Multiparametric Imaging of Prostate Cancer

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Objectives

- Review T2 weighted imaging of prostate cancer
- Demonstrate the value of
  - 3 dimensional imaging
  - Diffusion imaging, perfusion imaging
  - Suggest current indications for prostate MRI
(a) Oblique sagittal and (b) axial schematic representations of the prostate zones and their relationship to the prostatic urethra (white arrow) and ejaculatory ducts (black arrow).

Vargas H A et al. Radiology 2012;262:894-902

Radiologists general knowledge of prostate anatomy.
Basic MR imaging until 2008

- Endorectal coil + surface coil/1.5T magnet
- Axial T2WI 5mm thickness with 1.0mm gap – peripheral zone white
- Dark area cancer/prostatitis/blood
- Decent identification of capsule
- Focus on staging
- Patients disliked endorectal coil
MRI in 2008

• Accuracy in predicting T3 cancer 68-85%
• Not recommended as routine staging procedure in AUA guidelines – but things may be changing
(a) Axial and (b) coronal T2-weighted MR images (3150/105.4) in a 57-year-old patient with multifocal peripheral zone prostate cancer demonstrate similarity in T2 signal intensity of the normal central zone (arrows) and prostate cancer foci (dashed arrows).
(a) Axial and (b) coronal T2-weighted MR mages (3150/105.4) in a 57-year-old patient with multifocal peripheral zone prostate cancer demonstrate similarity in T2 signal intensity of the normal central zone (arrows) and prostate cancer foci (dashed arrows).

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MRI for initial staging, torso coil

• The following 3 cases were done at UNC as part of a research protocol investigating \textit{MR spectroscopy} using a \textit{torso coil} and a \textit{1.5T magnet}

• All subjects had low grade disease (PSA <10 and Gleason grade less than 7)

• All subsequently underwent radical prostatectomy
Patient 1

- Axial and coronal T2-weighted images show low signal in the right aspect of the peripheral zone
- Pathology revealed right sided disease only
Patient 2

- Axial and coronal T2-weighted images show low signal in the right aspect of the peripheral zone with a diffuse capsular bulge
- Pathology revealed diffused disease throughout the right side of the gland
Patient 3

- Axial and coronal T2-weighted images show extensive low signal in the right side of the peripheral zone
- Pathology revealed diffuse disease – right and left
Axial T2W images
New MRI techniques for prostate cancer - 2010

• 3T magnet – no endorectal coil
• Acquisition of entire prostate allows 3mm slices with no gap
• Diffusion – relies on water motion
• Perfusion – relies on blood flow/subtraction of pre-existing high signal
• ? Spectroscopy
**DWI + Perfusion Weighted Imaging**

Always read in conjunction with T2WI

DWI demonstrates motion of water within tumor

Can use the perfusion to calculate wash-in or wash-out rates or measure the leakiness of the capillary system.
DWI + Perfusion Weighted Imaging

in conjunction with T2WI

Diffusion shows motion of water in tumor

Can use the perfusion to calculate wash-in or wash-out rates or measure the leakiness of the capillary system
Large nodule, anterior

Low signal T2WI
Bright on DWI
Dark on ADC
Increased perfusion
MRSI basics

• MRI: Plot of signal intensity by location

• MRSI: Plot of signal intensity by frequency
MRSI findings in prostate cancer

MRSI exam time = 20 mins (total exam time = 60 mins)

Slides courtesy of Dr. Fergus Coakley
MRSI protocol

Water and lipid suppressed 3D PRESS
16 X 8 X 8 MATRIX
TR/TE = 1000/130 MSEC
ZERO-FILL IN AP DIRECTION
20 MIN ACQUISITION TIME
(~5% FAILURE RATE)

T2 axial slice with overlaid grid

Resulting spectral array (8-12/case)
Interpretation of MRSI

- Complex 1-5 scale developed at UCSF:
  - Based on metabolic ratios, SNR, and polyamines
- Reality: Pattern recognition (MDs = PhDs)

Radiology 2004; 233: 701-708
Negatives of spectroscopy

- Requires endorectal coil – even with 3T magnet
- Time consuming placement of radiofrequency pulse sites
- Performance of spectroscopy requires 20 minutes
- Post-processing requires hours of manpower
Accuracy of MRI staging now

- Increased to 80%
- Accuracy increases with radiologist experience
- Interobserver concordance is 75-80%
Who is doing prostate MR imaging and how many cases/year?

- UCSF 500
- UCLA 800
- NCI 1000
- NYU 1000
- Netherlands 2500

- Personal communication
What are nationwide indications for prostate MRI?

- **UCSF** 60% biopsy/20% surveillance/20% other
- **UCLA** 60% biopsy/20% staging/20% surveillance
- **NCI** 40-60% biopsy, 40% other
- **NYU** 100% biopsy
- **Nijmegen** 80% staging/20% biopsy
Surveillance MRI

- Gleason grade 6 on routine biopsy
- Patient/physician agree on watchful waiting
- MRI done at baseline and at 6 month intervals
- Change in T2/DWI/perfusion suggest development of cancer – biopsy performed
Recent literature

- 100 subjects with known low risk MRI underwent MPMR
- 2 reviewers
- Cancer >0.5 cm, Gleason grade >7
- PPV 85%

Targeted ultrasound biopsy

• How well does it work?
• No clear answer yet, however several recent papers suggest that it has value
• It is heavily marketed to physicians and patients
Recent literature

1. 499 patients, 241 low T2 SI lesions on MPMR
2. Biopsy with fused MR/US
3. Detection rate 80%

Multiparametric MR and subsequent MR/US fusion guided biopsy increases the detection of anteriorly located prostate cancers. Volkin et al, in press
Perfusion imaging – UCLA

Courtesy of Dr. Dan Margolis
Social media

• Facebook
• LinkedIn
• Pinterest
• Twitter
• YouTube
How does targeted biopsy work?

- Radiologist supervises specialized MR protocol for prostate evaluation – includes T2/DWI/Perfusion
- On review of MRI, suspicious lesions are marked in color
- These lesions are fused with US for targeted biopsy
Bringing target information from MRI to realtime US

- **Identify** cancer in pre-acquired MRI
- **Track** ultrasound probe and **register** with MRI
- **Show** MRI-identified cancer on **realtime ultrasound** image
  → **Guide** needle to target with realtime feedback

Courtesy P. Choyke
Prostate Fusion-targeted biopsy workflow

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<th>Prior to MRI Suite</th>
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<tr>
<td>MRI acquisition with ERC</td>
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<td>Prostate segmentation and target identification</td>
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<th>Day of Procedure</th>
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<tr>
<td>Pre-procedure</td>
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<tr>
<td>3D TRUS acquisition</td>
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<td>MRI – 3D TRUS registration</td>
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<td>Intra-procedure</td>
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<td>Realtime TRUS</td>
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<td>Corresponding MRI</td>
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<td>Targeted biopsy with realtime TRUS/MRI fusion</td>
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Anterior nodule
Why do prostate MRI?

- Useful when:
- Initial staging when physical exam and laboratory findings are at odds (small gland, high PSA)
- Follow-up in patients with Gleason 6 disease
- Negative biopsy with persistent elevation PSA - Biopsy guidance
UNC case

- Elevated PSA
- Multiple biopsies (outside location)
- MRI
- Target identified left mid gland
- Prostate cancer identified.
Perfusion
Thank you