



Multiparametric Prostate MRI (mpMRI)

JOSHUA D. HANELIN, MD

Prostate Cancer

- ▶ Most Common noncutaneous malignancy and second leading cause of cancer-related deaths in men in the U.S.

Prostate Cancer Diagnosis

- ▶ Only solid organ malignancy for which imaging is not used to determine who needs a biopsy.
- ▶ Systematic 12 core transrectal ultrasound-guided biopsy (TRUS-biopsy) in men with elevated PSA or abnormal DRE.

TRUS-biopsy based on PSA

- ▶ Men without cancer undergo unnecessary biopsy.
- ▶ Clinically insignificant cancers (Gleason 3+3) are detected and subsequently overtreated resulting in morbidity and significant economic impact.
- ▶ Clinically significant cancers (Gleason 3+4) missed or undersampled with a false negative rate of 30%¹.
- ▶ TRUS-biopsy carries significant morbidity and risk of life threatening sepsis.

1. Serefoglu EC, Altinova S, Ugras NS, et al. How reliable is 12-core prostate biopsy procedure in the detection of prostate cancer? *Can Urol Assoc J* 2013;7(5-6):E293-8.

Prostate MRI Indications

Prebiopsy evaluation

- ▶ PROMIS trial² demonstrated benefit of mpMRI in prebiopsy setting.
 - ▶ Sensitivity of 93% and NPV of 89% compared to 48% and 74% for TRUS-biopsy.
 - ▶ Selecting men for biopsy based on mpMRI → decrease primary biopsies by 27%, reduce detection of clinically insignificant cancer by 5%, increase detection of clinically significant cancer 18%.
 - ▶ Suggests possibility of foregoing biopsy if mpMRI is negative.
 - ▶ Decrease number of cores if targeted biopsy plus systematic biopsy.

2. Ahmed HU, El-Shater Bosaily A, Brown LC, et al. Diagnostic accuracy of multi-parametric MRI and TRUS biopsy in prostate cancer (PROMIS): a paired validating confirmatory study. *Lancet* 2017; 389(10071):815–22. 21. Yin Y, Zhang Q, Zhang H.

Prostate MRI Indications

Elevated PSA with negative TRUS-biopsy

- ▶ Increase cancer detection rate and pathologic upgrading in up to 38% of cases in men with persistent clinical suspicion of prostate cancer despite prior negative biopsy³.
- ▶ TRUS-biopsy samples posterior prostate and misses anterior lesions.

3. Bjurlin MA, Meng X, Le Nobin J, et al. Optimization of prostate biopsy: the role of magnetic resonance imaging targeted biopsy in detection, localization and risk assessment. J Urol 2014;192(3):648–58.

Prostate MRI Indications

Disease staging and surgical planning

- ▶ Evaluate:
 - ▶ Tumor volume.
 - ▶ Extraprostatic extension for invasion of seminal vesicles, neurovascular bundles, bladder, rectum.
 - ▶ Pelvic lymph nodes.
 - ▶ Pelvic and lumbar bone marrow.
- ▶ Preoperative MRI altered surgical approach with respect to the neurovascular bundle 27% of the time⁴.

4. McClure TD, Margolis DJ, Reiter RE, et al. Use of MR imaging to determine preservation of the neurovascular bundles at robotic-assisted laparoscopic prostatectomy. *Radiology* 2012;262(3):874-83.

Prostate MRI Indications Surveillance

- ▶ Low risk disease detected at TRUS-biopsy.
- ▶ Confirm no additional suspicious lesions missed by TRUS-biopsy.
- ▶ In men eligible for active surveillance based on systematic biopsies, 1/3 to 1/2 of men made ineligible based on MR and targeted biopsies⁵.

5. Schoots IG, Petrides N, Giganti F, et al. Magnetic resonance imaging in active surveillance of prostate cancer: a systematic review. *Eur Urol* 2015;67(4): 627–36. 24. Radtke JP

Prostate MRI Indications

Evaluation of Biochemical recurrence

- ▶ Local recurrence in prostate bed or irradiated gland.
- ▶ Local metastases in pelvic lymph nodes and bone marrow.

Prostate MRI Indications

Focal therapy planning

- ▶ Evaluate candidacy for focal therapy.
- ▶ Map extent of disease.
- ▶ Intraprocedural monitoring with thermal maps to determine adequacy of ablation.
- ▶ Posttreatment monitoring for recurrence.

Prostate MRI Indications

Radiation therapy planning

- ▶ Risk grouping with migration to higher risk categories indicating addition of hormonal therapy and chemotherapy.
- ▶ Simulation scans.
- ▶ Evaluation of disease recurrence.

Prostate MRI Technique

Patient preparation

- ▶ NPO for 3-4 hours before exam to reduce bowel peristalsis.
- ▶ No enema.
- ▶ Standard contraindications for MRI.
- ▶ Metal in pelvis and hip may degrade images.

Prostate MRI Technique

Equipment

- ▶ 3T MRI
- ▶ 1.5T if contraindications at 3T.
- ▶ No endorectal coil!
- ▶ Pelvic surface coil.
- ▶ Power injector for contrast.

Prostate MRI Technique

Equipment



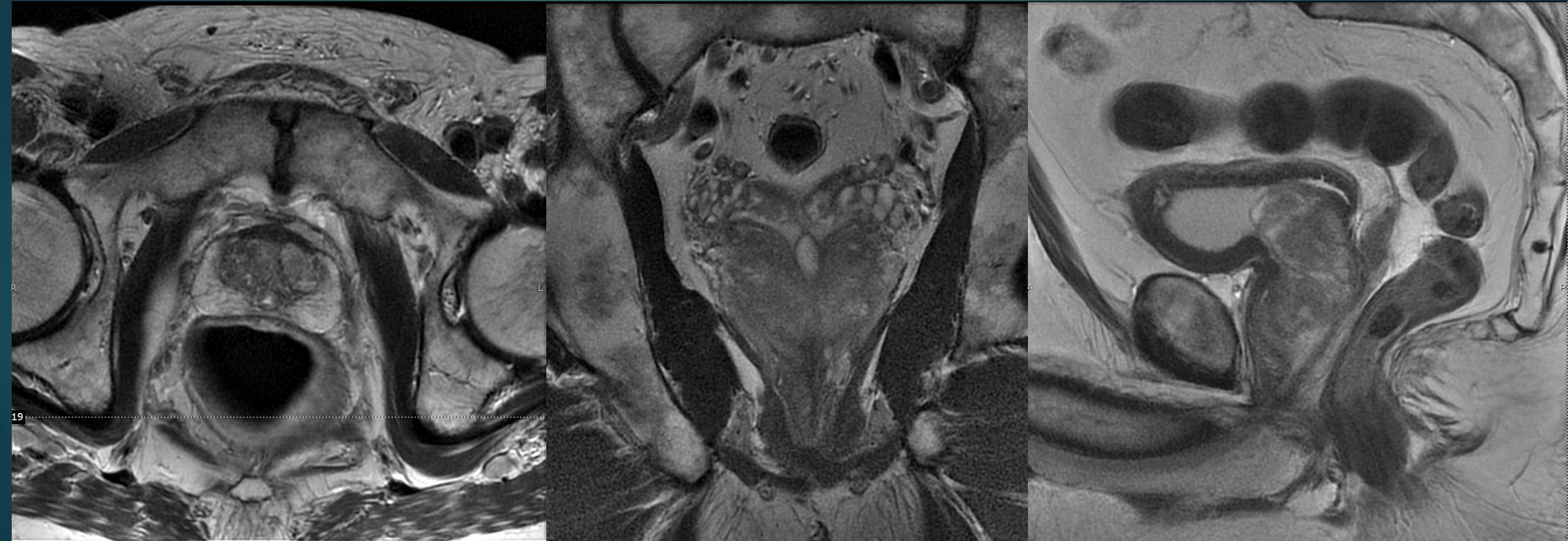
Prostate MRI Technique

MRI Sequences

- ▶ Anatomic sequences
 - ▶ T2: High soft tissue contrast, zonal anatomy, evaluation of seminal vesicles, neurovascular bundles, and bladder.
 - ▶ T1: Evaluation for biopsy-related hemorrhage, which may obscure lesions.

Prostate MRI Technique

MRI Sequences: T2



Prostate MRI Technique

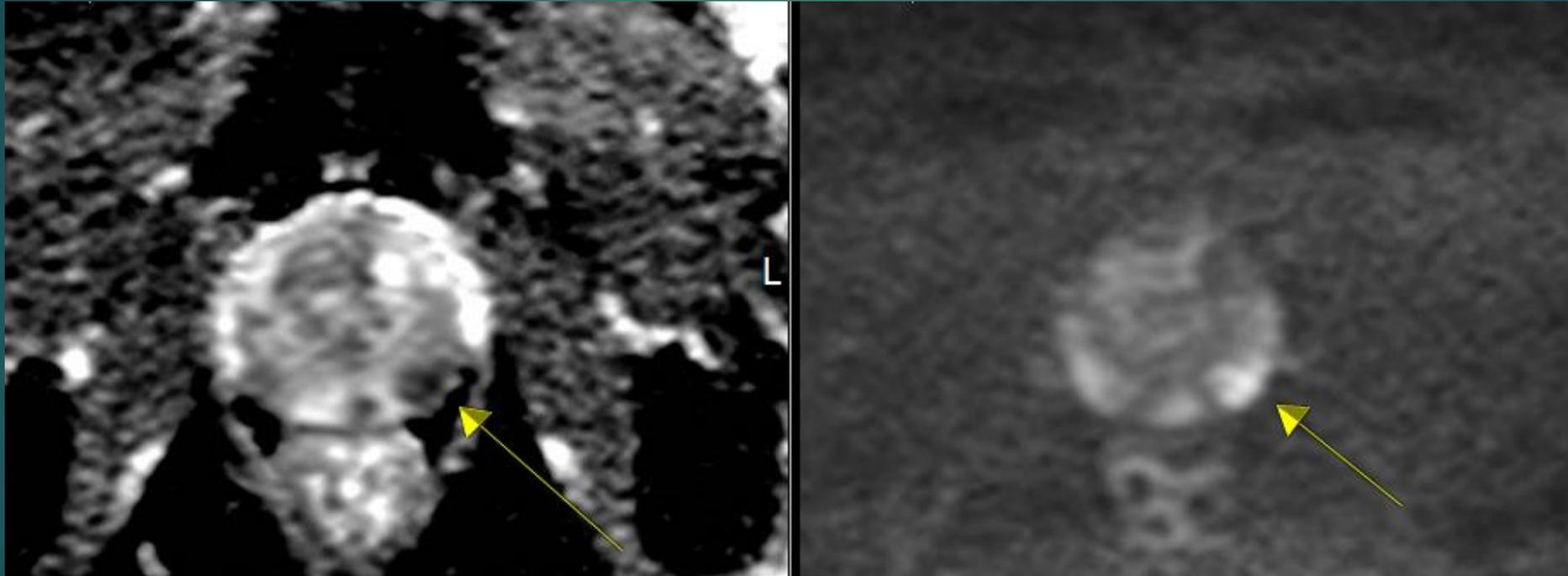
MRI Sequences

- ▶ Functional Sequences

- ▶ DWI/ADC: Assesses tissue cellularity by measuring the mobility of water molecules in tissue.
 - ▶ Prostate cancer impedes diffusion of water.
 - ▶ Inverse correlation between ADC values and prostate cancer grade.
- ▶ Perfusion: Characterizes tissue vascularity by imaging whole gland sequentially after IV contrast administration.
 - ▶ Prostate cancer contains highly permeable neovascularity.

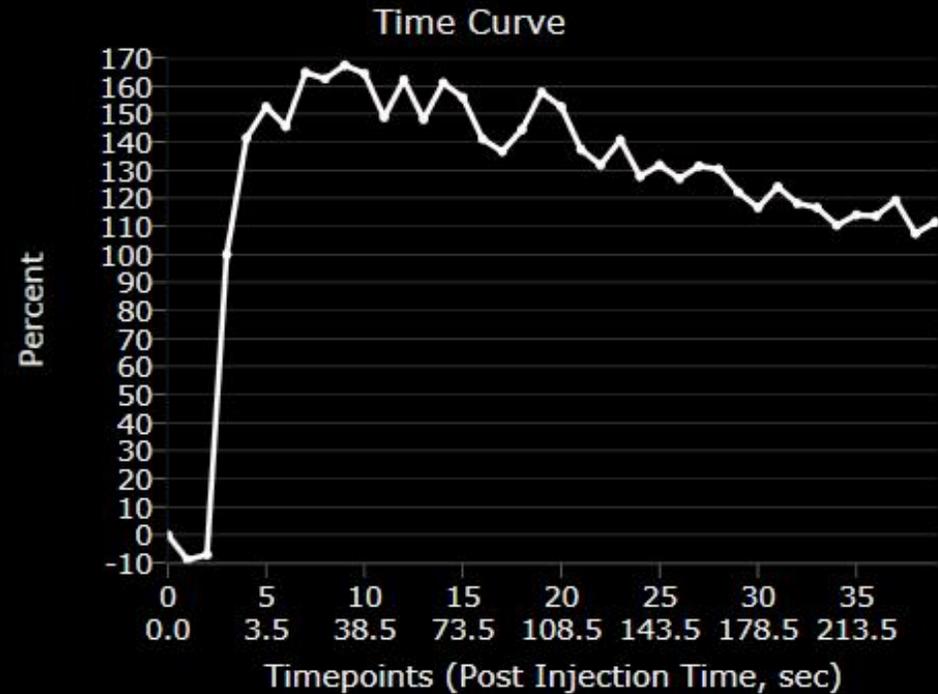
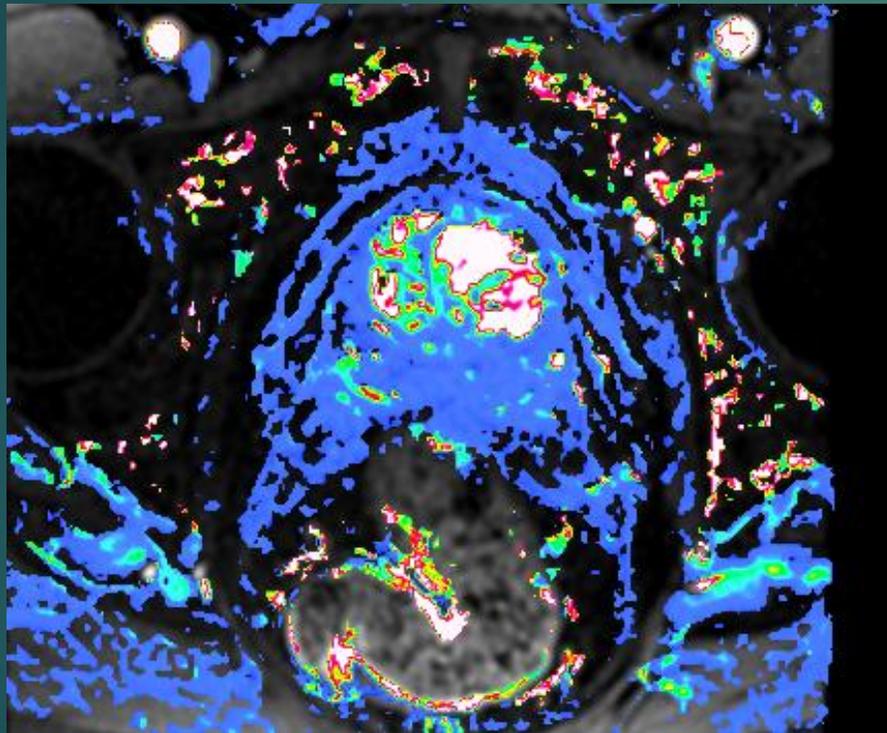
Prostate MRI Technique

MRI Sequences: DWI



Prostate MRI Technique

MRI Sequences: Perfusion



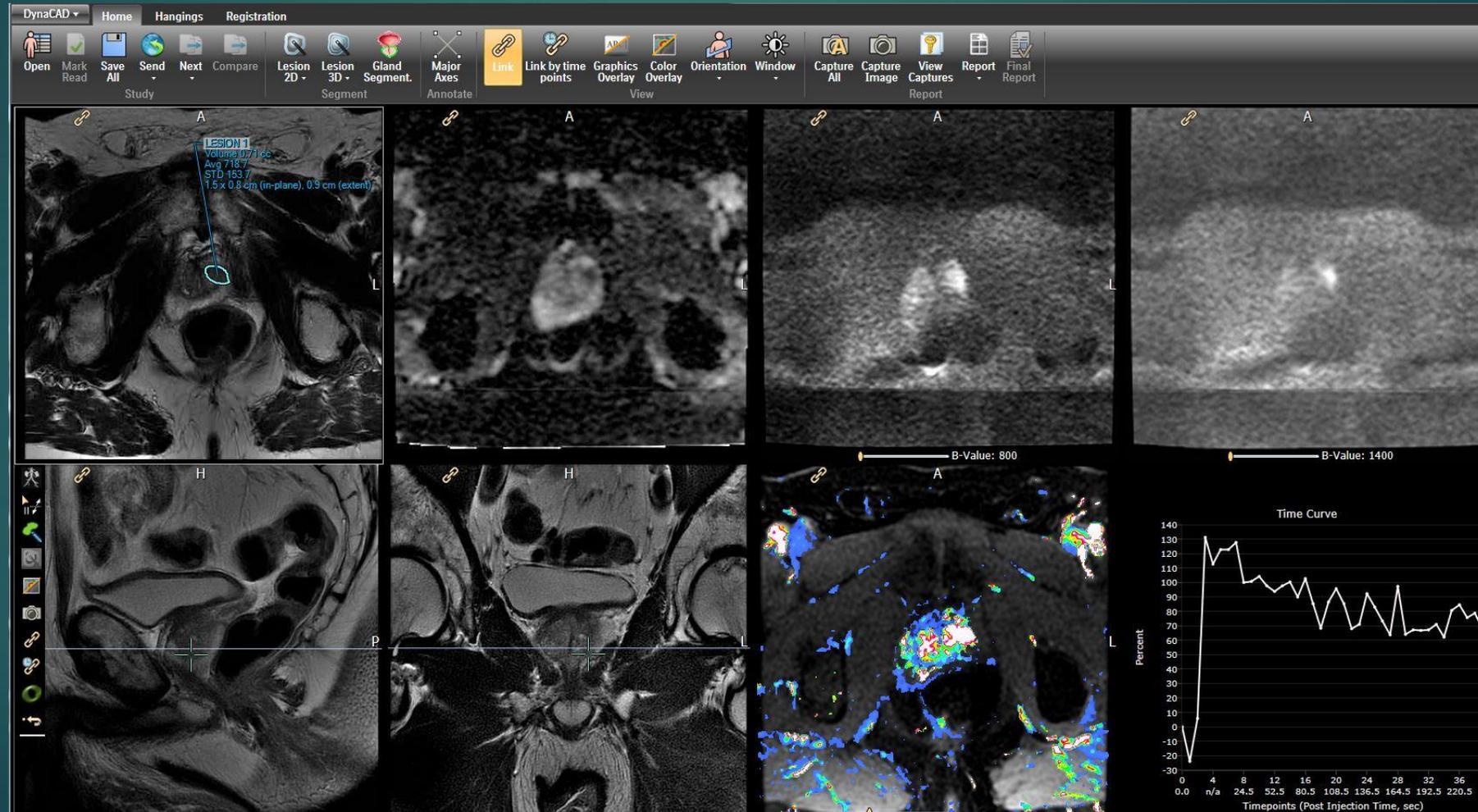
Prostate MRI Analysis

Dynacad: 3D Segmentation



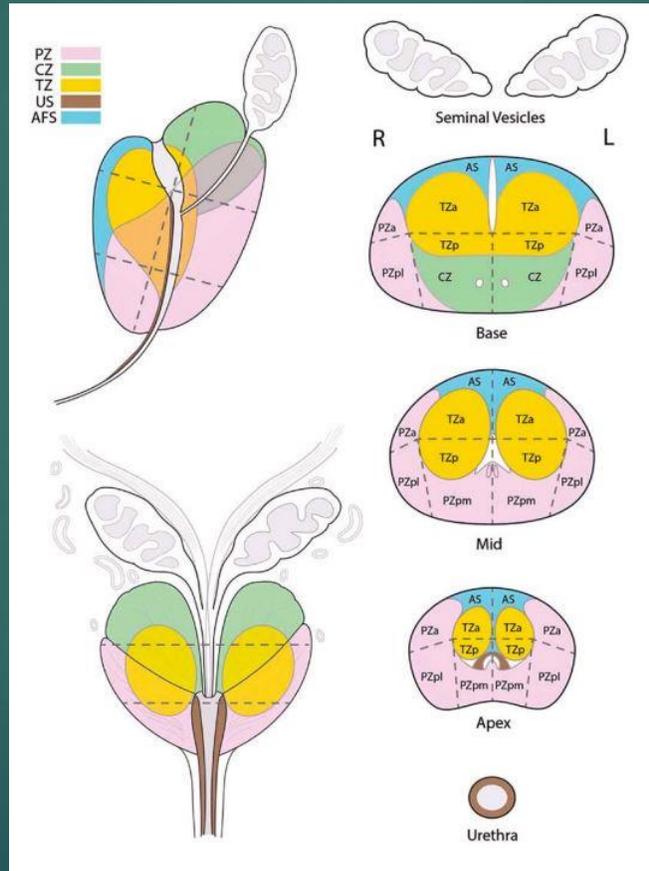
Prostate MRI Analysis

Dynacad: Target Lesions



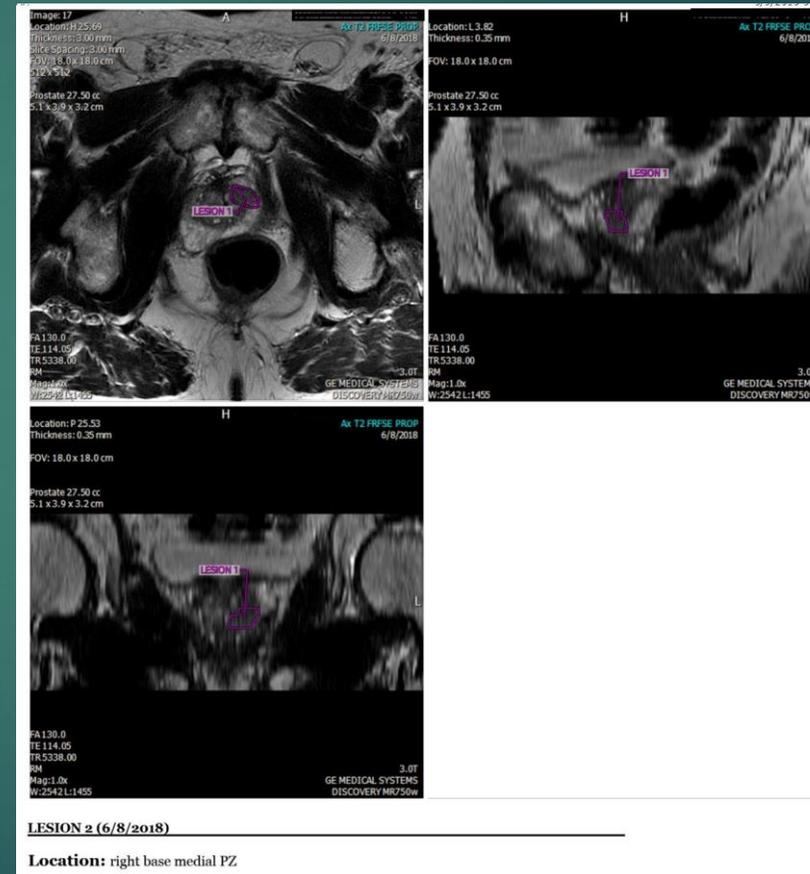
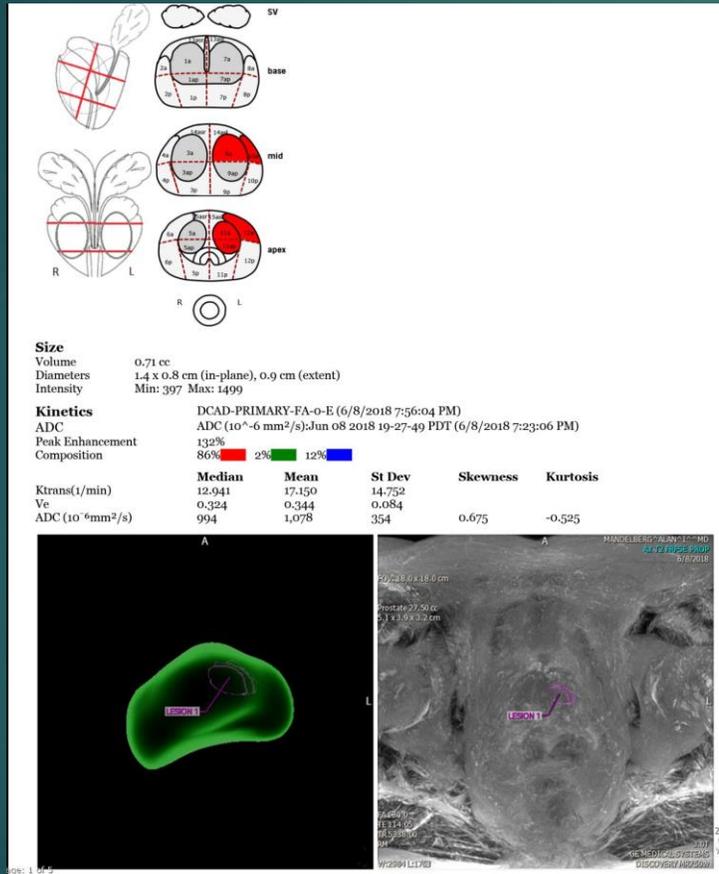
Prostate MRI Reporting

PI-RADS: Sector Map



Prostate MRI Reporting

Dynacad Report



Prostate MRI Reporting

PI-RADS

PI-RADS™ v2 Assessment Categories

PIRADS 1 – Very low (clinically significant cancer is highly unlikely to be present)

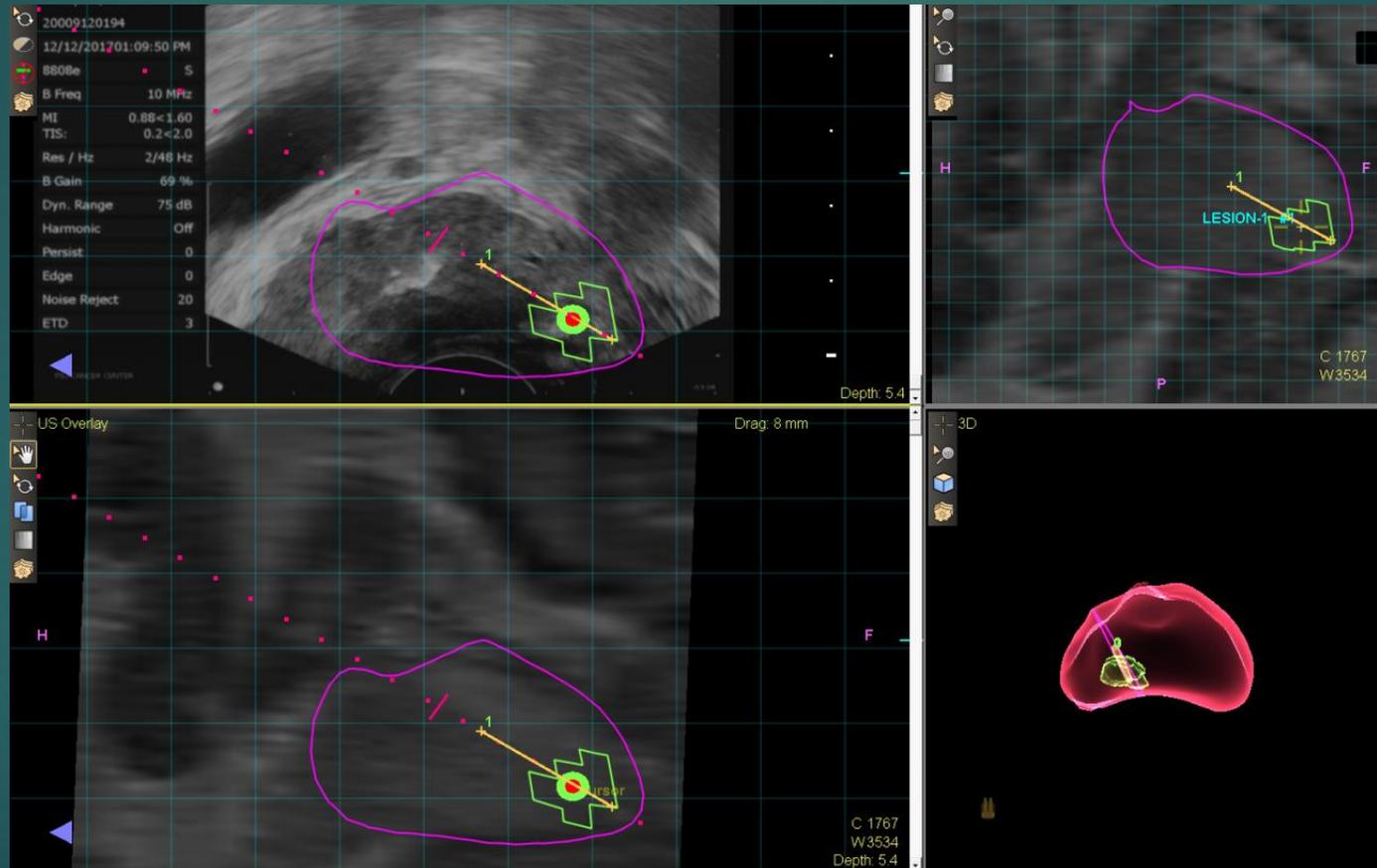
PIRADS 2 – Low (clinically significant cancer is unlikely to be present)

PIRADS 3 – Intermediate (the presence of clinically significant cancer is equivocal)

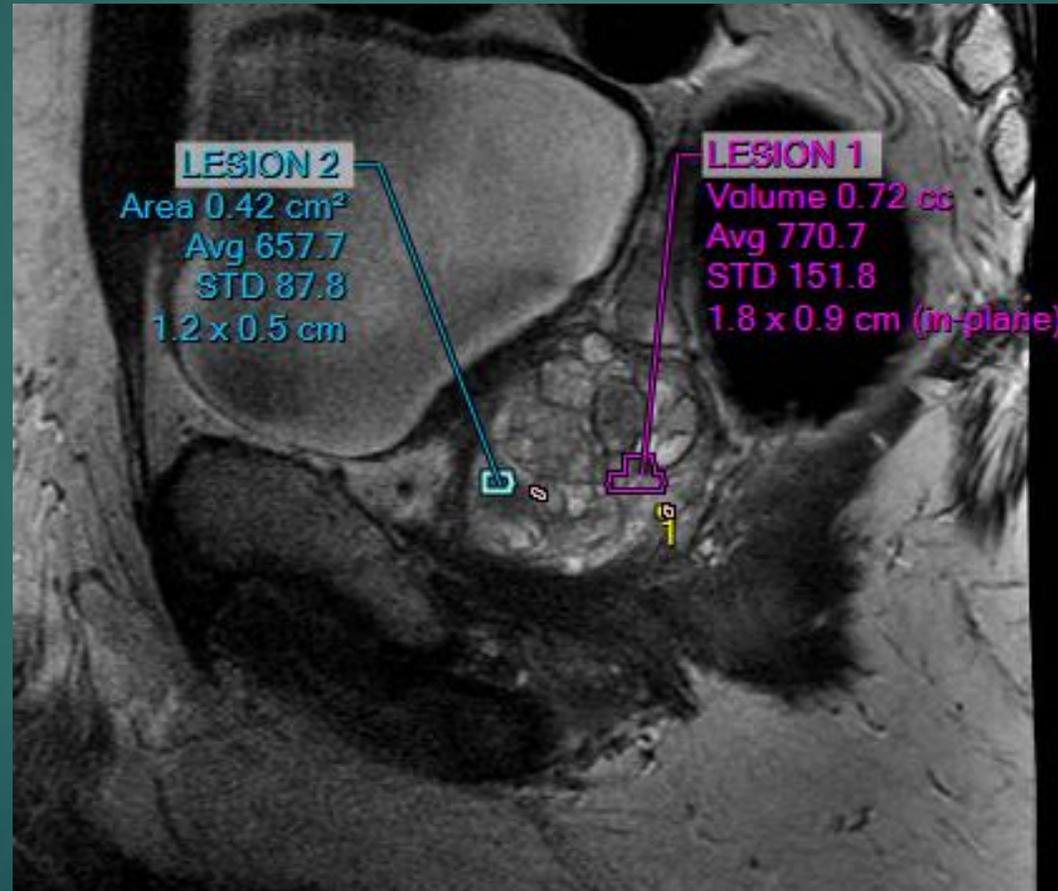
PIRADS 4 – High (clinically significant cancer is likely to be present)

PIRADS 5 – Very high (clinically significant cancer is highly likely to be present)

Prostate MRI US Fusion Biopsy



Prostate MRI US Fusion biopsy



Multidisciplinary Prostate Conference

- ▶ Twice monthly at JWCI.
- ▶ Correlate MRI findings with pathology specimens from targeted biopsy and prostatectomy.



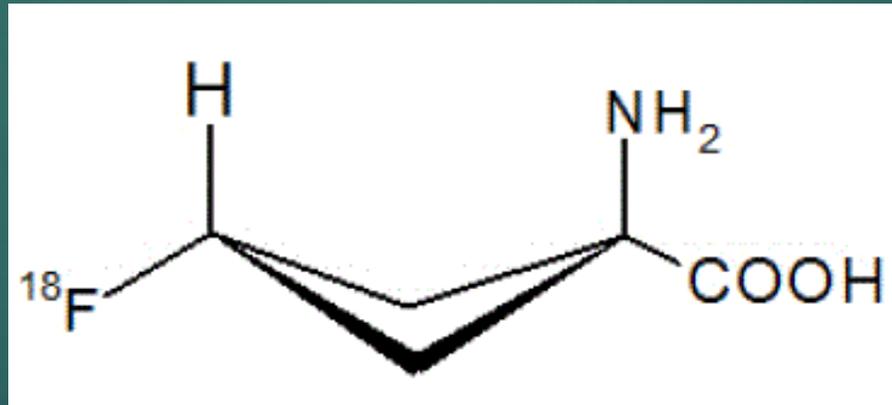
Axumin (Fluciclovine) PET/CT

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Axumin

Molecular Properties

- ▶ Non-naturally occurring F18 labeled amino acid PET radiotracer.
- ▶ Upregulation of transmembrane amino acid transport in prostate cancer.



Axumin

Approved indication

- ▶ FDA approved in May of 2016 for suspected prostate cancer recurrence based on elevated PSA following prior treatment.
- ▶ CMS pass through reimbursement effective January 2017.

Prostate Cancer

Evaluation of recurrence and mets

- ▶ Initially, spreads through lymphatic channels and bones.
- ▶ Pelvic nodes primary and most frequent site of nodal dissemination.
- ▶ Anatomic imaging with MRI and CT lacks sensitivity.
- ▶ FDG-PET/CT limited role due to low glyceemic activity of prostate ca.
- ▶ ¹¹C-choline PET-CT inferior to Axumin PET-CT.

Prostate Cancer

Evaluation of recurrence and mets

- ▶ Therapy planning depends on determining extent of disease.
- ▶ Prostate/prostate bed vs extraprostatic confined to pelvis vs extrapelvic.
- ▶ Modification of radiation field to cover pelvic lymph nodes for curative salvage vs systemic hormonal treatment.

Axumin

Detection disease recurrence

- ▶ PET sensitivity for detecting recurrent disease varies with PSA values, with reported detection rates in the post-prostatectomy biochemical failure setting of 72.0%, 83.3%, and 100% at PSA levels < 1, 1–2, and ≥ 2 ng/ml respectively¹.

1. Akin-Akintayo OO, Jani AB, Odewole O, et al. Change in salvage radiotherapy management based on guidance with FACBC (fluciclovine) PET-CT in postprostatectomy recurrent prostate cancer. *Clin Nucl Med*. 2017;42:e22-e28.

Axumin

Detection of disease recurrence

- ▶ Recurrent disease in the treated prostate/prostate bed:
 - ▶ An analysis of 93 patients demonstrated an overall sensitivity, specificity, positive predictive value (PPV) and accuracy of 90.2%, 40.0%, 75.3%, 73.6% respectively².
- ▶ Not accounting for PSA levels or doubling times:
 - ▶ Sensitivity, specificity, PPV, and accuracy of 18F-fluciclovine in detection of recurrent extraprostatic disease has been reported to be 55.0%, 96.7%, 95.7%, and 72.9% respectively².

2. Schuster DM, Nieh PT, Jani AB, et al. Anti-3-[(18)F]FACBC positron emission tomography-computerized tomography and (111)In-capromab pendetide single photon emission computerized tomography-computerized tomography for recurrent prostate carcinoma: results of a prospective clinical trial. J Urol. 2014;191:1446-1453.

Axumin

Detection of disease recurrence

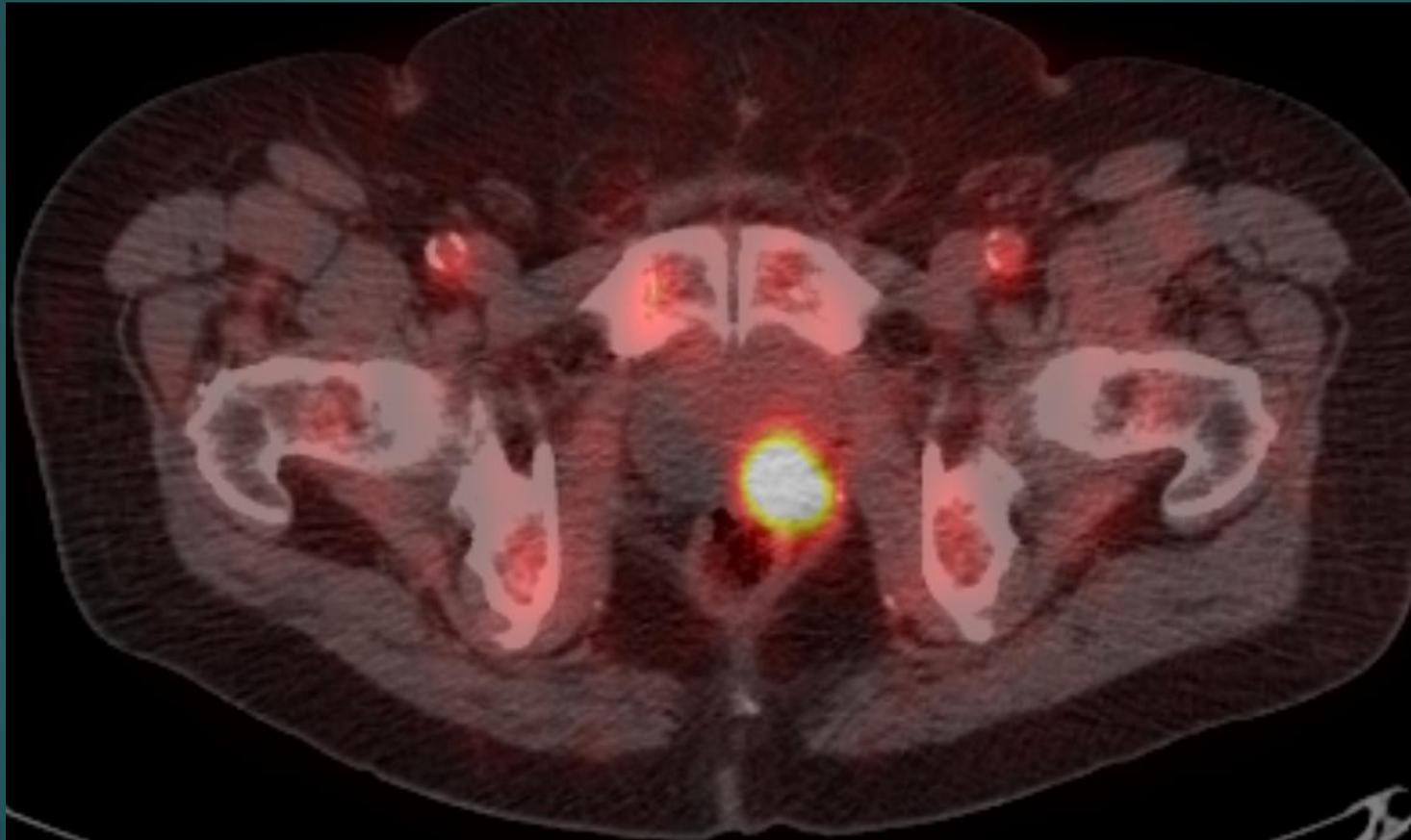
- ▶ Accumulation in osteolytic lesions and mixed osteolytic/osteoblastic lesions.
- ▶ Little uptake in osteoblastic lesions.

Axumin PET/CT Technique

- ▶ 4 hour fast.
- ▶ No heavy exercise prior to study.
- ▶ Isotope injected while patient on scanner and imaged after 4 minute delay.

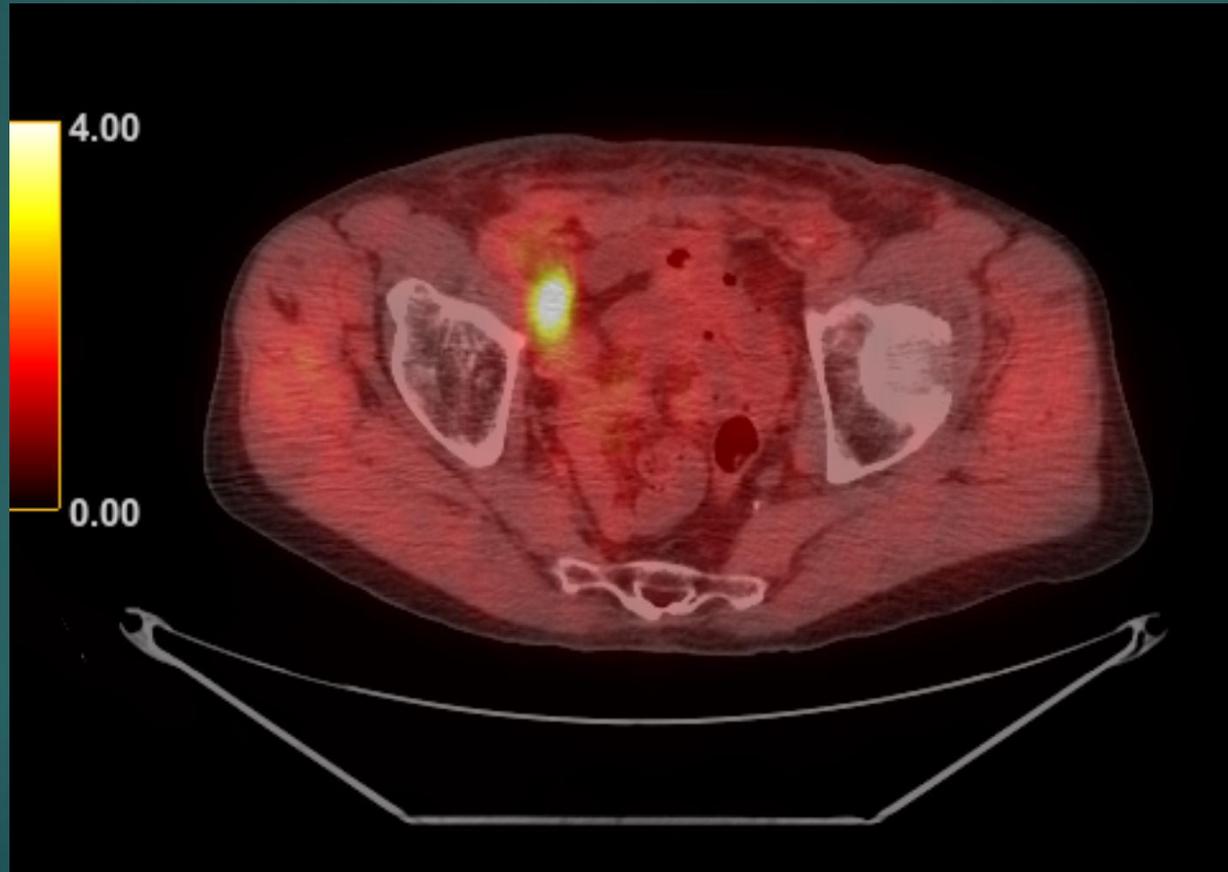


Axumin Recurrence after RT



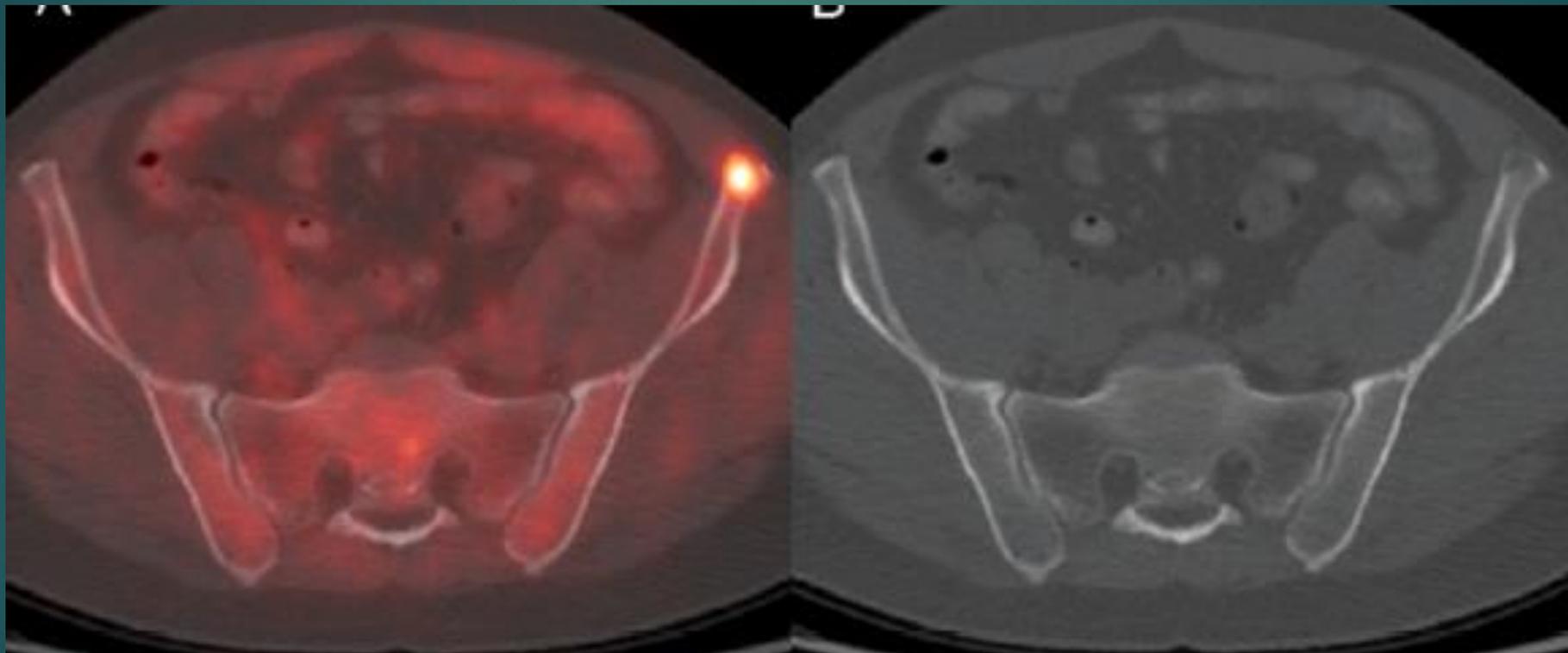
Axumin

Nodal met after prostatectomy



Axumin

Bone met



Axumin

Lung met



Future PET tracers for prostate ca

- ▶ PSMA agents that bind to the transmembrane protein on prostate ca cells.
- ▶ Early studies demonstrate superiority to Axumin³.
- ▶ Currently under development by Blue Earth.
- ▶ Ongoing research at UCSF and UCLA.
- ▶ No FDA approval.

1. Calais J, Fendler WP, Herrmann K, Eiber M, Ceci F. Head-to-head comparison of (68)Ga-PSMA-11 PET-CT and (18)F-fluciclovine PET-CT in a case series of 10 patients with prostate cancer recurrence. *JNucl Med*. December 14, 2017



Metal Artifact Reduction in MRI (MAVRIC)

JOSHUA D. HANELIN, MD

Metal Artifact Causes

- ▶ Aging population with increasing prevalence of metal implants:
 - ▶ Hip and knee arthroplasties
 - ▶ Fracture fixation hardware
 - ▶ Spinal stabilization hardware

Metal Artifact Causes

- ▶ MRI requires a homogenous magnetic field.
- ▶ Metal implants distort the magnetic field leading to multiple artifacts.

Clinical Relevance

- ▶ Hardware failure and complications:
 - ▶ Aseptic loosening
 - ▶ Osteolysis
 - ▶ Pseudotumors
 - ▶ Infection
 - ▶ Abscess
 - ▶ Osteomyelitis

Clinical Relevance

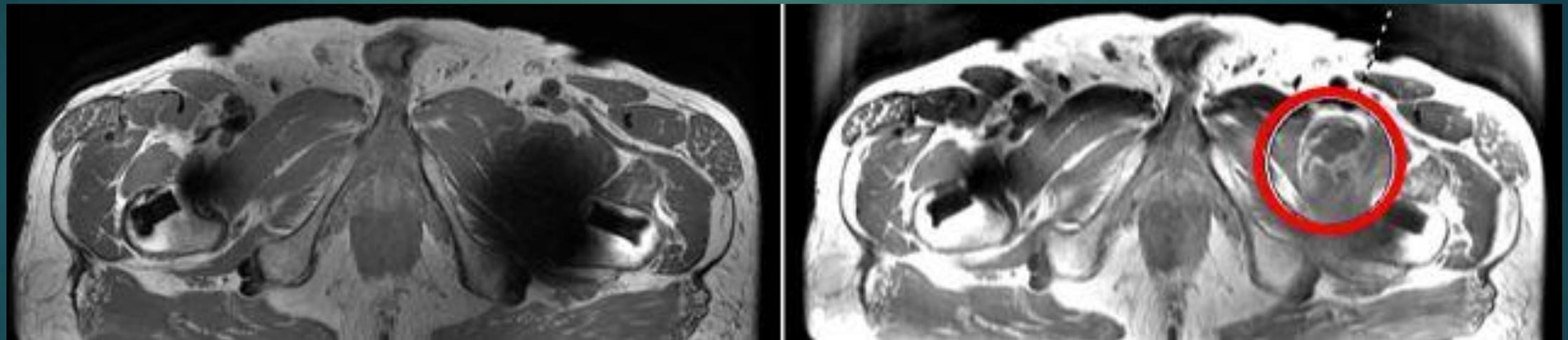
- ▶ Disease adjacent to metal:
 - ▶ Fractures
 - ▶ Tendon and ligament tears
 - ▶ Labral and meniscal tears
 - ▶ Cartilage injury
 - ▶ Spinal stenosis
 - ▶ Bursitis

Clinical Relevance

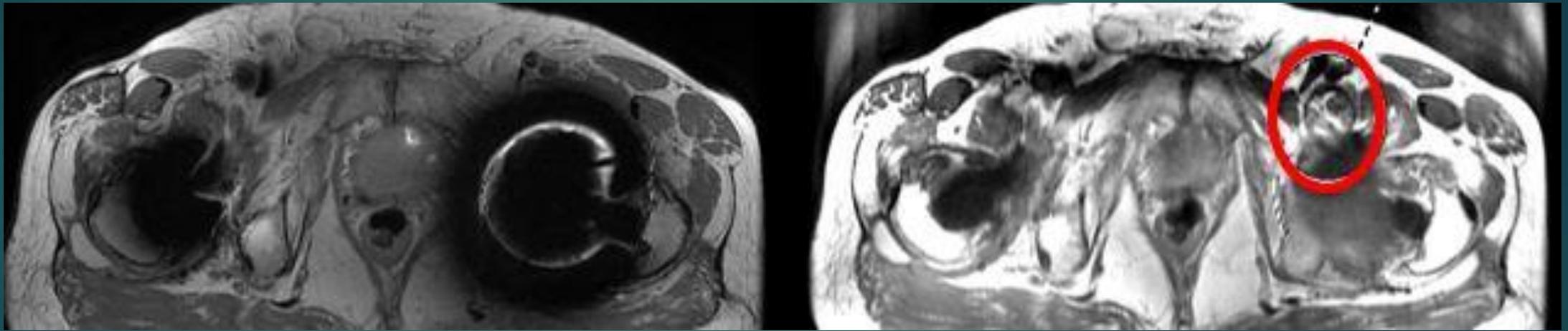
- ▶ Almost half of the abnormal imaging findings were missed on conventional sequences compared with advanced metal suppression sequences¹.

1. Sutter R, Ulbrich EJ, Jellus V, Nittka M, Pfirrmann CW. Reduction of metal artifacts in patients with total hip arthroplasty with sliceencoding metal artifact correction and view-angle tilting MR imaging. *Radiology* 2012;265:204–214.

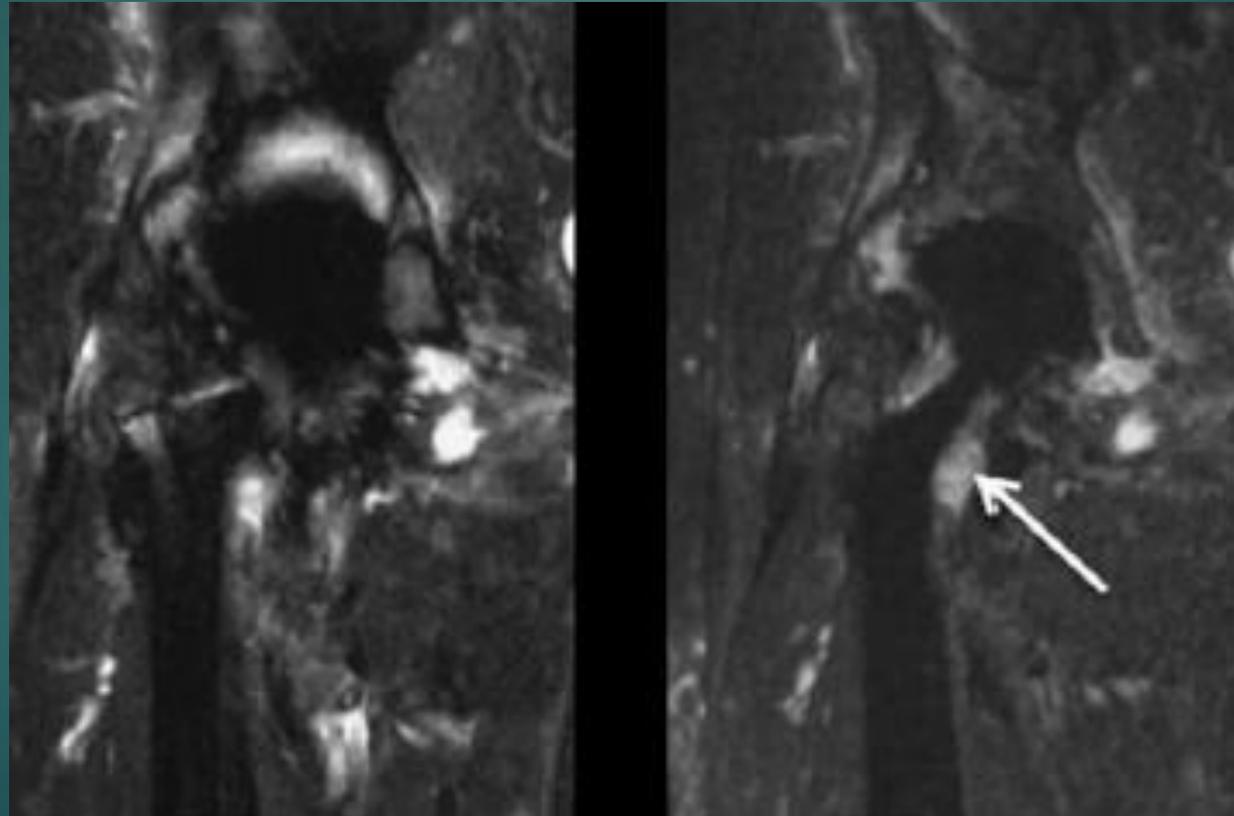
Pseudotumor



Iliopsoas bursitis



Periprosthetic abscess



Rotator cuff tear

