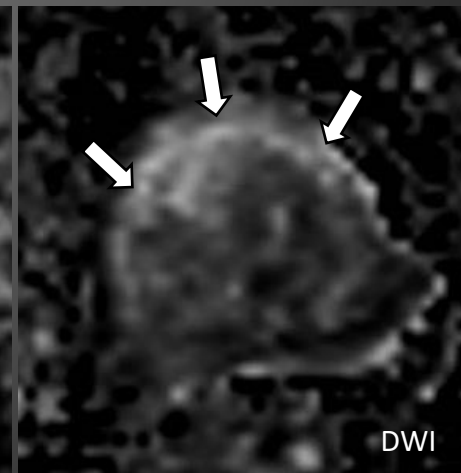
Prostate Cancer



Active Surveillance

- MRI can help with the triage¹:
 - Negative MRI: NPV $\geq 96\%$
 - Score 5: 87-98% sensitive for upgrading
- ASSIT trial² – RCT (n = 273)
- Upgrade from GG 1 to GG ≥ 2
 - Confirmatory Bx -> SBx arm: 23% vs. MRI arm: 21%
 - 2-year follow up Bx: SBx arm: 27% vs. MRI arm: 13%

PCa (GS 3 + 3) on AS
 $\uparrow$ PSA 24.3 ng/dL
MRI-targeted Bx: PCa 3 + 4
RP: GS 3 + 4, + ant. EPE

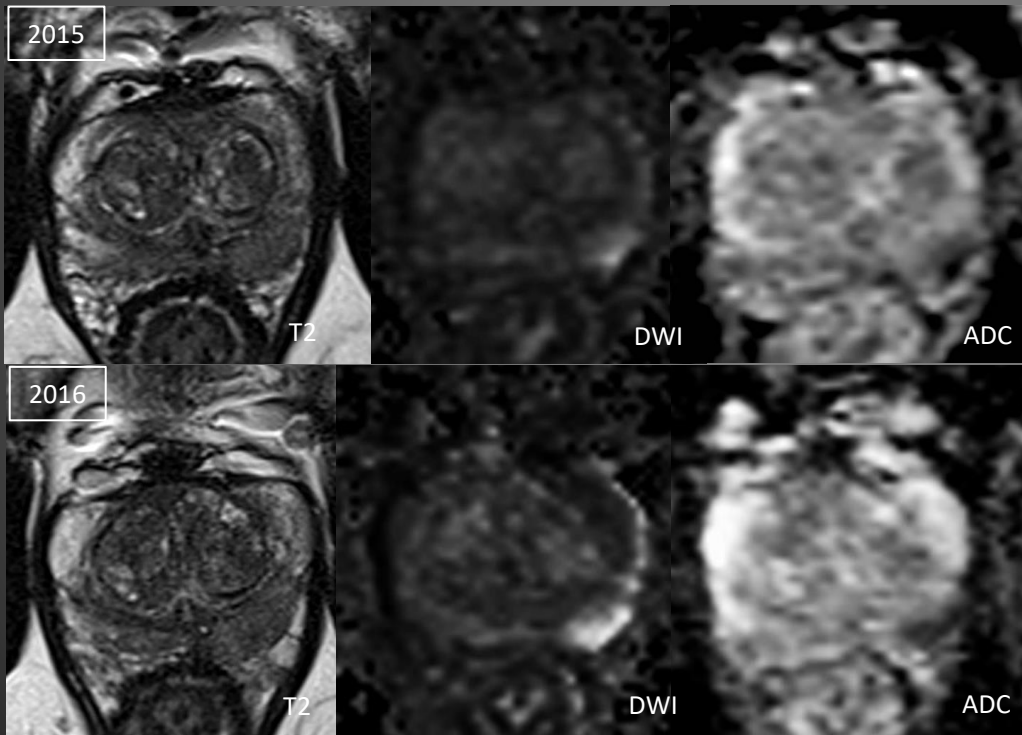


¹Vargas HA, et al. J Urol 2012; PMID: 23017866

²Klotz L, et al. Eur Urol. 2020; PMID: 31708295

Active Surveillance

- MRI for evaluation of progression
 - Prostate Cancer Radiological Estimation of Change in Sequential Evaluation (**PRECISE**)³



MRI-targeted Bx 2015: PCa GG1

MRI-targeted Bx 2016: PCa GG3

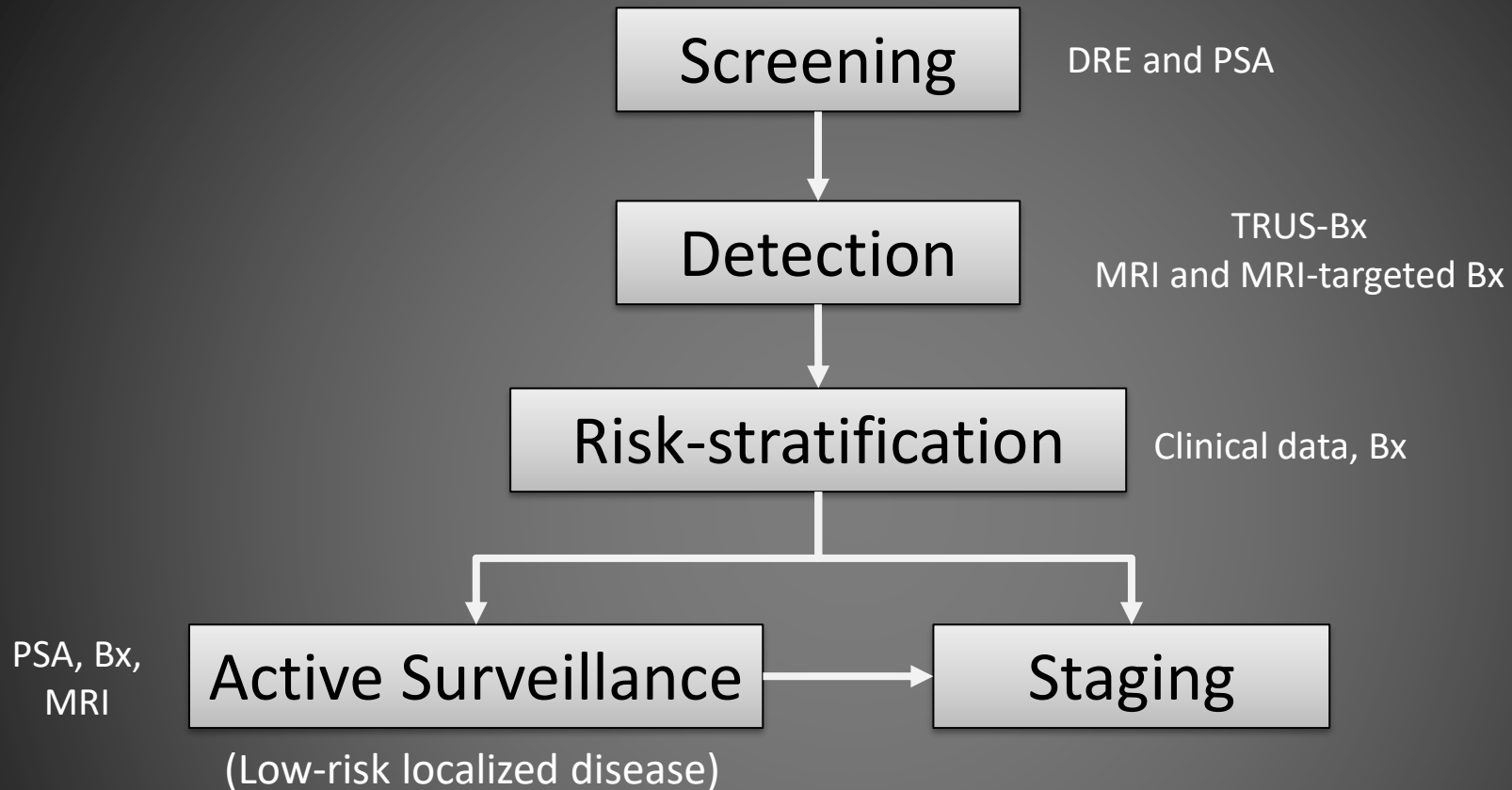
³Moore C, et al. Eur Urol 2017; PMID: 27349615

Reporting Magnetic Resonance Imaging in Men on Active Surveillance for Prostate Cancer: The PRECISE Recommendations—A Report of a European School of Oncology Task Force

Likert	Assessment of likelihood of radiographic progression	Example
1	Resolution of previous features suspicious on MRI	Previously enhancing area no longer enhances
2	Reduction in volume and/or conspicuity of previous features suspicious on MRI	Reduction in size of previously seen lesion that remains suspicious for clinically significant disease
3	Stable MRI appearance: no new focal/diffuse lesions	Either no suspicious features or all lesions stable in size and appearance
4	Significant increase in size and/or conspicuity of features suspicious for prostate cancer	Lesion becomes visible on diffusion-weighted imaging; significant increase in size of previously seen lesion
5	Definitive radiologic stage progression	Appearance of extracapsular extension, seminal vesicle involvement, lymph node involvement, or bone metastasis

*Threshold for size/volume increase has not been set

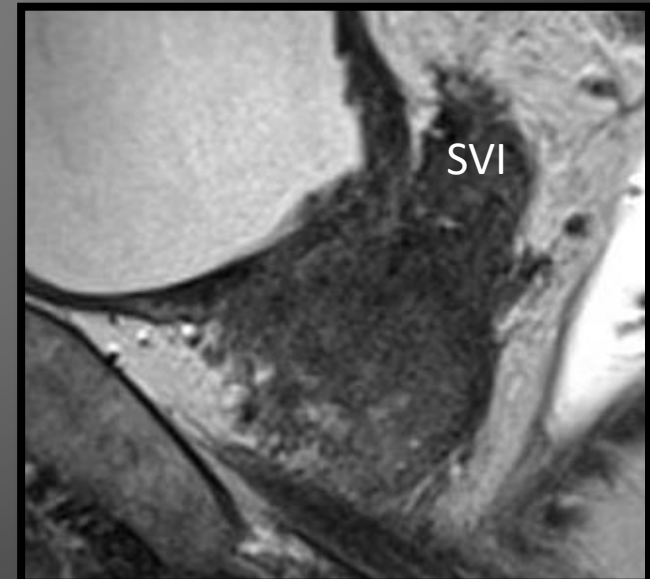
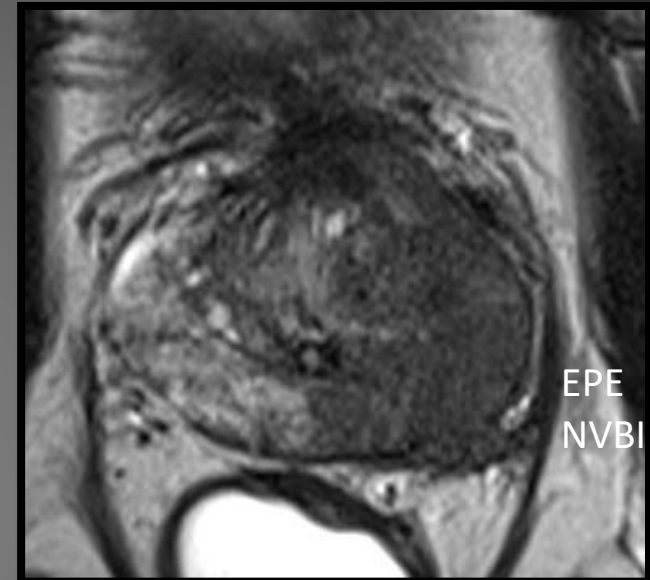
Prostate Cancer



PCa Staging

- EPE and NVBI: affects treatment selection and planning
- DRE: under stages 25-30% of cases
- MRI is appropriate for staging intermediate/high risk PCa¹

Risk	PSA	GS	Stage
Low	<10	6	T1-2a
Interm.	10-20	7	T2b
High	≥ 20	≥ 8	≥ T2c

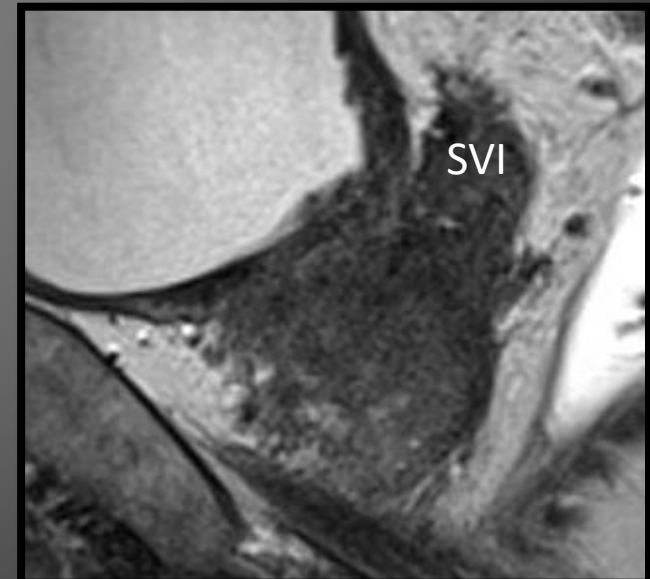
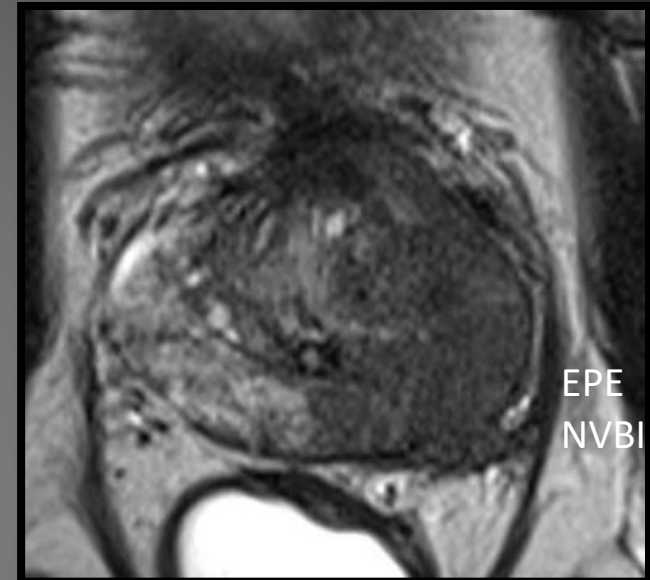


¹Akin O, et al. [ACR appropriateness criteria](#), JACR 2022 PMID: 37236742

PCa Staging

- Meta-analysis²
- 75 studies (9796 patients)
- EPE/SVI sensitivity improved with:
 - T2-WI + DWI/DCE
 - 3 T
- ERC did not improve sensitivity for EPE

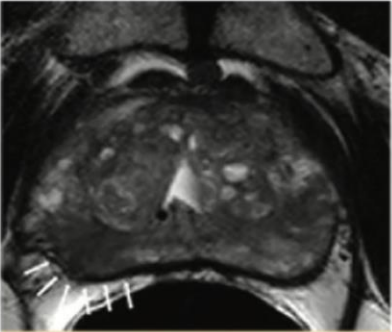
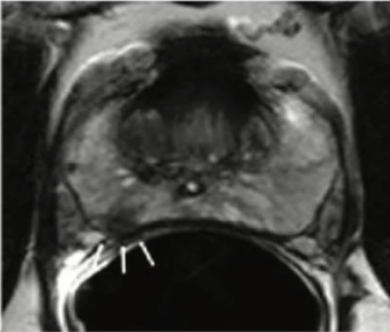
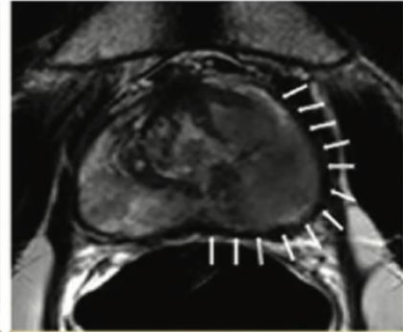
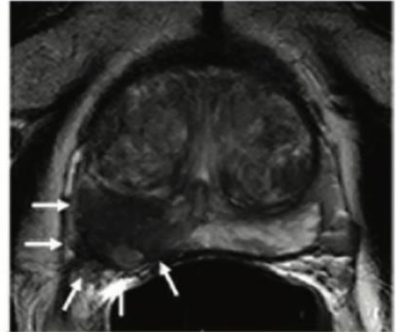
	Sensitivity	Specificity
EPE	0.57	0.91
SVI	0.58	0.96
pT3	0.61	0.88



PCa Staging

- Probability of EPE based on MRI features

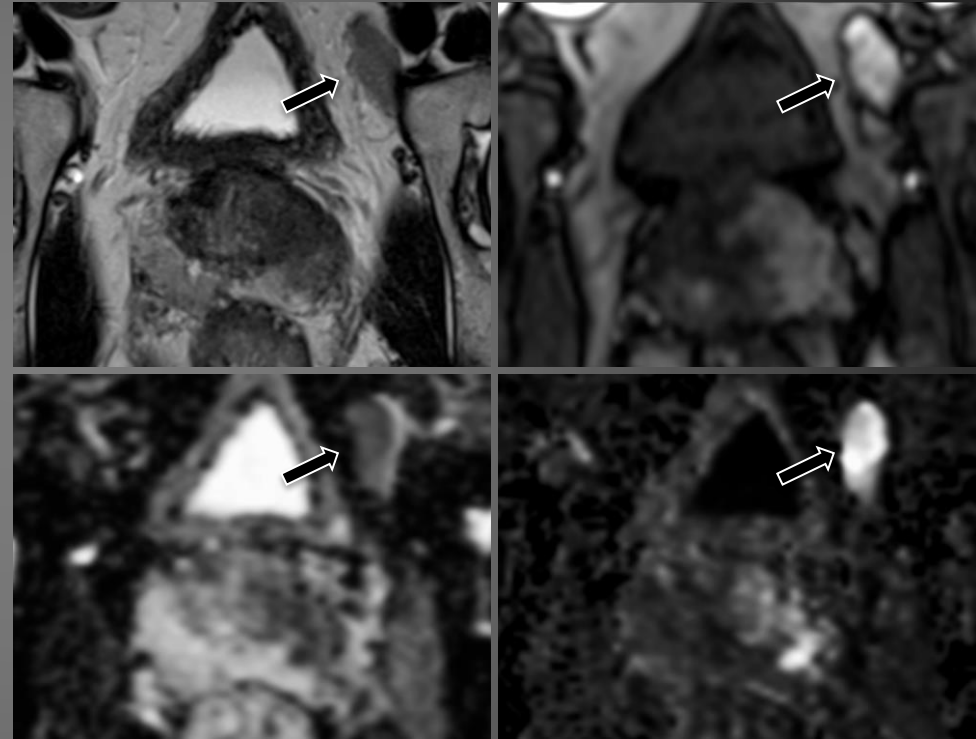
Assessment of Risk of Extraprostatic Extension of Prostate Cancer at MRI

			
<u>MRI-Derived EPE Grade 1</u>	<u>MRI-Derived EPE Grade 1</u>	<u>MRI-Derived EPE Grade 2</u>	<u>MRI-Derived EPE Grade 3</u>
pEPE Risk 24.3%	pEPE Risk 24.3%	pEPE Risk 38.2%	pEPE Risk 66.1%
Curvilinear contact length ≥ 1.5 cm	Capsular bulge/irregularity	Curvilinear contact length <u>and</u> capsular bulge/irregularity	Frank breach of prostatic capsule or invasion of adjacent structures

PCa Staging

- Lymph nodes¹
- MRI Sens.: 39%; Spec.: 82%
- Size (short axis)
 - > 10 mm (> 8 mm if rounded)
- Borders and signal (subjective)
- Bones²
- MRI Sens.: 95.2%; Spec.: 99%
- PPV: 86.9–100%;NPV: 99.7%

PCa GS 4 + 5 Pre-op MRI
+EPE ; +Nodes



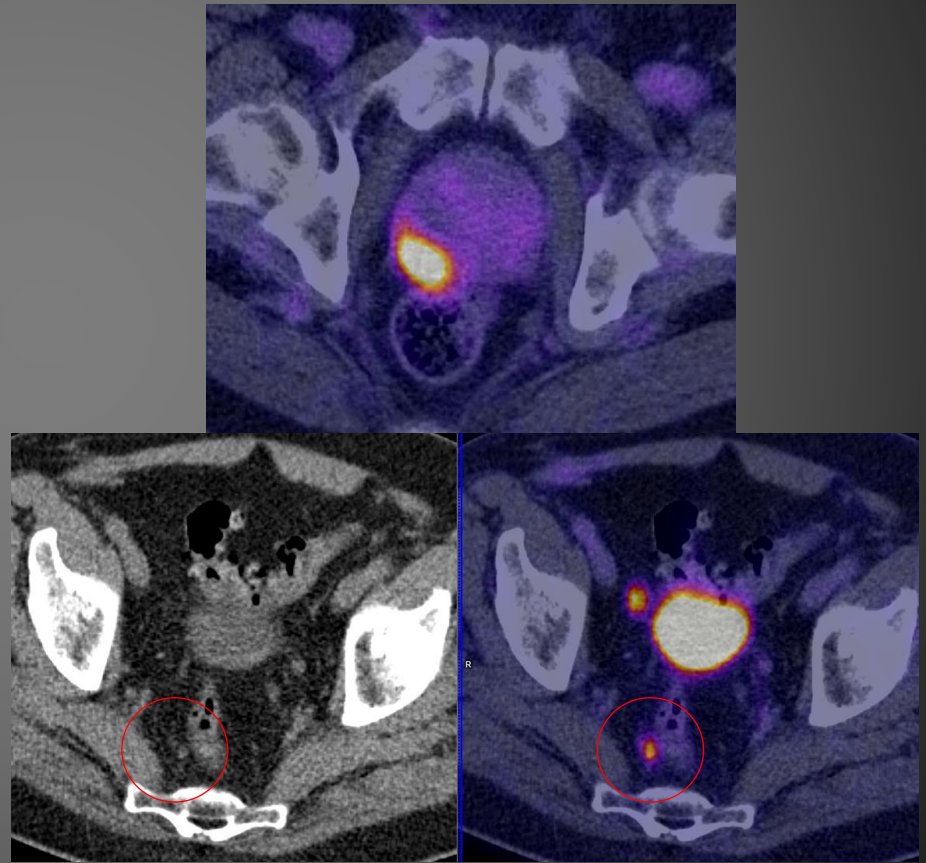
¹Hovels A, et al. Clin. Radiol. 2008 PMID: 18325358

²Woo S, et al. AJR 2016 PMID: 27043655

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- PPV: 86.9–100%; NPV: 99.7%

PCa GS 4 + 4
Pre-treatment staging
F18-DCFPyL-PSMA PET/CT



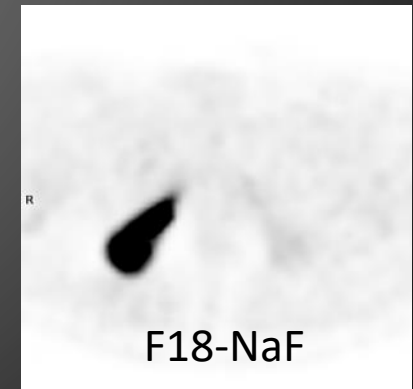
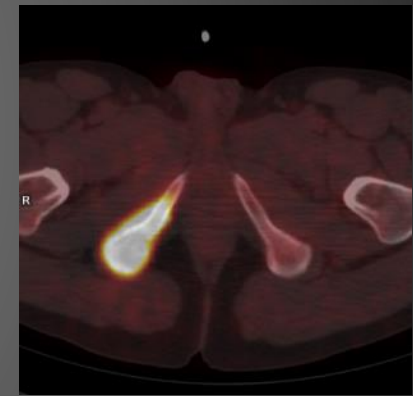
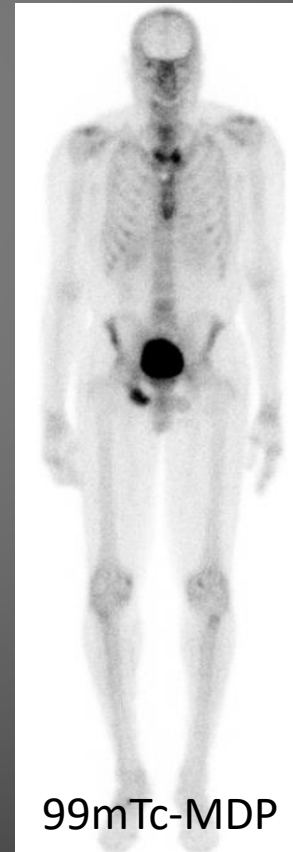
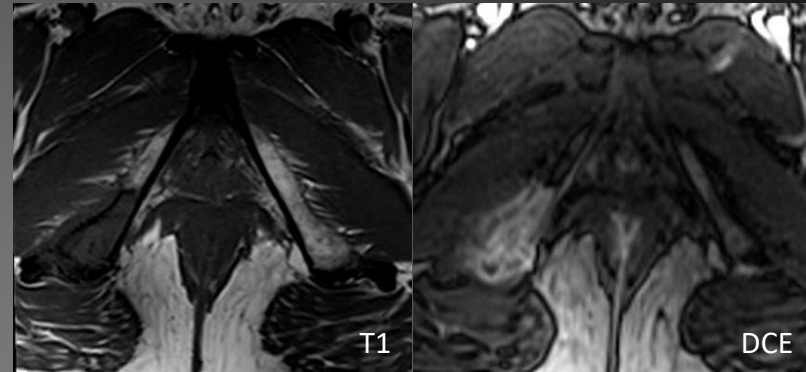
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PCa Staging

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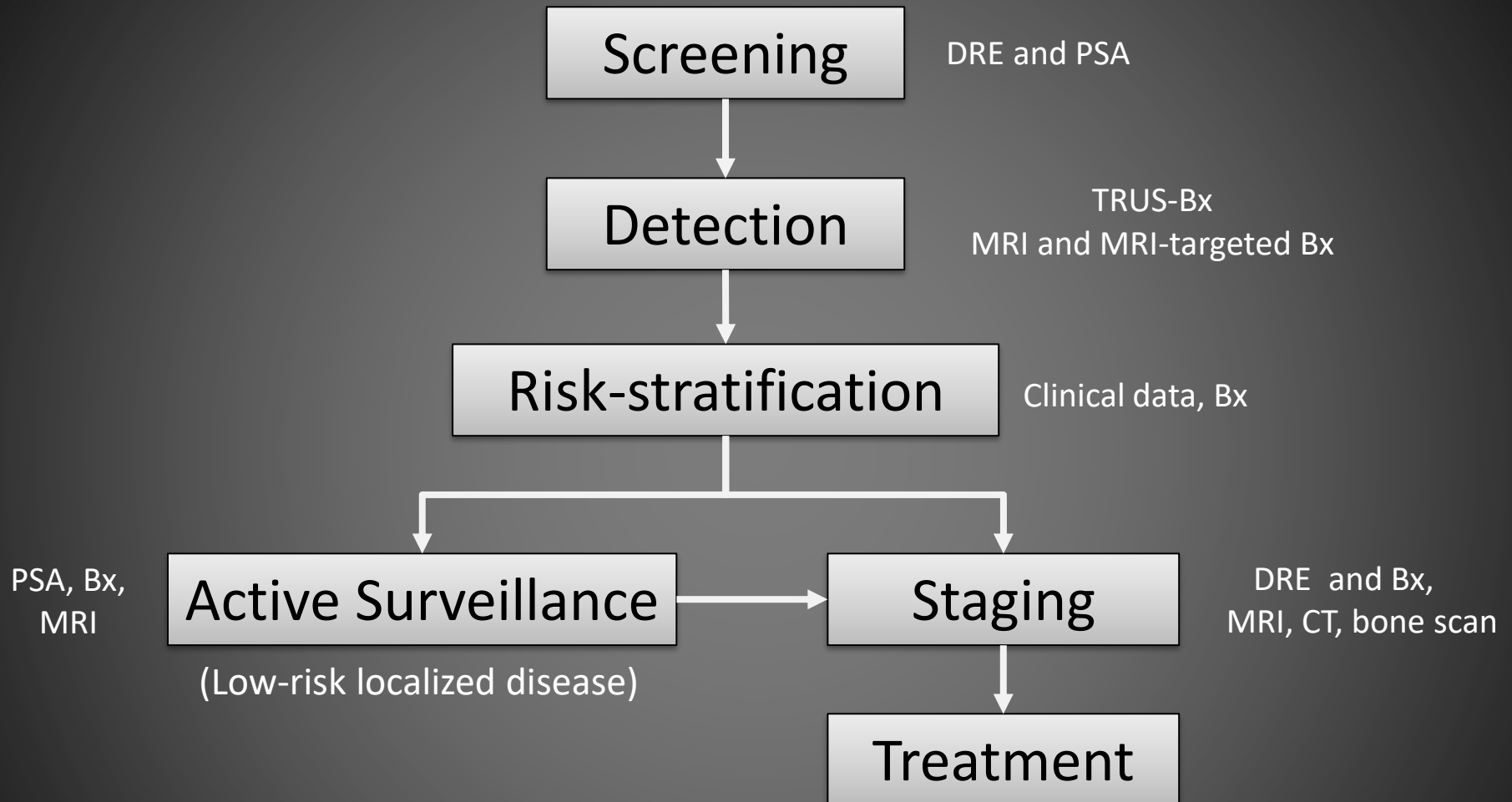
PCa GS 3 + 4, PSA: 70.4ng/mL



¹Hovels A, et al. Clin. Radiol. 2008 PMID: 18325358

²Woo S, et al. AJR 2016 PMID: 27043655

Prostate Cancer



MRI-guided PCa Treatments

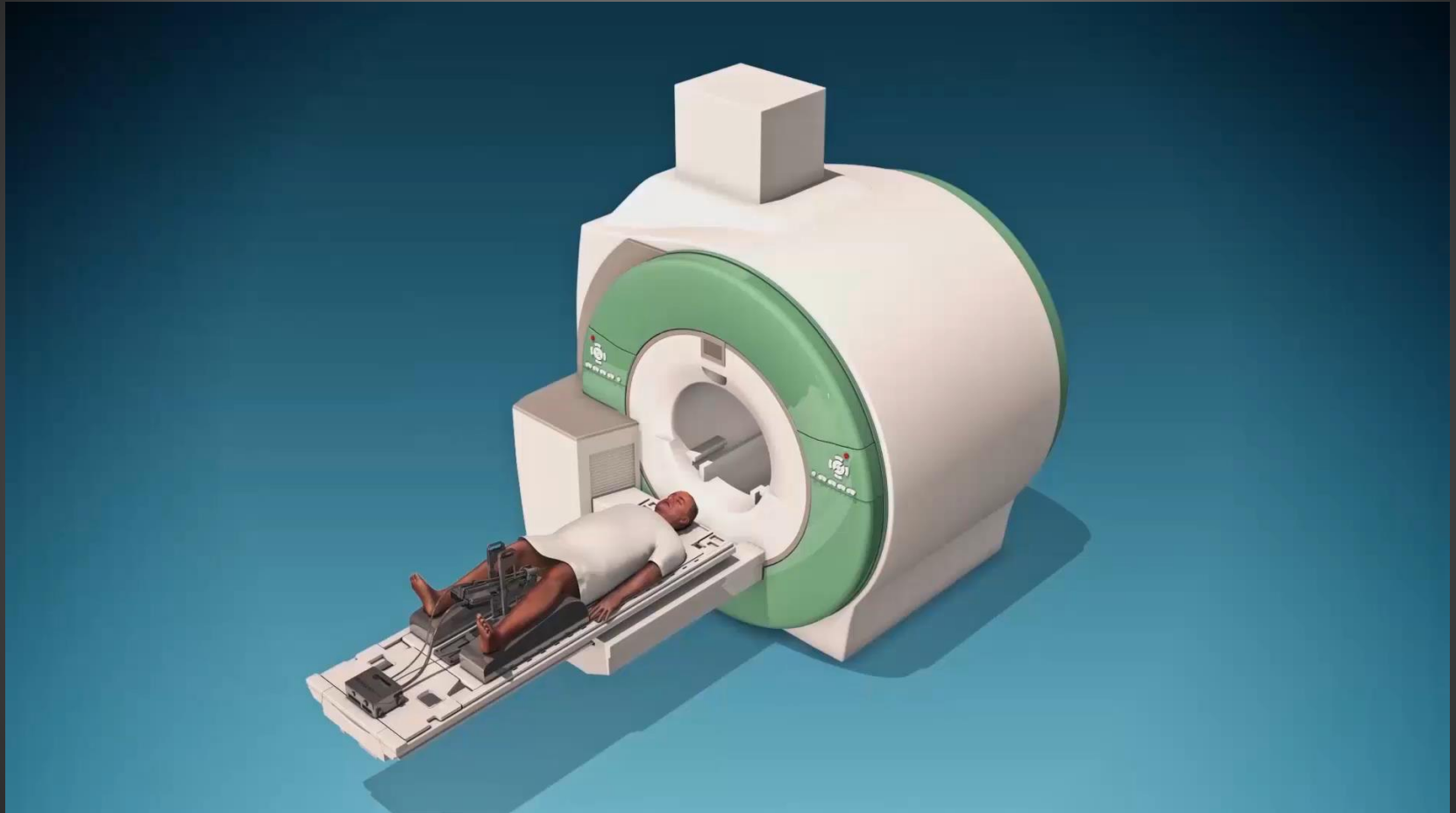
- Potential for lower morbidity and side effects with comparable functional and oncologic outcomes
- Some alternatives are more attractive to potent patients
- Most patients remain eligible to salvage treatments

Prostatectomy	Radiation treatment	Energy ablations
Surgical margin*	Focal boost (FLAME trial**)	Whole gland or focal treatment
Nerve sparing*	Nerve sparing (POTEN-C)	Nerve sparing
Partial resection (Hemi-gland or tumor resection)		HIFU, Cryoablation, Laser

*PMID: 36372633

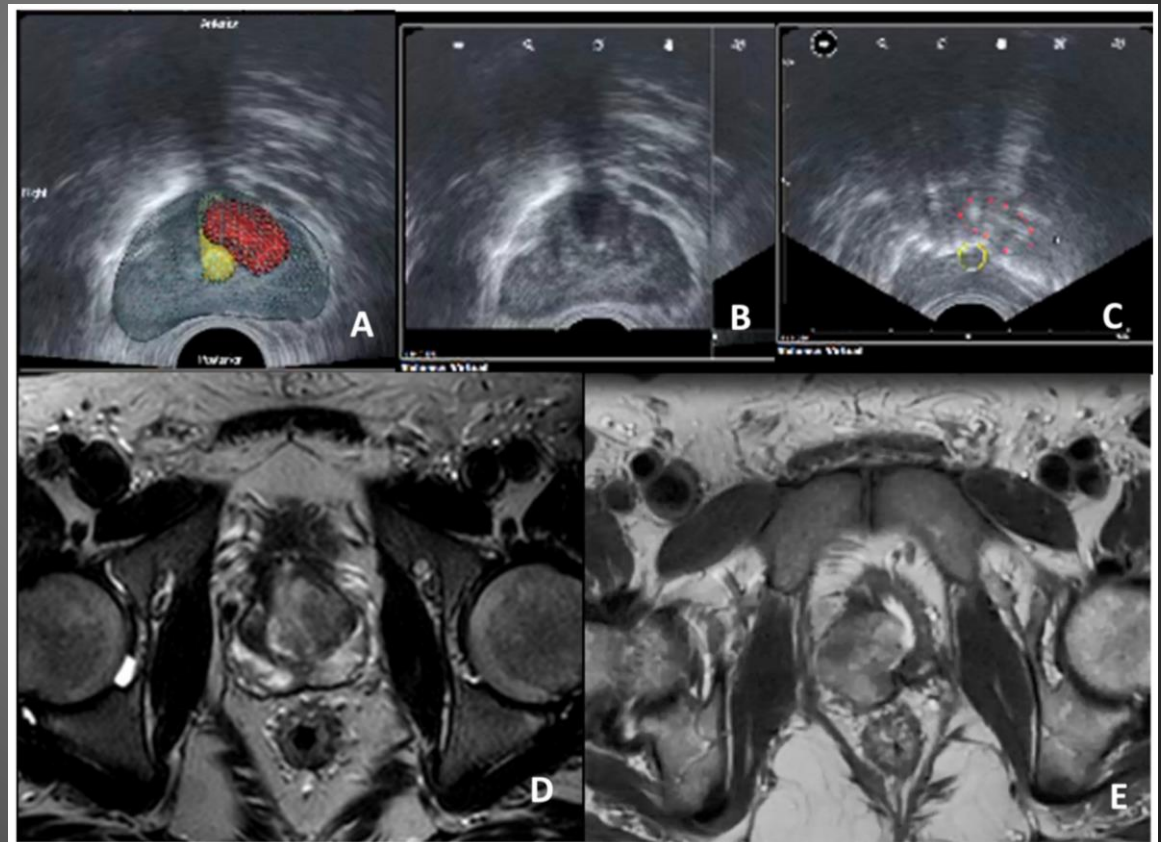
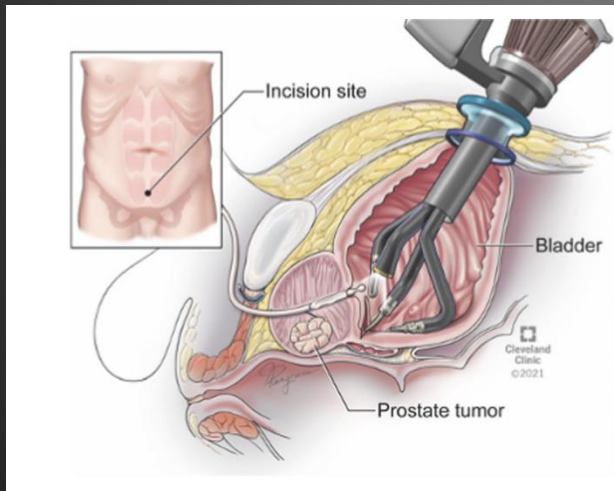
**PMID: 33471548

MRI-guided PCa Treatments

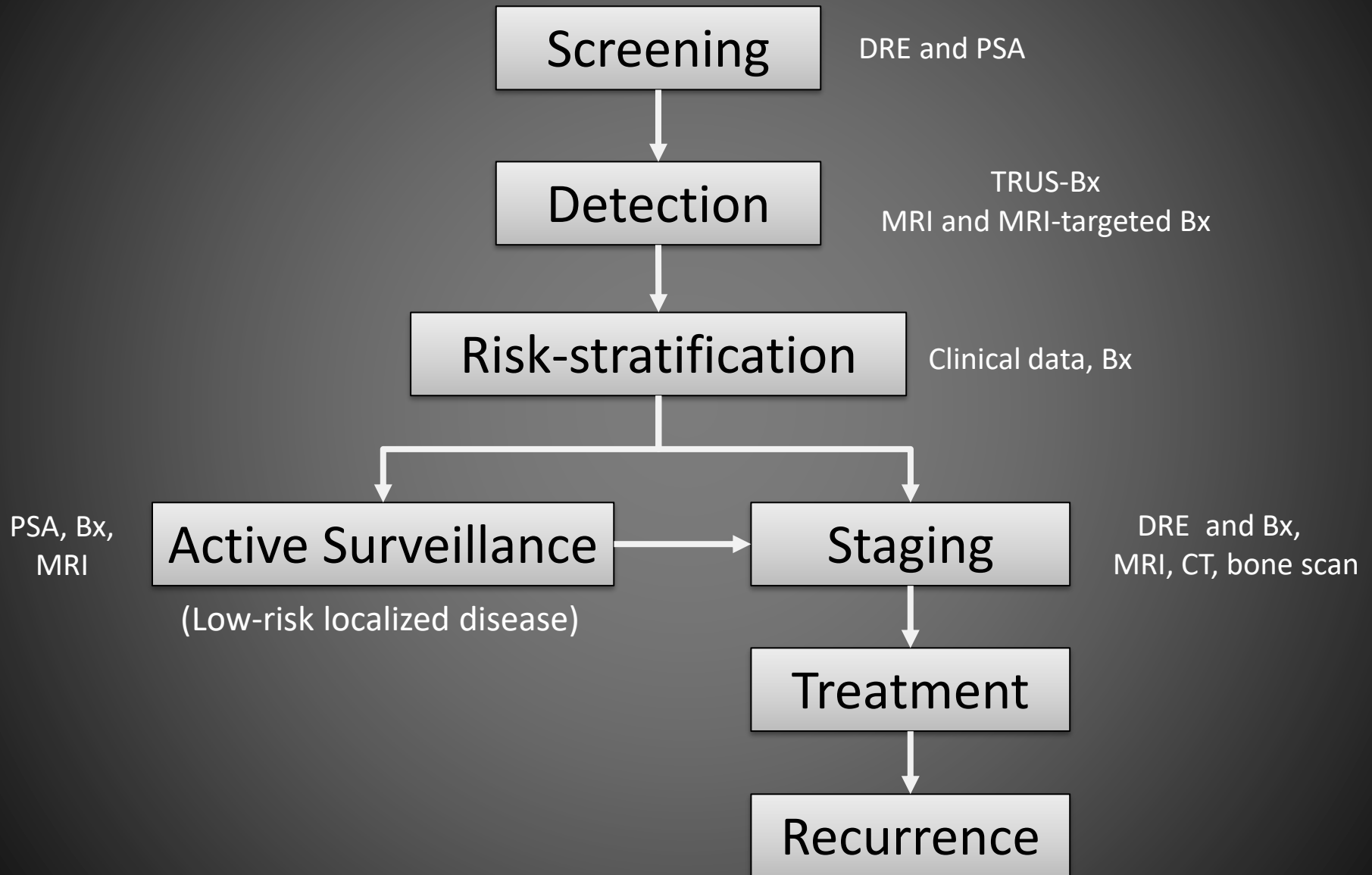


MRI-guided PCa Treatments

Single-port Robotic Transvesical Partial Prostatectomy for Localized Prostate Cancer: Initial Series and Description of Technique



Prostate Cancer



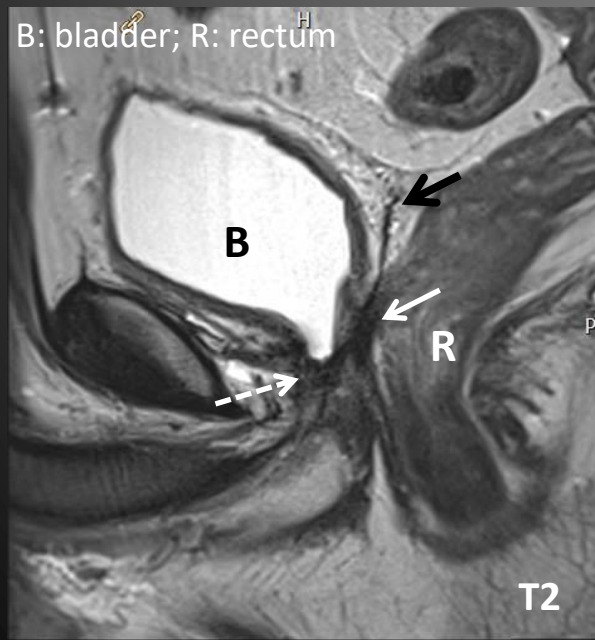
PCa Recurrence

- Occurs in 10-53% of patients, depending on risk group and treatment modality
- Typically detected by elevation in PSA levels after treatment, which can precede symptoms by months to years

Treatment modality	Biochemical recurrence (BCR) criteria
Radical Prostatectomy (RP)	Two consecutive PSA levels > 0.2 ng/mL
Radiation therapy (RT)	PSA level $\geq$ 2.0 ng/mL above nadir
Tissue ablation treatments	No consensus, but some use same as RT

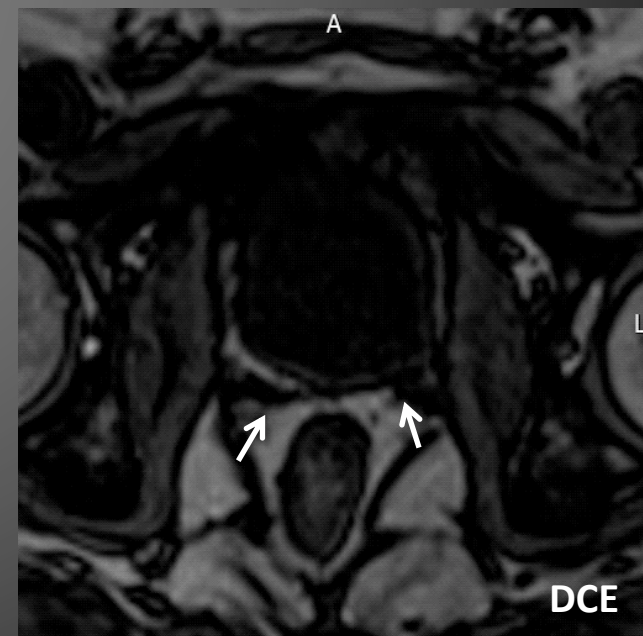
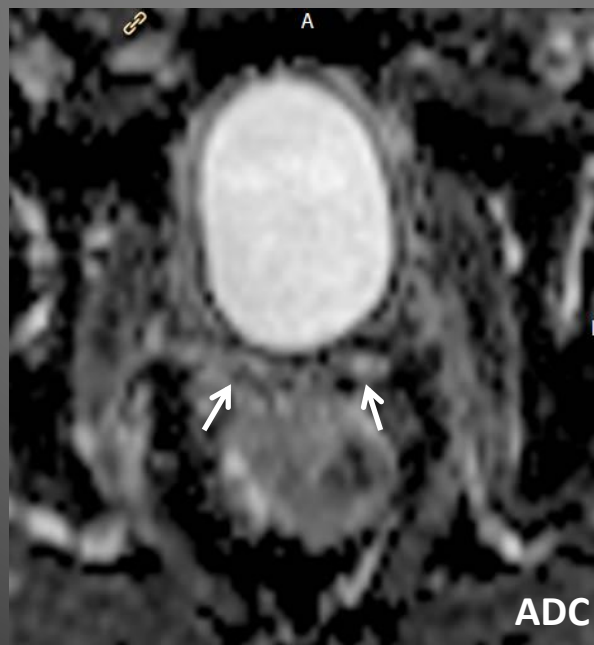
MRI after RP – Expected Findings

- **Fibrotic tissue** develops in the prostatectomy bed and vesicoureteral anastomosis
 - T2-WI: symmetric non-mass like tissue with low signal
 - DWI/ADC: no restricted diffusion
 - DCE: delayed and progressive enhancement



MRI after RP – Expected Findings

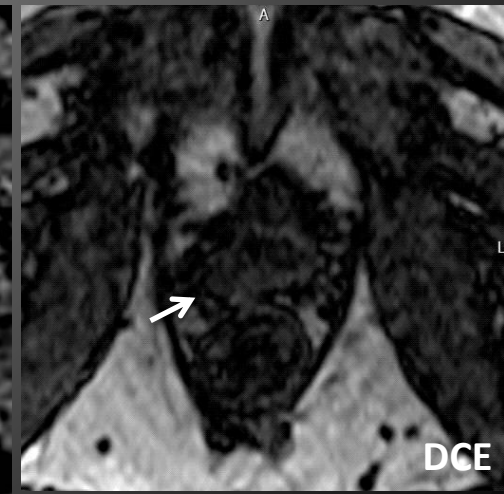
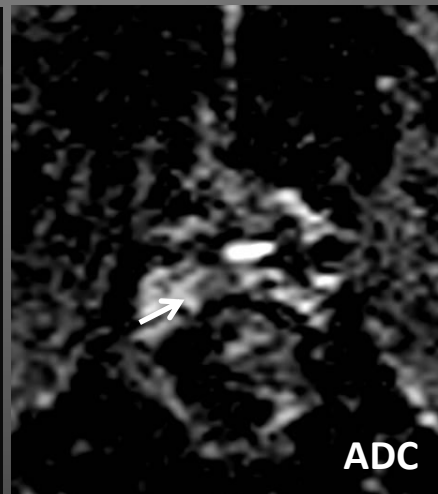
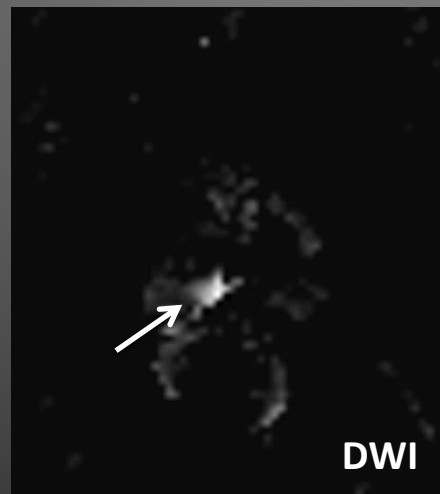
- **Fibrotic tissue** develops in the prostatectomy bed and vesicoureteral anastomosis
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 - DWI/ADC: no restricted diffusion
 - DCE: delayed and progressive enhancement



MRI after RP – Recurrence

- Locations: **perianastomotic**, retrovesical, or in the SV bed
- MRI features:
 - T2-WI: focal mass-like lesion with intermediate SI
 - DWI/ADC: focal mass-like lesion with markedly restricted diffusion
 - DCE: focal mass-like lesion with early enhancement

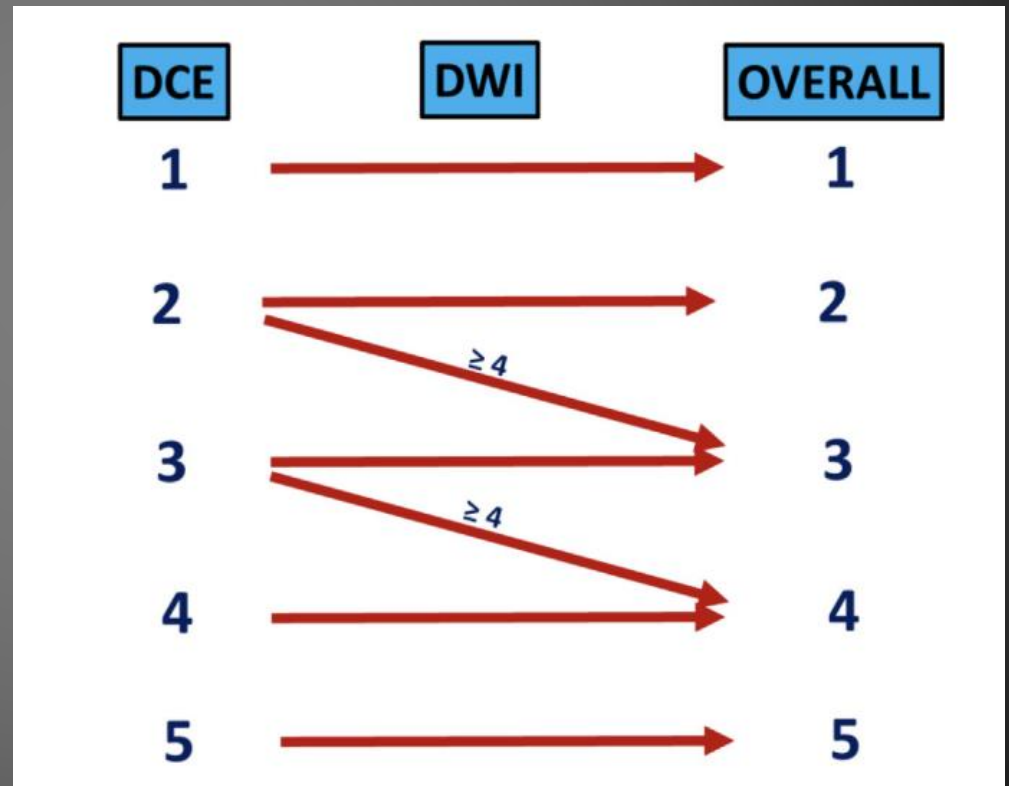
77 y.o man s/p RP for GS 3+4 stage T2b PCa presents with BCR (PSA: 2.6ng/mL)



MRI after RP – Recurrence

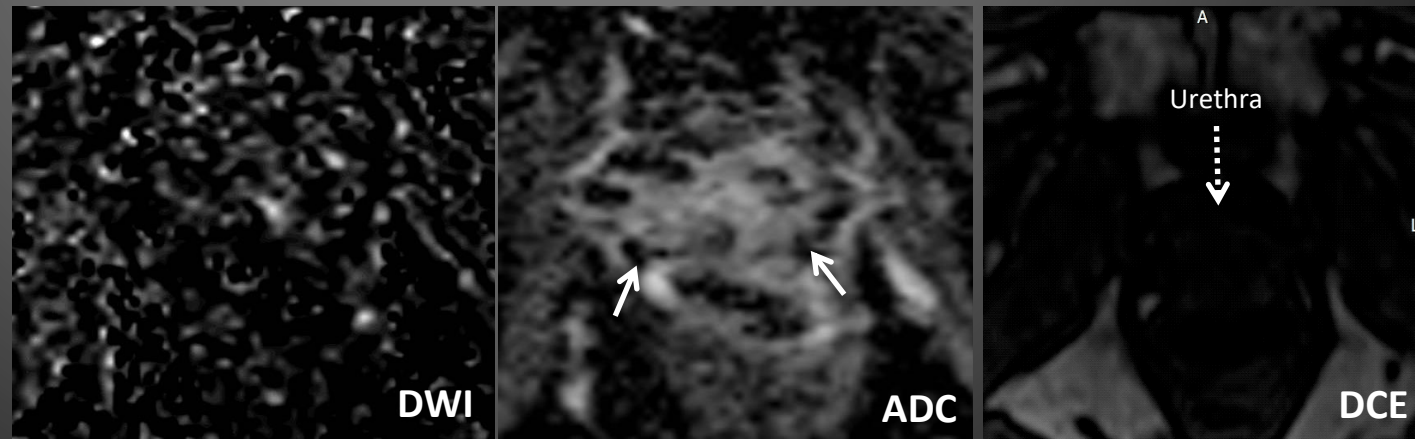
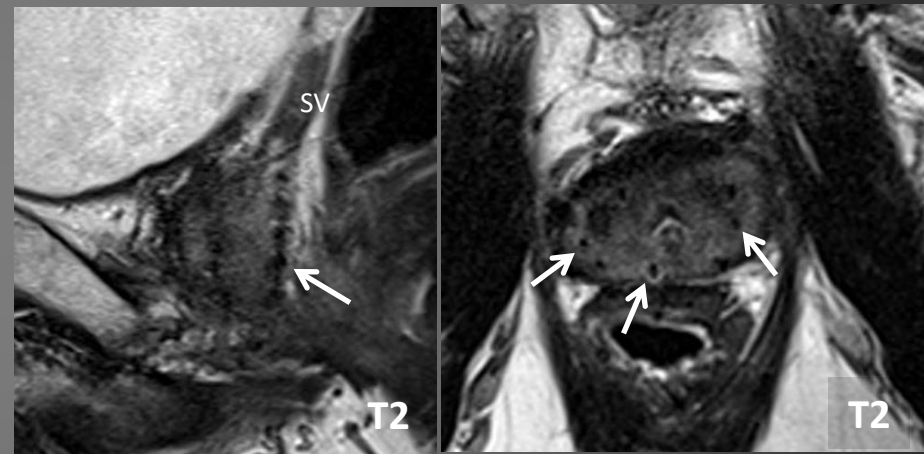
Prostate Magnetic Resonance Imaging for Local Recurrence Reporting (PI-RR): International Consensus -based Guidelines on Multiparametric Magnetic Resonance Imaging for Prostate Cancer Recurrence after Radiation Therapy and Radical Prostatectomy

Score	DCE Pattern
1	No enhancement
2	Diffuse heterogeneous enhancement
3	Focal or mass-like late enhancement
4	Focal or mass-like early enhancement not at the site of primary tumor tumor site unknown
5	Same as 4 but at the site of primary tumor



MRI after RT– Expected findings

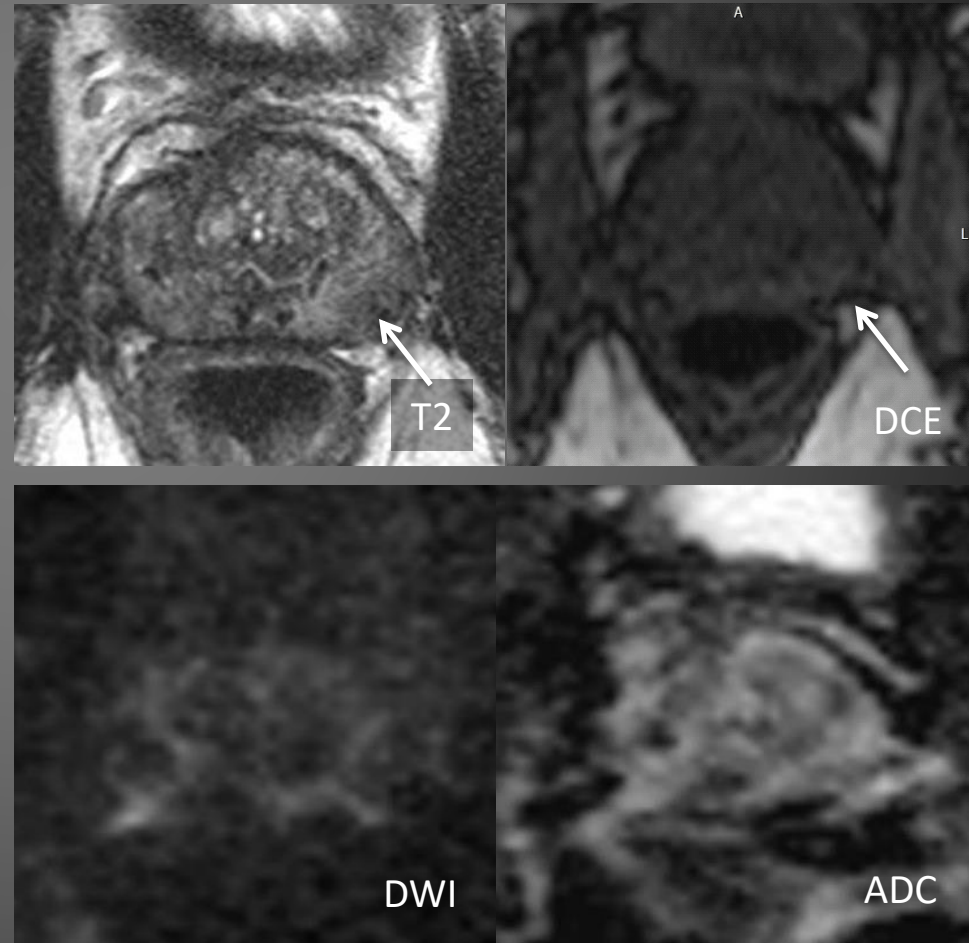
- T2-WI: diffuse low signal and loss of zonal anatomy
- DWI/ADC: no restricted diffusion
- DCE: decreased and delayed enhancement except for urethra and residual BPH



MRI after RT– Recurrence

- Local recurrence often occurs in the site of the original disease
- MRI features:
 - T2-WI: nodular lesion with intermediate/low signal
 - DWI/ADC: may have restricted diffusion
 - **DCE**: early enhancement

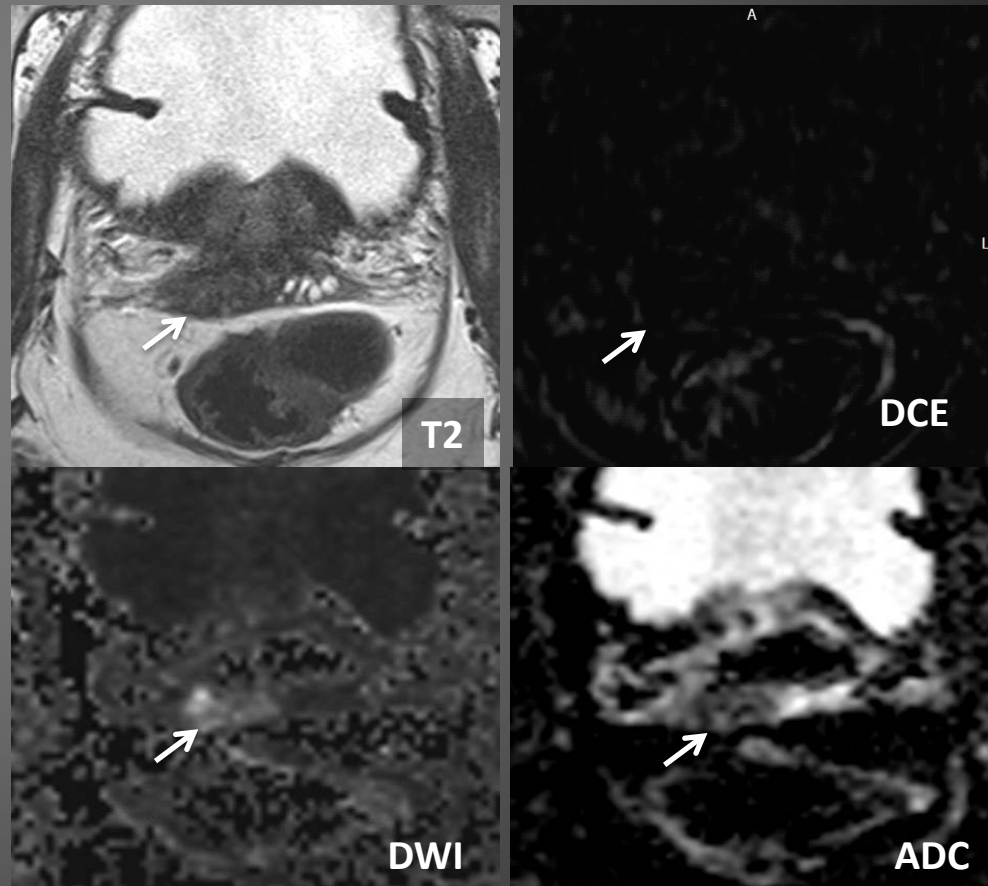
72 y.o. man s/p **Brachytherapy** for GS 3+4 PCa detected by TRUS biopsy of left sided sextants, now with BCR (PSA 6.1 ng/mL)



MRI after RT– Recurrence

- Local recurrence often occurs in the site of the original disease
- MRI features:
 - T2-WI: nodular lesion with intermediate/low signal
 - DWI/ADC: may have restricted diffusion
 - **DCE**: early enhancement

75 y.o man s/p **brachytherapy** for GS 4+3 detected by TRUS in right sided sextants, now with BCR (PSA 3.5ng/mL)



In summary

Prostate MRI:

- a. Accurate method for detection of PCa, especially those that are likely to be significant
- b. Helps identify men who are suitable for active surveillance
- c. Provides important information that can assist with staging and treatment planning
- d. Detects recurrent PCa, usually at the site of original disease and using DCE

Thank you!