Prostate Imaging
An Update…..

Mayfair Diagnostics Presentation

for Prostaid Calgary

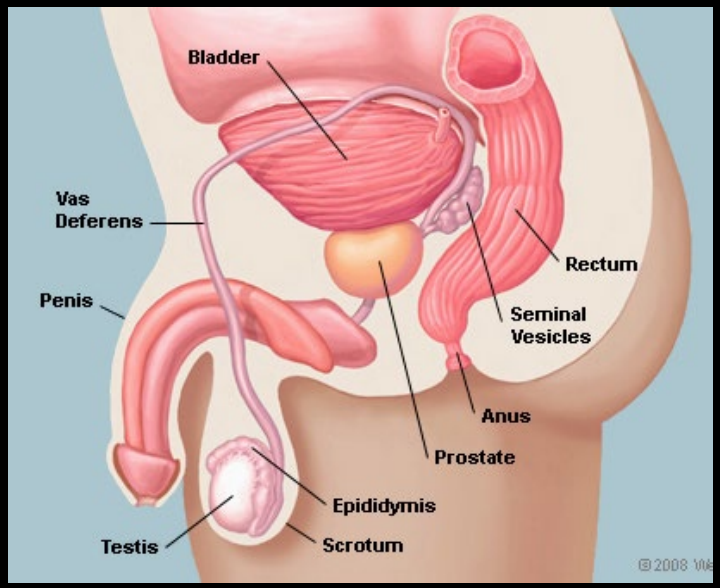
March 12, 2019

Outline

- Shelley Spaner -
  - review of prostate cancer diagnosis, discussion of the expanded role of MRI and brief review of relevant literature
- Brendan Diederichs –
  - Overview of the new 3Tesla MRI at the Rockyview General hospital with case examples
- Grace Yeung –
  - Overview of the targeted biopsy program at the Rockyview General hospital

Prostate Cancer in Canada

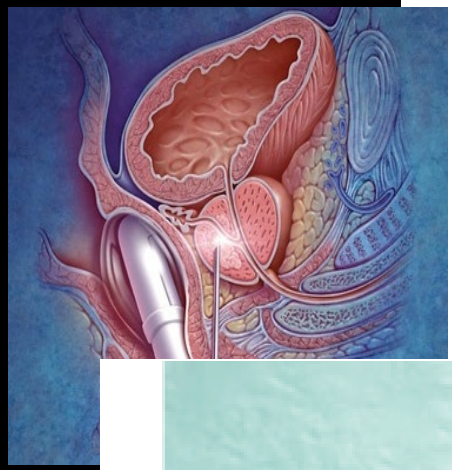
- Prostate cancer is the most commonly diagnosed cancer in Canadian men
- Third leading cause of cancer death, behind lung and colorectal cancers
- Rate of newly diagnosed cases:
  - increased by ~1.1% year from 1995 - 2006
  - decreased by ~ 3.8% per year from 2006 -12
- The rate of deaths from prostate cancer decreased by an average of 2.9% per year from 1995 to 2012
- From 1995 to 2012:
  - the median age at diagnosis decreased from 71 to 67
  - the median age of death increased from 78 to 82

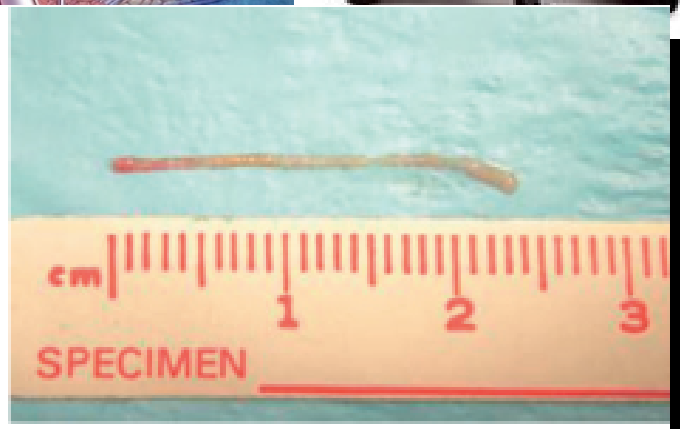


Ellison, Lawrence. 2016. “Prostate cancer trends in Canada, 1995 to 2012.” *Health at a Glance*. Statistics Canada Catalogue no. 82-624-X.

Diagnosing Prostate Cancer….

- Elevated PSA and/or abnormal DRE
- US guided needle biopsy is needed to confirm diagnosis
- 5-7.5 MHz transrectal probe
- Systematic sextant core biopsies are obtained



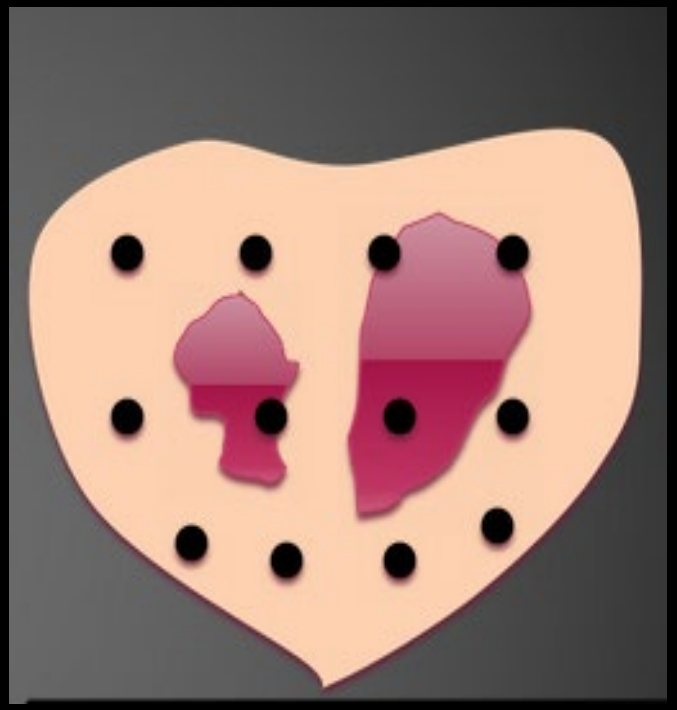


18-gauge prostate needle biopsy core specimen.

Limitations of Transrectal Biopsy

- Cancer is missed in 10-38 % of patients with prostate cancer
- Prostate apex, lateral and anterior cancers are not well evaluated with standard sextant biopsy

- Total volume of core extracted is small in comparison with gland volume [< 1%]
- Underestimate Gleason grade in up to 46 % of cases



Over detection of low-grade microfocal cancers of little clinical significance

Under detection of large clinically significant cancers

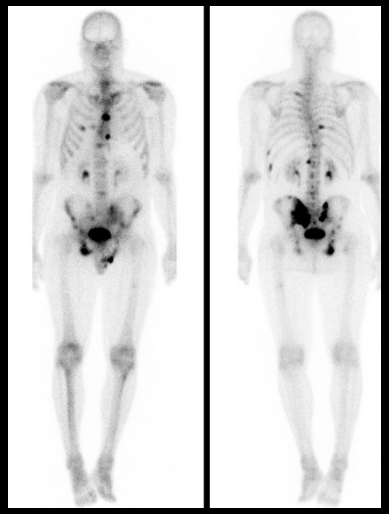
Limitations of a Contemporary Prostate Biopsy: The Blind March Forward Uro onco 2010, Sep-Oct 29 (5); 546-549

Diagnosis made…Now what….

Investigations for staging

Assessment for patient's considering active surveillance or treatment with curative intent should consist of:

- History and physical examination
- Blood tests - CBC, creatinine, urinalysis, PSA
- Nuclear Medicine bone scan-
  - indicated for those with high risk disease
- CT imaging
  - indicated for those with high-risk disease



Alberta Health Services Clinical Practice Guidelines
Version 4 September 2013 – updated January 2017 and January 2018

Diagnosis made…Now what….

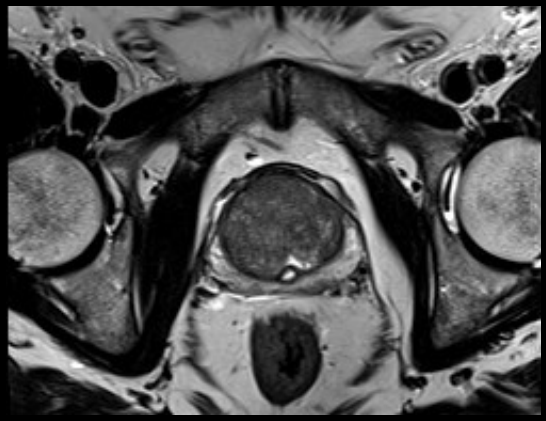
Investigations for staging

Staging -

MRI is not routinely recommended

Active Surveillance -

– MRI can be considered if there is discordance between the clinical and pathological information



Alberta Health Services Clinical Practice Guidelines
Version 4 September 2013 – updated January 2017 and January 2018…..

Controversies in Screening…..

- 44 % reduction in prostate cancer mortality in the last 20 years
  - 45-70% reduction attributable to PSA screening
- USPSTF (2012) recommended against PSA screening, citing over diagnosis and over treatment of indolent tumors
- PIVOT suggests focus of screening should be on selectively identifying potentially aggressive cancers

AUA Update Series 2014
Contemporary Prostate Imaging and Applications for Diagnosis and Staging of Prostate Cancer

The NEW ENGLAND JOURNAL of MEDICINE

Prostate Cancer Screening — A Perspective on the Current State of the Evidence

Paul F. Pinsky, Ph.D., Philip C. Prorok, Ph.D., and Barnett S. Kramer, M.D., M.P.H.

N Engl J Med 2017; 376:1285-1289 | March 30, 2017 | DOI: 10.1056/NEJMsb1616281

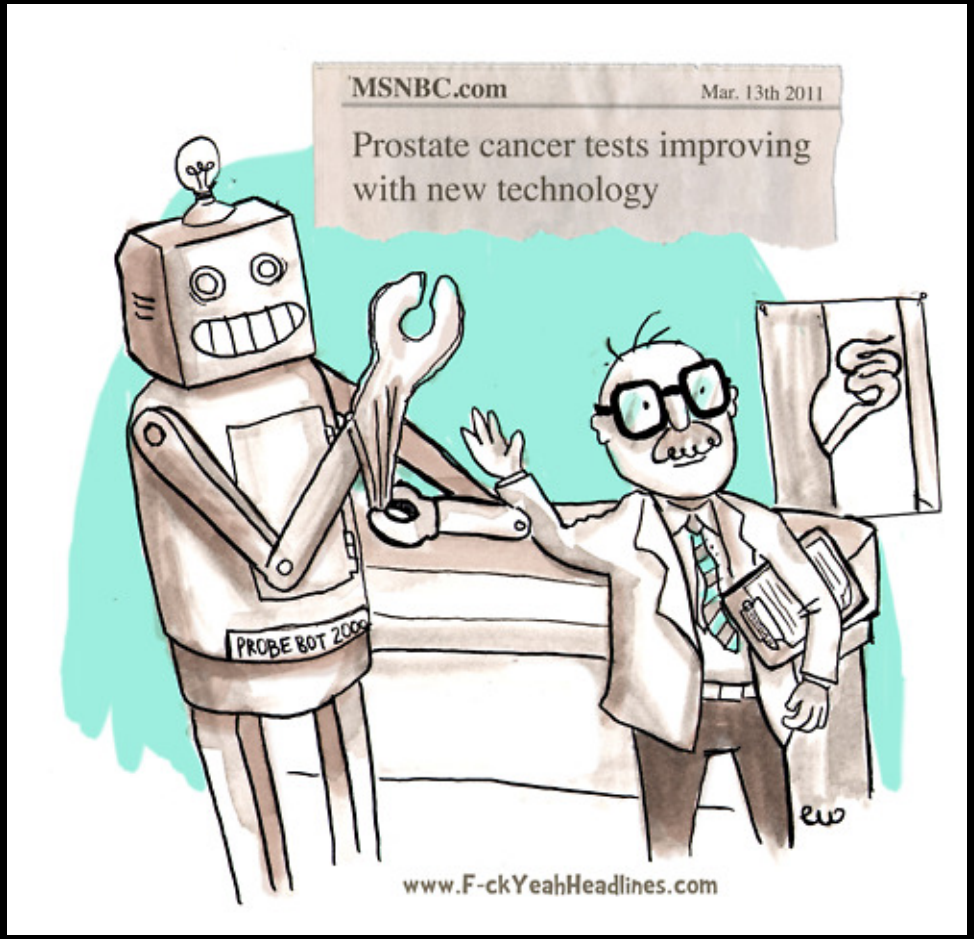
MARCH 30, 2017

- ….that there is still no clarity about the usefulness and desirability of routine PSA-based screening after 25 years and two large trials suggests that its net benefit is unlikely to be more than marginal, whereas the harms are proven and substantial. ….Under the “first do no harm” principle, it seems reasonable to forgo mass screening as a public health policy at this point but to continue to perform research on how to reduce the harms of PSA screening while maintaining any benefits.

- There is a critical need for strategies to reduce the burdens associated with the diagnosis of indolent disease, through a combination of not diagnosing it in the first place and accurately classifying it as not needing any further follow-up or treatment, while still maintaining any mortality benefits for men with aggressive disease….. Perhaps that is the most pressing research challenge going forward.

- What can we do to differentiate indolent from aggressive cancers?

The Future of Prostate Imaging



- High resolution ultrasound
- Contrast enhanced ultrasound
- Mp-MRI
- Molecular Imaging

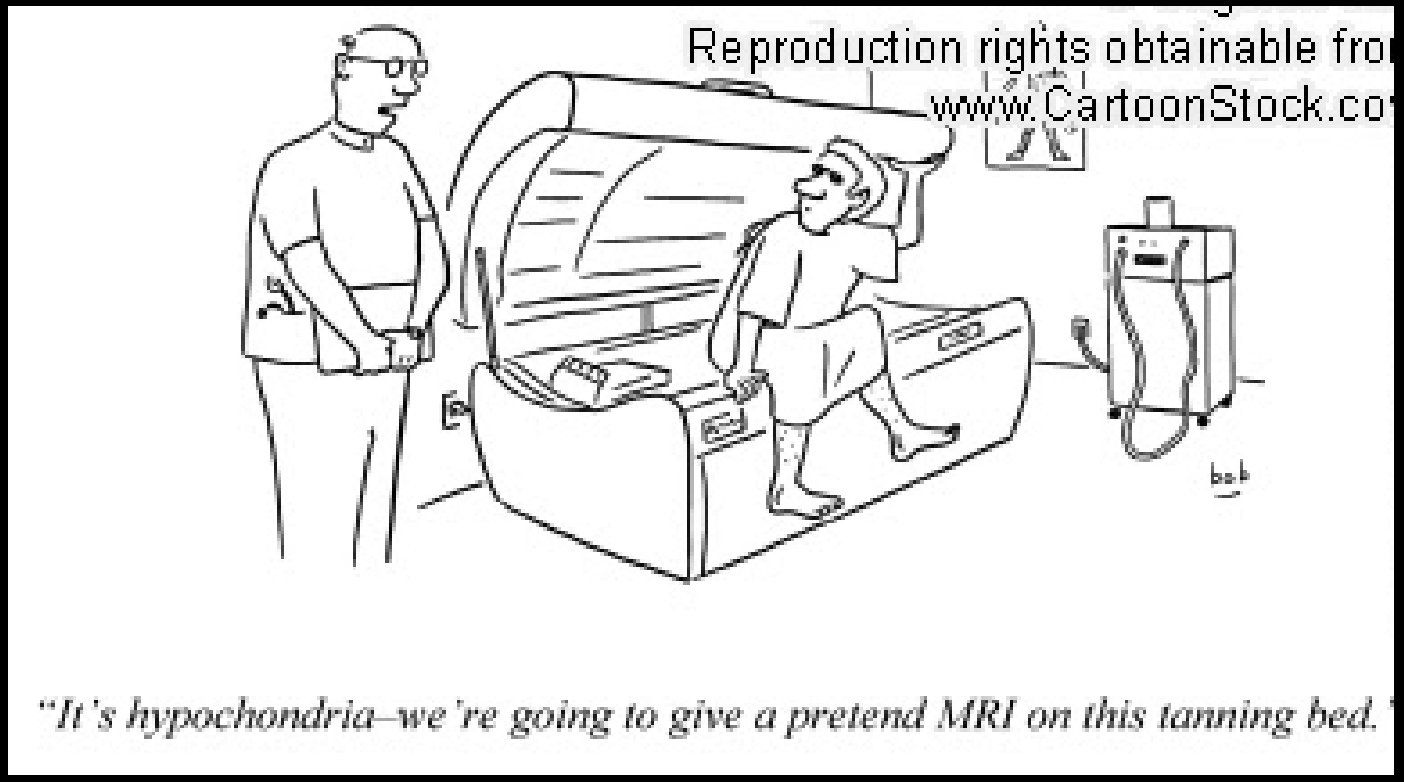
NHS APPROVES TRIAL FOR DOGS DETECTING PROSTATE CANCER

http://food4petreviews.com/news/nhs-approves-trial-for-dogs-detecting-prostate-cancer.html

The emerging role of MRI …..

The Past…..

- Introduced in the 1980s
- Limited capability to distinguish clinically significant prostate cancer from insignificant cancer



"It's hypochondria–we're going to give a pretend MRI on this tanning bed."

Preamble…..

The ideal test for prostate cancer would be:

- Minimally invasive
- Have few side effects
- Identify a high proportion of men who would benefit from treatment
- Minimize the identification of men with clinically insignificant cancer in order to prevent overtreatment…..

March 19, 2018 - PRECISION Trial

(Prostate Evaluation for Clinically Important disease: Sampling using Image guidance or not)

The NEW ENGLAND JOURNAL of MEDICINE

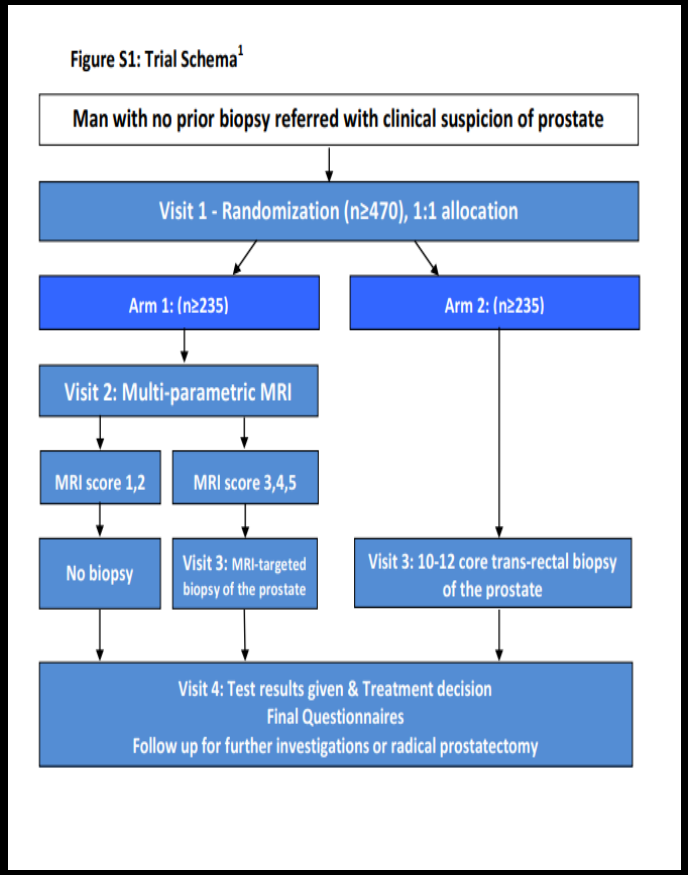
ORIGINAL ARTICLE

MRI-Targeted or Standard Biopsy for Prostate-Cancer Diagnosis

Veeru Kasivisvanathan, M.R.C.S., Antti S. Rannikko, Ph.D., Marcelo Borghi, M.D., Valeria Panebianco, M.D., Lance A. Mynderse, M.D., Markku H. Vaarala, Ph.D., Alberto Briganti, Ph.D., Lars Budäus, M.D., Giles Hellawell, F.R.C.S.(Urol.), Richard G. Hindley, F.R.C.S. (Urol.), Monique J. Roobol, Ph.D., Scott Eggener, M.D., et al., for the PRECISION Study Group Collaborators*

The Trial….

- From February 2016 through August 2017, a total of 500 participants underwent randomization
- 252 participants were assigned to the MRI-targeted biopsy group
- 248 to the standard-biopsy
- The characteristics of the participants at baseline were similar in the two groups
- A total of 71 of 252 participants (28%) in the MRI-targeted biopsy group had a result on MRI that was not suggestive of prostate cancer (PI-RADS v2 score, ≤2), and so they did not undergo biopsy
- Among the participants with a positive result on MRI, 51 of 175 (29%) had a PI-RADS v2 score of 3, 70 (40%) had a score of 4, and 54 (31%) had a score of 5
- The remaining 6 men did not complete the MRI



PRECISION Trial

(Prostate Evaluation for Clinically Important disease: Sampling using Image guidance Or Not)

- In men with a clinical suspicion of prostate cancer who had not undergone prostate biopsy previously, the PRECISION trial showed that MRI, with or without targeted biopsy, led to:
  - fewer men undergoing biopsy (~1/4 of men avoided bx)
  - more clinically significant cancers being identified
  - less overdetection of clinically insignificant cancer
  - fewer biopsy cores being obtained than standard TRUS bx
  - 30-day participant-reported side-effect profile more favorable in the MRI-targeted biopsy group than in the standard-biopsy group

Outcomes…..

- Clinically significant cancer was detected in 95 men (38%) in the MRI-targeted biopsy group, as compared with 64 (26%) in the standard-biopsy group
- Fewer participants received a diagnosis of clinically insignificant cancer in the MRI-targeted biopsy group than in the standard-biopsy group (23 men [9%] vs. 55 [22%]
- A greater percentage of cores were positive for cancer in the MRI-targeted biopsy group (422 of 967 cores [44%]) than in the standard-biopsy group (515 of 2788 [18%])

Key strengths – size and pragmatism

- Allowed nonacademic centers outside the original expert group to take part.
- Either 1.5-T or 3.0-T MRI machines were permitted
- Endorectal coil was permitted but not required.
- Various techniques of MRI-targeted biopsy, with visual registration or software-assisted registration
- Transrectal or transperineal access routes, were permitted

- On average, MRI with or without targeted biopsy was conclusively superior to standard transrectal ultrasonography–guided biopsy.

Limitations…..

- Concerns about the men with negative results on MRI who do not undergo biopsy.

- It has been shown that these men have a low risk of clinically significant cancer, but nonetheless, follow-up with monitoring of the PSA level is routine, reasonable, and safe.

Limitations….

- It is possible that clinically significant cancers may have been missed by the omission of standard biopsy cores in men in the MRI-targeted biopsy group

- We acknowledge that the acquisition and reporting of MRI of the prostate are specialist skills with a learning curve and that the radiologists involved in this trial were reporting a high volume of MRIs per year (median, 300 MRIs per year).

- We acknowledge that a change in the standard of care for prostate-cancer diagnosis would entail changes in health care systems to accommodate appropriate MRI capacity and to meet the training needs of radiologists and urologists.

- From a health economics perspective, the cost savings with MRI, with or without targeted biopsy, over standard TRUS biopsy may emerge from the earlier detection of clinically significant cancers, fewer cases of insignificant cancer diagnosed, and fewer repeat biopsies.

Conclusion…..

- …. in men with a clinical suspicion of prostate cancer, we found that a diagnostic pathway including risk assessment with MRI before biopsy and MRI-targeted biopsy in the presence of a lesion suggestive of cancer was superior to the diagnostic pathway of standard transrectal ultrasonography–guided biopsy.

The potential implications of this trial:

- A redefining of the prostate cancer diagnostic pathway
- A reduction in the number of patients undergoing prostate biopsy
- A reduction in the number of biopsy cores taken per patient
- A reduction in biopsy related sepsis, pain and other side effects
- A reduction in the over diagnosis of clinically insignificant prostate cancer
- A reduction in the economic burden of diagnosing and treating prostate cancer

News | Science

News › Science

MRI for all men suspected of prostate cancer could save thousands of lives - new study

share

2

MRI caught 12 per cent more cases of dangerous prostate cancer CREDIT: PHILIP HOLLIS FOR THE SUNDAY TELEGRAPH/ PHILIP HOLLIS FOR THE SUNDAY TELEGRAPH

By **Henry Bodkin**
19 MARCH 2018 • 6:28PM

Giving all men with suspected prostate cancer an immediate MRI scan would save thousands of lives a year, the results of a new study suggest.

A trial by British scientists found the comprehensive scan was 12 per cent more likely to detect dangerous tumours than the traditional biopsy, and that the number of men who undergo a biopsy needlessly could be reduced by 28 per cent.

Every year more than 120,000 men in the UK undergo a biopsy, which involves inserting an ultrasound probe into the affected area to take a sample of cells from the prostate that might contain cancer.

European Association of Urology ...
@Uroweb

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PRECISION: MRI-targeted biopsy strategy leads to fewer men needing biopsy. Article with video interviews with Veeru Kasivisvanathan and Declan Murphy

PRECISION: MRI-targeted biopsy strategy leads to fewer men needing biopsy...
A MRI targeted biopsy strategy results in fewer men needing biopsy, fewer biopsy cores required and more men with clinically significant cancer detected.
eau18.uroweb.org

BJUI
BJU International

PRECISION delivers on the PROMIS of mpMRI in early detection of prostate cancer

23

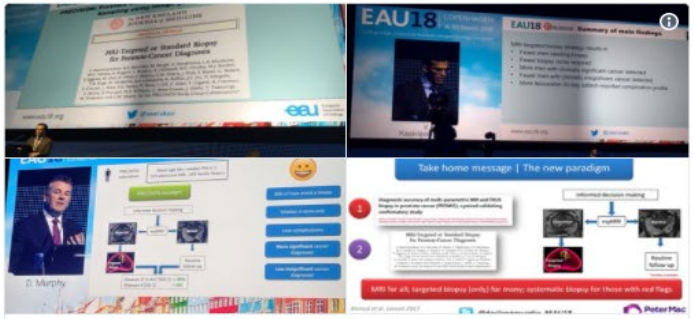
19 Mar 2018

#EAU18, BJUI Blog, Blog, Blogs, BRCA, Caroline Moore, Copenhagen, Declan Murphy, Denmark, EAU, Mark Emberton, MRI, PRECISION, PROMIS, prostate, PSA, Veeru Kasivisvanathan

by Declan Murphy

Like 1 Tweet Share Rate this article: ★★★★★ 1,958 views

Today, **Dr Veeru Kasi** of University College London, presented the results of the PRECISION (PRostate Evaluation for Clinically Important disease: Sampling using Image-guidance Or Not?) study in the "Game Changing" Plenary session at the #EAU18 Annual Meeting in Copenhagen. The accompanying paper was simultaneously published in the **New England Journal of Medicine**. And it is stunning! Everyone in the packed eURO auditorium knew they were witness to a practice-changing presentation, and the swift reaction on social media around the world confirms this.



Declan Murphy
@declangmurphy

Fundamental paradigm shift in prostate cancer diagnostics, from @veerukasi @mrsprostate #EAU18 today, and @NEJM now online. What a day nejm.org/doi/full/10.10…

1:25 AM - Mar 19, 2018 · Copenhagen, Denmark

♡ 85 66 people are talking about this

US Preventive Services Task Force | FREE

Recommendation Statement

May 8, 2018

Screening for Prostate Cancer

US Preventive Services Task Force Recommendation Statement

US Preventive Services Task Force

Article Information

JAMA. 2018;319(18):1901-1913. doi:10.1001/jama.2018.3710

Editorial Comment | Related Articles | Interviews | Multimedia

Abstract

Importance In the United States, the lifetime risk of being diagnosed with prostate cancer is approximately 13%, and the lifetime risk of dying of prostate cancer is 2.5%. The median age of death from prostate cancer is 80 years. Many men with prostate cancer never experience symptoms and, without screening, would never know they have the disease. African American men and men with a family history of prostate cancer have an increased risk of prostate cancer compared with other men

For men aged 55 to 69 years, the decision to undergo periodic PSA-based screening for prostate cancer should be an individual one and should include discussion of the potential benefits and harms of screening with their clinician.

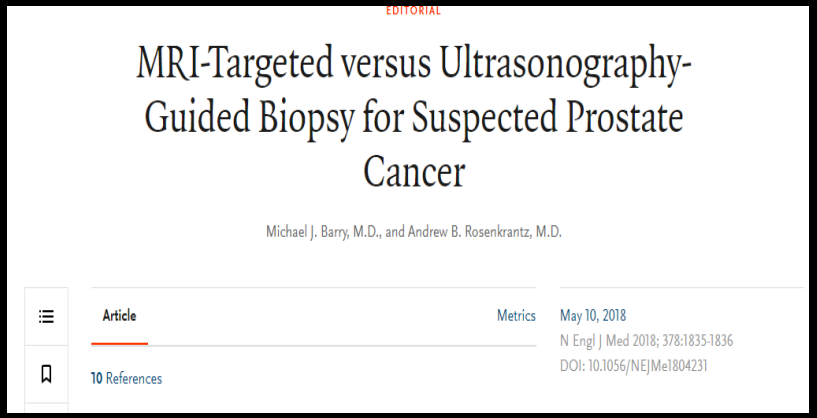
Screening offers a small potential benefit of reducing the chance of death from prostate cancer in some men.

In determining whether this service is appropriate in individual cases, patients and clinicians should consider the balance of benefits and harms on the basis of family history, race/ethnicity, comorbid medical conditions, patient and other health needs.

The USPSTF recommends against PSA-based screening for prostate cancer in men 70 years and older

May 10, 2018

The NEW ENGLAND JOURNAL of MEDICINE


EDITORIAL

MRI-Targeted versus Ultrasonography-Guided Biopsy for Suspected Prostate Cancer

Michael J. Barry, M.D., and Andrew B. Rosenkrantz, M.D.

Article Metrics May 10, 2018

10 References

N Engl J Med 2018; 378:1835-1836

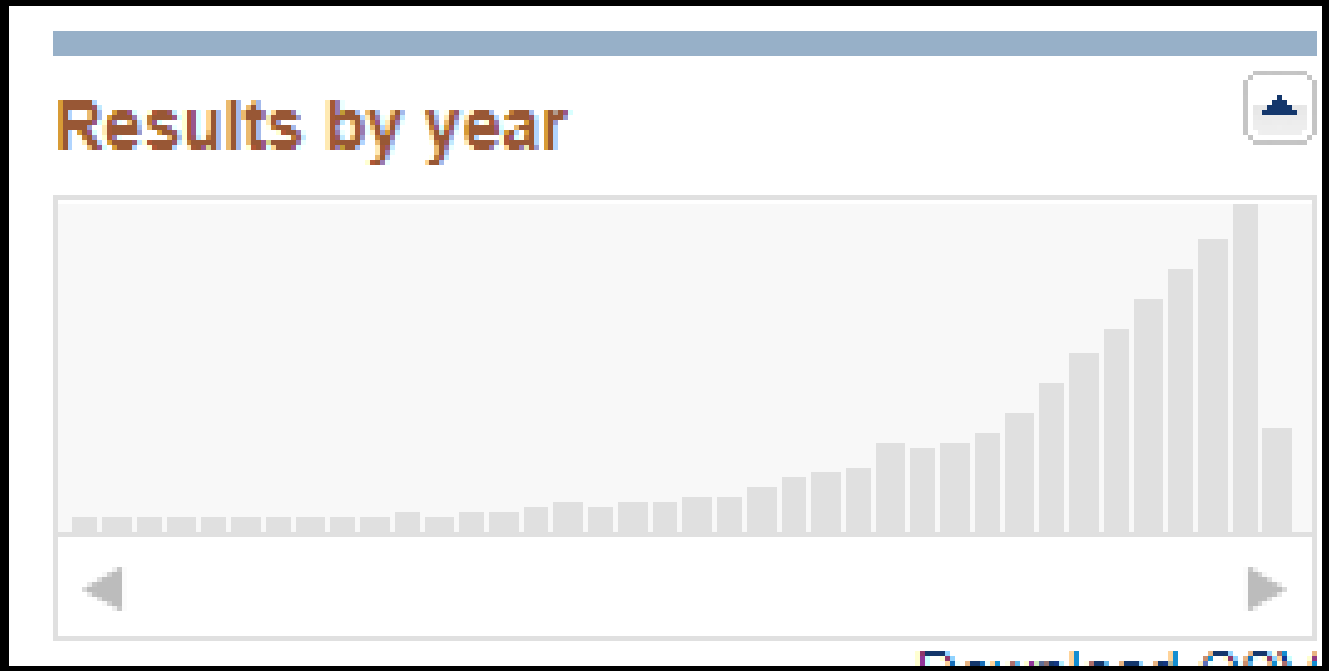
DOI: 10.1056/NEJMe1804231

…the findings suggest that multiparametric MRI may have a place in decisions about prostate biopsy. Because of the major implications for wider use of multiparametric MRI in evaluating men with elevated PSA levels — including the need for additional MRI equipment and personnel and the effect on total costs — these findings should be replicated and extended

N Engl J Med 2018; 378:1835-1836
DOI: 10.1056/NEJMe1804231

Literature Update….

Pubmed Search – Prostate MRI



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2019 Genitourinary Cancer Symposium

- Historically, mpMRI only used for staging purposes after prostate cancer diagnosis
- Recently, mpMRI is becoming utilized for pre-biopsy disease localization and for risk stratification in men with a borderline or elevated PSA
- Greater than 95% of patients at NYU receive a mpMRI during their prostate cancer evaluation
- Pre-biopsy mpMRI and MRI-targeted biopsy allows for improved high-grade cancer detection while minimizing the diagnosis of indolent prostate cancers.

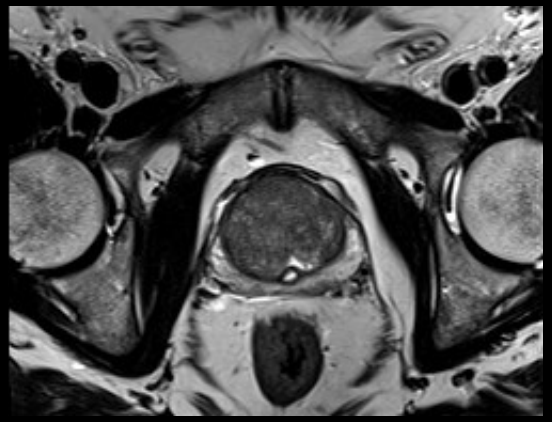
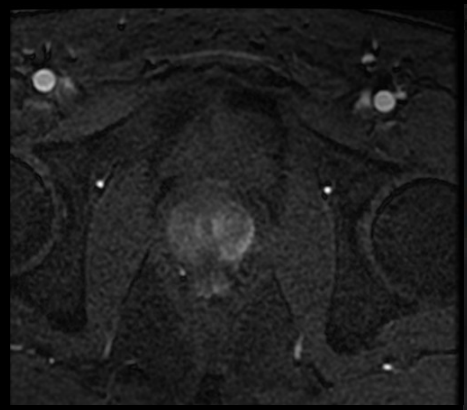
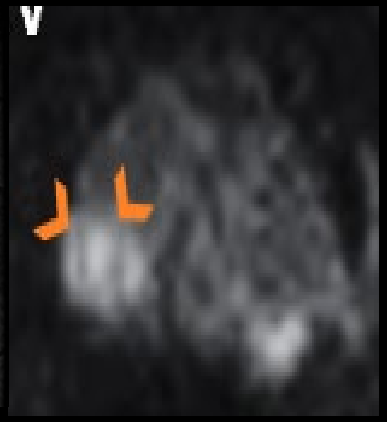
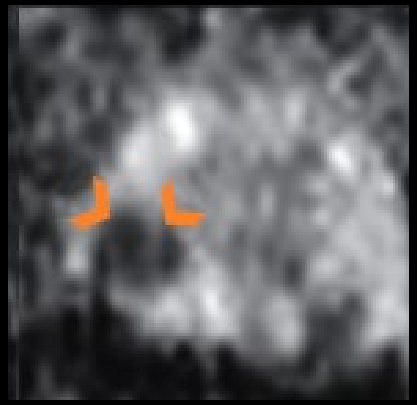
- There remain the issues of cost, reproducibility, and quality control that are hurdles to the broad implementation of mpMRI in all men with suspicion of prostate cancer
- Future studies will help improve the adoption of this technology over time.

Samir S. Taneja, MD, Professor of Urologic Oncology, Department of Urology, Professor, Department of Radiology, Vice Chair, Department of Urology, Co-Director, Smilow Comprehensive Prostate Cancer Center, Genito-Urologic Program Leader, NYU Perlmutter Cancer Center, Director, Urologic Oncology, NYU Langone Health, New York, New York

Conclusion…..

- …. in men with a clinical suspicion of prostate cancer, we found that a diagnostic pathway including risk assessment with MRI before biopsy and MRI-targeted biopsy in the presence of a lesion suggestive of cancer was superior to the diagnostic pathway of standard transrectal ultrasonography–guided biopsy.

The Present …..
Multiparametric Prostate MRI

MAYFAIR

3T PROSTATE MRI AT THE ROCKYVIEW GENERAL HOSPITAL

Brendan Diederichs MD, FRCPC
Abdominal and Pelvic Radiologist
Clinical Assistant Professor
University of Calgary

UNIVERSITY OF CALGARY

DIAGNOSTICS / IN-HOSPITAL / TELERADIOLOGY / ACADEMY

PROSTATE MR AT THE ROCKYVIEW GENERAL HOSPITAL: AN UPDATE

In December 2017 a proposal was made on was made to AHS to upgrade outgoing 1.5 T with an advanced 3T system

A stated primary goal in this proposal included high level DI support to Urology as the patient and family centric Centre of Excellence for Southern Alberta at RGH

Additional stated goal to expand the regional capacity for 3T imaging research in Urology, Body imaging, MSK, and Ophthalmology

PROSTATE MR AT THE ROCKYVIEW GENERAL HOSPITAL: AN UPDATE

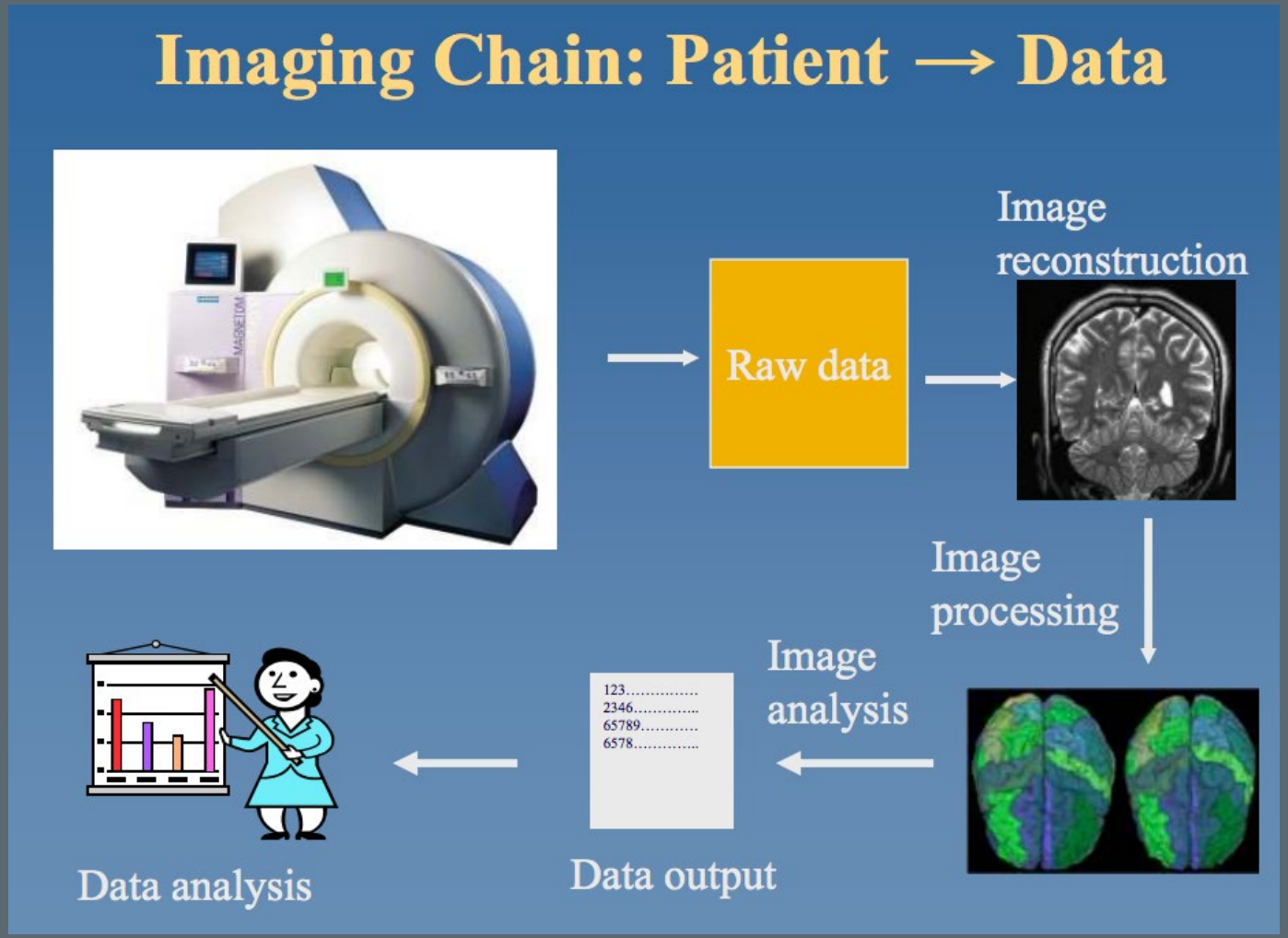


Image credit: Dr. Susanna Lee MD, PhD

PROSTATE MR AT THE ROCKYVIEW GENERAL HOSPITAL: AN UPDATE

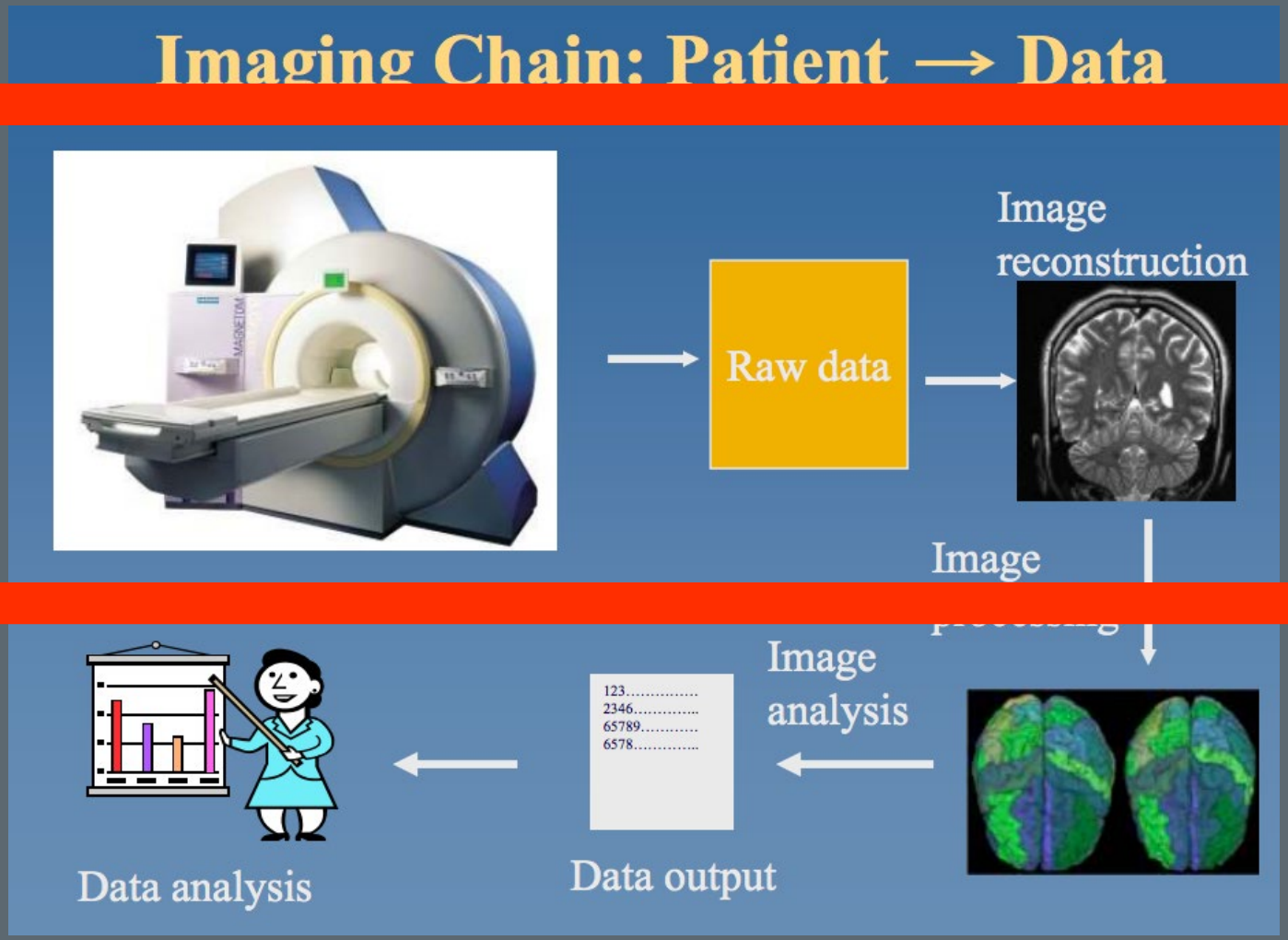


Image credit: Dr. Susanna Lee MD, PhD

PROSTATE MR AT THE ROCKYVIEW GENERAL HOSPITAL: AN UPDATE

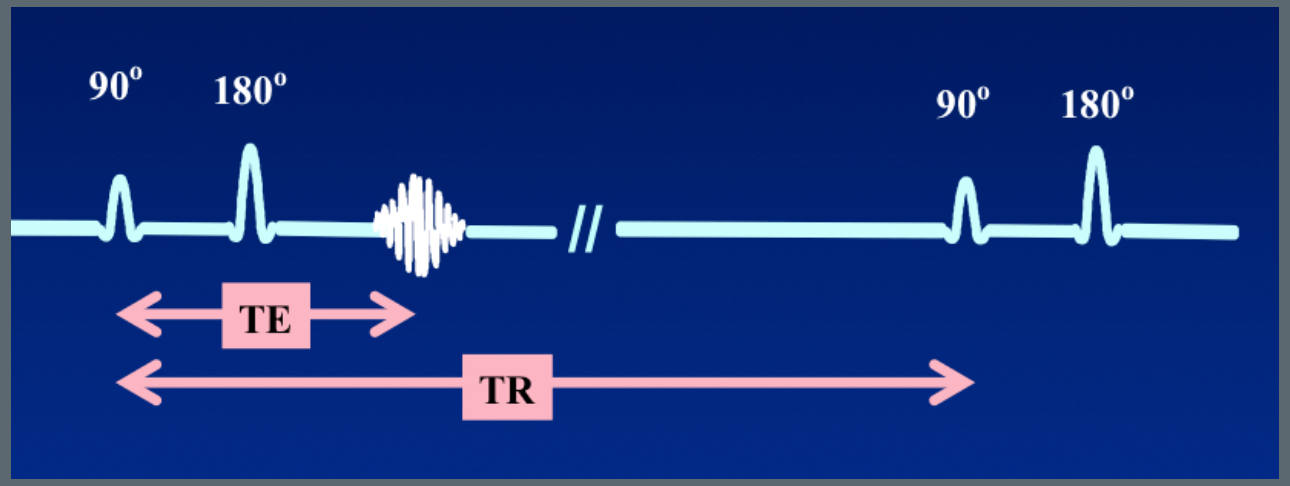
Brief update on step one: establishment of a robust core prostate mpMRI protocol at the Urology Centre of Excellence for Southern Alberta.

MRI BASICS IN 10 SECONDS

a) lining up protons in a patient along a magnetic field

b) deflecting, tilting or flipping protons in a variety of sequences to generate differences in spin or orientation to provide contrast according to tissue type or environment

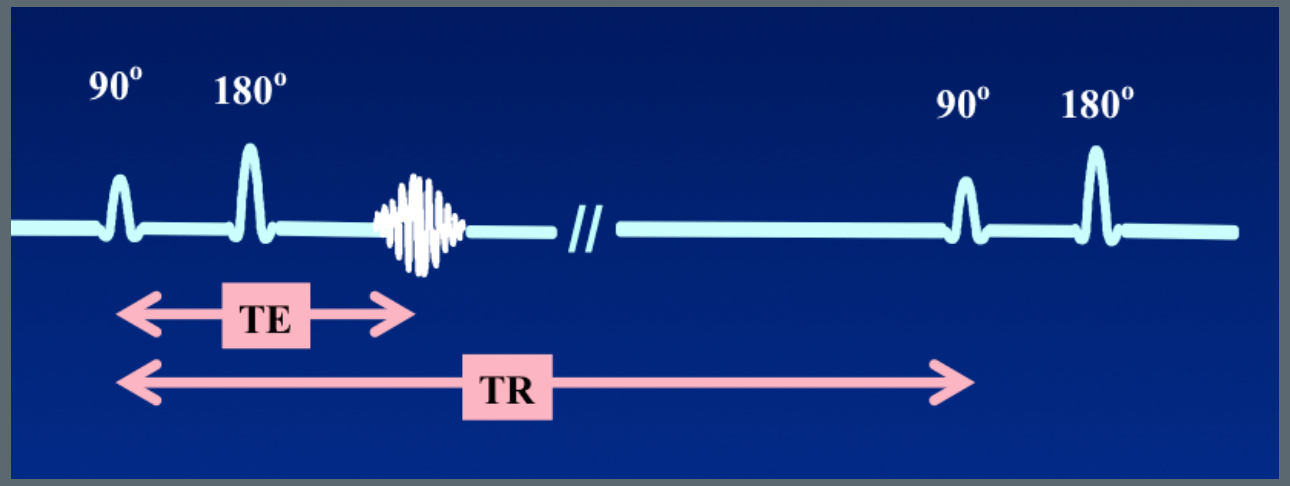
c) listen to the "signal" emitted back from the patient as protons "relax" back to alignment with the magnetic field



MRI BASICS IN 10 SECONDS

MR can generate a huge variety of tissue contrasts based on how protons differently react to a series of radiofrequency pulses or magnetic gradients within a static magnetic field.

These are boiled down to simple "flavours" of imaging sequences based on their relative weighting (T1, T2) though in reality this weighting is relative (on a sliding scale) and the amount of imaging variables can be thought of as an order of magnitude greater than other imaging modalities.



PROSTATE MRI BASICS

Current Regional Indications:

1. High PSA/clinical suspicion for significant cancer, negative systematic biopsy: are we missing treatable malignancy?

2. Known high risk cancer, pre-operative staging: where is the cancer and how specifically should surgery be performed?

3. Active surveillance monitoring in known low risk cancer: do we need to re-biopsy?

PROSTATE MRI BASICS

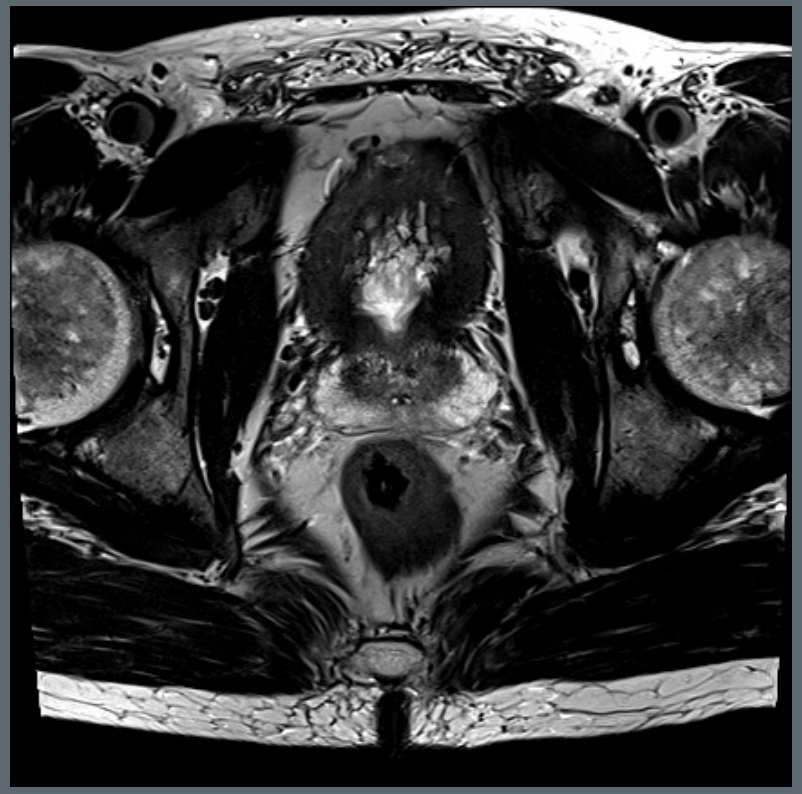
Anatomic detail

T2

PROSTATE MRI BASICS

T2

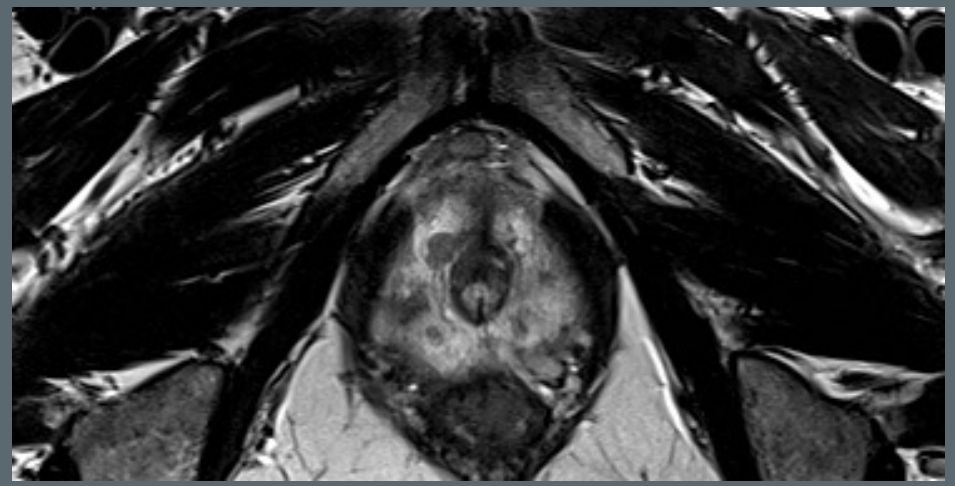
Anatomic detail



PROSTATE MRI BASICS

T2

Anatomic detail
Tumour localization in PZ



PROSTATE MRI BASICS

Anatomic detail
Tumour localization in PZ
Primary assessment in TZ

T2

PROSTATE MRI BASICS

T2

Anatomic detail
Tumour localization in PZ
Primary assessment in TZ
Pre-op tumour margin staging

PROSTATE MRI BASICS

Primary assessment in PZ
Secondary assessment in TZ

DWI

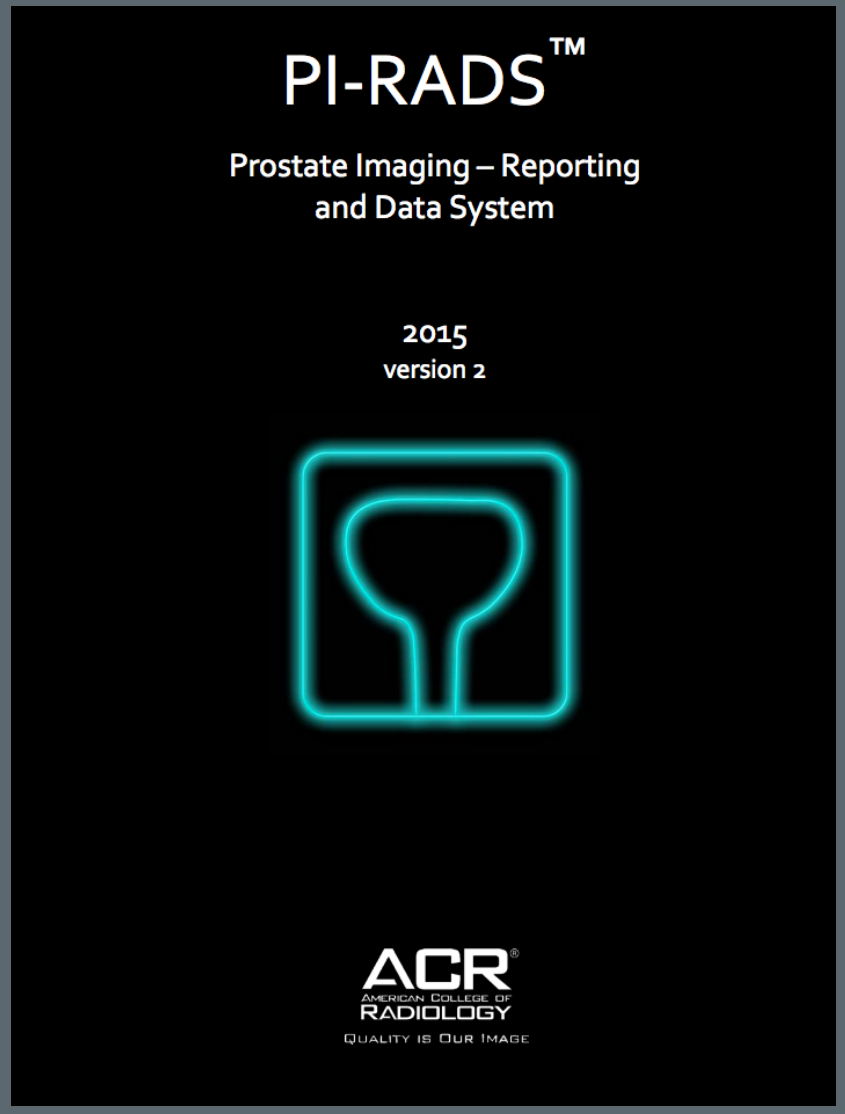
PROSTATE MRI BASICS

Lesion perfusion
Adjunct in tumour assessment
Adjunct in pre-op margins

DCE

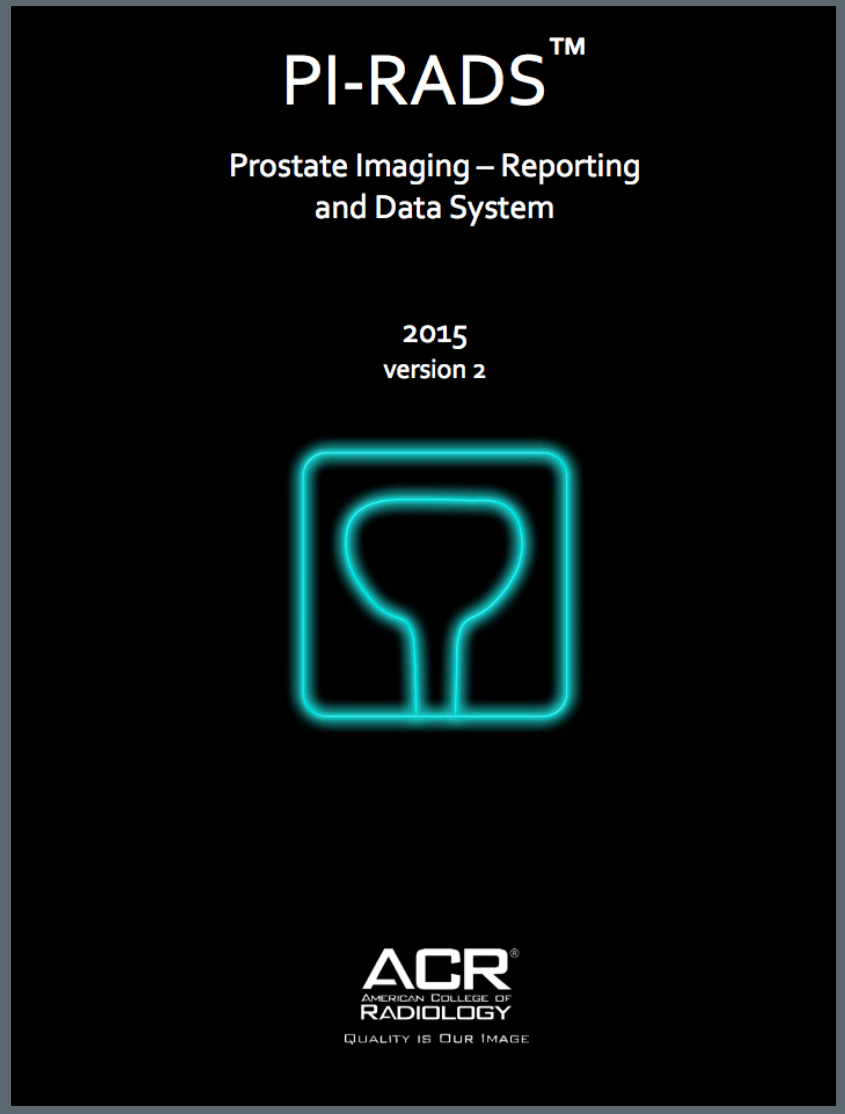
PROSTATE MRI BASICS

"Designed to promote global standardization and diminish variation in the acquisition, and interpretation of prostate mpMRI examinations and it is intended to be a “living” document that will evolve as clinical experience and scientific data accrue. PIRADS v2 needs to be tested and validated for specific research and clinical applications."



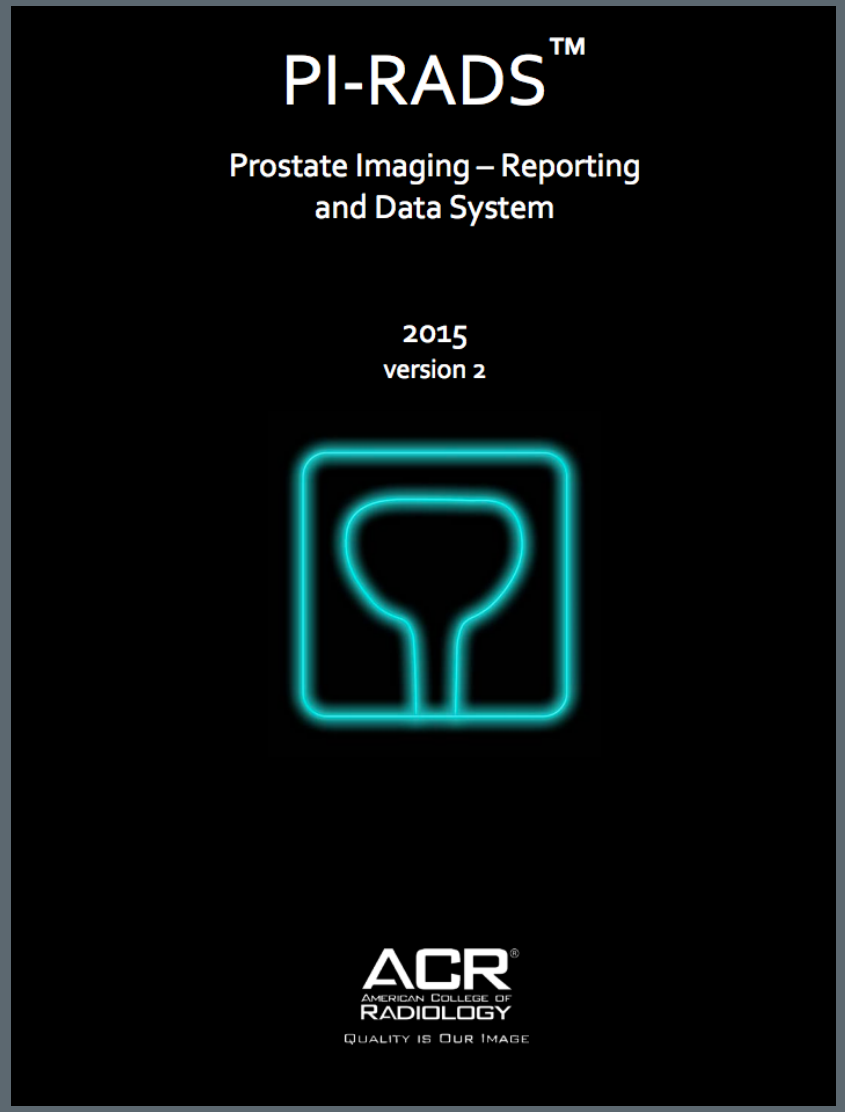
PROSTATE MRI BASICS

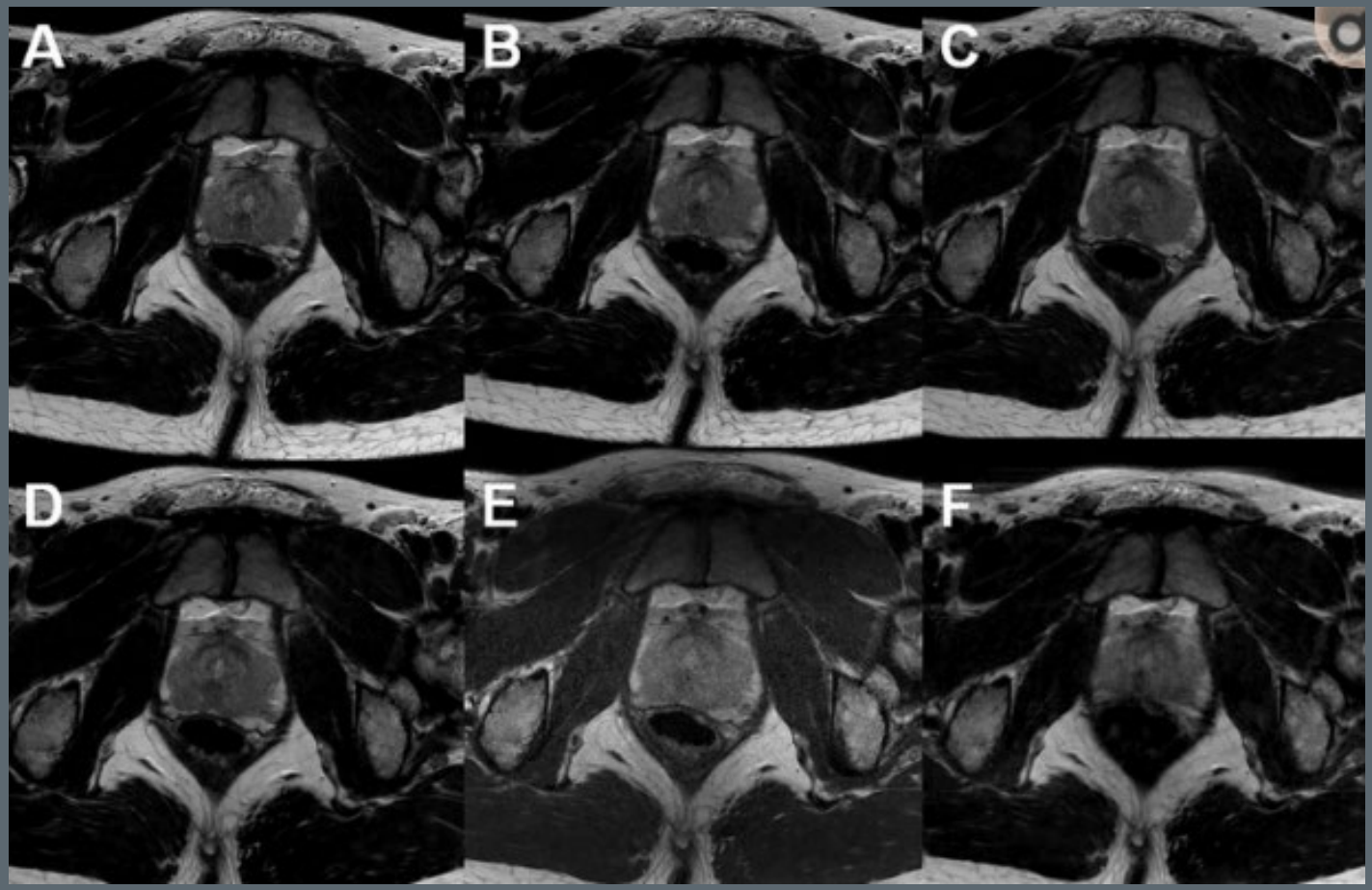
PI-RADS v2 gives us a common language and a baseline minimum framework to work with



PROSTATE MRI BASICS

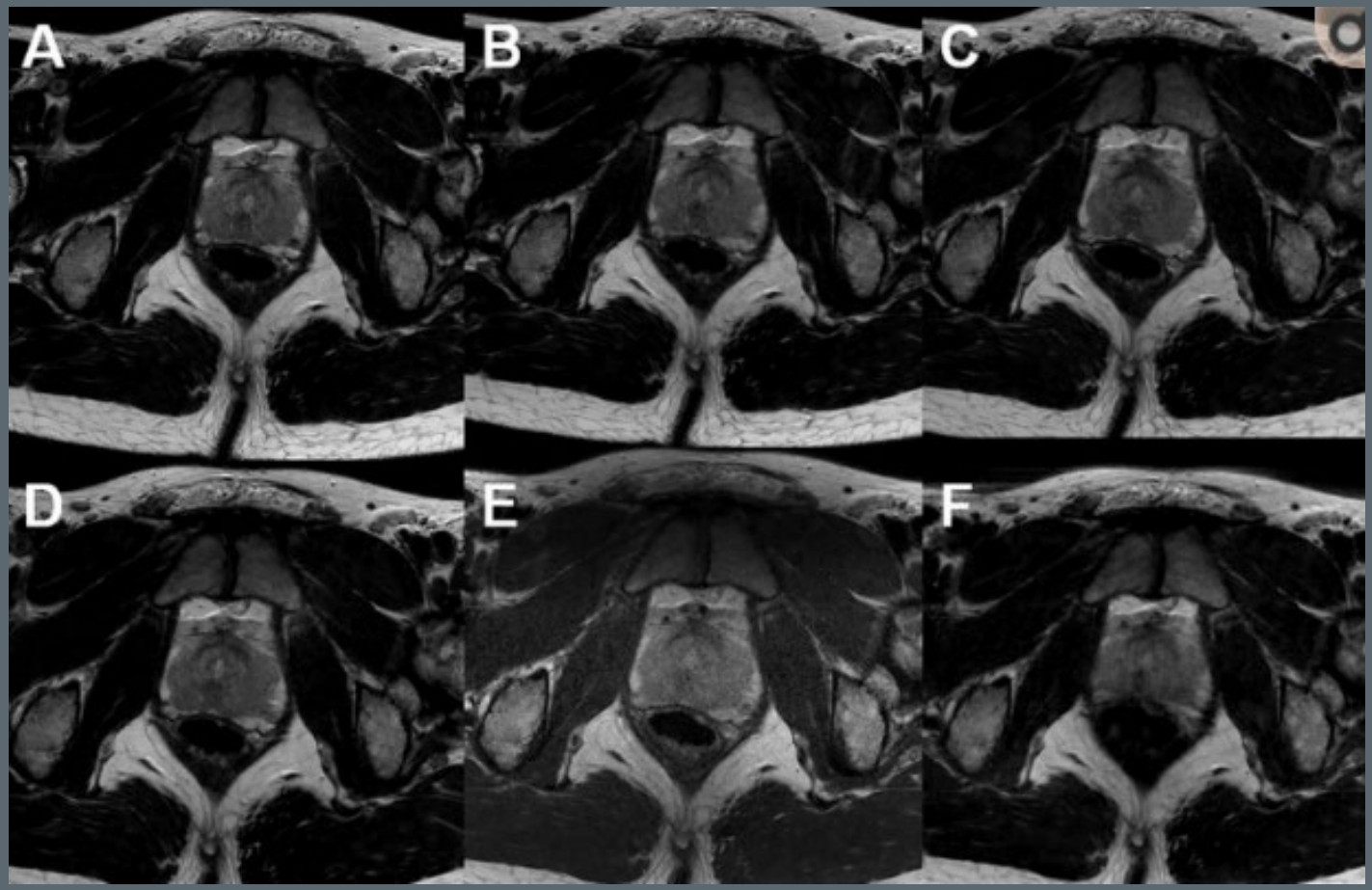
"it does not elucidate or prescribe optimal technical parameters"





Axial T2W images acquired at 3-T using surface arrays coils. All acquisitions fulfilled the recommendations stated in PI-RADs v2. However, substantial differences in acquisition times and image quality can be noted: (a) acquisition time is 2 min 55 s; (b) acquisition time is 2 min 30 s; (c) acquisition time is 2 min 20 s; (d) acquisition time is 2 min 55 s; (e) acquisition time is 3 min 10 s; (f) acquisition time is 3 min 7 s. All images have the same windowing.

Acta Radiol Open. 2017 Dec; 6(12): 2058460117745574



"strict adherence to PI-RADs guidelines is not sufficient to ensure the best image quality with an acceptable acquisition time"

Acta Radiol Open. 2017 Dec; 6(12): 2058460117745574

VARIABLES IN MRI

VARIABLES IN MRI

Field Strength

System Gradient Specifications

Receiver Coils

VARIABLES IN MRI

Field Strength

System Gradient Specifications

Receiver Coils

Basic Sequence Type (T1, T2, PD, DWI)
Acquisition type (2D vs 3D, spin echo, fast spin echo, gradient recalled echo, segmented readout)
Acceleration Factors (Simultaneous Multislice, Parallel Imaging)
Image Filters
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Phase and frequency encoding direction
Number of Excitations
Matrix size
FOV
Bandwidth
Slice thickness
Number of slices in volume
Echo time (TE)
Repetition time (TR)
b-value
Specific Absorption Rate

VARIABLES IN MRI

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Specific Absorption Rate

Signal to noise ratio (SNR)
Contrast to noise ratio (CNR)
Spatial resolution
Contrast Resolution

VARIABLES IN MRI

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b-value
Specific Absorption Rate

Imaging Time

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VARIABLES IN MRI

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Signal to noise ratio (SNR)
Contrast to noise ratio (CNR)
Spatial resolution
Contrast Resolution

VARIABLES IN MRI

Field Strength

Prostate MRI is currently acquired using a 1.5-T or 3-T MR scanner.

Higher field strength provides a higher signal-to-noise ratio (SNR).

Induced MR signal in a receiver coil is proportional to the square of the main magnetic field (B0) while the noise has a linear dependence at field strengths > 1.0-T. Thus, the theoretical SNR gain of the 3-T vs. 1.5-T is two times higher.

In reality, several real-world limitations make the real SNR gain of 3-T vs. 1.5-T in the range of 1.5–1.8 x

Magn Reson Imaging Clin N Am. 2007 Aug;15(3):277-90

VARIABLES IN MRI

Field Strength

Although prostate MRI at both 1.5 T and 3T has been well established, most members of the PI-RADS Steering Committee prefer, use, and recommend 3T for prostate MRI

VARIABLES IN MRI

Field Strength

1.5 T

3 T

VARIABLES IN MRI

Field Strength

RGH: Siemens 3T VIDA system

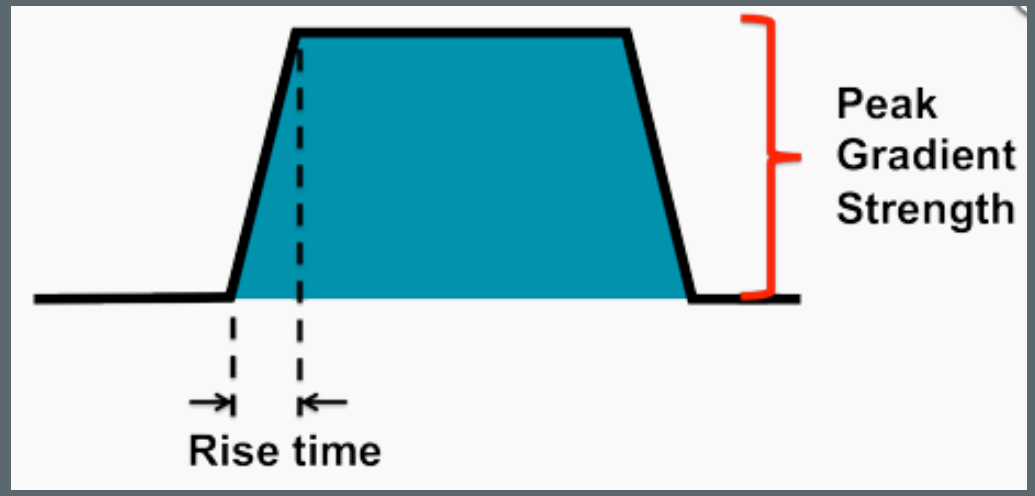
STAMPEDE
403-571-6800

SIEMENS

VARIABLES IN MRI

System Gradient Specifications

Gradient performance underpins an MR system's spatial resolution capabilities, imaging speed, purchase cost, and (in areas relevant to prostate imaging) interpretation limiting artifacts



http://mriquestions.com/gradient-specifications.html

VARIABLES IN MRI

System Gradient Specifications

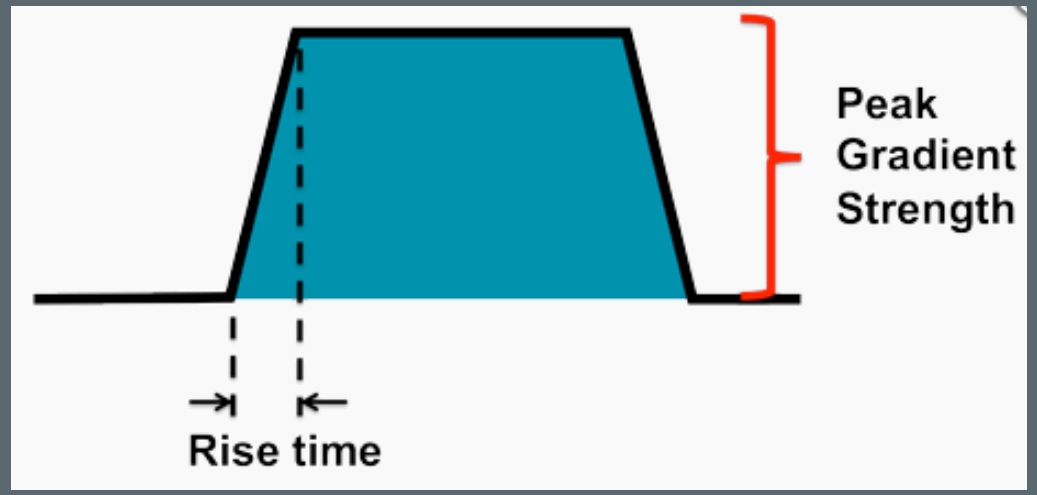
3 T

3 T

VARIABLES IN MRI

System Gradient Specifications

Maximum (peak) gradient strength (mT/m)
Bigger is better

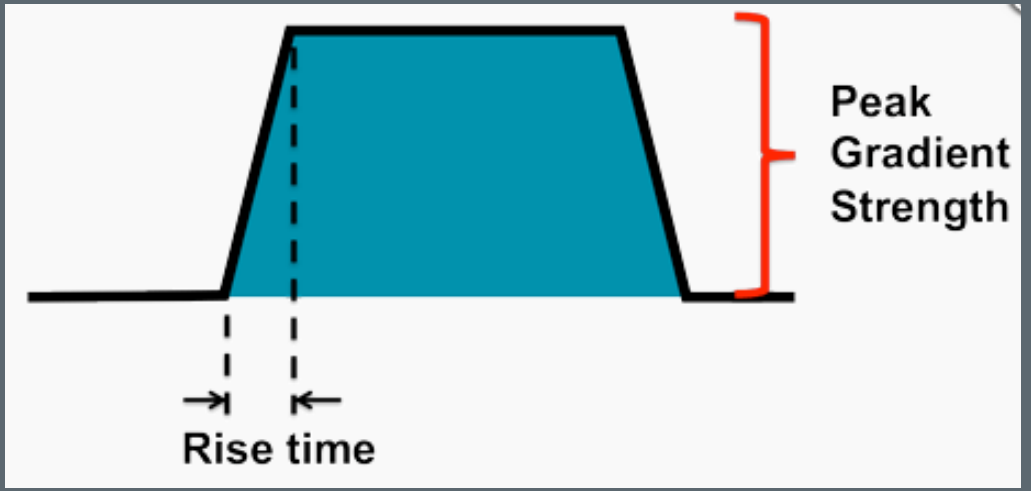


http://mriquestions.com/gradient-specifications.html

VARIABLES IN MRI

System Gradient Specifications

Slew rate = peak/rise time (T/m/sec)
Faster is better



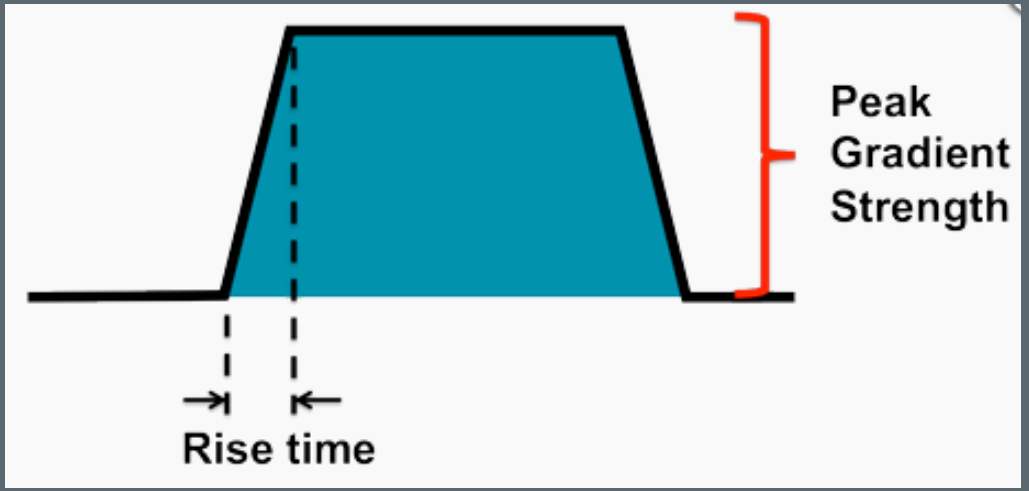
http://mriquestions.com/gradient-specifications.html

VARIABLES IN MRI

System Gradient Specifications

RGH system = Vida XT gradients
First and to date only XT Vida in Canada

Peak strength 60 mT/m
Slew rate 200 T/m/sec



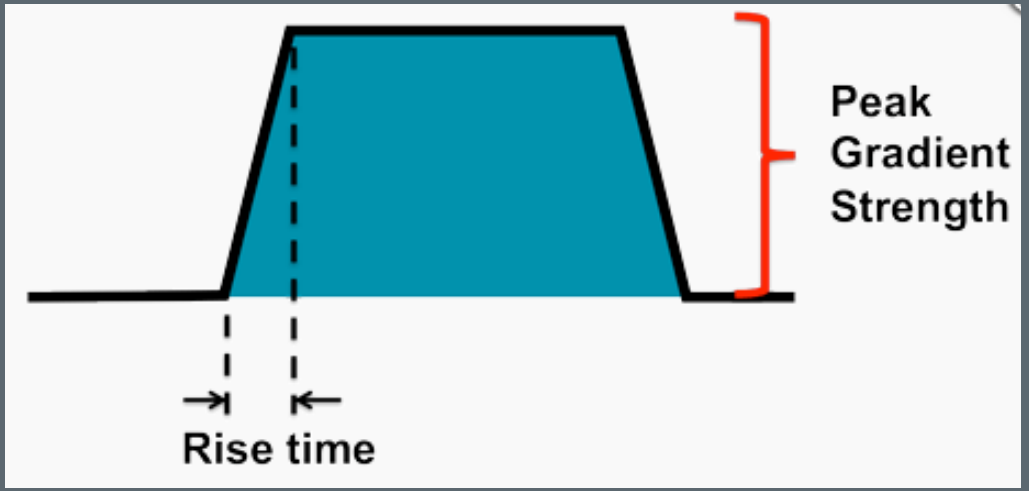
http://mriquestions.com/gradient-specifications.html

VARIABLES IN MRI

System Gradient Specifications

Peak strength 60 mT/m

Comparison:
SHC 45 mT/m
GE Signa Pioneer 36 mT/m



http://mriquestions.com/gradient-specifications.html

VARIABLES IN MRI

System Gradient Specifications

Peak strength 60 mT/m

In addition to cost, typical downside to ++ gradient specs on par with dedicated research systems is a decreased in bore size

VARIABLES IN MRI

System Gradient Specifications

Peak strength 60 mT/m

RGH Vida XT bore = 70 cm = largest in region

VARIABLES IN MRI

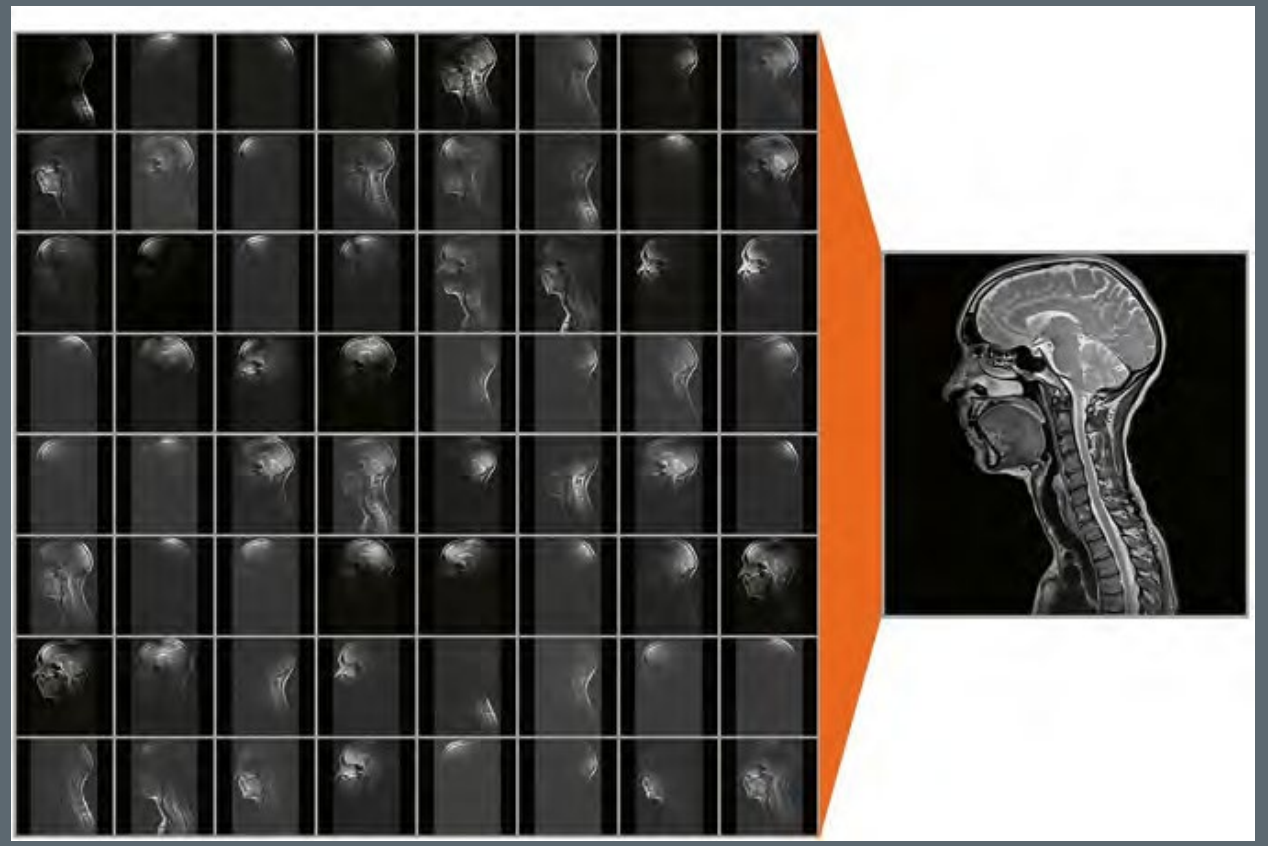
Receiver Coils

RF-coils are responsible for detecting MR signal. Oscillating net magnetic flux from the patient's excited protons are captured by the coil and an induced electric current is generated. The current is amplified, digitized, and filtered to extract frequency and phase information.

MAGNETOM Flash (70) 1/2018

VARIABLES IN MRI

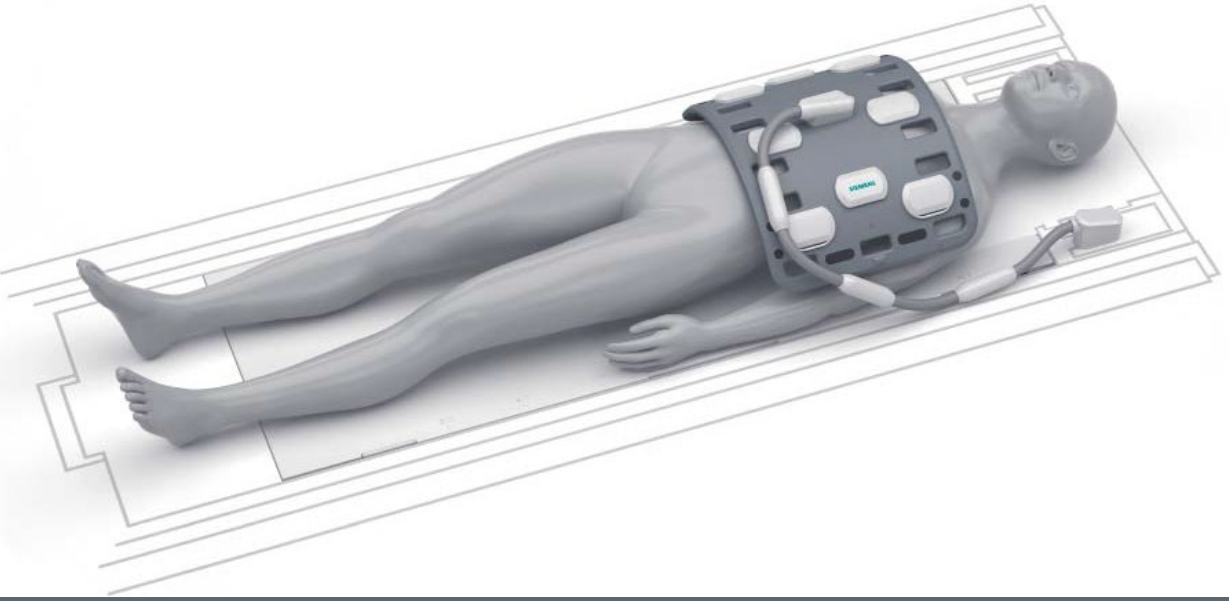
Receiver Coils



MAGNETOM Flash (70) 1/2018

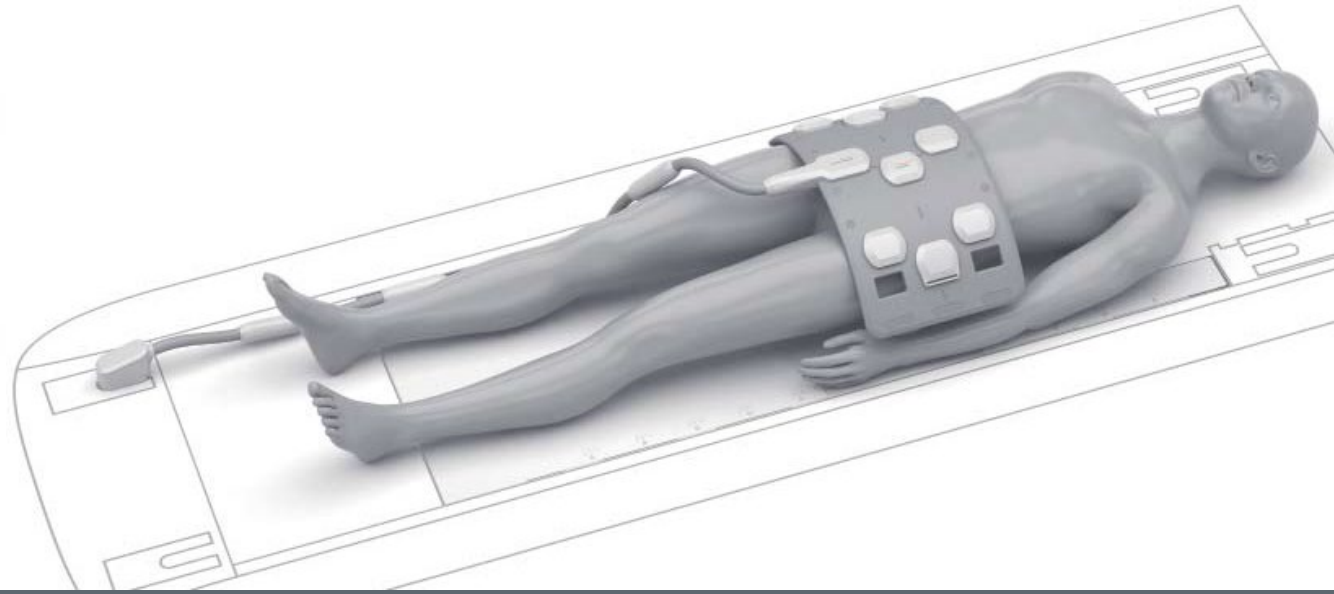
VARIABLES IN MRI

Receiver Coils



Body 18 Coil

Specific Coil Density:
4.7 receiver channels per
10 cm patient length



RGH UltraFlex Large Coil
BioMatrix Spine 32 (built in table)

Specific Coil Density:
6.2 + 2.7 = 8.9 receiver channels per
10 cm patient length

CRITICAL T2 VARIABLES

Field Strength

System Gradient Specifications

Receiver Coils

Basic Sequence Type (T1, T2, PD, DWI)
Acquisition type (2D vs 3D, spin echo, fast spin echo, gradient recalled echo, segmented readout)
Acceleration Factors (Simultaneous Multislice, Parallel Imaging)
Image Filters
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Phase and frequency encoding direction
Number of Excitations
Matrix size
FOV
Bandwidth
Slice thickness
Number of slices in volume
Echo time (TE)
Repetition time (TR)
b-value
Specific Absorption Rate

Imaging Time

Signal to noise ratio (SNR)
Contrast to noise ratio (CNR)
Spatial resolution
Contrast Resolution

CRITICAL T2 VARIABLES

Field Strength

System Gradient Specifications

Receiver Coils

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b-value
Specific Absorption Rate

Imaging Time

Signal to noise ratio (SNR)
Spatial resolution

CRITICAL T2 VARIABLES

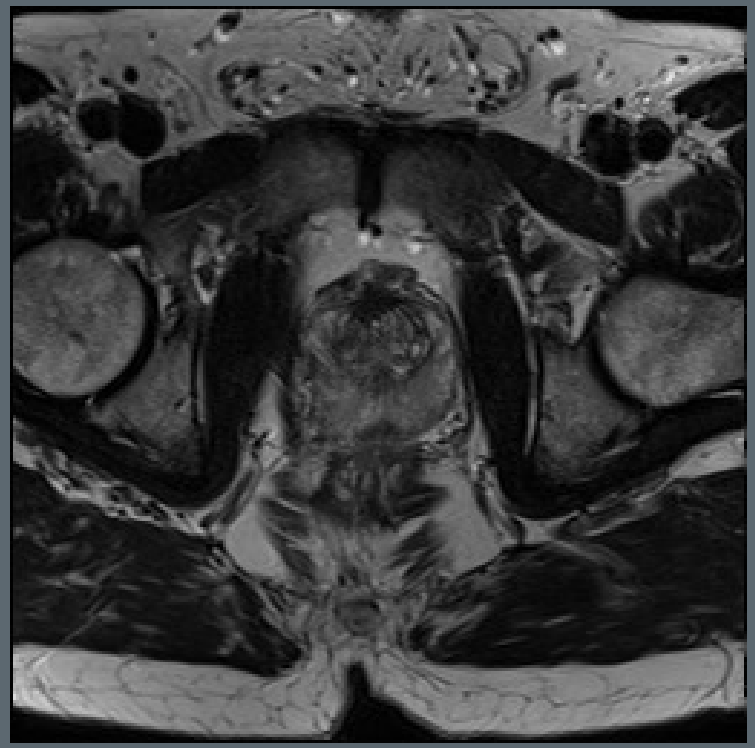
RGH Solutions

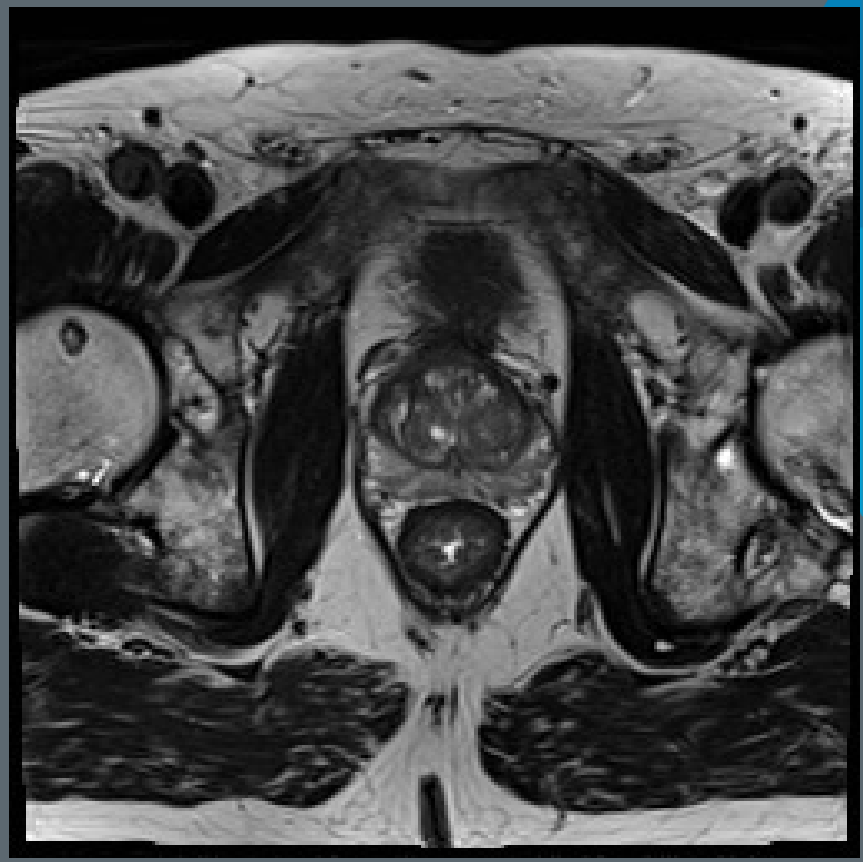
3T field strength, high density receiver coils
Voxel size decreased, FOV decreased, NEX increased
System with "under the hood" features dedicated for high resolution imaging

$$SNR = K(\text{voxel volume})\sqrt{\frac{\text{number of measurements}}{\text{bandwidth}}}$$

T2

**





T2

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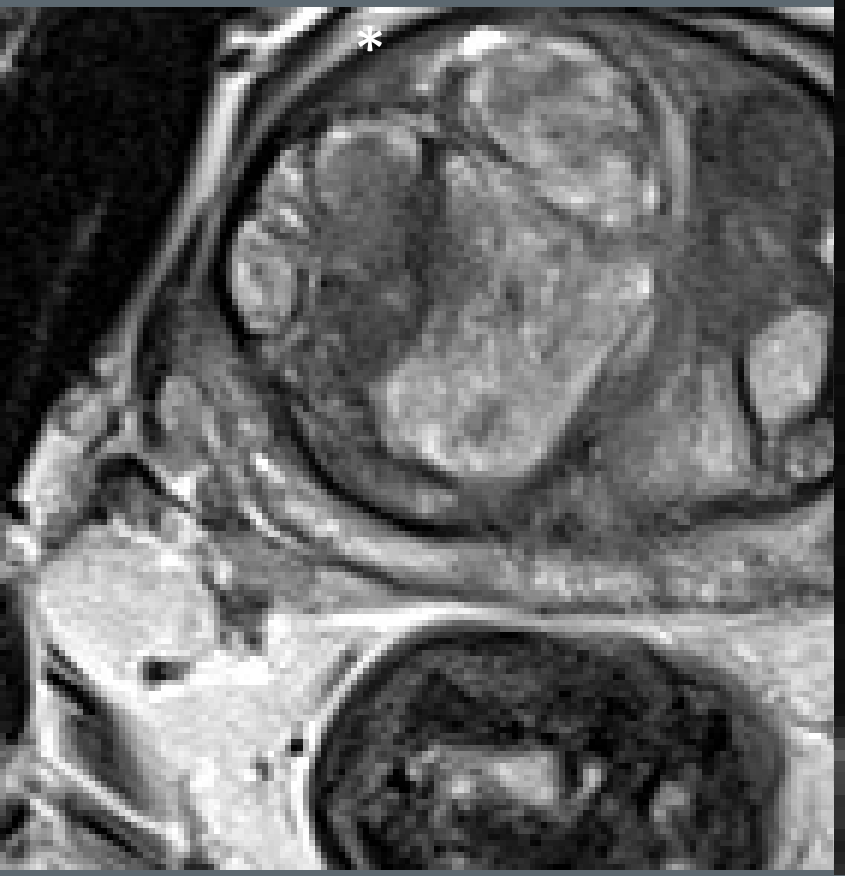

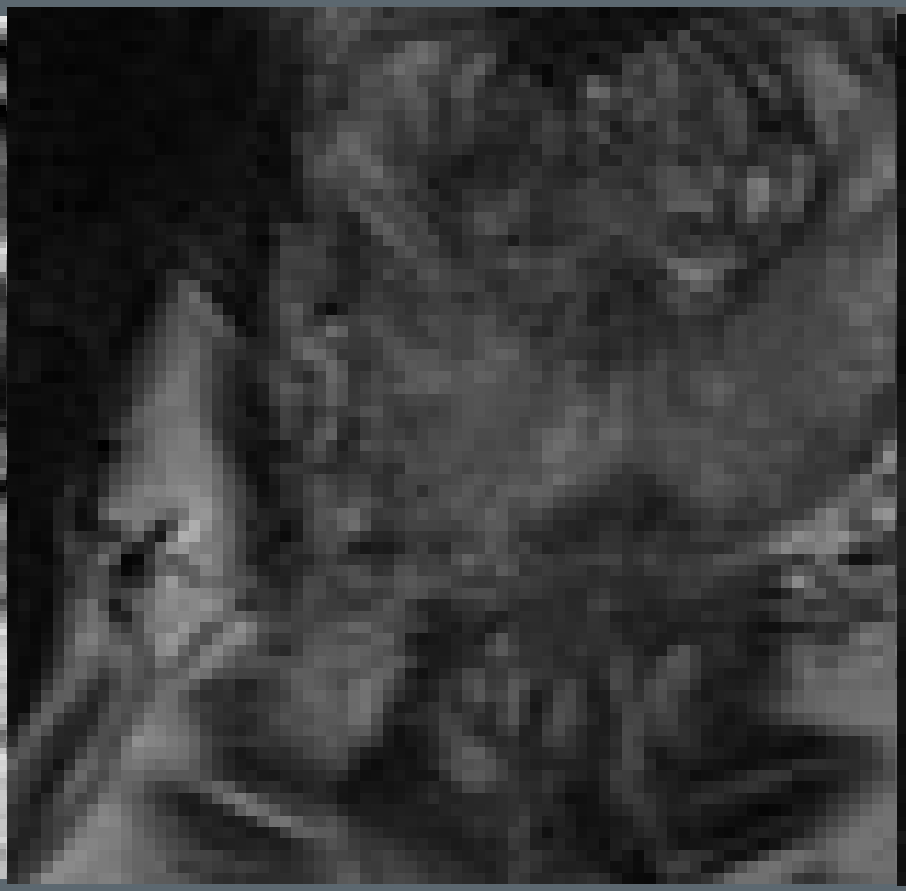

T2

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T2

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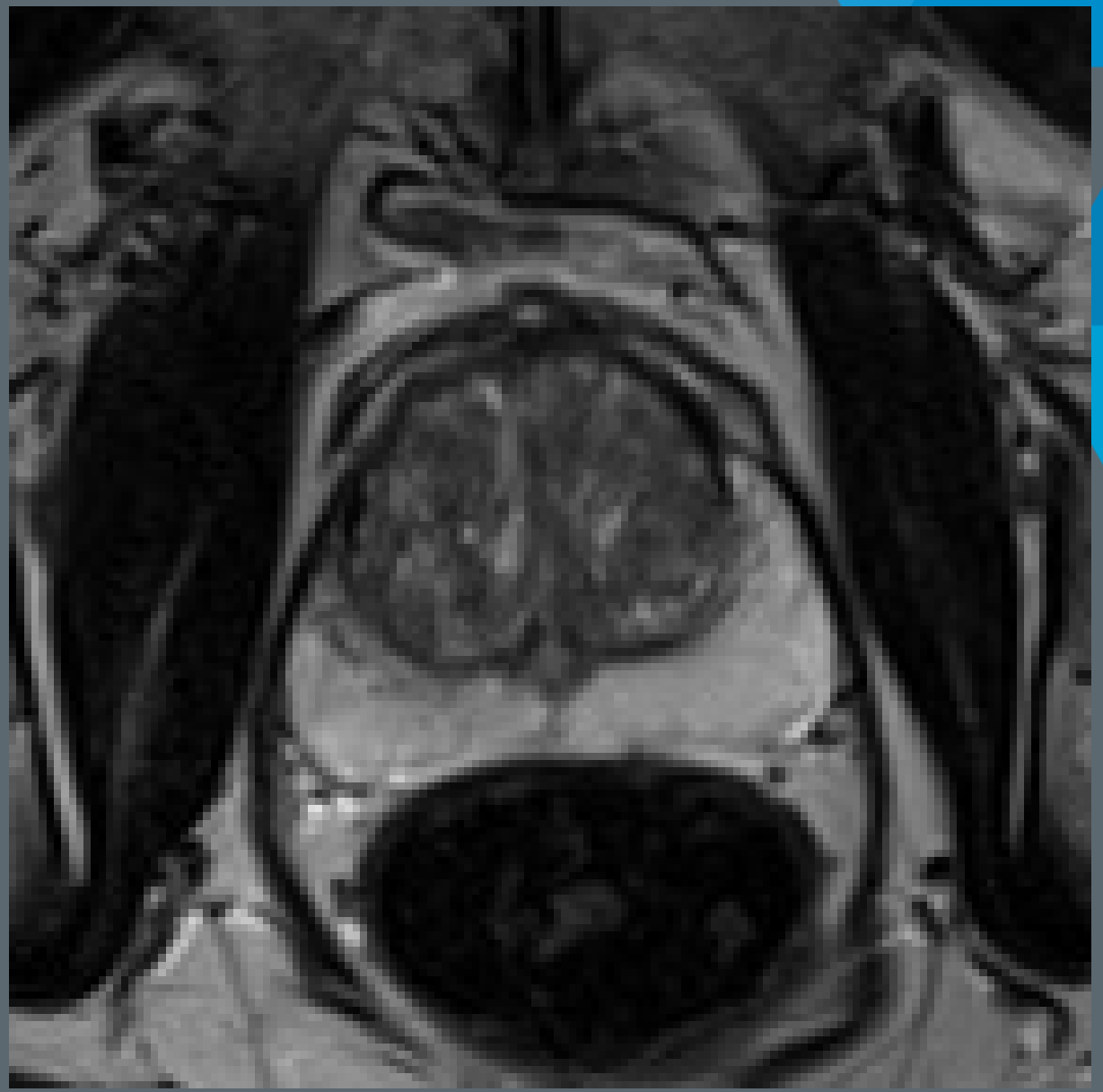
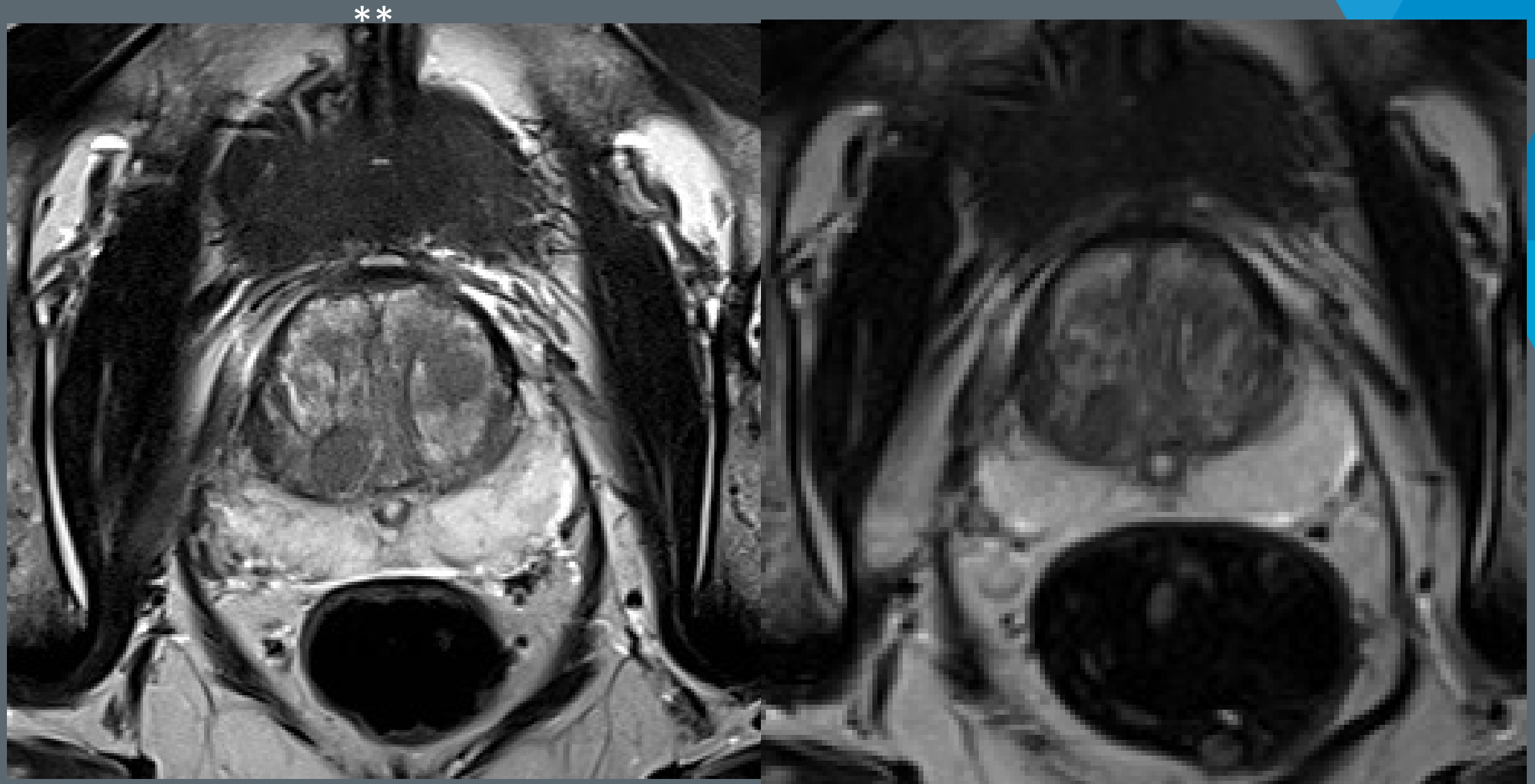


T2



T2

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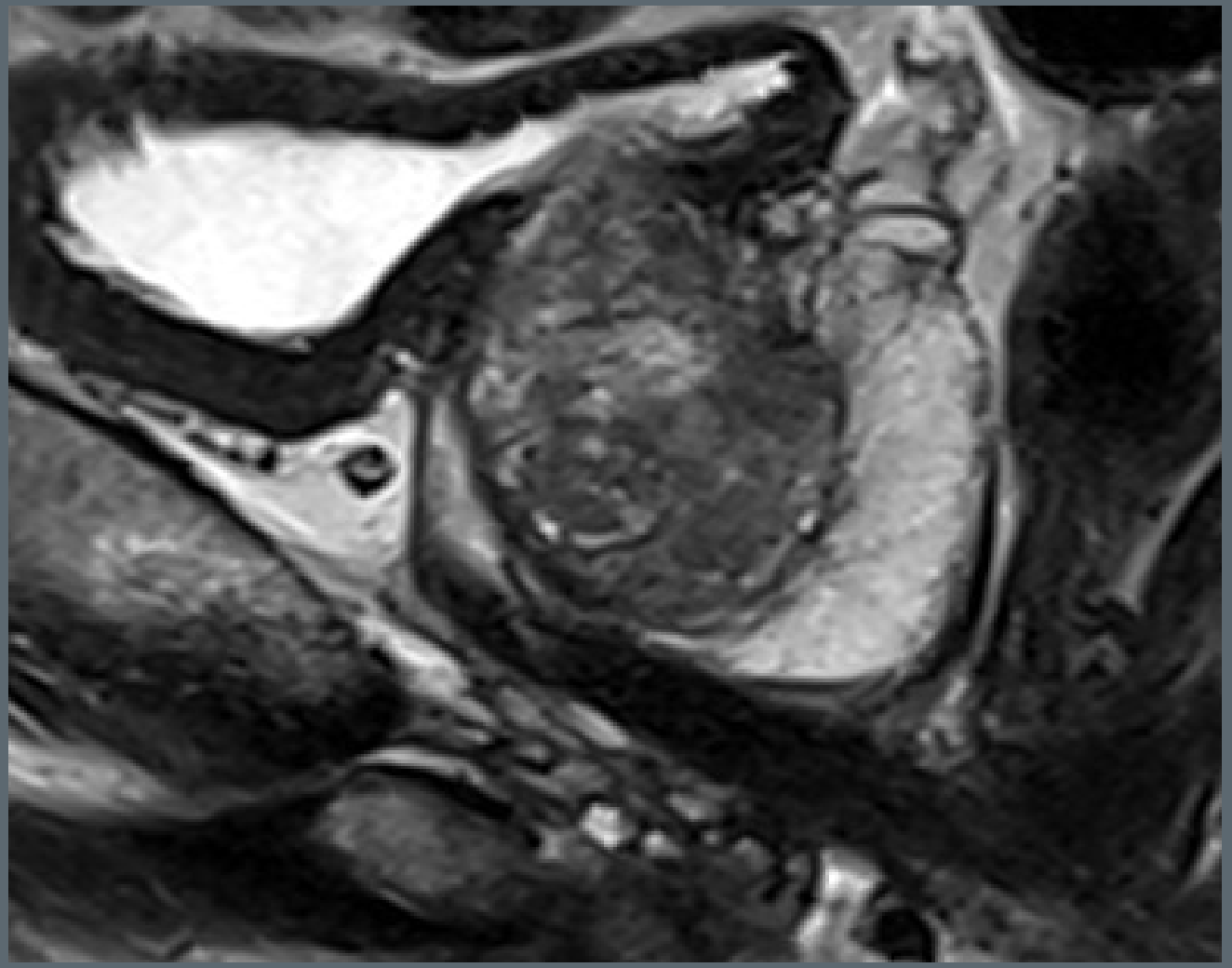

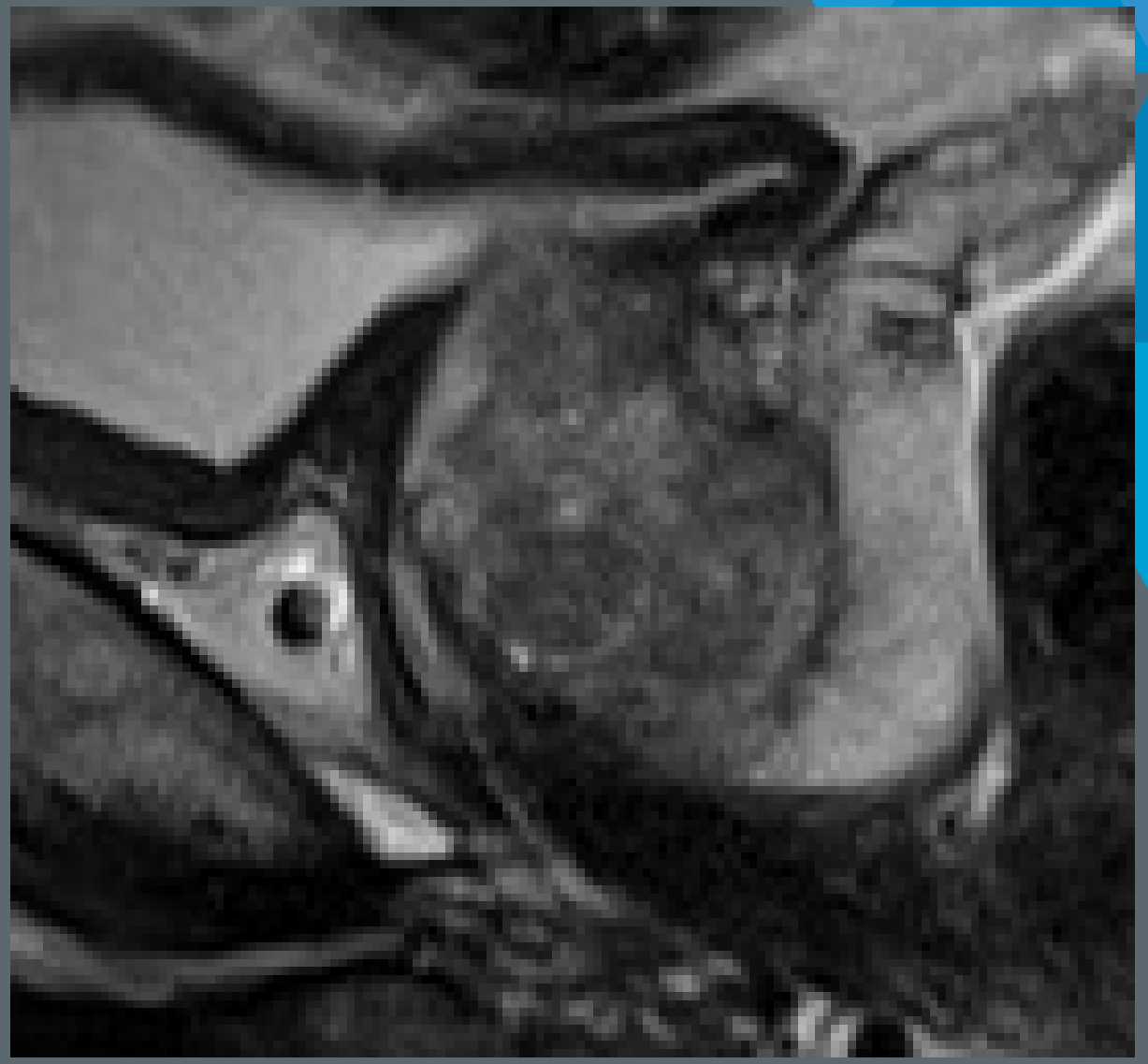

CRITICAL DWI VARIABLES

Field Strength
System Gradient Specifications
Receiver Coils

Basic Sequence Type (T1, T2, PD, DWI)
Acquisition type (2D vs 3D, spin echo, fast spin echo, gradient recalled echo, segmented readout)
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b-value
Specific Absorption Rate

Imaging Time

Signal to noise ratio (SNR)
Contrast to noise ratio (CNR)
Spatial resolution
Contrast Resolution

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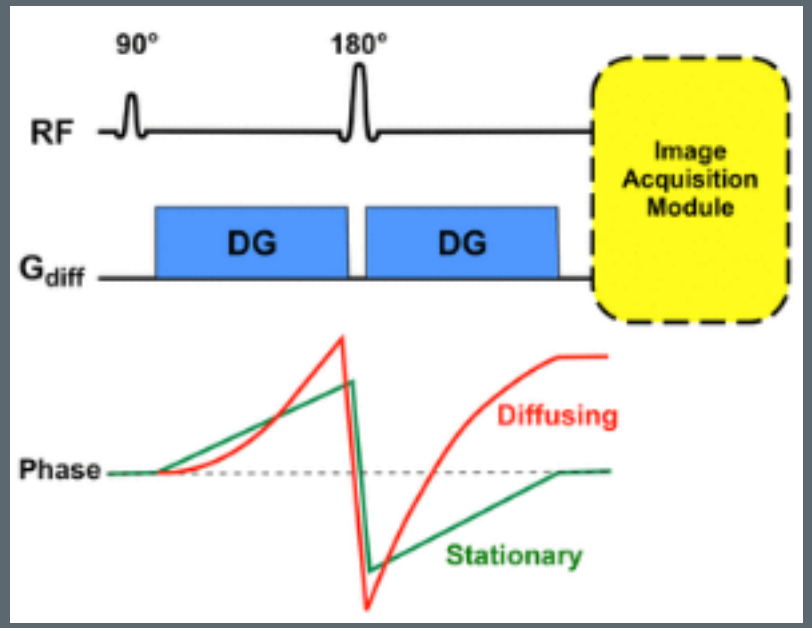
Signal to noise ratio (SNR)
Contrast to noise ratio (CNR)

CRITICAL DWI VARIABLES

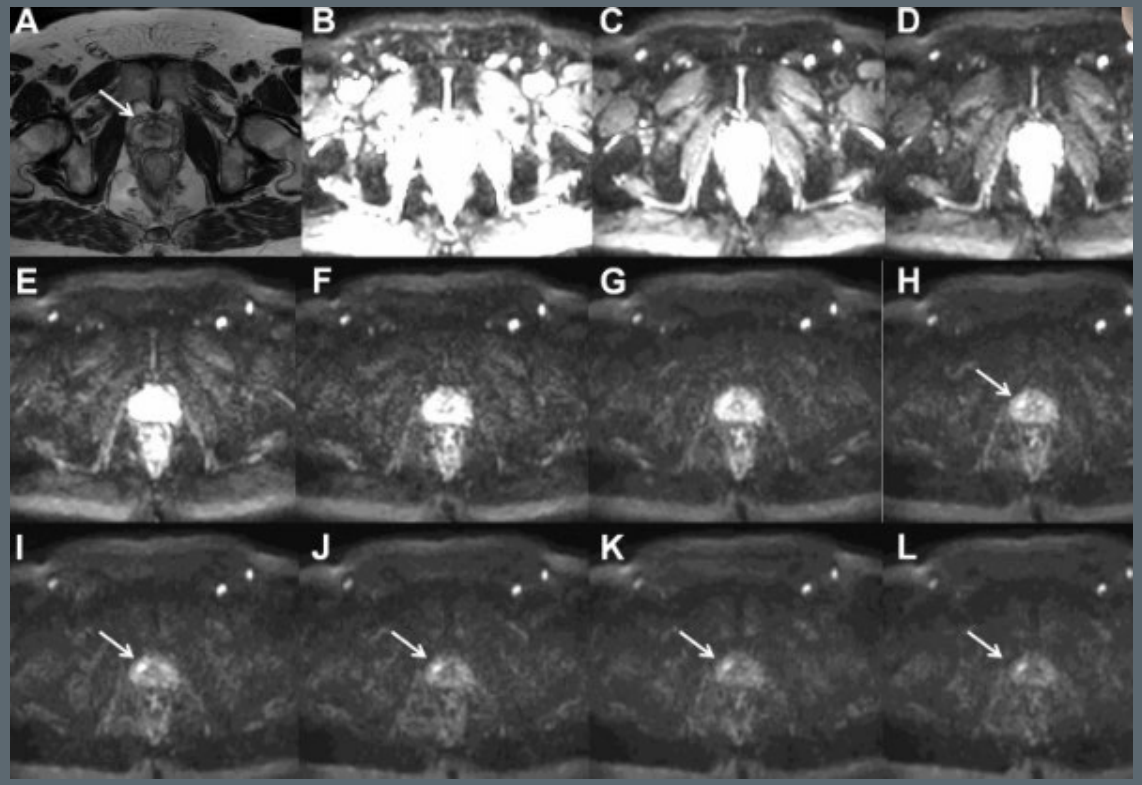
In prostate imaging, high cellularity in cancerous tissue means more cell membranes = brighter signal

b-value is a parameter that specifies the degree of diffusion weighting



http://mriquestions.com/making-a-dw-image.html

CRITICAL DWI VARIABLES



Axial T2W image ((a), arrow points to prostate cancer lesion) and trace DWI images of b = 0 (b), 300 (c), 600 (d), 900 (e), 1200 (f), 1500 (g), 1800 (h), 2100 (i), 2400 (j), 2700 (k), and 3000 (l) s/mm2 of a patient (the same patient as in Fig. 9) with histologically confirmed Gleason score 4 + 3 prostate cancer demonstrate increasing contrast between the cancer lesion and benign tissue with increasing b-values

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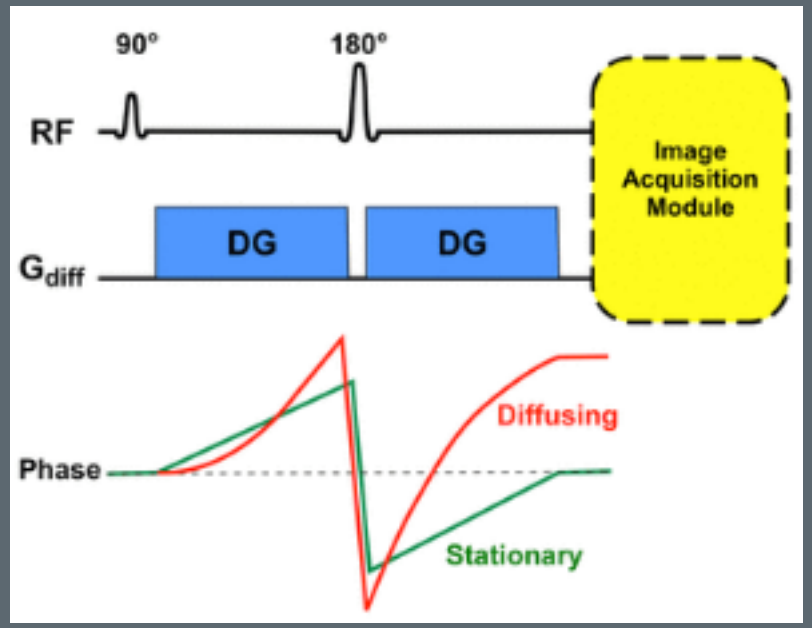
CRITICAL DWI VARIABLES

PI-RADS mandates an evidence supported recommendation that high b-values must be used.

Minimum is 1400 (currently used in region) but there is evidence that even higher may offer superior test characteristics

Must balance b-value vs. tradeoff in imaging quality

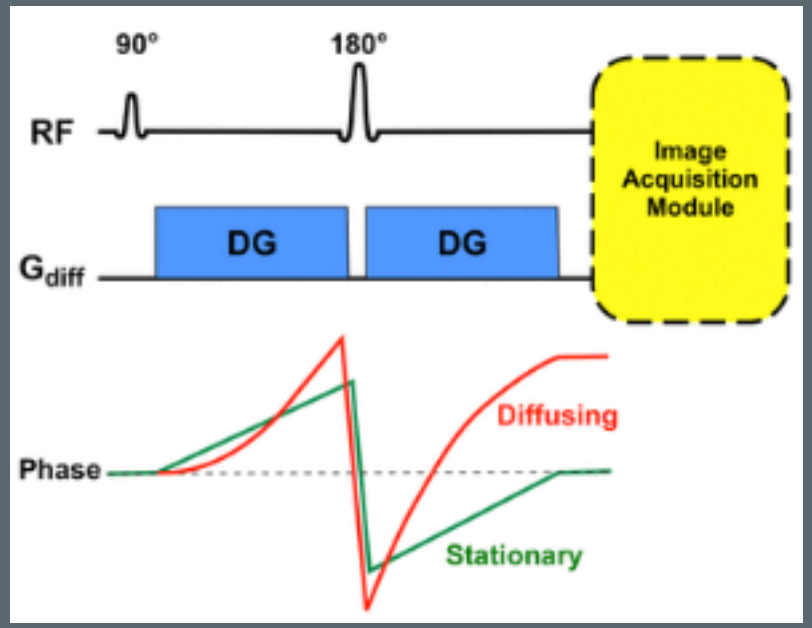


http://mriquestions.com/making-a-dw-image.html

CRITICAL DWI VARIABLES

To increase b-value, the system must either increase the diffusion gradient strength OR the time between gradients

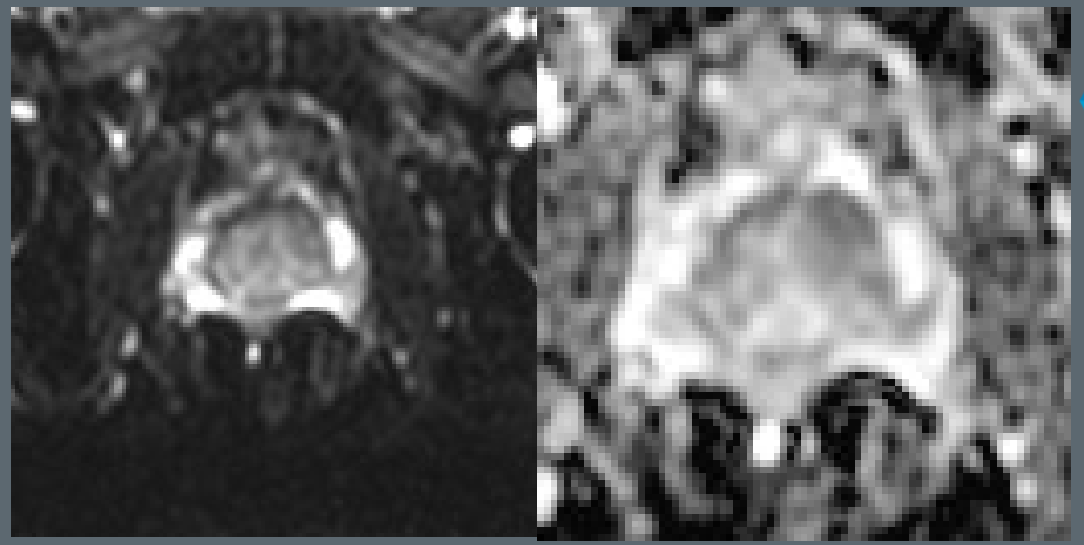
Problem: increasing time between gradients (TE) results in a sharp drop-off in SNR and a large increase in artifacts



http://mriquestions.com/making-a-dw-image.html

CRITICAL DWI VARIABLES

Examples of rectal gas: extremely common on regional 3T protocols to date at b=1400, not encountered at 1.5T



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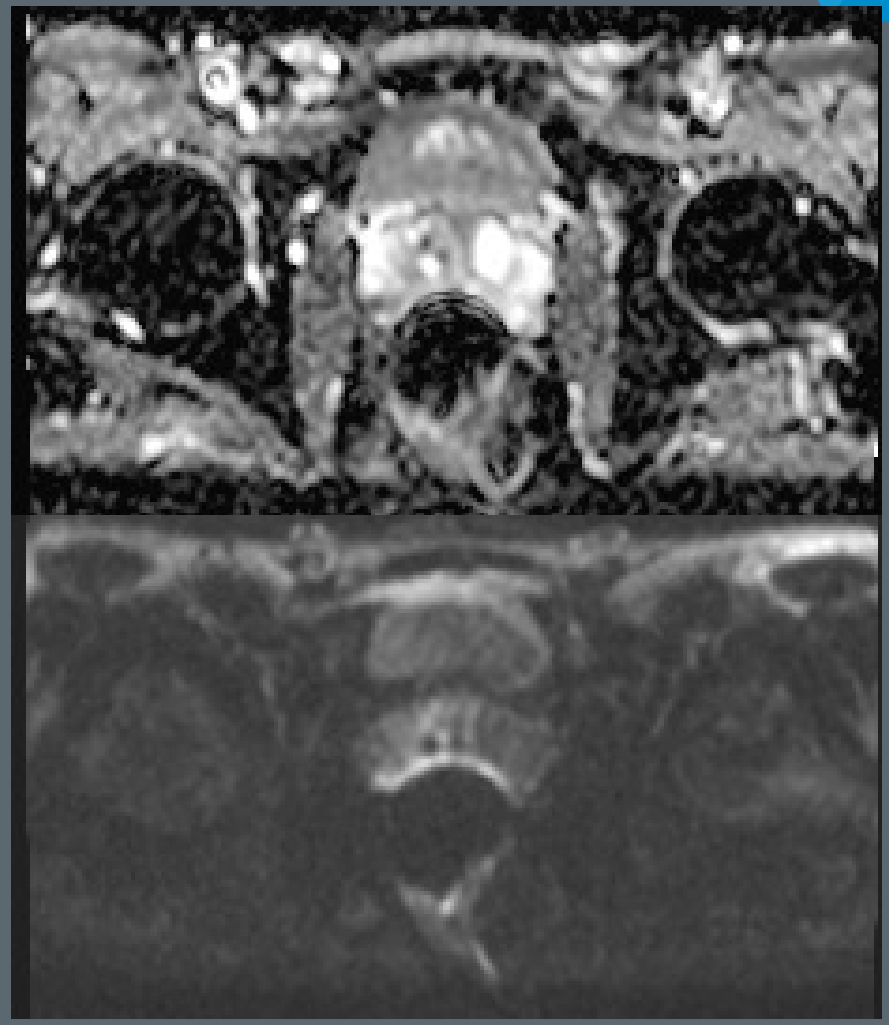
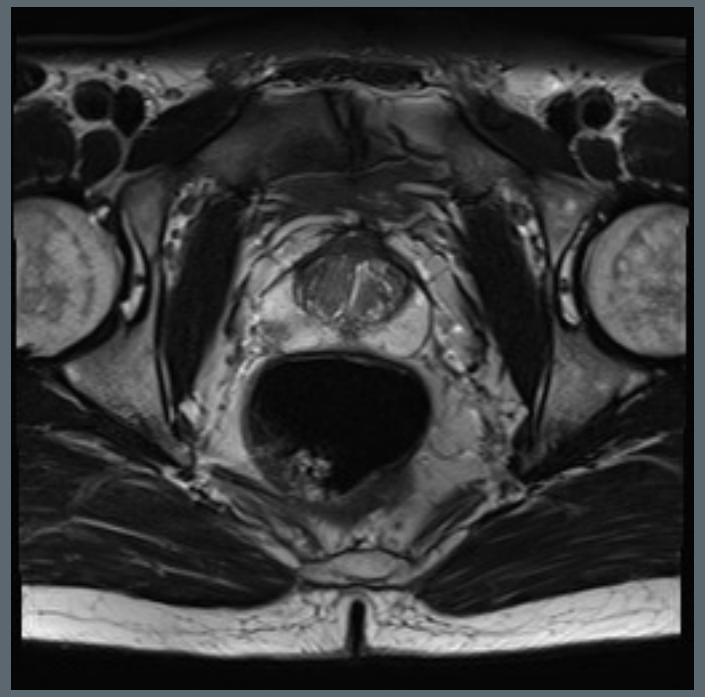
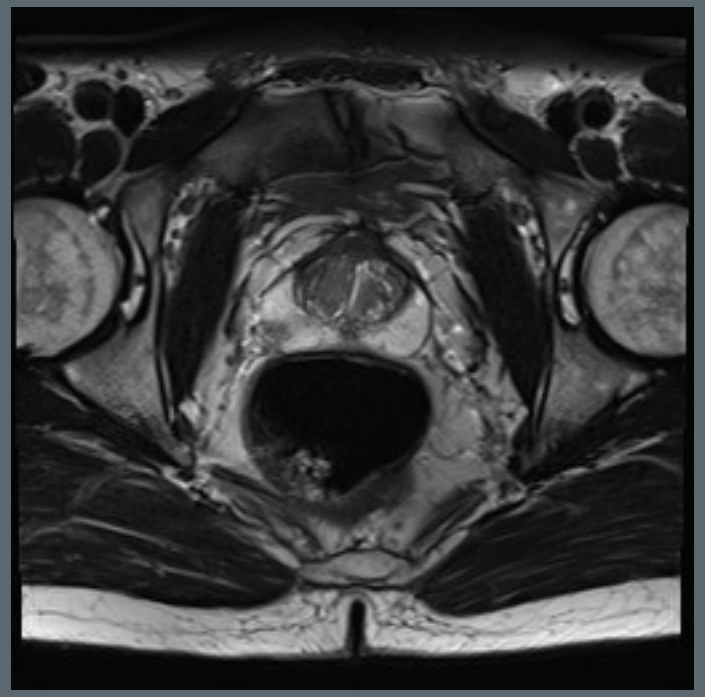
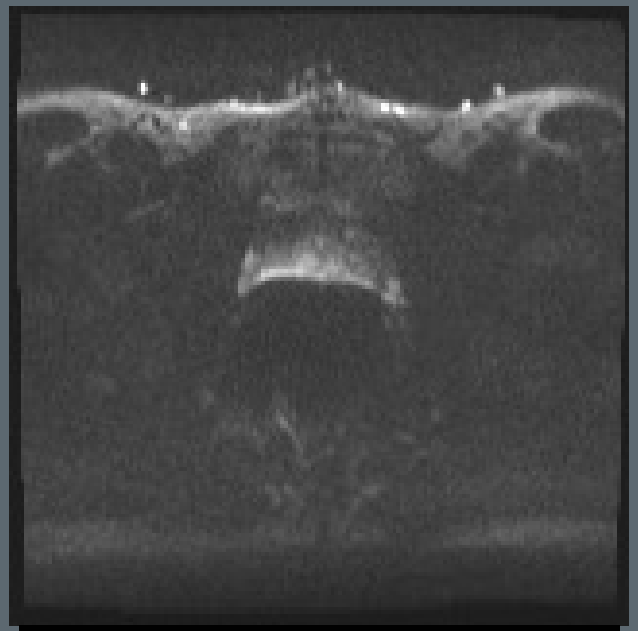


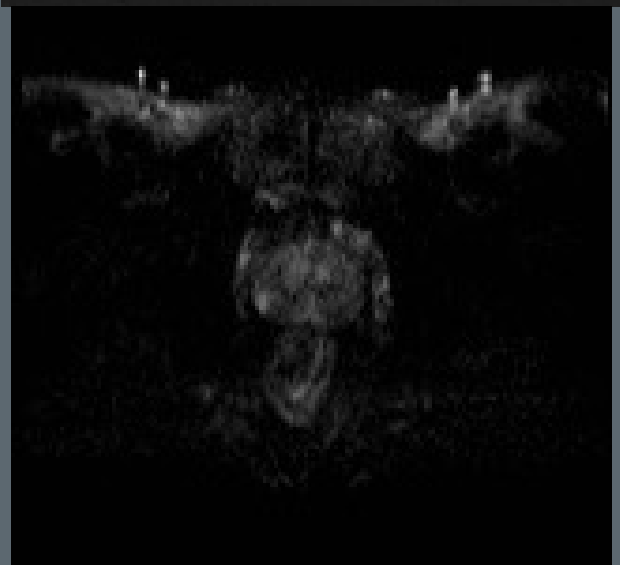
CRITICAL DWI VARIABLES



CRITICAL DWI VARIABLES

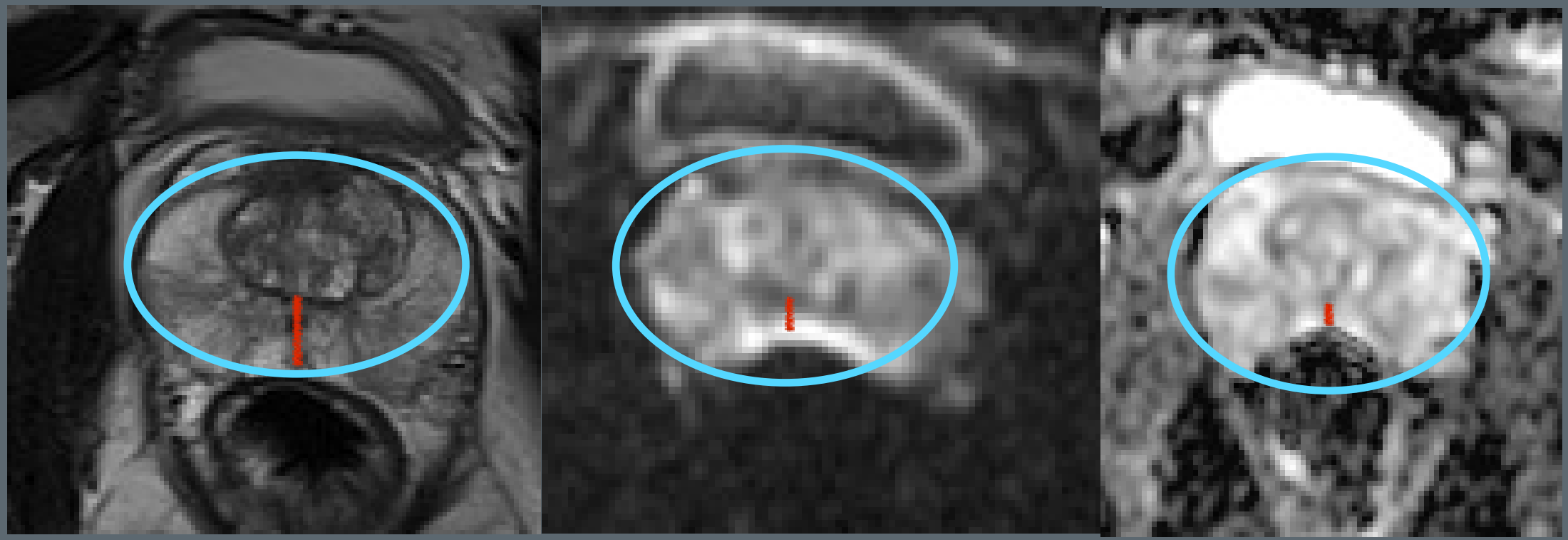




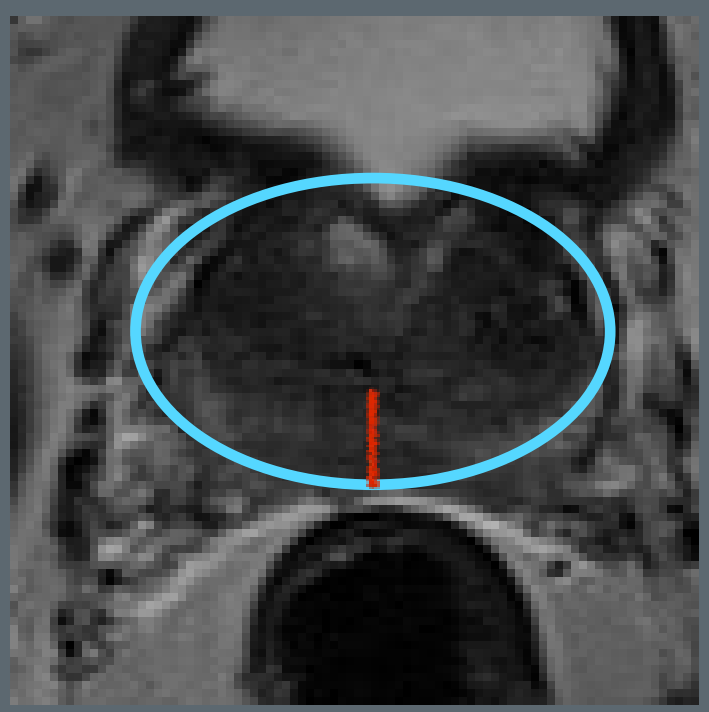


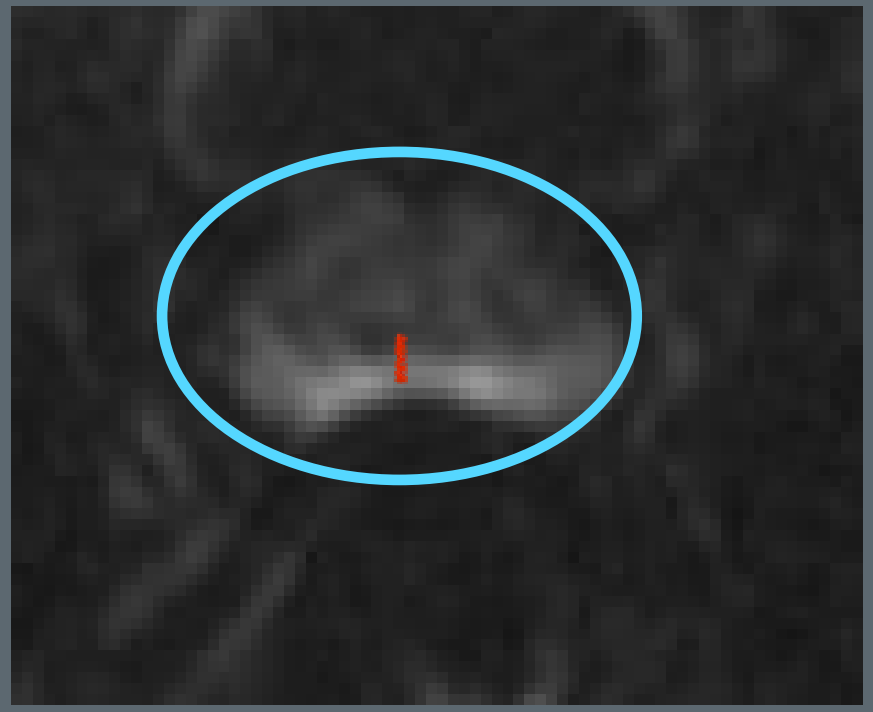
PI-RADS 4

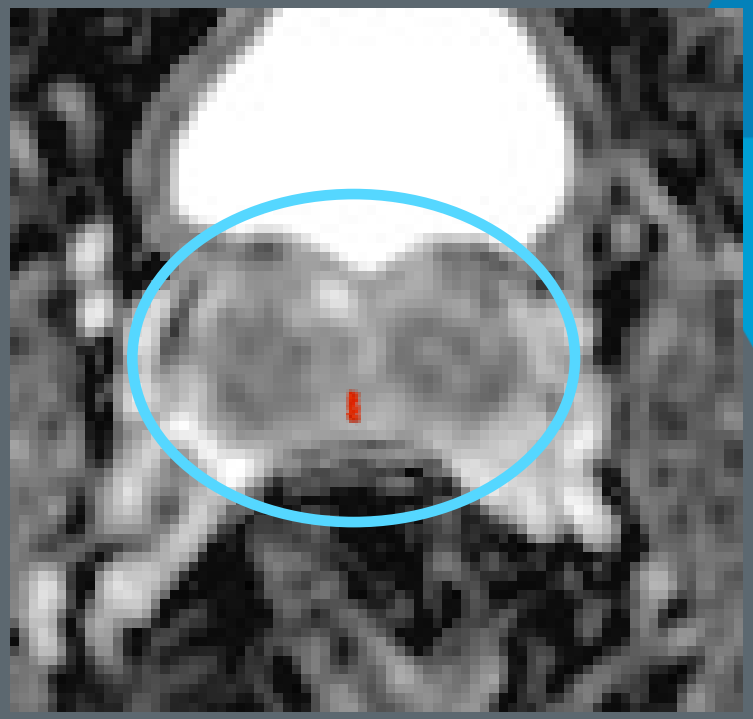
CRITICAL DWI VARIABLES



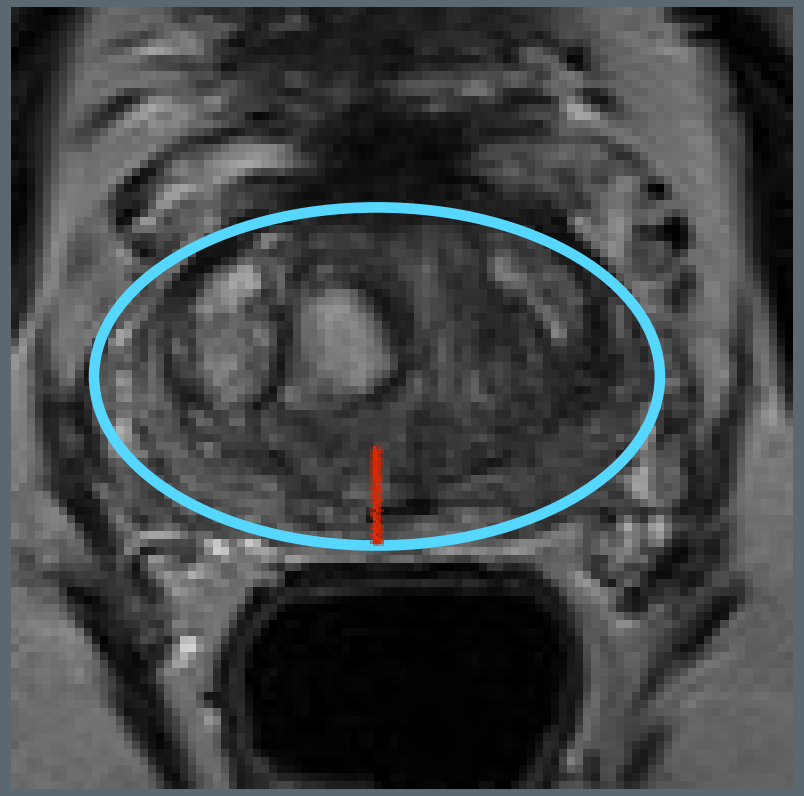
CRITICAL DWI VARIABLES

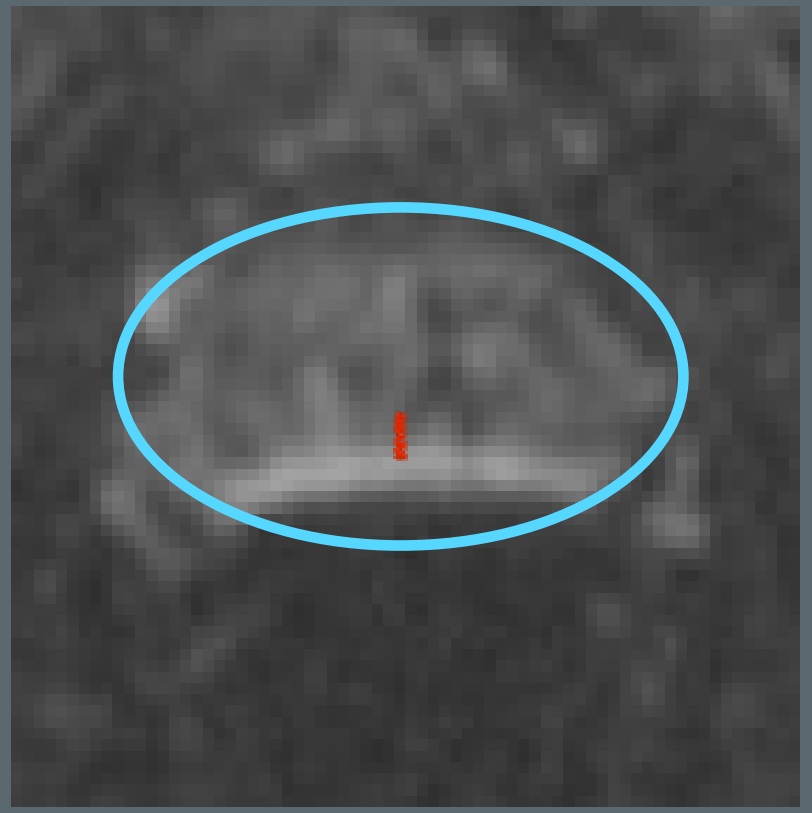


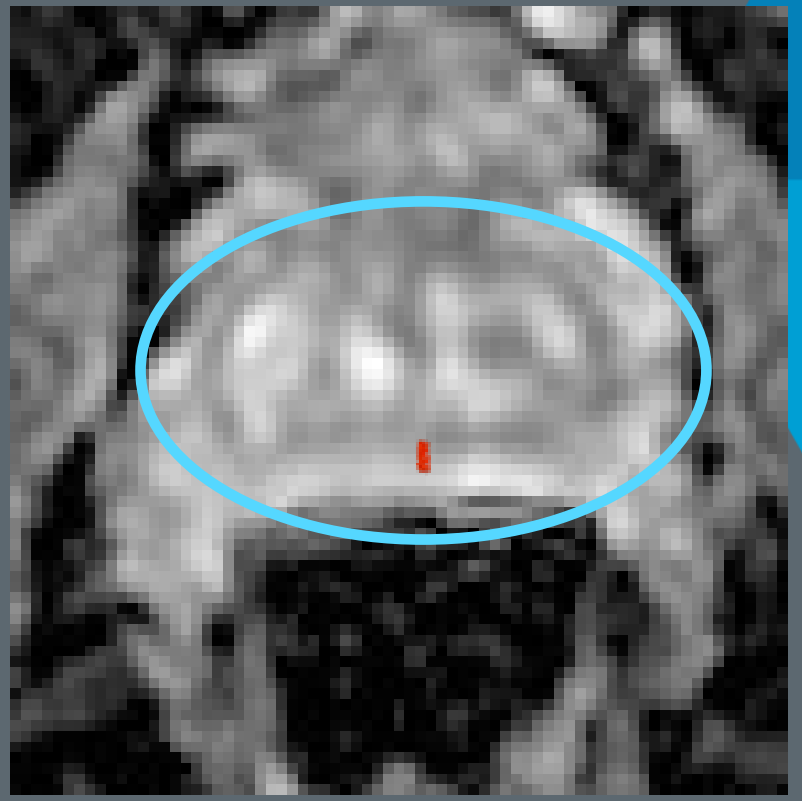




CRITICAL DWI VARIABLES







CRITICAL DWI VARIABLES

RGH Solution:

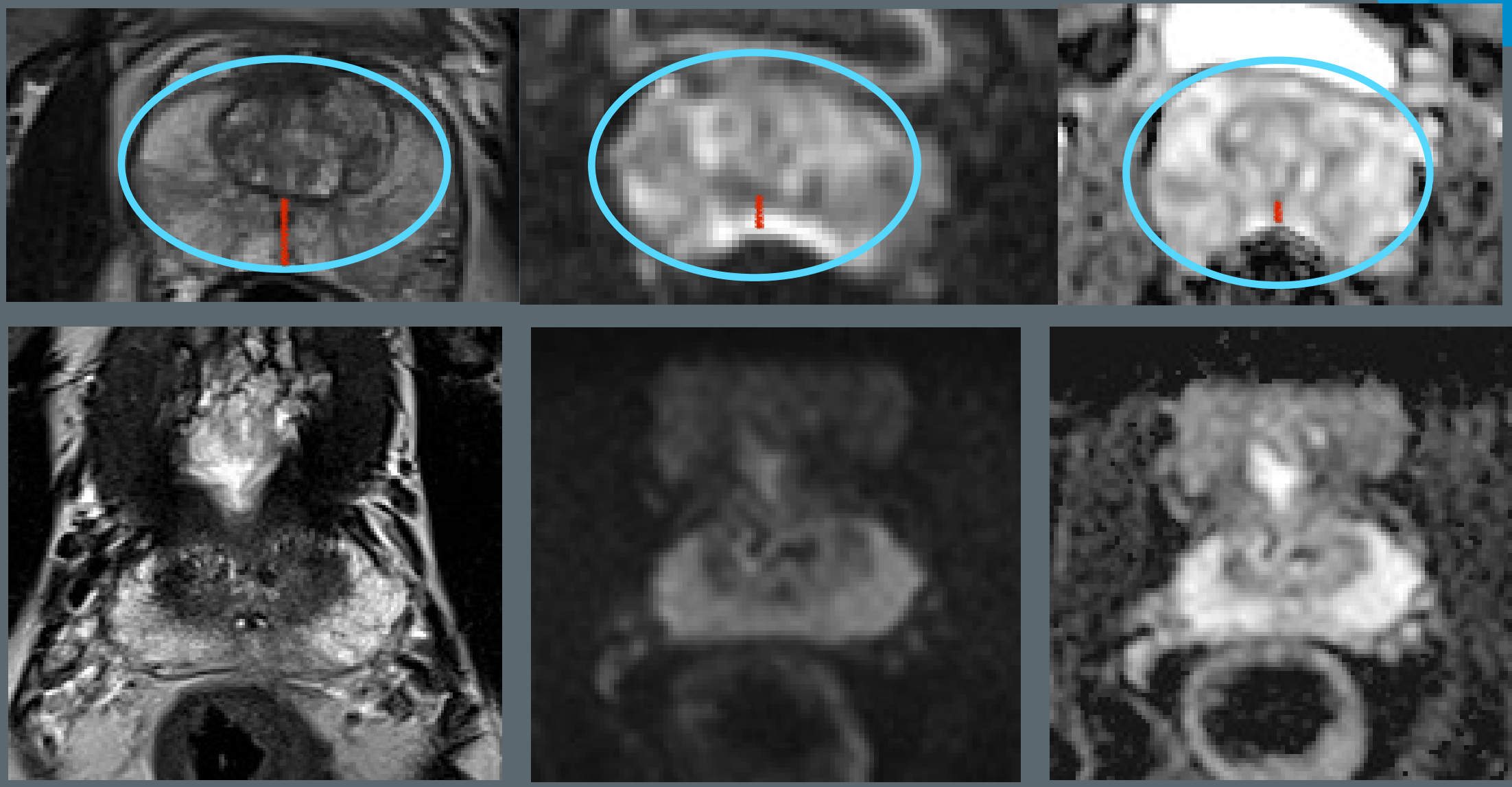
DWI imaging quality considered at all steps: system selection, system specs (gradients), hardware selection (including coils), and sequence design/optimization

Gas related susceptibility artifact resolved

SNR increased

Spatial resolution increased

DWI



DWI

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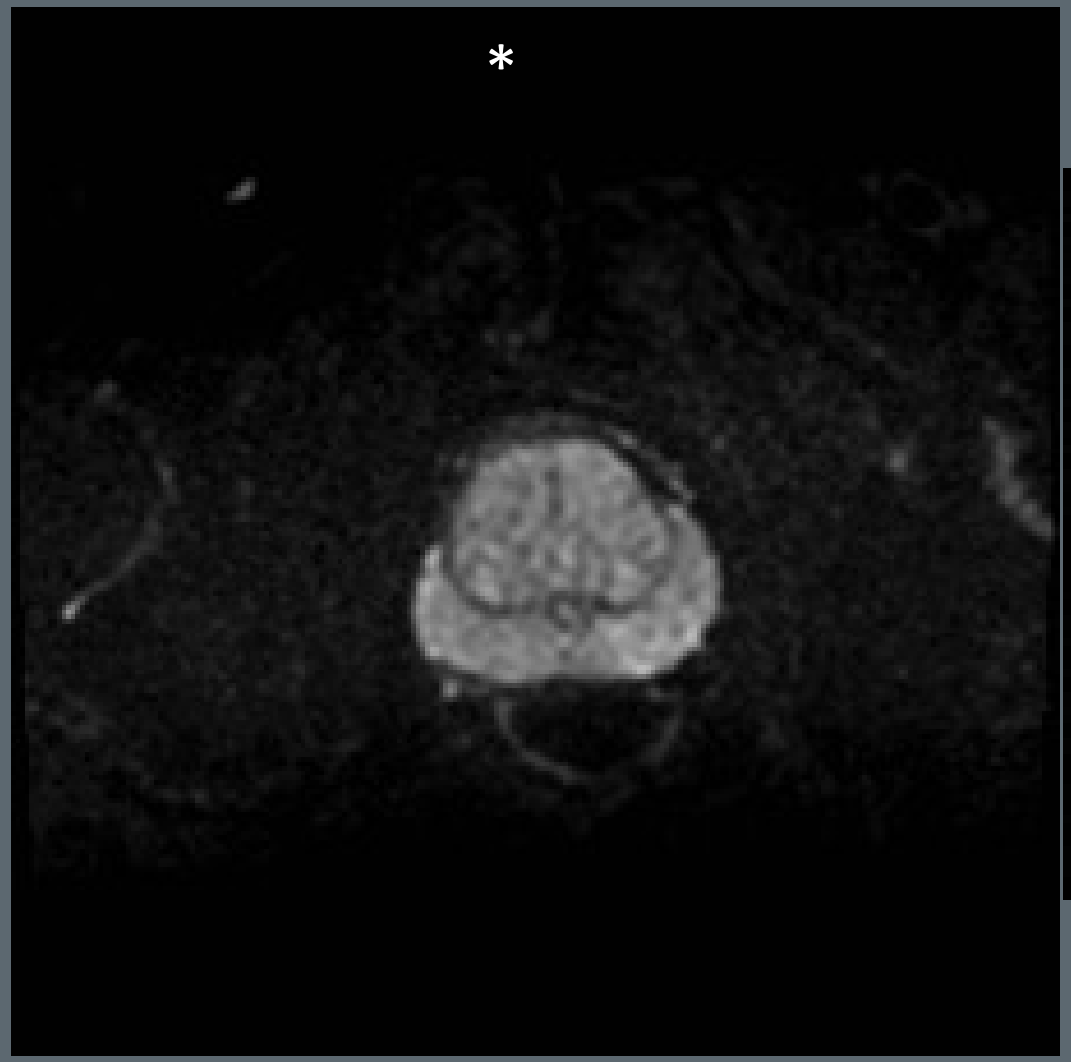
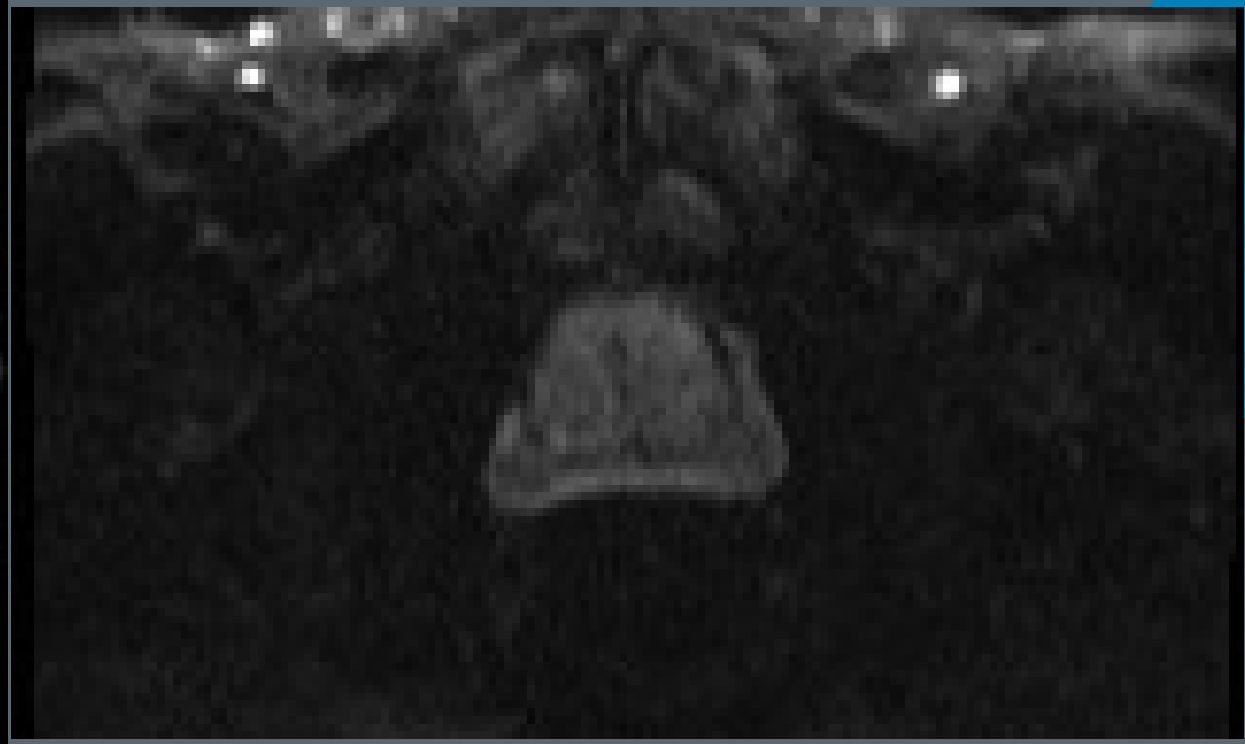


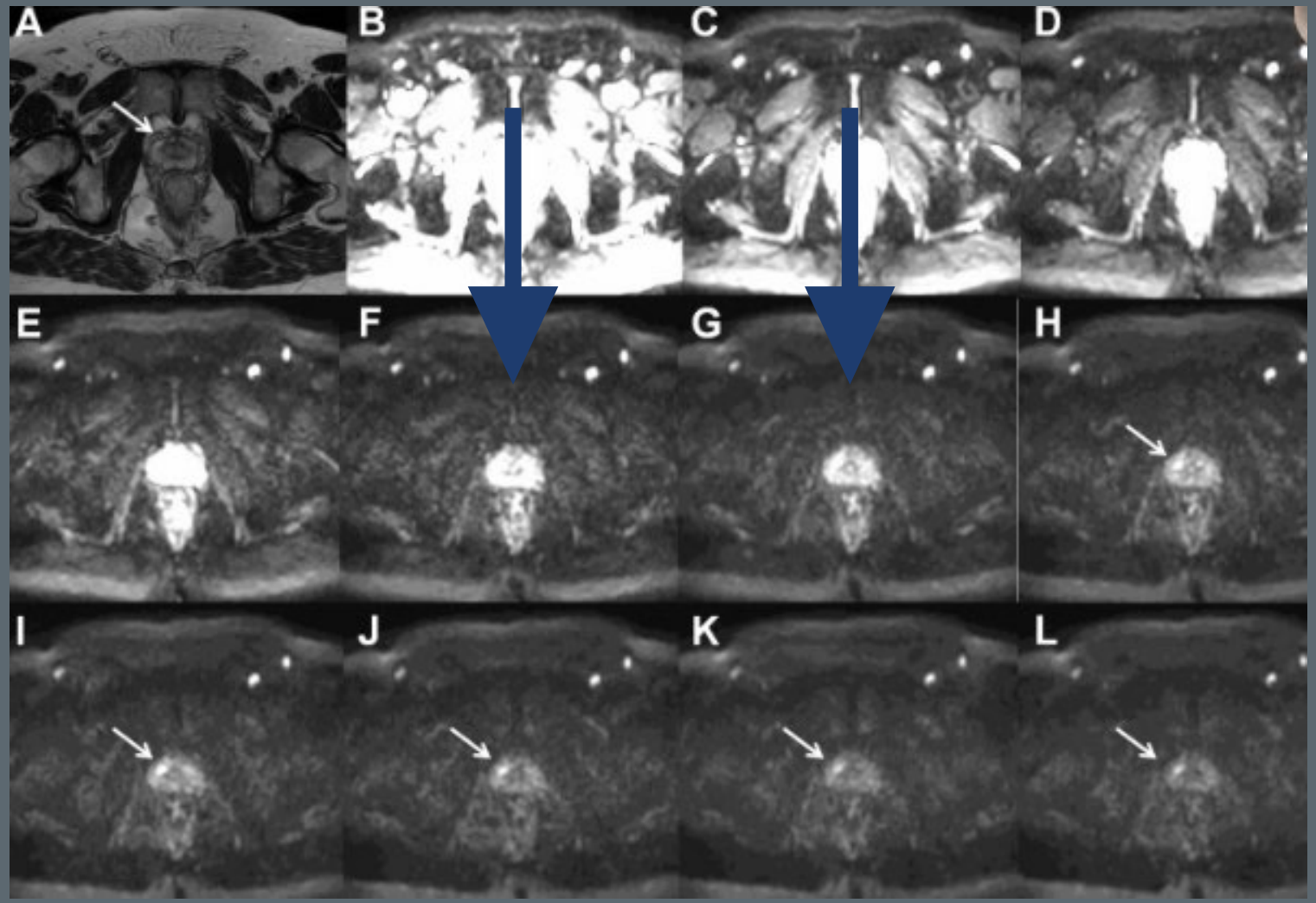


DWI

Issue of b-value: how high should we go?

At present a hotly debated topic, with some mixed evidence in part due to variation in hardware specs, sequence differences (calculated vs. natively acquired, readout type, SNR and NEX, etc, etc)

DWI



Issue of b-value: how high should we go?

Currently b=1400 (minimum permissible)

DWI

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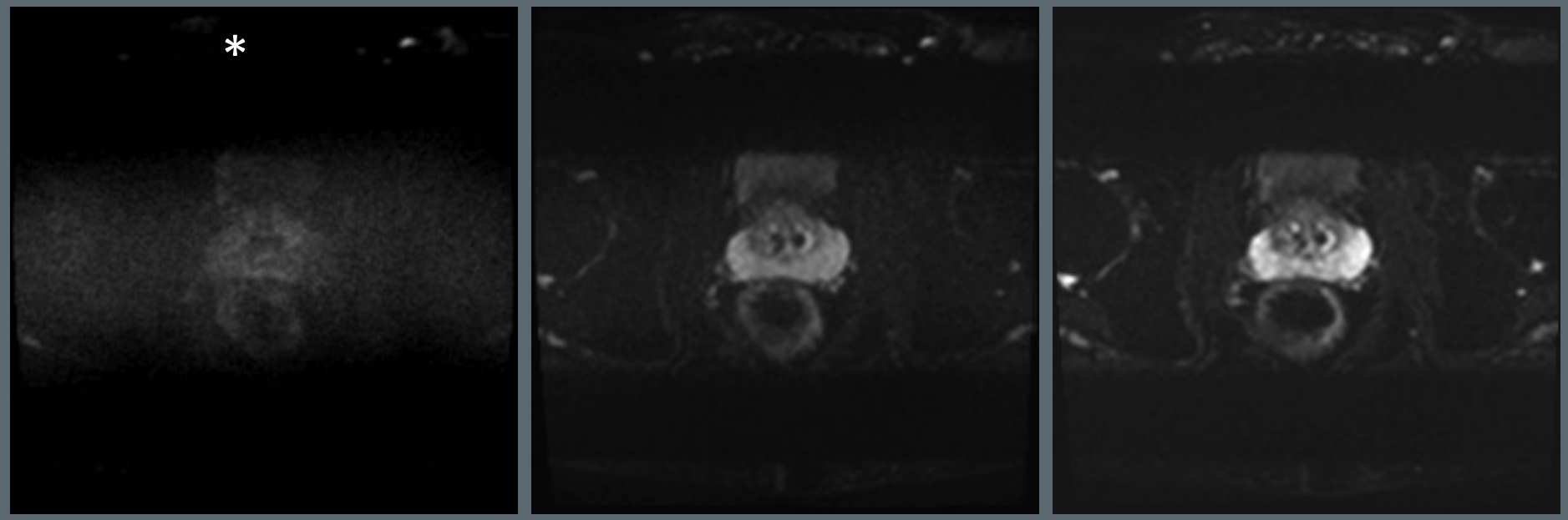

new b=2000

DWI

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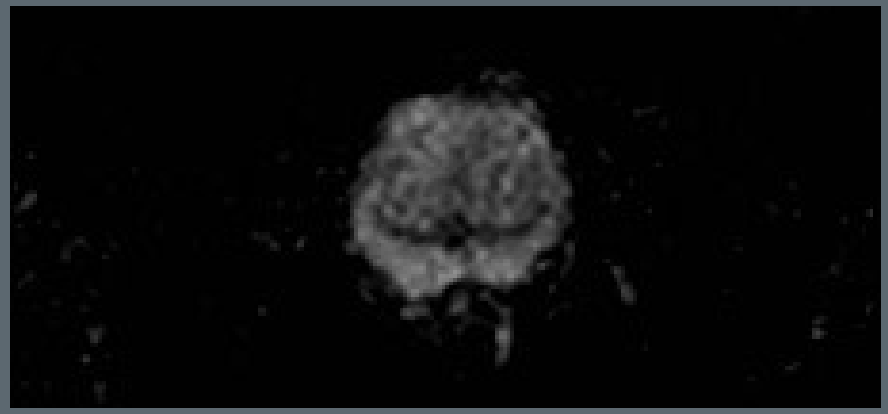
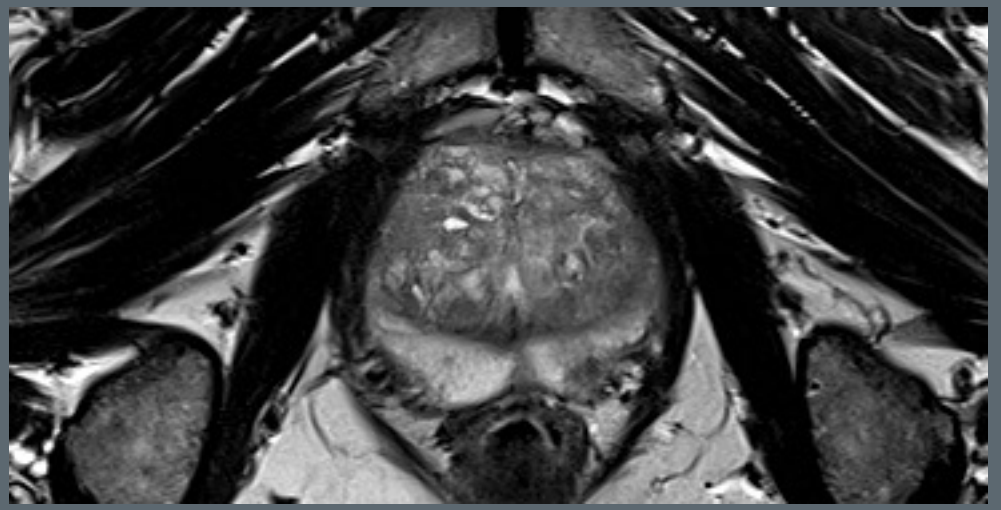


new b=2000

calculated b=1400 default windowing



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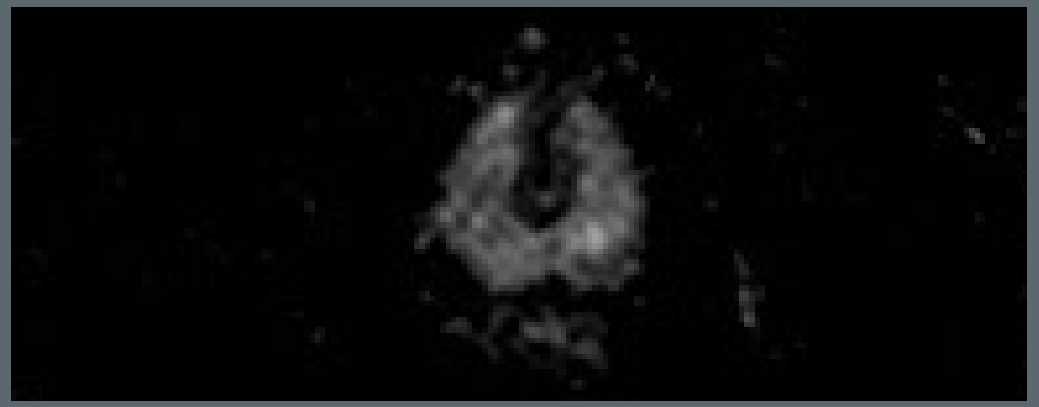

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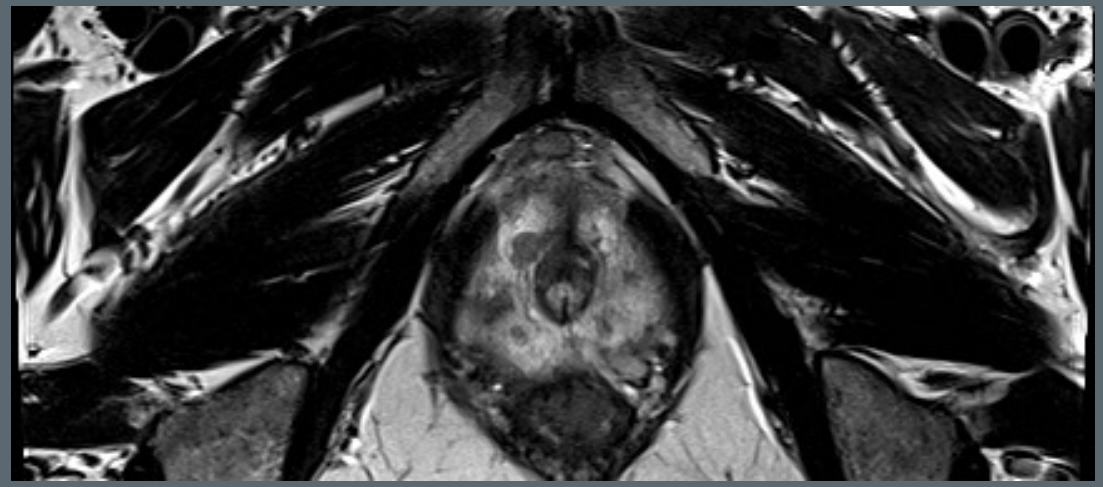


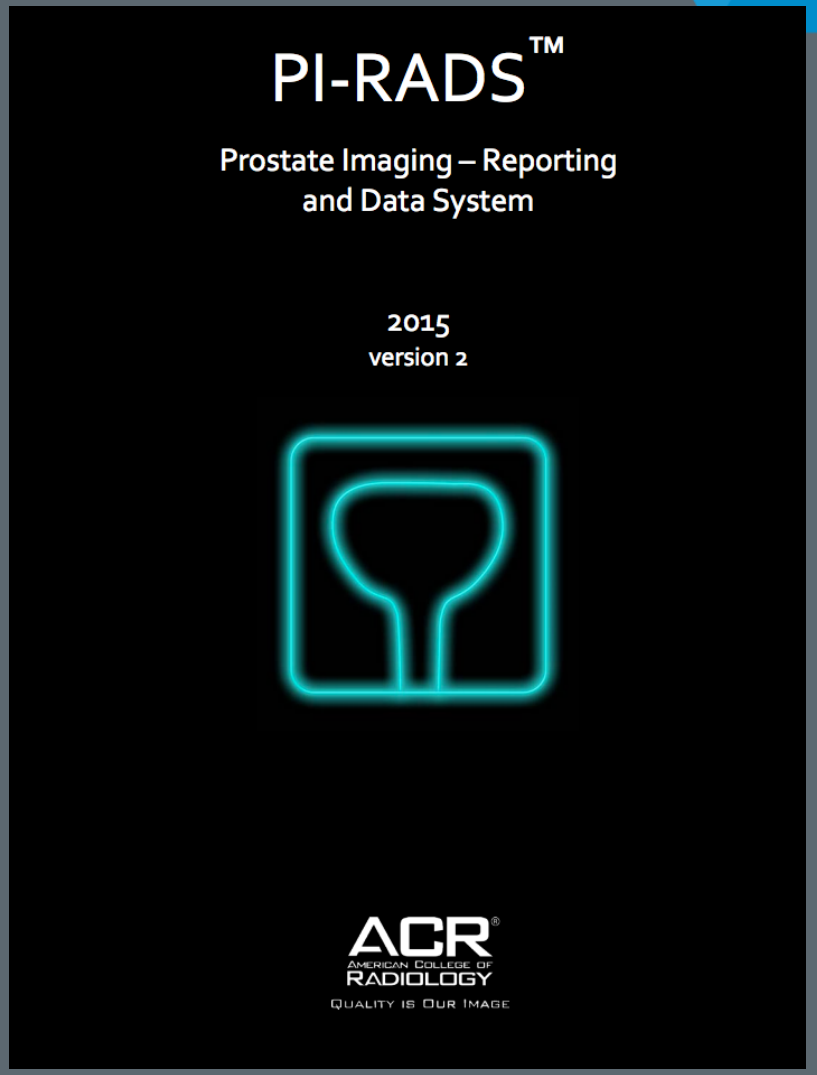
DYNAMIC CONTRAST ENHANCEMENT

Role limited to moving a particular subset of PI-RADS 3 to 4.

Either positive or negative

Criteria for positivity: "enhancement focal, and; earlier than or contemporaneously with enhancement of adjacent normal prostatic tissues, and; corresponds to suspicious finding on T2W and/or DWI"

Core requirement: "Temporal resolution: ≤10sec (<7sec is preferred)"



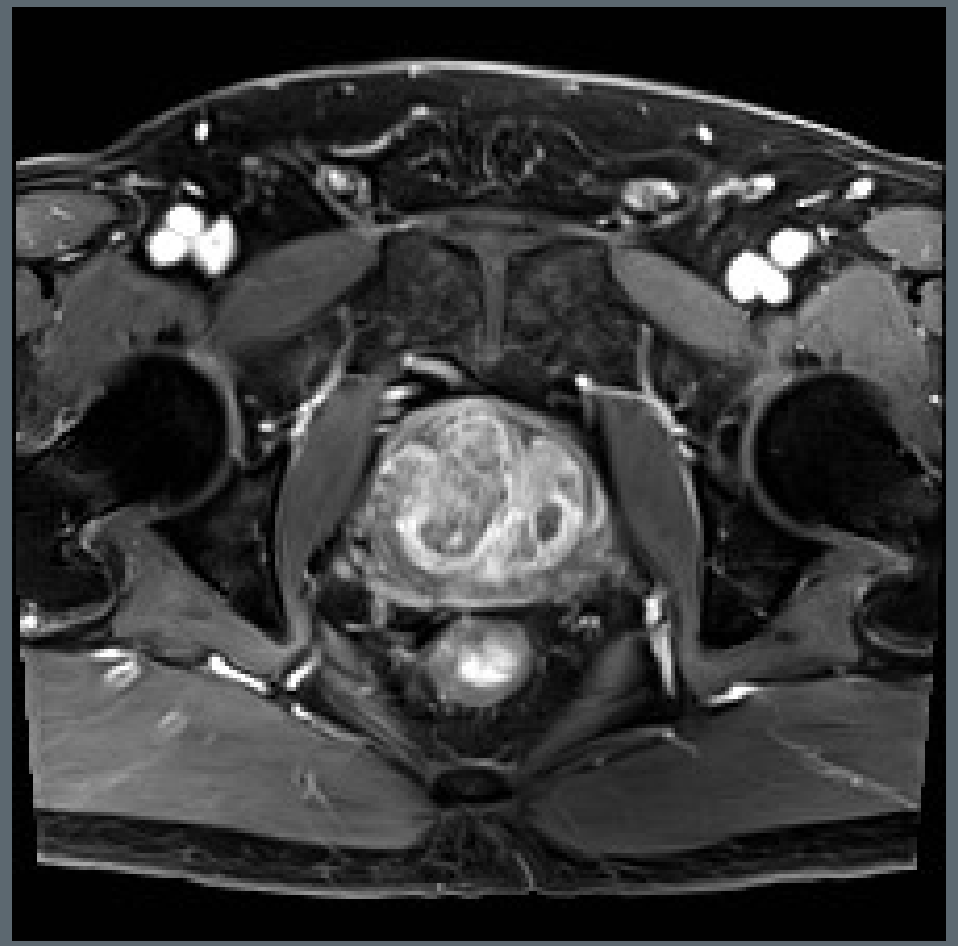
RGH DCE

Brand new sequence "GRASP-VIBE" originally developed to allow free breathing liver MRI

Highly-accelerated volumetric dynamic MRI technique allows previously impossible combinations of temporal resolution, spatial resolution and volumetric coverage

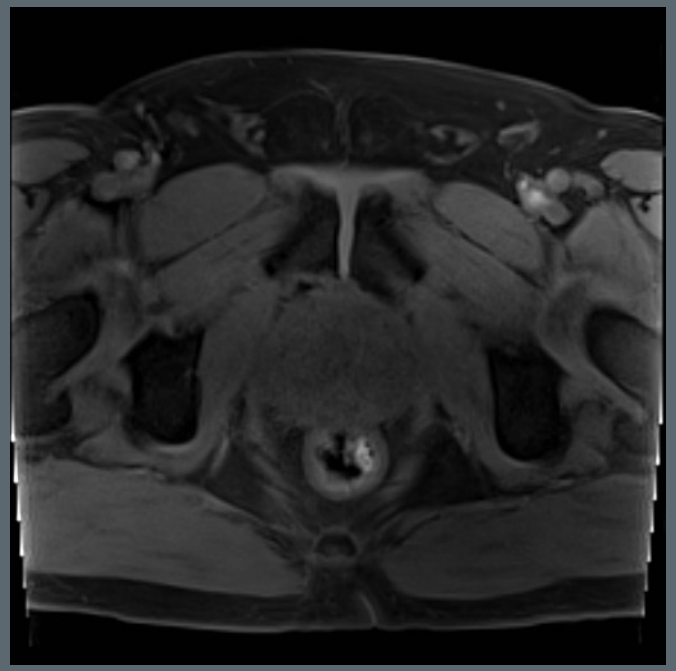
RGH: turned sequence on its head to leverage temporal resolution where motion correction is less important

RGH DCE



RGH DCE

RGH DCE



RGH DCE

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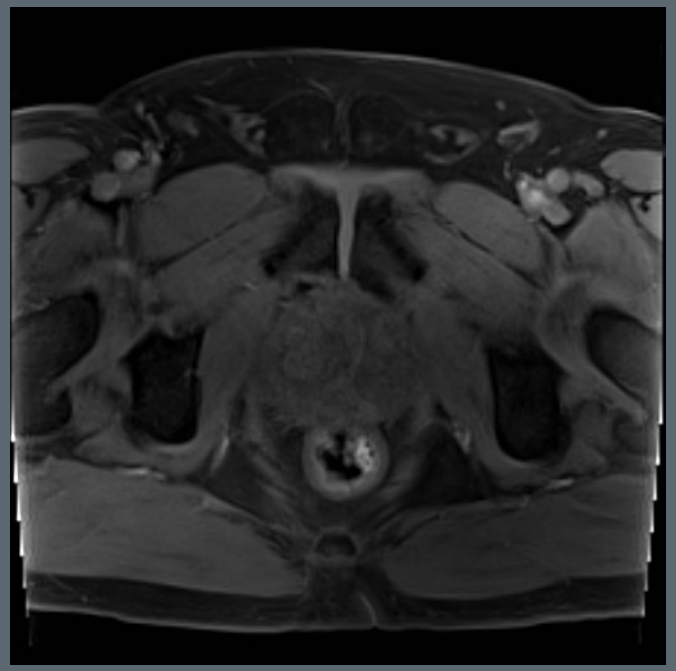

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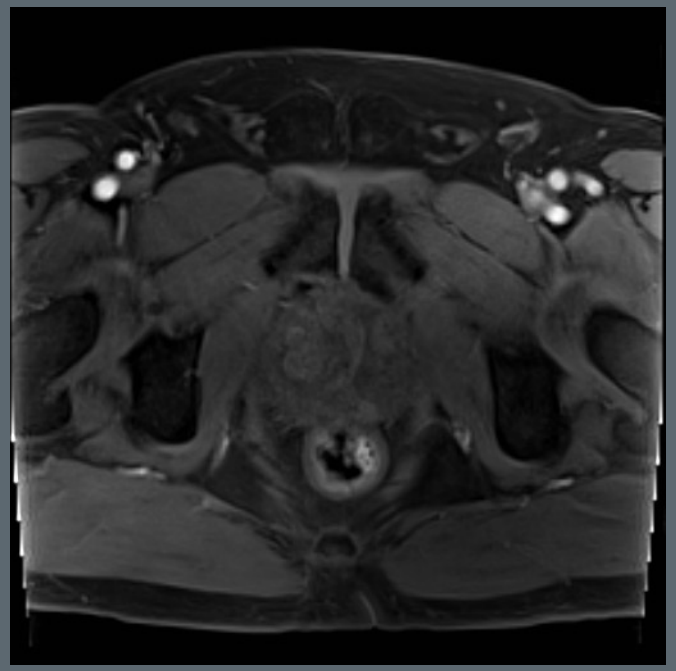

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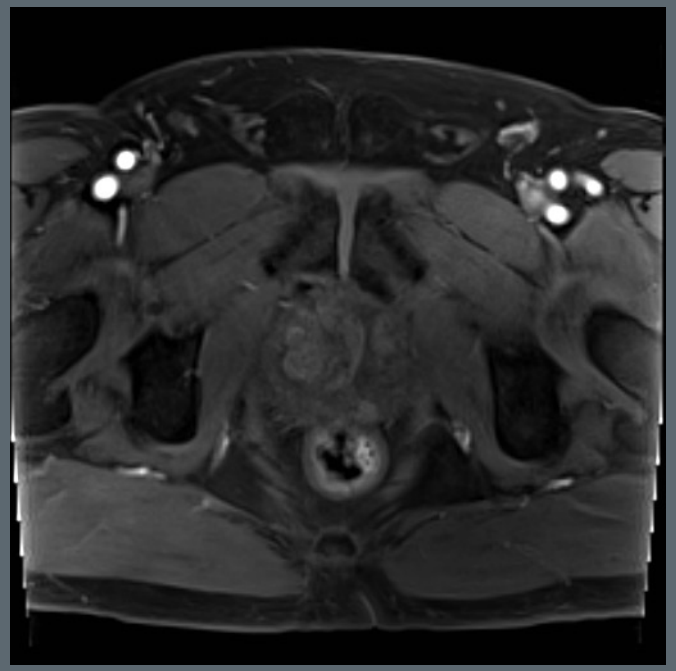

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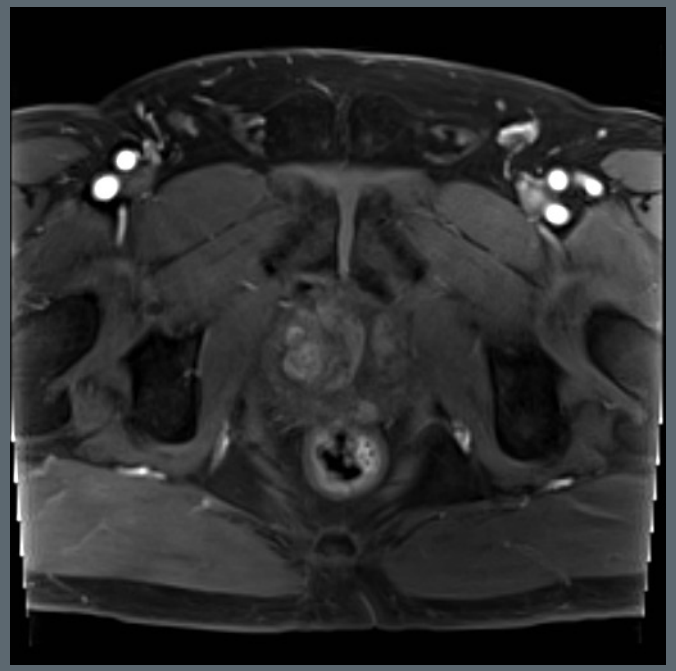

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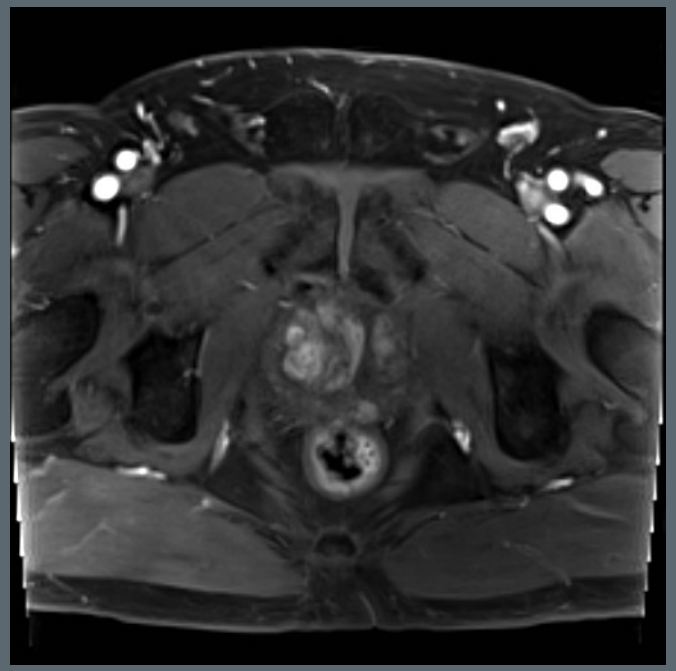

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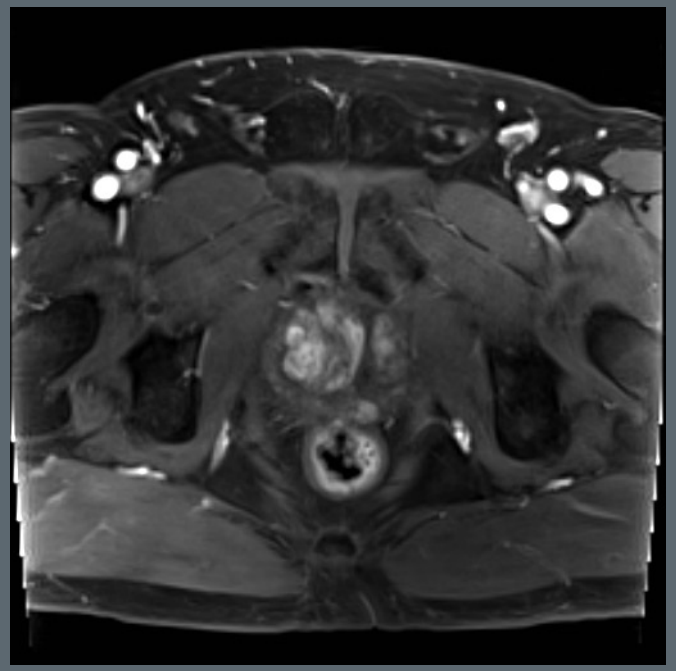

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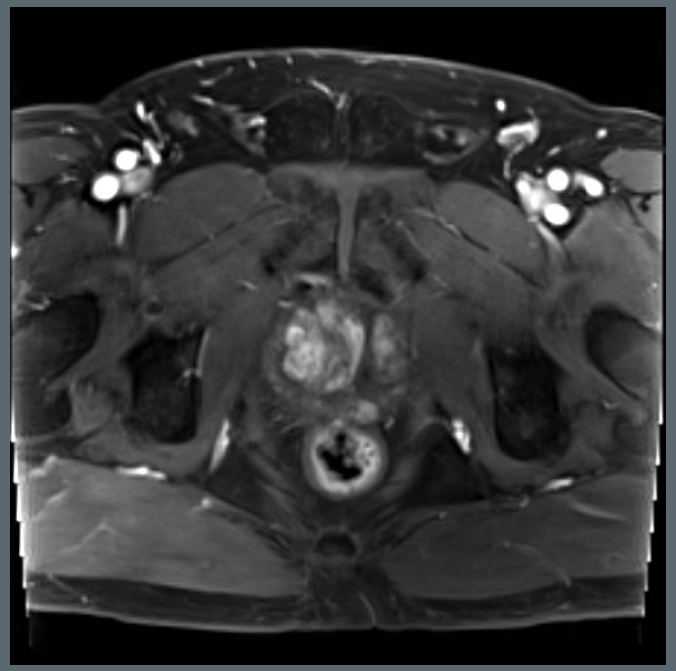

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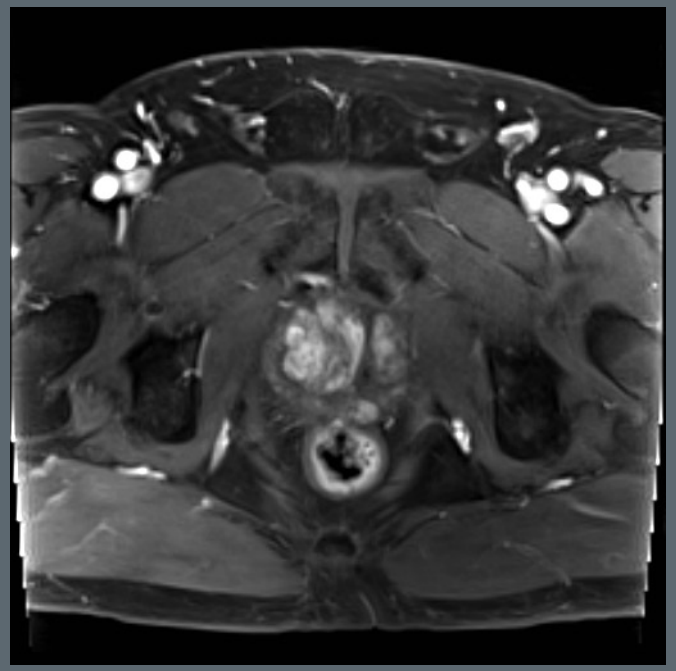

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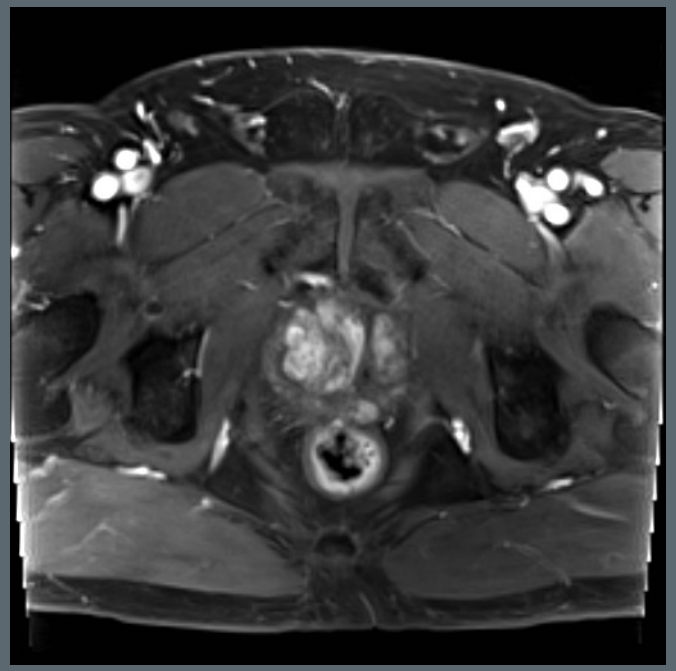

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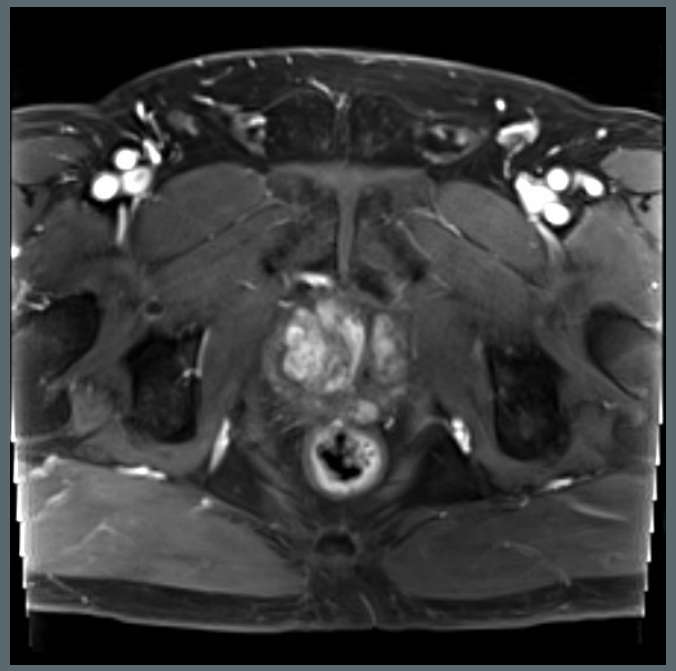

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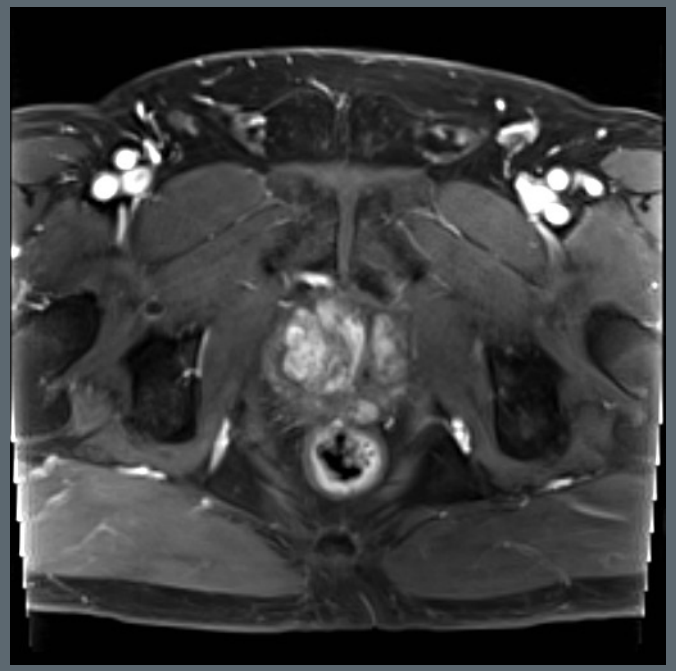

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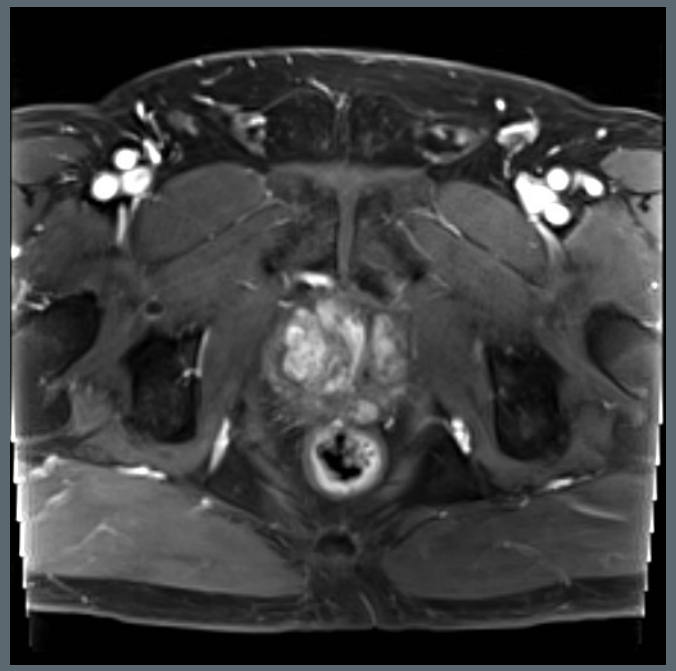

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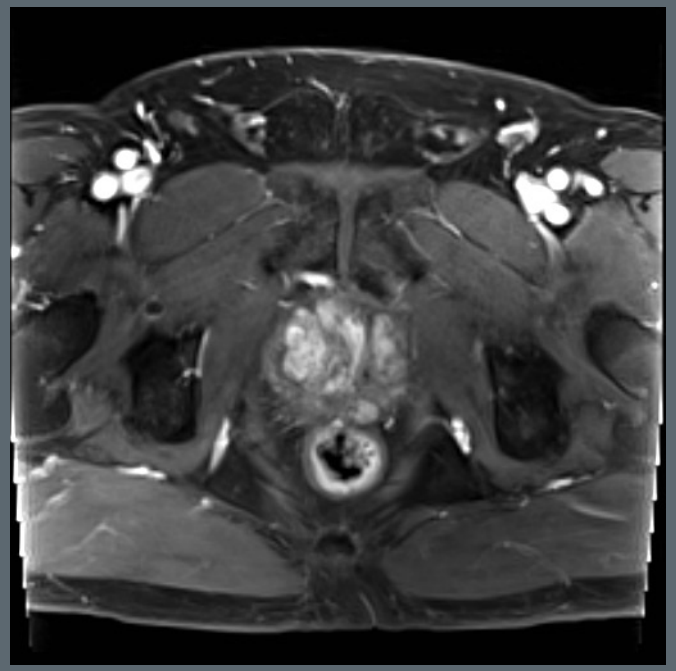

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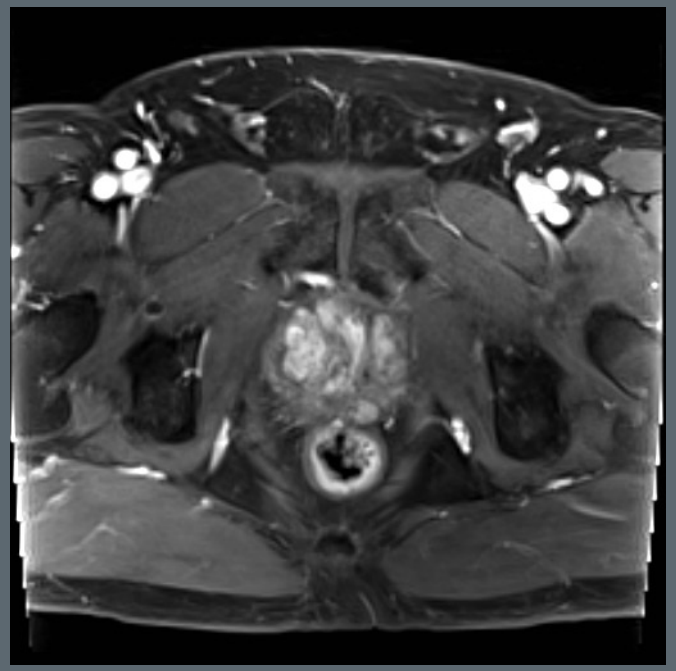

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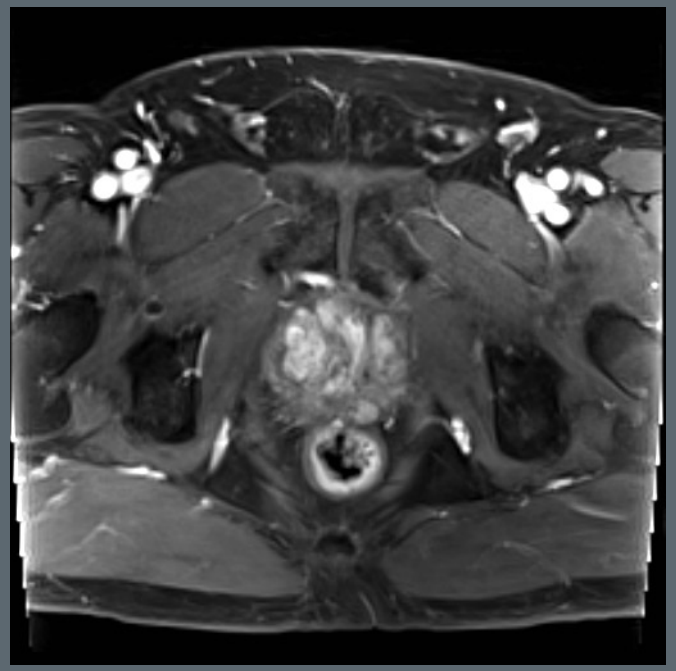

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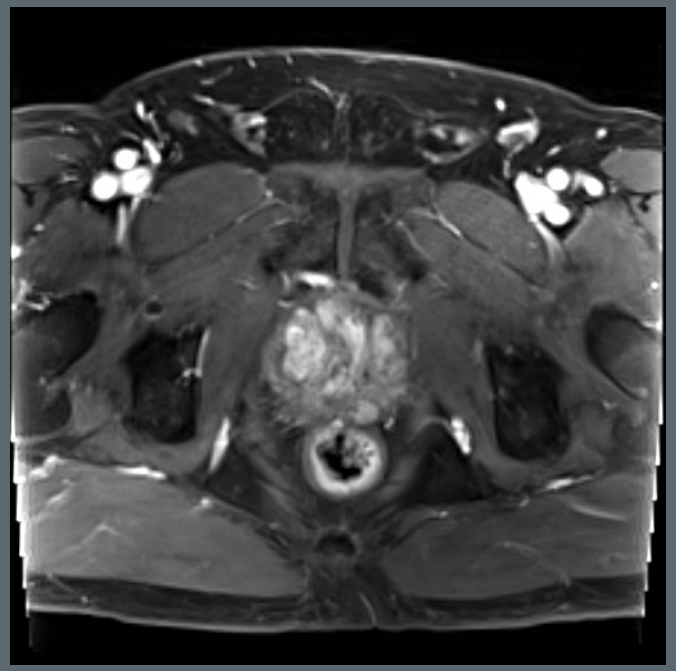

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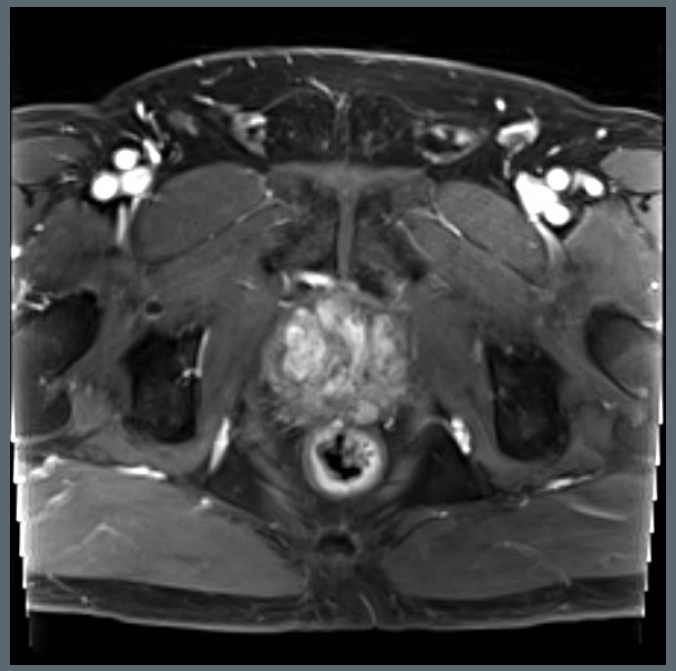

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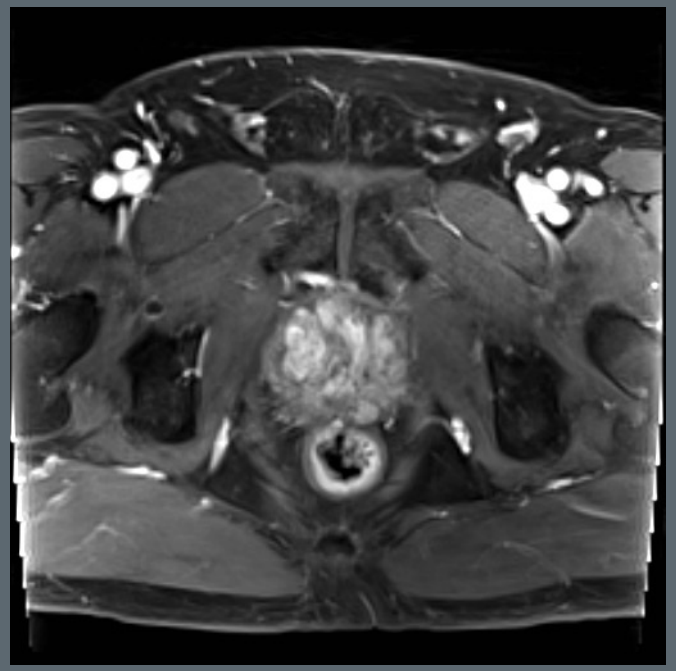

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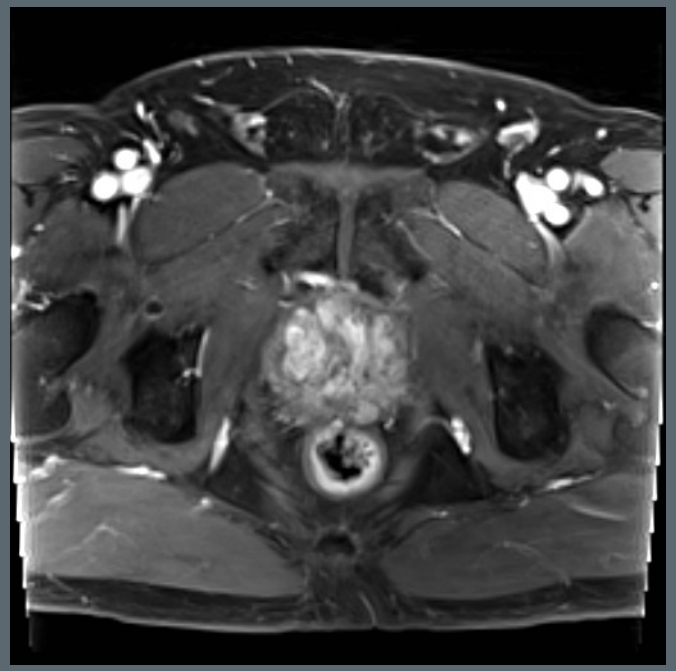

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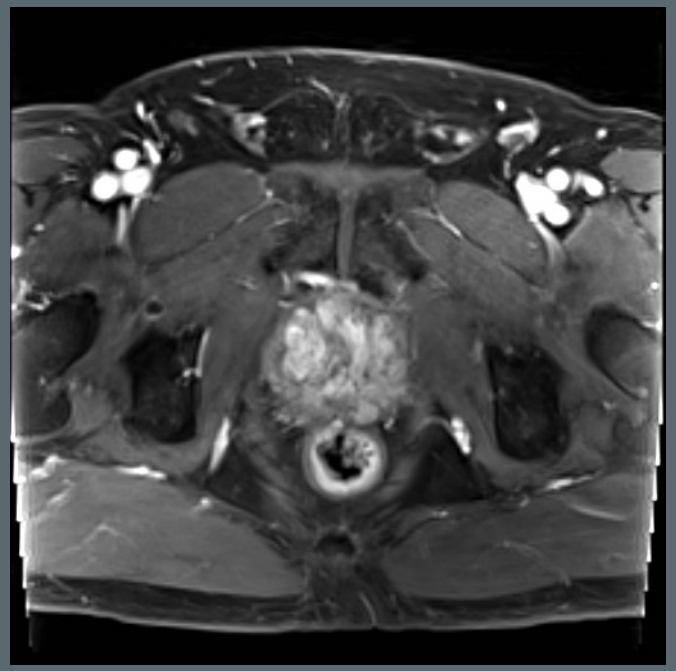

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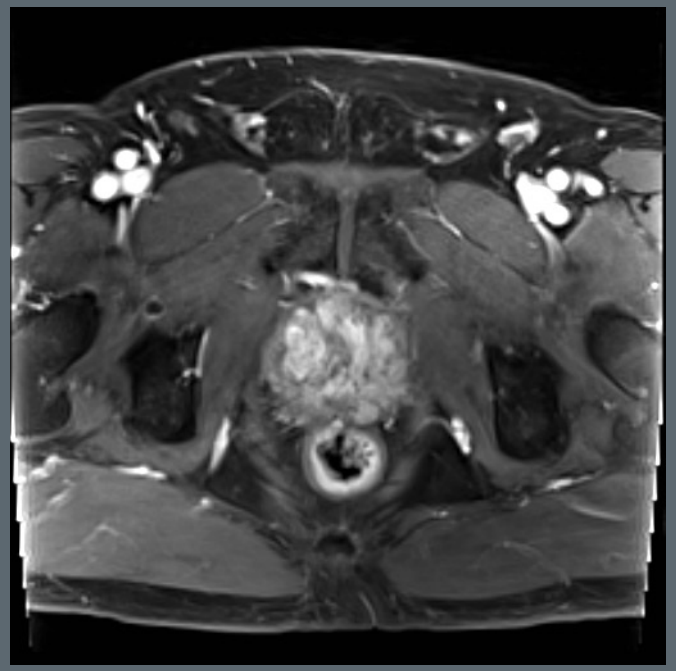

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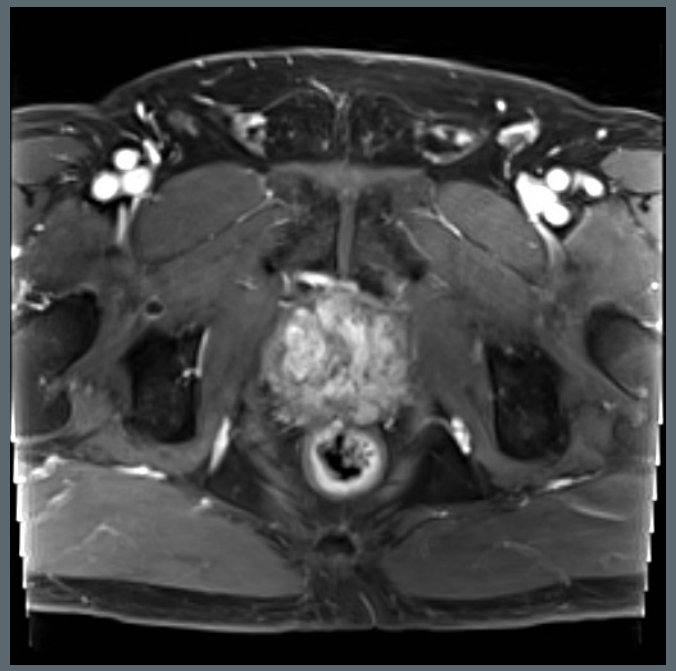

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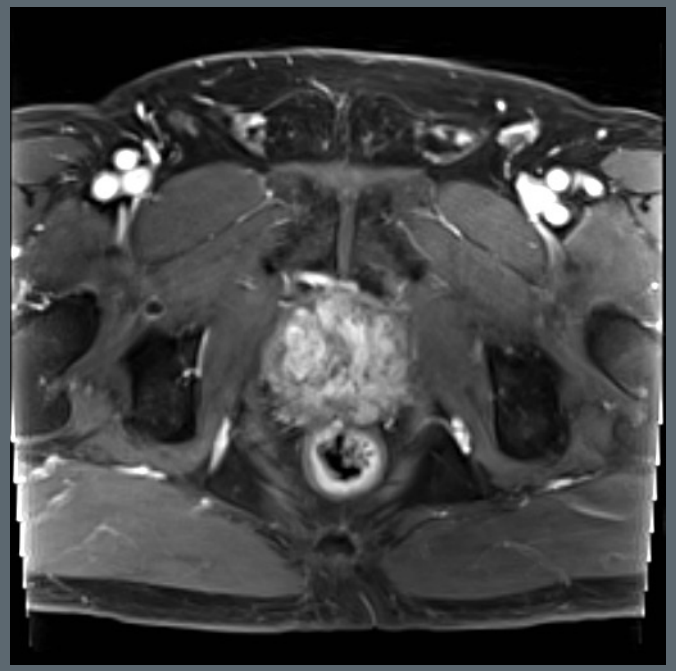

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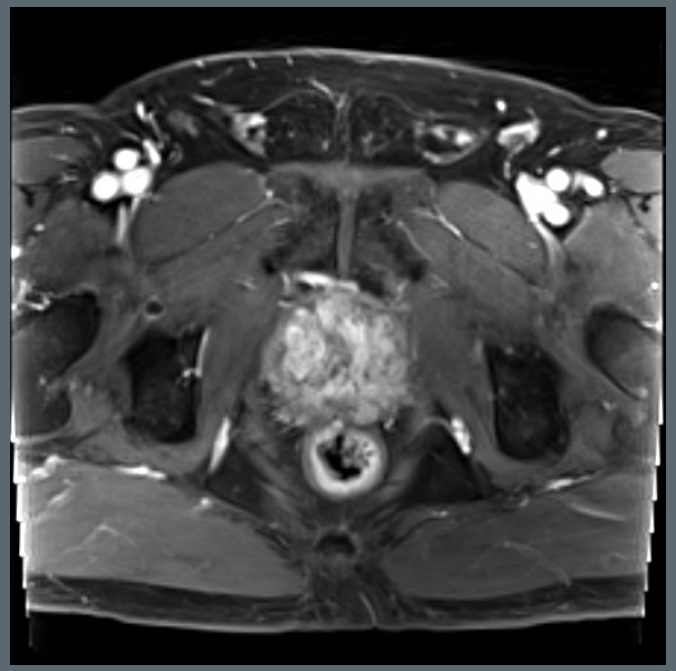

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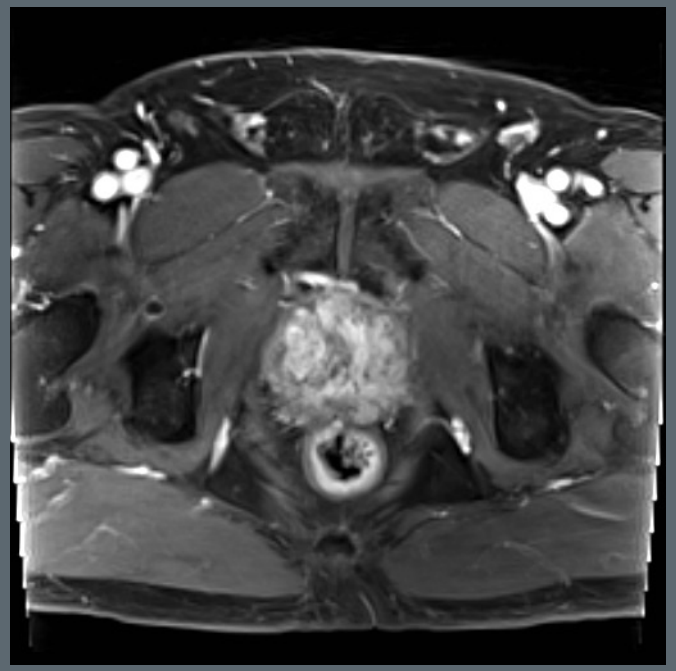

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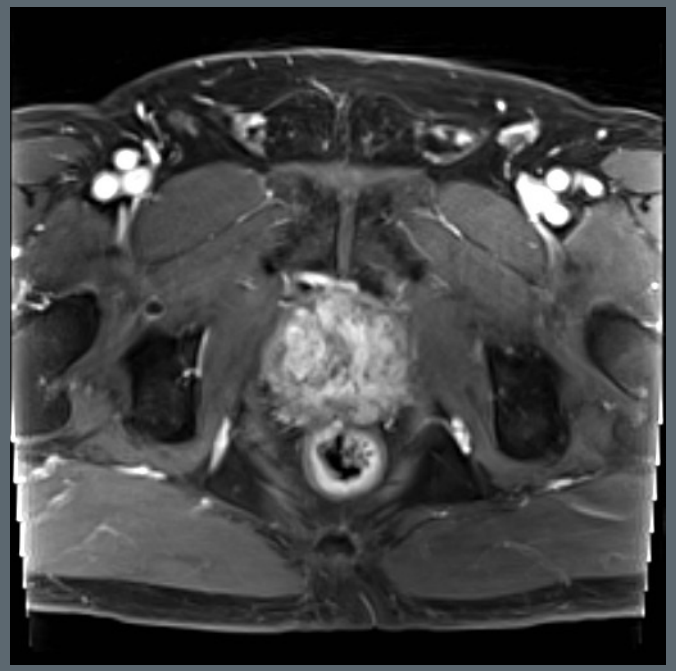

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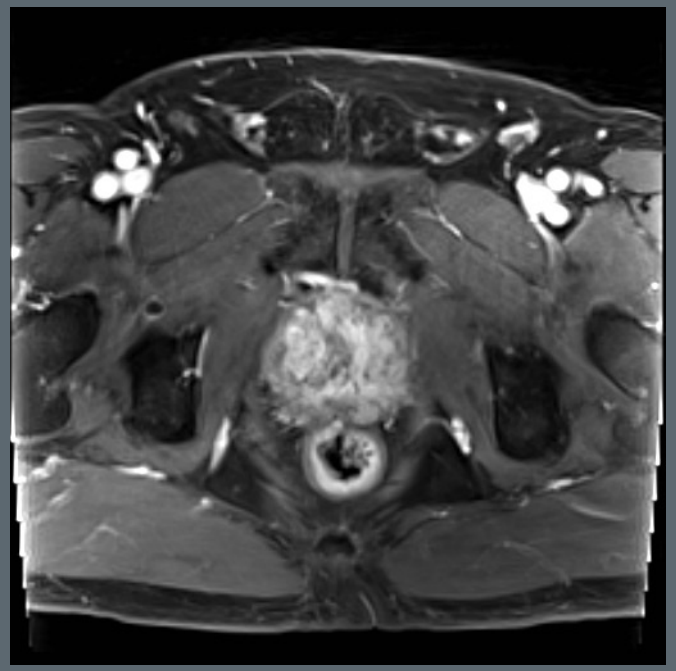

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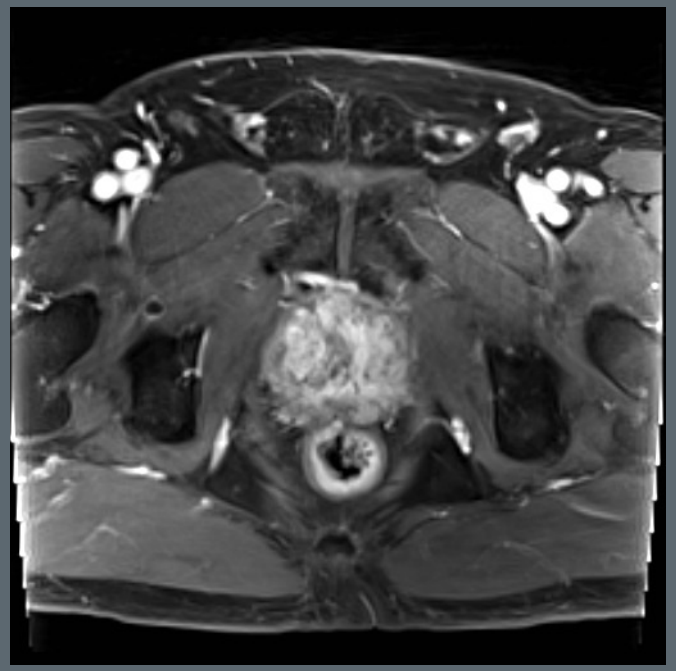

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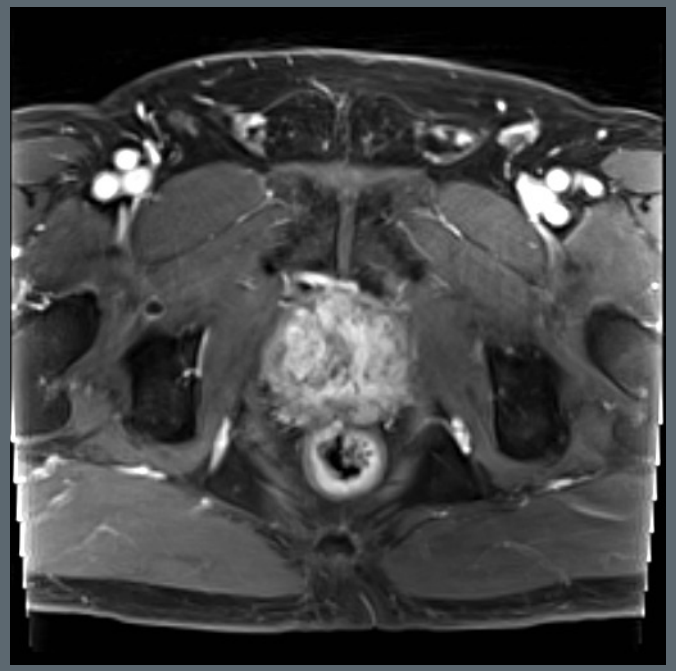

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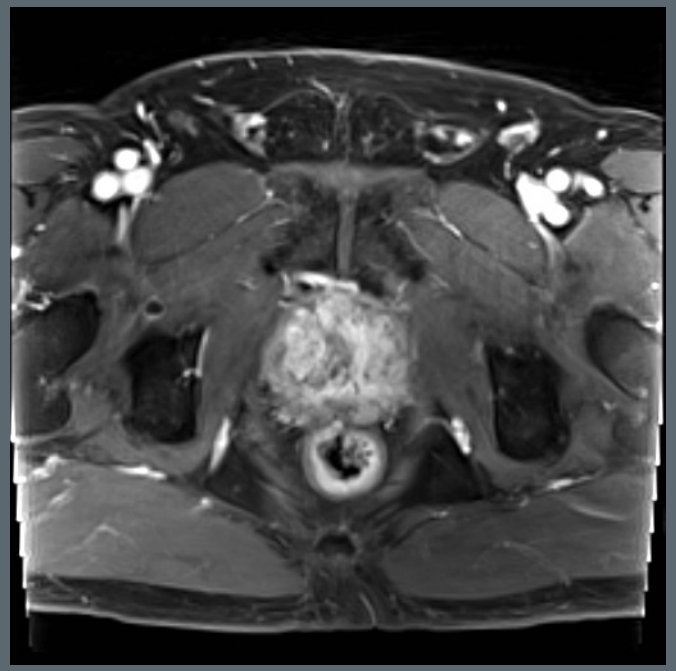

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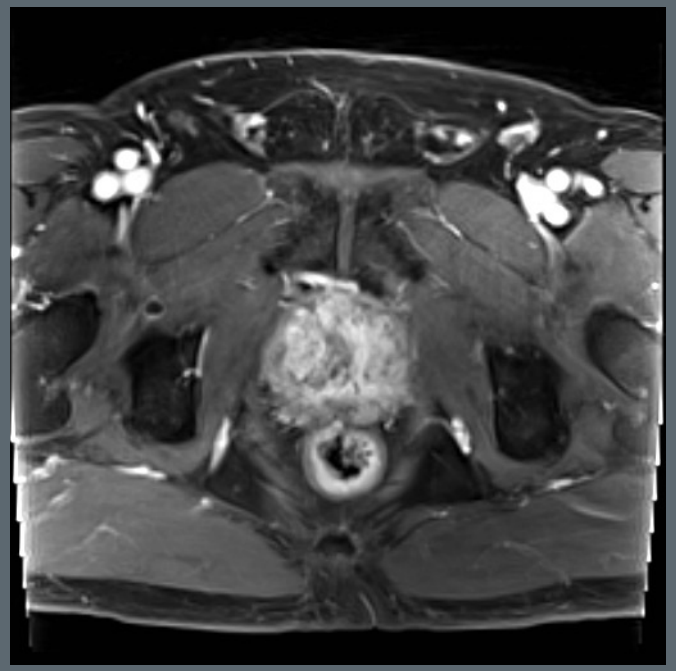

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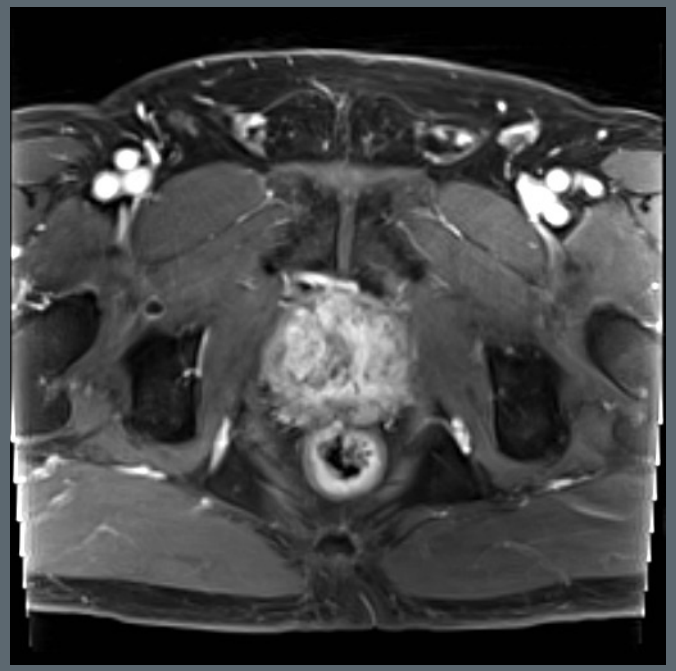

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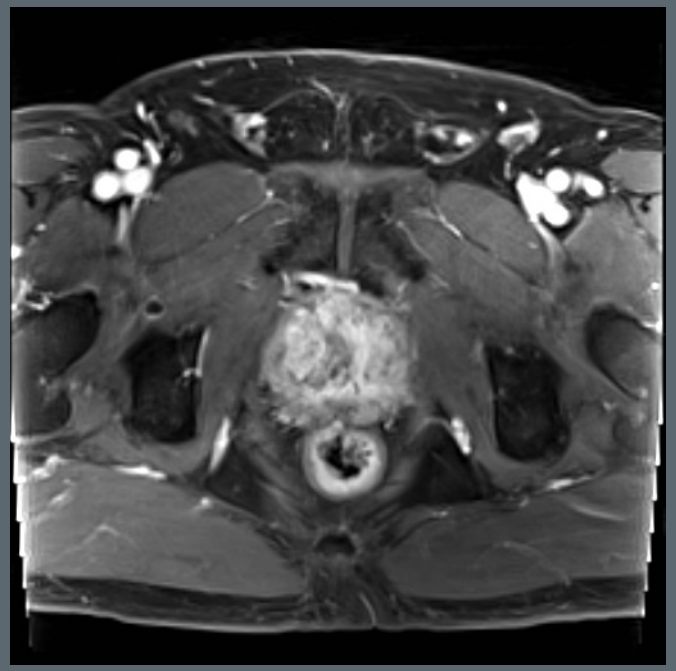

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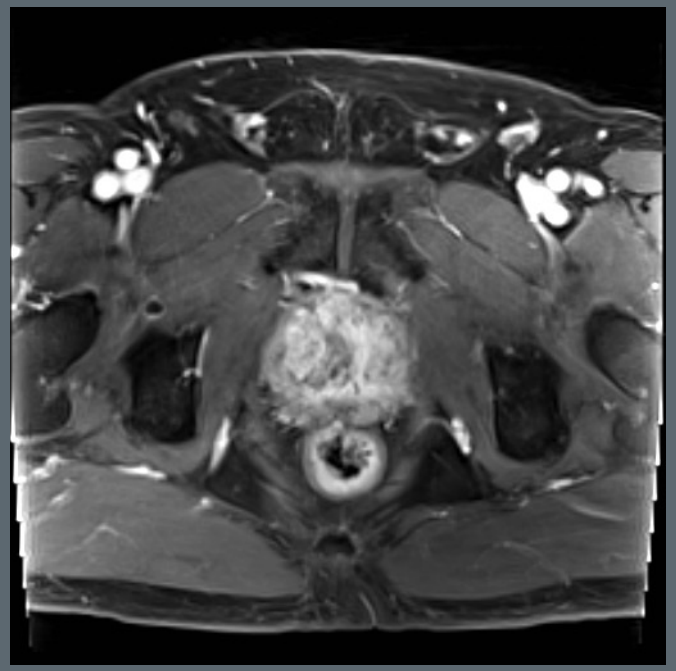

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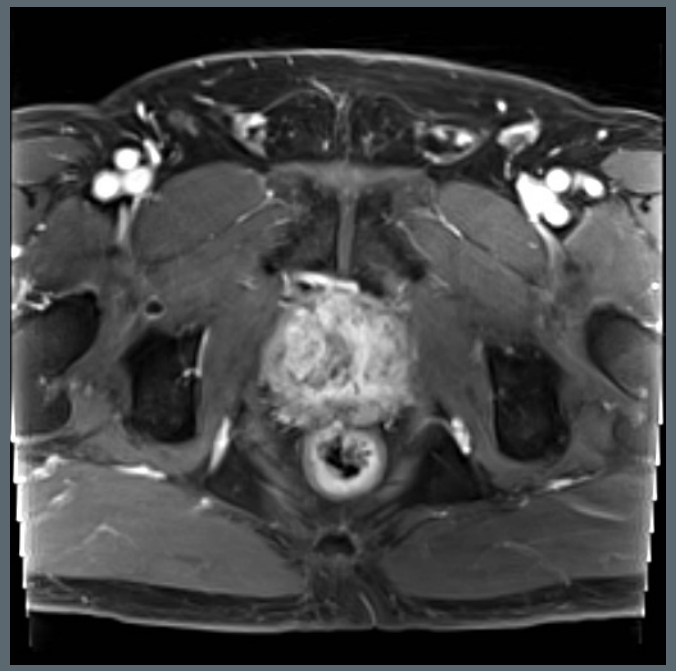
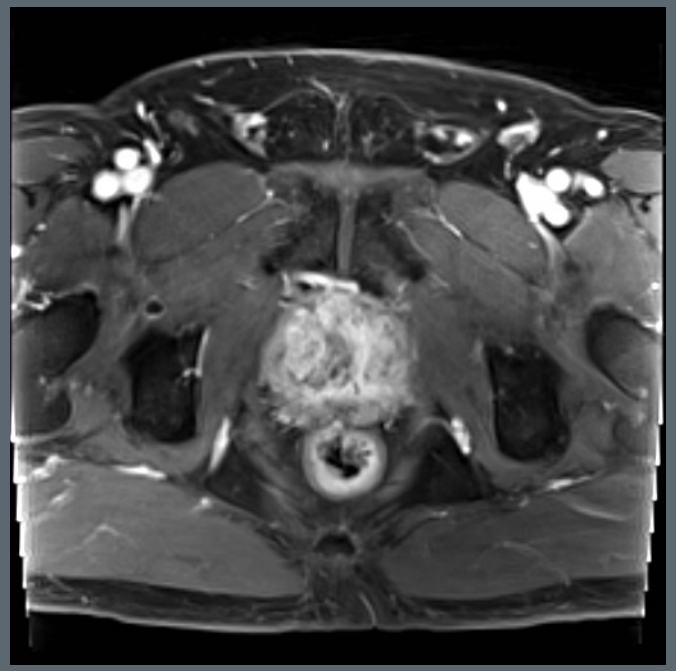


RGH DCE



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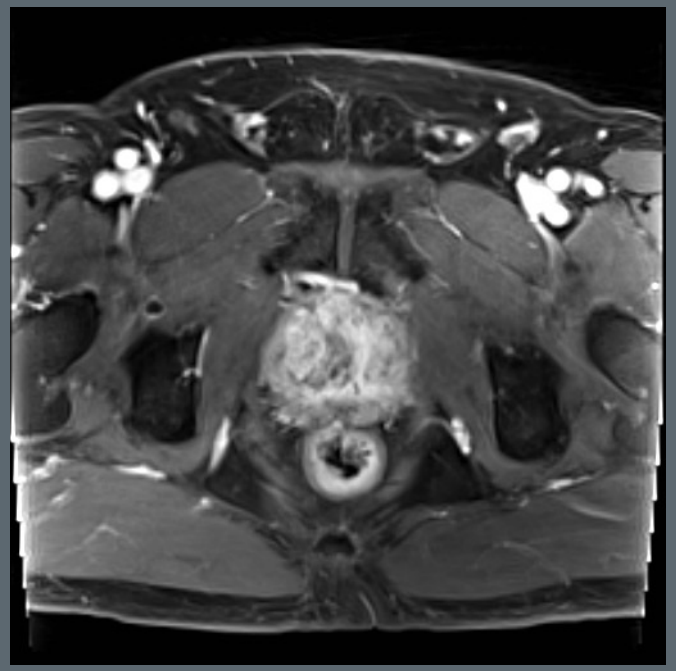

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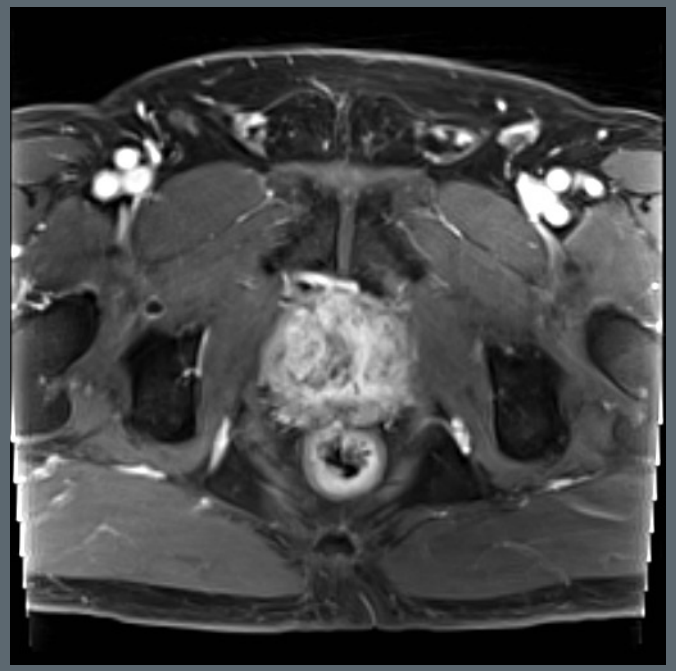

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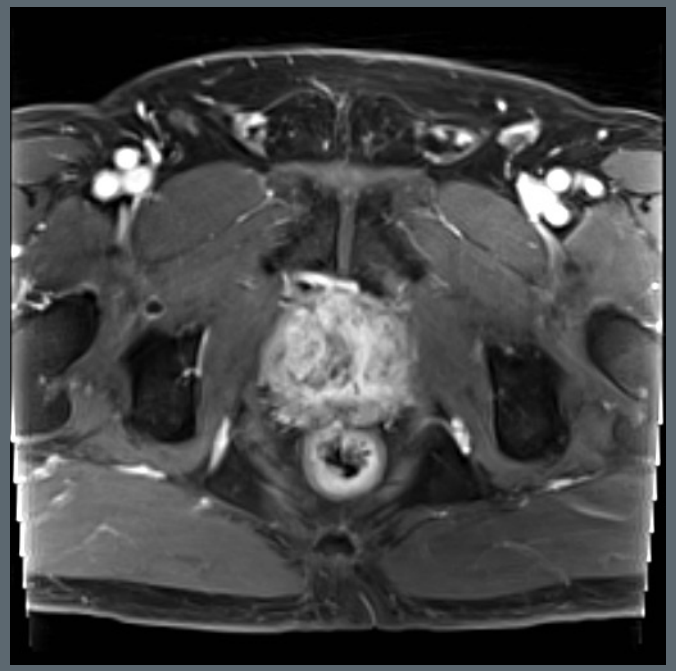

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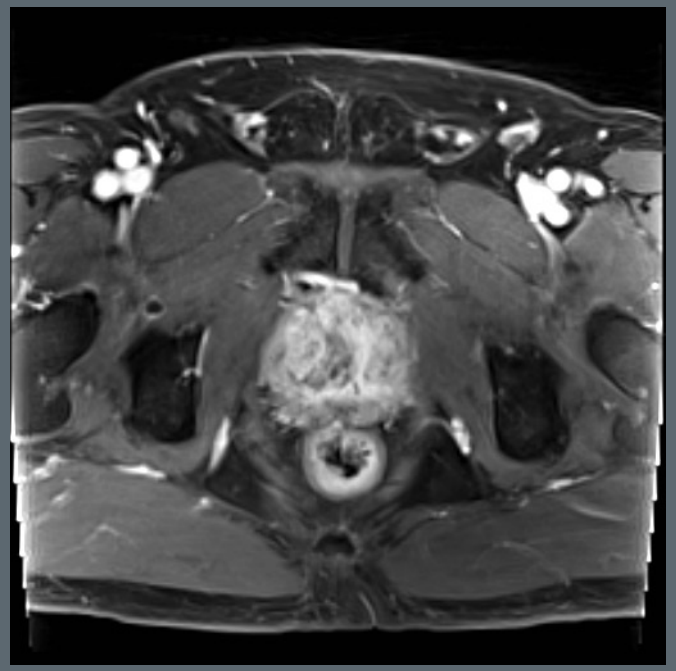

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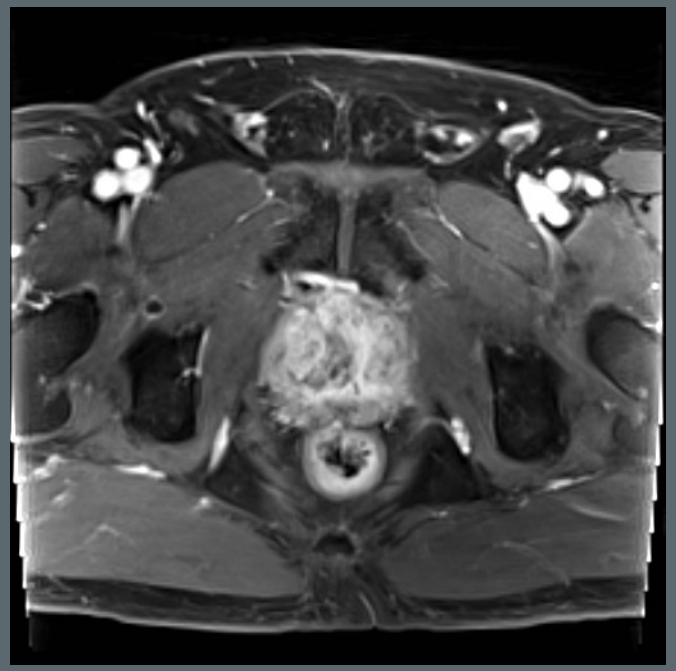

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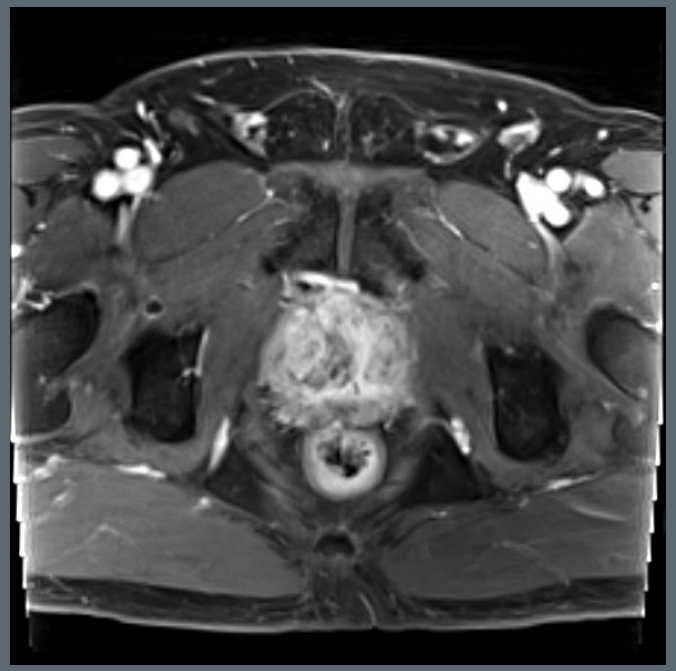

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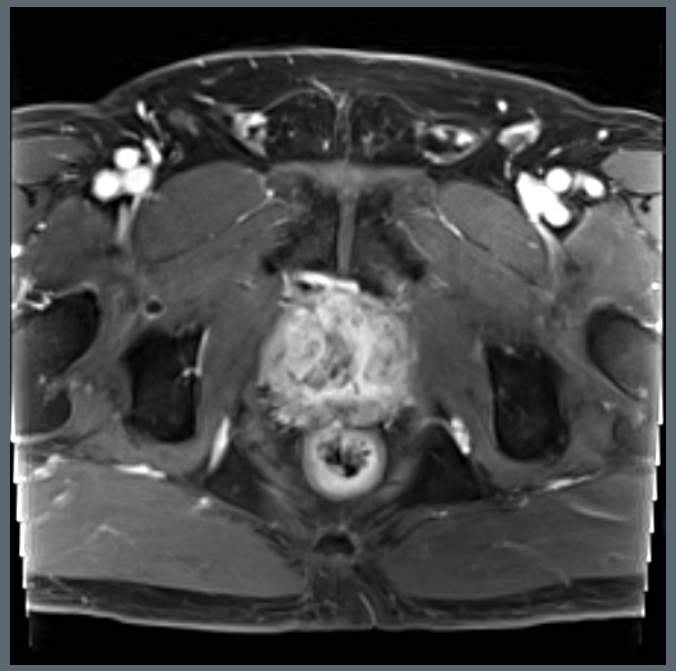

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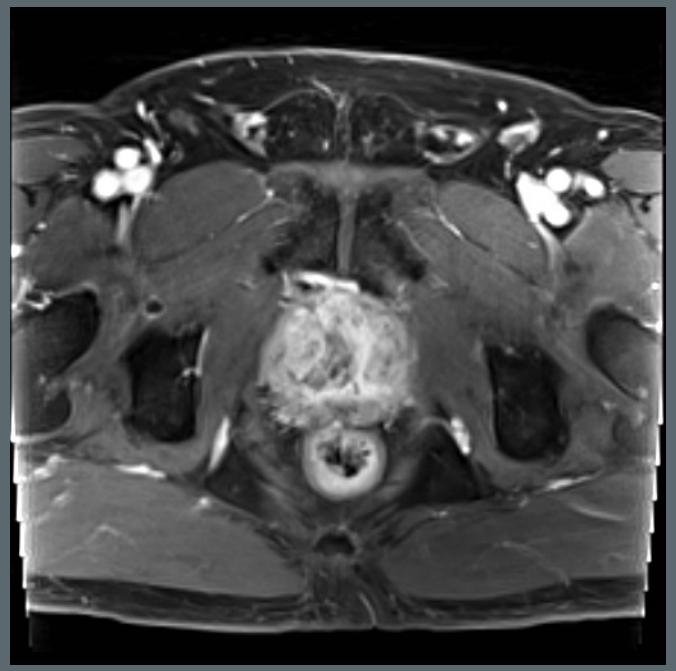

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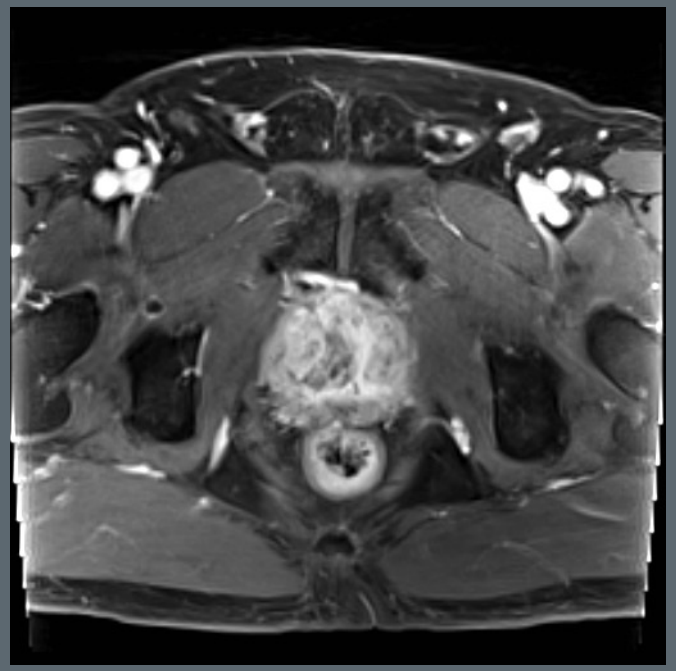


MEDICAL
IMAGING
REIMAGINED

radiology.ca

MAYFAIR

Prostate Biopsy

Grace W.S. Yeung, MD, FRCPC

DIAGNOSTICS / IN-HOSPITAL / TELERADIOLOGY

Topics:

- Historical background and Relevance
- Transrectal Ultrasound Guided Biopsy
- MRI guided targeted biopsy
- Targeted biopsy program at Rockyview General Hospital

RELEVANCE

Why should we care?

Prostate cancer screening and detection

- Prostate Specific Antigen (PSA)
  - Increased rate of cancer detection
  - Role in cancer related mortality reduction debated
    - Low specificity
    - Clinically significant cancer in patients with PSA <4nG/mL

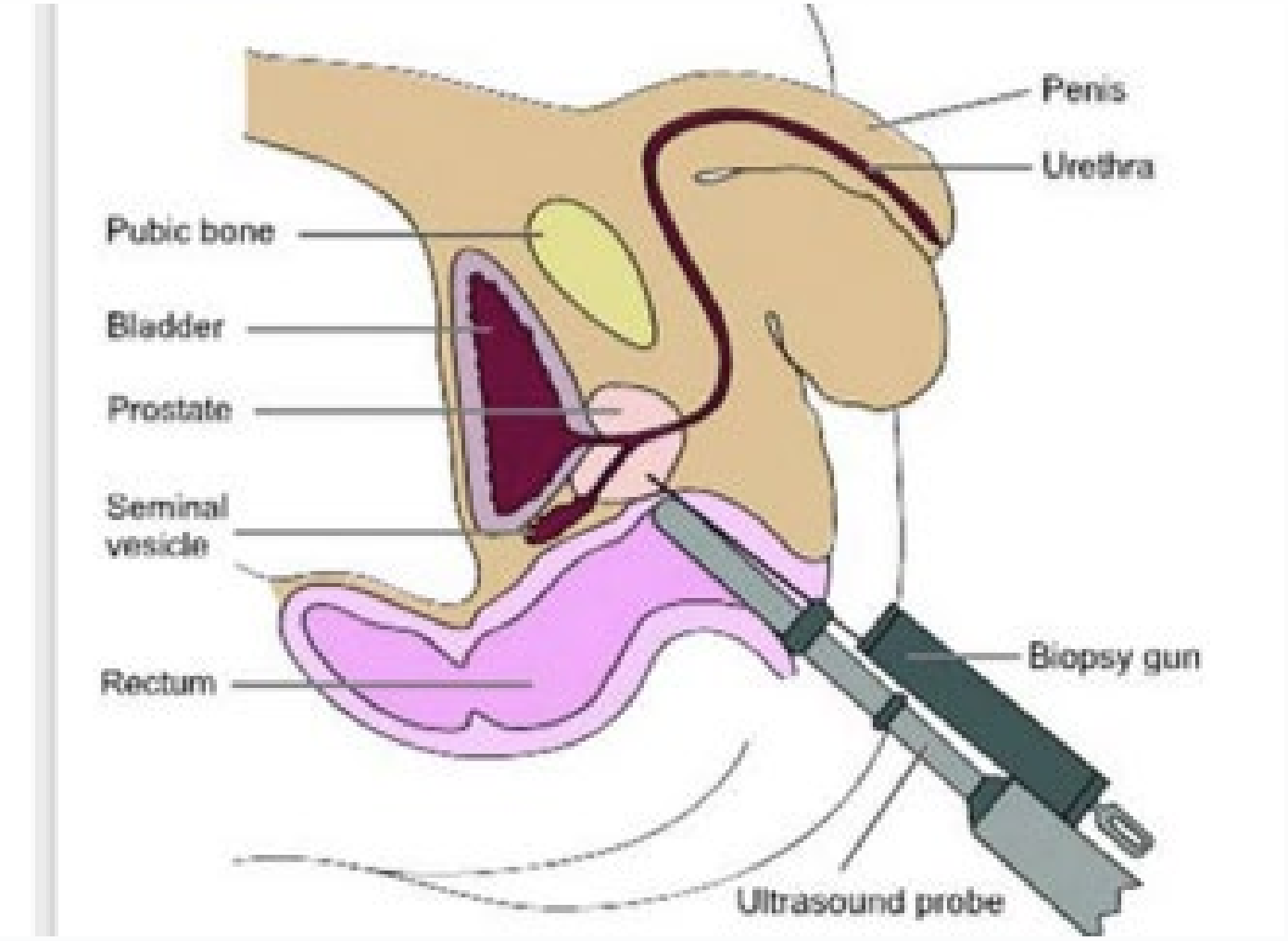
- Systematic trans-rectal ultrasound (TRUS) guided biopsy
  - 12 point biopsy

Maddams J, Utley M, Møller H. Projections of cancer prevalence in the United Kingdom, 2010–2040. *Br J Cancer* 2012; 107:1195–1202

Etzioni R, Tsodikov A, Mariotto A, et al. Quantifying the role of PSA screening in the US prostate cancer mortality decline. *Cancer Causes Control* 2008; 19:175–181

TRUS biopsy

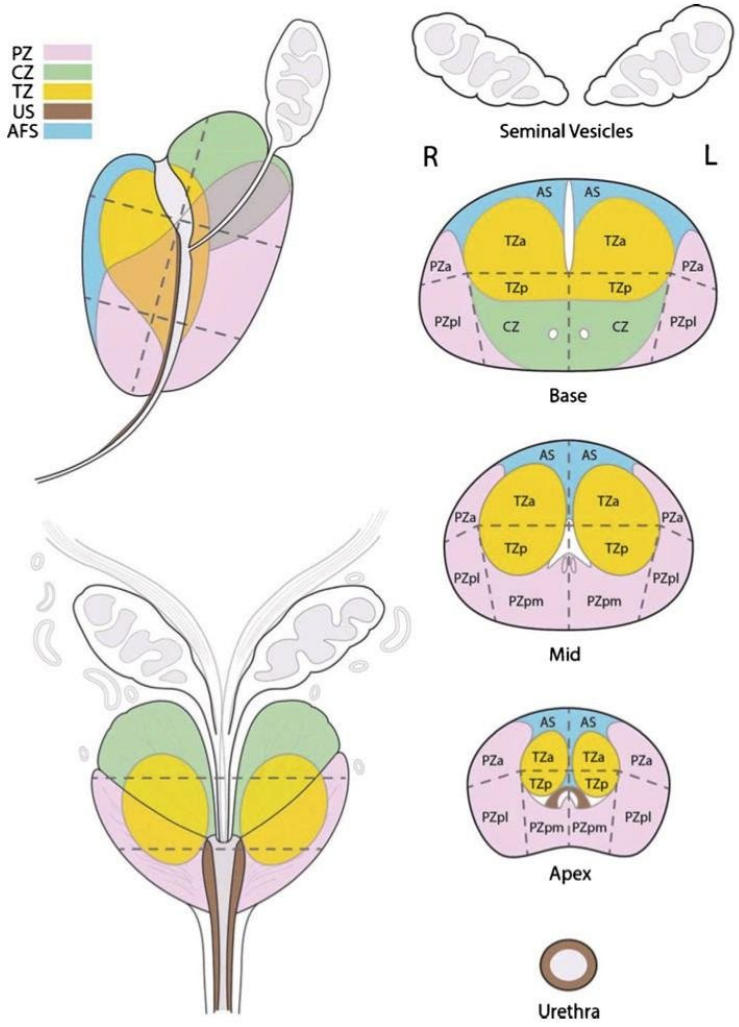
- Bowel preparation
- Prophylactic antibiotics
- Analgesia
  - Sedation
  - Topical local anaesthetic
  - Regional block



Slide courtesy of Dr S Spaner

TRUS biopsy

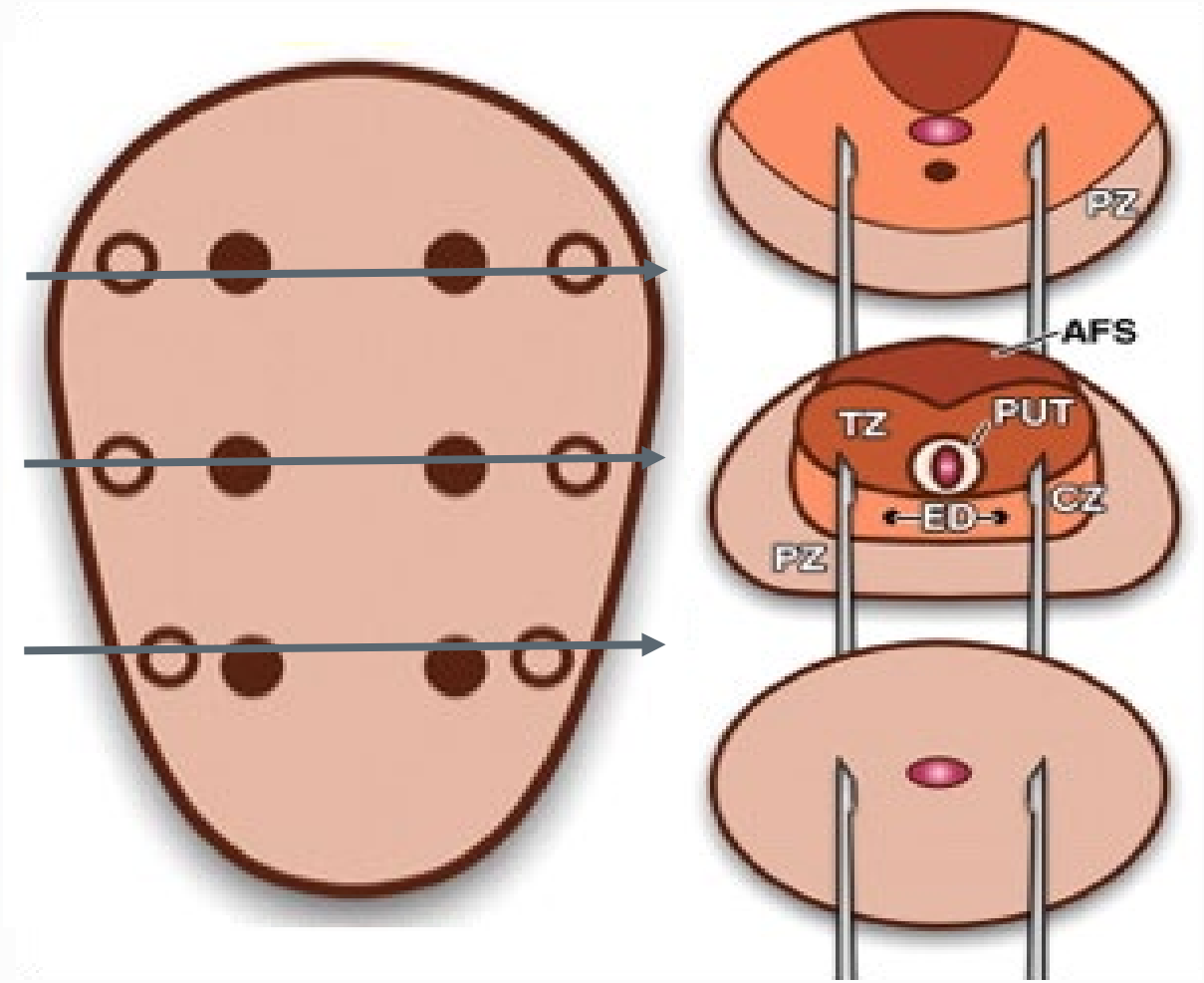
- 70% peripheral zone
- 25% transitional zone
- 5 % central zone



https://pubs.rsna.org/doi/full/10.1148/rg.323115053

PI-RADS Prostate Imaging – Reporting and Data System: 2015, Version 2

12 point Systematic TRUS



https://pubs.rsna.org/doi/full/10.1148/rg.323115053

RISKS/COMPLICATIONS

Bleeding
Infection
Urinary Symptoms

Bleeding

- Type:
  - Hematuria: 10-84%
  - Hematospermia: 1-93%
  - Hematochezia: 1-45%
- Severe
  - <1%
- Independent of core number (6-12)
  - Exception hematospermia

European Urology 64 (2013)876-892

Infection

- 0-6% rates of hospitalization
- Type:
  - UTI
  - Epididymitis
  - Meningitis/Osteomyelitis
  - Sepsis
- Infection rates increasing over time
  - Antibiotic resistance
- Risk factors
  - More cores
  - Repeat biopsy

European Urology 64 (2013)876-892

Lower Urinary Tract Symptoms

- Lower urinary tract symptoms/urinary retention: 0.2-1.7%
- Dysuria 6-25%
- Reduction technique
  - α blockers

European Urology 64 (2013)876-892

OPTIMIZATION OF BIOPSY TECHNIQUE

Antibiotic
Analgesia
Approach

Biopsy optimization

- Antibiotic prophylaxis
  - Fluoroquinolones
    - Ciprofloxacin po for 3 days
  - Expanding antibiotic regimen
  - Rectal swab cultures and targeted antibiotic regimen
  - Changing technical technique

- AHS currently investigating new prophylaxis regimen

European Urology 64 (2013)876-892

Pain management

- Sedoanalgesia
- Periprostatic Nerve blockade
  - 10-20cc 1%lidocaine
  - Apical/basal blockade or combination
- Topical lidocaine
- Strong evidence to support analgesia

European Urology 64 (2013)876-892

Transperineal

- Increasing in popularity
- Comparative studies fail to show difference in complication rates

European Urology 64 (2013)876-892

LIMITATIONS

TRUS limitations

Limitations of TRUS biopsy

- Samples 1% of gland
  - Low sensitivity
  - High false negative
    - Repeat biopsy
      - Diminishing detection rate
- Misrepresentation of the grade of cancer
- Anterior zone
- Morbidity and mortality

https://pubs.rsna.org/doi/full/10.1148/rg.323115053

Goal of biopsy

- Minimize the need for biopsy
- Maximize the yield:
  - Detect clinically significant cancer

MRI TARGETED BIOPSY

Is this the future?

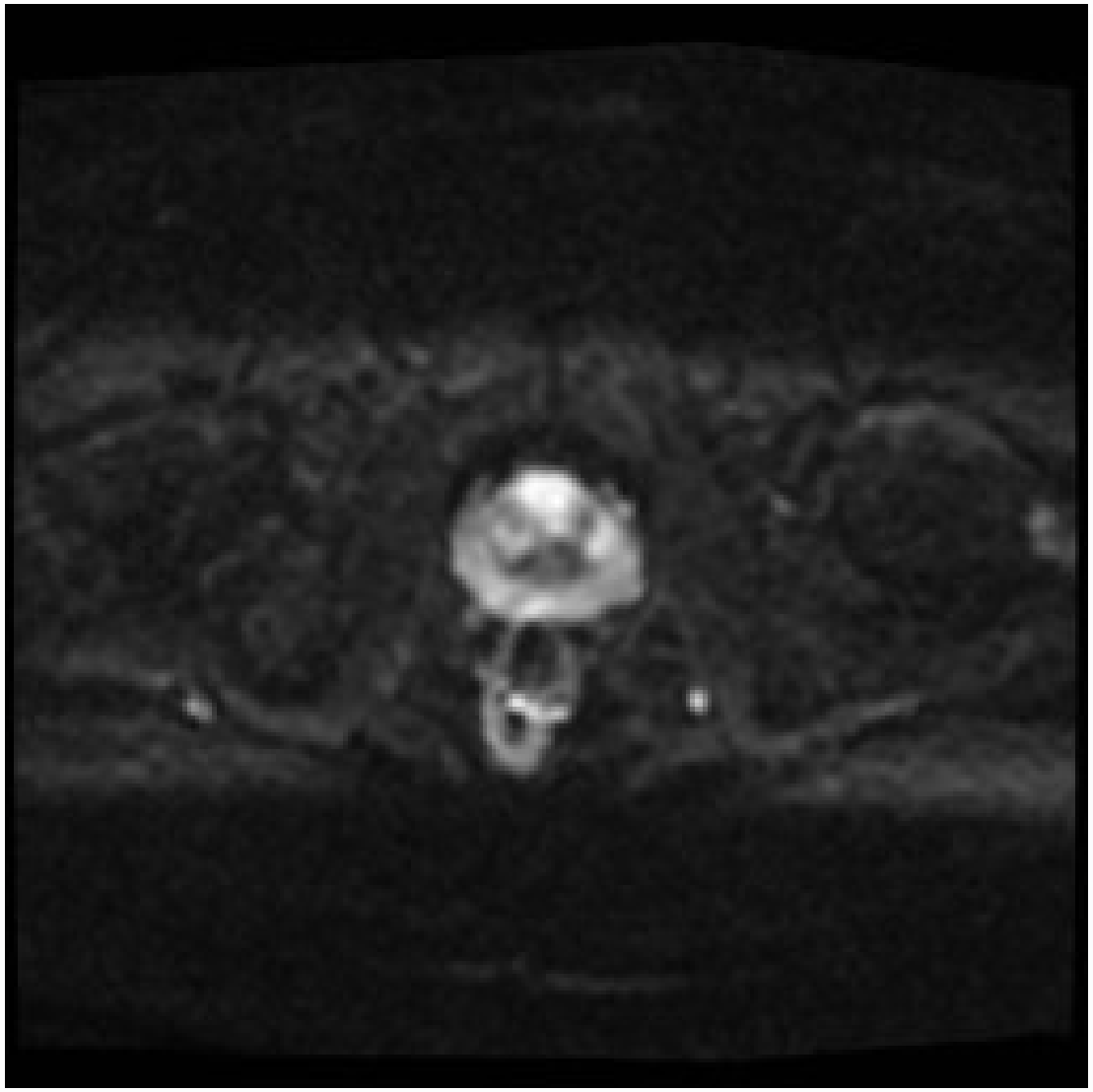
Yield of standard vs targeted biopsy

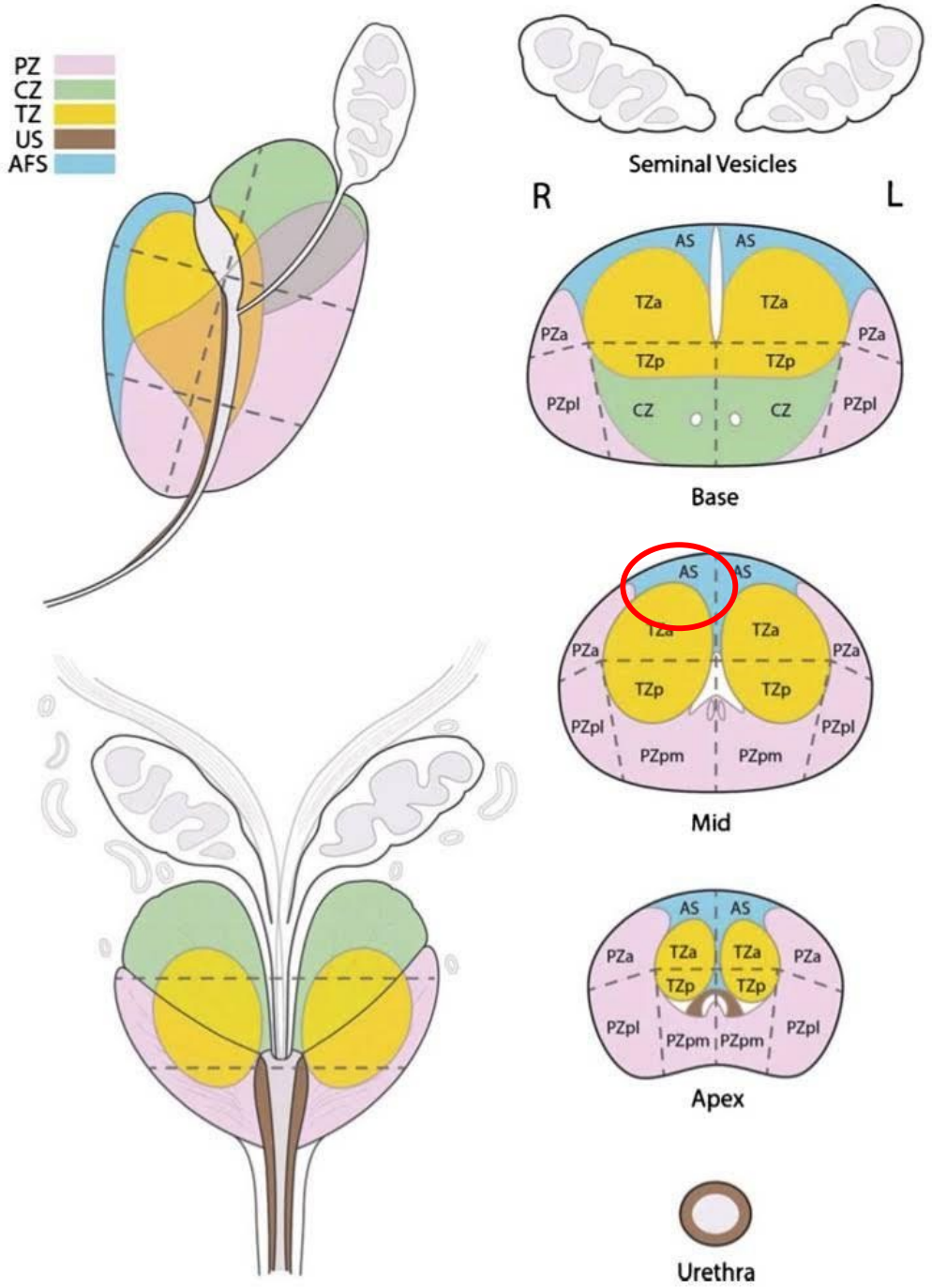
- PRECISION trial
  - MRI-targeted biopsy was superior to standard TRUS in men at clinical risk for prostate cancer who had not undergone biopsy previously.

- European Journal of Radiology
  - January 2018
  - Targeted biopsy using mpMRI-TRUS fusion has incremental diagnostic value in comparison to conventional random biopsy, better detecting clinically significant prostate cancers.

http://www.jurology.com/article/S0022-5347(17)31396-4/fulltext
Eur Radiol. 2018 Jan;28(1):11-16. doi: 10.1007/s00330-017-4939-0. Epub 2017 Jul 7

Case

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Mid
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Apex
Urethra

RIGHT

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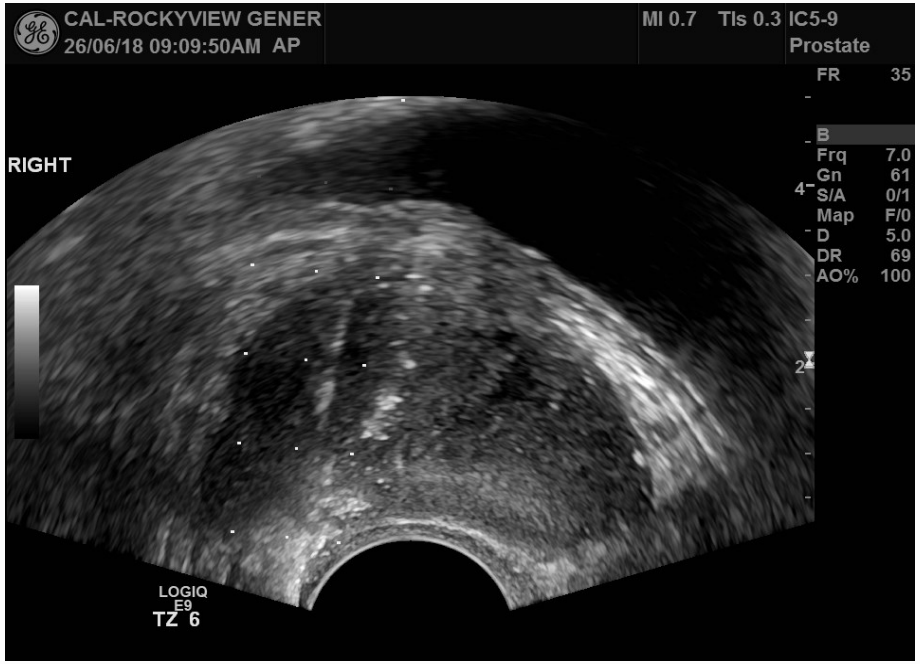
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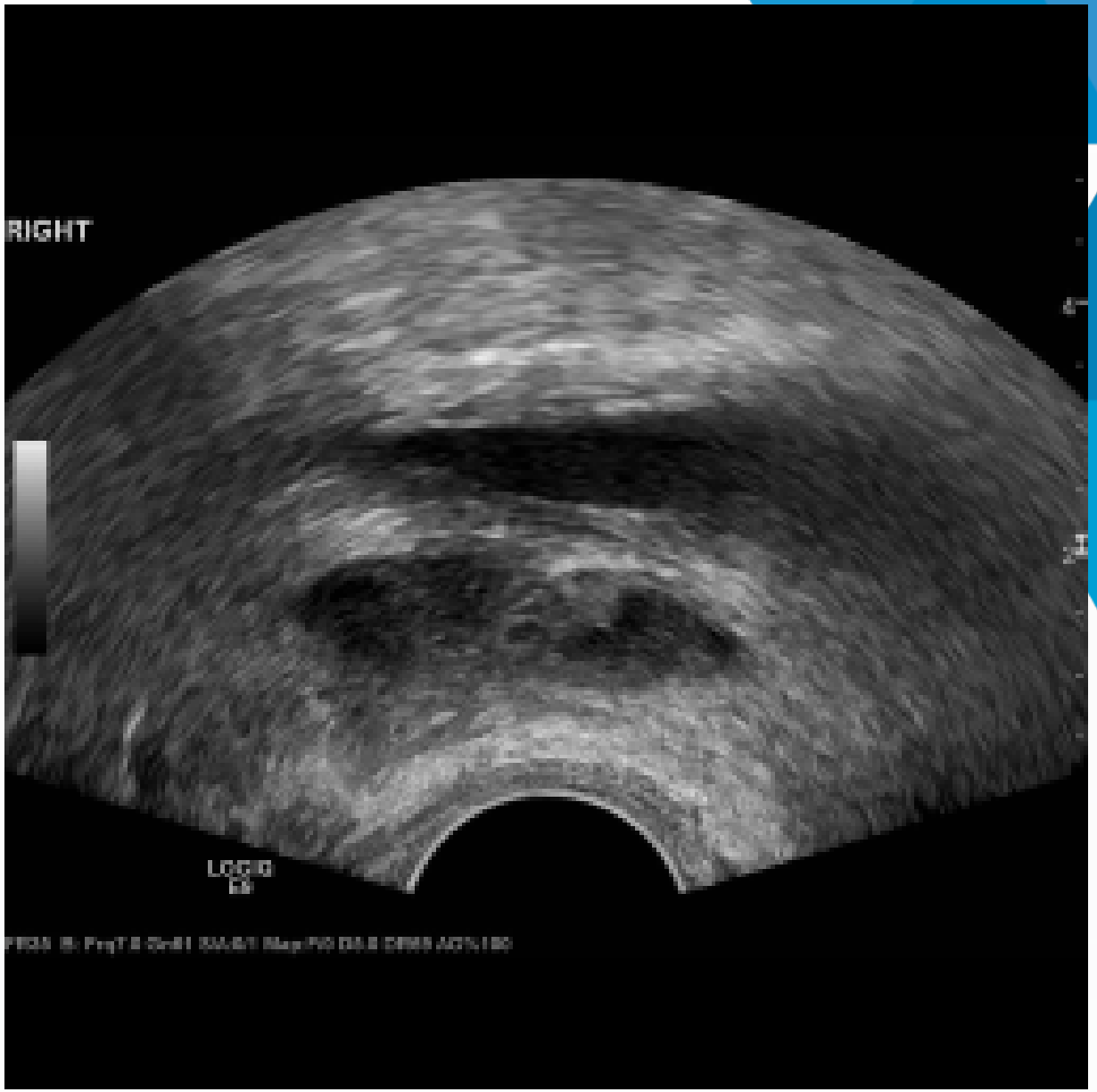

RIGHT

Case outcome

Patient PSA: 12

2 prior biopsies:

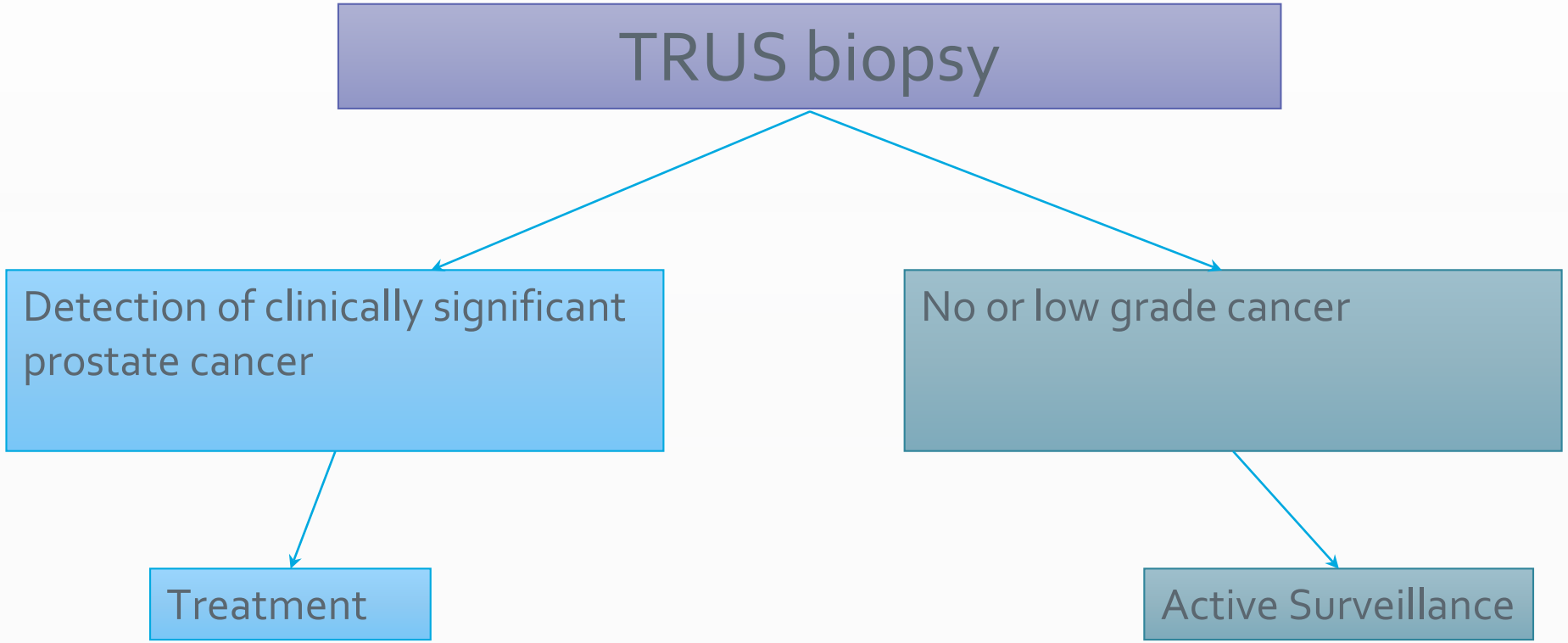
2015: Atypical cells

2013: Benign

Diagnosis: Gleason 7 carcinoma

Goals of MRI targeted biopsy

- Minimize the need for biopsy
- In cases of diagnosed cancer
  - Tissue sampling of the most clinically relevant region
- In cases of no cancer detection
  - True negative biopsy


TRUS biopsy
Detection of clinically significant prostate cancer
No or low grade cancer
Treatment
Active Surveillance

TARGETED BIOPSY AT RGH

Our preliminary data

Our Experience

Time period

Oct 2016 to date

Number of patients

106

Our Experience

Concordance

- Definition: Clinically significant cancer on target
- 106 patients → 105 lesions PIRAD 3 to 5 →44%
- PRECISION: 38%
- MGH: 34.5%

"Discordance"

- Definition: No clinically significant cancer on target

FUTURE PROSPECTIVES

Future goals

- Targeted biopsy
  - A closed loop service

- MRI for risk stratification and active surveillance
  - The wave of the future?

MEDICAL
IMAGING
REIMAGINED