Prostate MRI: A Review of Current Knowledge and Literature

Brian Rutt
Charlie McKenzie

July 18, 2007
Prostate MRI: A Review of Current Knowledge and Literature

Prostate Anatomy

Choi YJ et al, Radiographics 2007;27:63-75
MRI Techniques

- Endorectal coil
- T2 weighted imaging
- Proton spectroscopy
- Diffusion weighted imaging
- DCE MRI
MRI Techniques

- Endorectal coil
- T2 weighted imaging
- Proton spectroscopy
- Diffusion weighted imaging
- DCE MRI
Endorectal Coil
(Medrad)

Rigid Endorectal Coil

Prostate Coil
Endorectal Coil

Figure 4: Example of a 1.8-cm³ prostate cancer focus located in the central gland that was localized correctly only with ERC MR imaging in a 64-year-old man (prostate-specific antigen level, 6.9 ng/mL; final Gleason score, 3+3; stage, pT2c). (a) All four radiologists missed the cancer focus with BAC MR imaging. (b) With ERC MR imaging, three of the four radiologists localized the focus (arrows) correctly. (c) Histopathologic examination revealed the ventral cancer focus (T) outlined in blue, as well as two small peripheral zone tumor foci (volumes, <0.5 cm³) outlined in blue.

Heijmink et al, Radiology 2007;244:184-195
Figure 5

Endorectal Coil

Heijmink et al, Radiology 2007;244:184-195
Endorectal Coil MRI

MR image quality of the prostate improves significantly with the use of an erCoil.

For prostate cancer localization, performance with erCoil MR imaging was significantly better than was that with external array MR imaging.

erCoil is necessary for accurate localization and staging of prostate cancer.

Heijmink et al, Radiology 2007;244:184-195
MRI Techniques

- Endorectal coil
- T2 weighted imaging
- Proton spectroscopy
- Diffusion weighted imaging
- DCE MRI
T2 Weighted Endorectal Coil MRI

Choi YJ et al, Radiographics 2007;27:63-75
T2 Weighted Endorectal Coil MRI

T2-weighted MRI has significant limitations for depicting cancer in the transitional and central zones:
• cancer and normal tissues both have low signal intensity on T2-weighted images

In addition, low signal intensity may be seen in the peripheral zone on T2-weighted images in the presence of many noncancerous abnormal conditions

Choi YJ et al, Radiographics 2007;27:63-75
T2 Weighted Endorectal Coil MRI

At 1.5T, sensitivity of 77%–91% and specificity of 27%–61% have been reported for prostate cancer detection with T2w MRI using erCoil.

At 3T, these numbers may increase substantially.

Choi YJ et al, Radiographics 2007;27:63-75
3T T2w Endorectal Coil MRI
accuracy 94%, sensitivity 88%, specificity 96%

Image courtesy of JO Barentsz
MRI Techniques

- Endorectal coil
- T2 weighted imaging
- Proton spectroscopy
- Diffusion weighted imaging
- DCE MRI
MRS (Cho+Cr/Citrate) correlates with Gleason Grade.

- Limited to PZ
- 29 of 123 patients excluded
- Patients with prostatitis excluded

Zakian KL, Radiology 2005
ACRIN 6659
MRI and MRSI of Prostate Cancer Prior to Radical Prostatectomy: A Prospective Multi-Institutional Clinicopathological Study

<table>
<thead>
<tr>
<th>Role</th>
<th>Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>PI</td>
<td>Jeffrey Weinreb, MD</td>
</tr>
<tr>
<td>Co-PI</td>
<td>Fergus Coakley MB BCh</td>
</tr>
<tr>
<td>Spectroscopy Advisor</td>
<td>John Kurhanewicz PhD</td>
</tr>
<tr>
<td>Pathology Advisor</td>
<td>Thomas Wheeler MD</td>
</tr>
<tr>
<td>Statistical Advisor</td>
<td>Jeffrey Blume PhD</td>
</tr>
<tr>
<td>Biostatistician</td>
<td>Jean Cormack PhD</td>
</tr>
<tr>
<td>Lead Data Manager</td>
<td>Karen Boparai RT</td>
</tr>
<tr>
<td>Mem Sloan Kettering CC</td>
<td>Scott Gerst</td>
</tr>
<tr>
<td>U Texas MD Anderson CC</td>
<td>Haesun Choi</td>
</tr>
<tr>
<td>Mayo Clinic Rochester</td>
<td>Akira Kawashima</td>
</tr>
<tr>
<td>U Pennsylvania Med Ctr</td>
<td>Mark Rosen</td>
</tr>
<tr>
<td>Brigham and Women’s Hosp</td>
<td>Clare Tempany</td>
</tr>
<tr>
<td>Johns Hopkins U</td>
<td>Katarzyna Macura</td>
</tr>
<tr>
<td>ACRIN Staff</td>
<td></td>
</tr>
</tbody>
</table>

Supported by NCI Grants U01 #CA079778 & #CA80098
Technical Assistance from GE Healthcare
Endorectal Coils provided by MEDRAD
Preliminary Results of ACRIN Trial

- Satisfactory quality erCoil MRI and MRSI were obtained from all sites, although MRSI was more consistently of higher quality at some sites.

- Both MRI and MRI+MRSI performed significantly better for tumors based on:
  - Size (> 10mm)
  - Volume (> 0.5cc)
  - Gleason Score (≥ 7)
  - Location (midgland best)

- All readers had the same AUC for both MRI and MRI+MRSI.

Overall, there was no incremental benefit for MRI+MRSI compared with MRI alone.
MR Spectroscopy

Advantages of MR spectroscopy:
• generally accepted accuracy
• capability for depicting possible cancer in the transitional zone

Disadvantages of MR spectroscopy:
• long acquisition time
• variability due to postprocessing or shimming
• no direct visualization of the periprostatic anatomy
• uncertain benefit on top of modern MRI alone
MRI Techniques

- Endorectal coil
- T2 weighted imaging
- Proton spectroscopy
- Diffusion weighted imaging
- DCE MRI
Peripheral zone tumors
Geometric mean diameter $\geq 4\text{mm}$

Haider, van der Kwast, Evans, Trachtenberg et al
<table>
<thead>
<tr>
<th></th>
<th>Peripheral Zone</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>T2</td>
</tr>
<tr>
<td><strong>Sensitivity</strong></td>
<td>73/127 (58)</td>
</tr>
<tr>
<td><strong>Specificity</strong></td>
<td>152/167 (91)</td>
</tr>
<tr>
<td><strong>PPV</strong></td>
<td>73/88 (83)</td>
</tr>
<tr>
<td><strong>NPV</strong></td>
<td>152/206 (74)</td>
</tr>
<tr>
<td><strong>Accuracy</strong></td>
<td>225/294 (77)</td>
</tr>
</tbody>
</table>

Haider, van der Kwast, Evans, Trachtenberg et al
Diffusion Weighted MRI

Advantages:
- significant differences in the mean ADC values between cancerous and normal tissues,
- DWI may provide an incremental diagnostic accuracy increase over T2w MRI alone

Disadvantages
- individual variability decreases the diagnostic accuracy of ADC measurement for prostate cancer detection and localization
MRI Techniques

- Endorectal coil
- T2 weighted imaging
- Proton spectroscopy
- Diffusion weighted imaging
- Dynamic Contrast Enhanced MRI
DCE MRI of Cancer

Choi YJ et al, Radiographics 2007;27:63-75
<table>
<thead>
<tr>
<th></th>
<th>n=34</th>
<th>T2</th>
<th>MRS</th>
<th>DCEMRI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td></td>
<td>52-67</td>
<td>77-80</td>
<td>84-85</td>
</tr>
<tr>
<td>Specificity</td>
<td></td>
<td>73-74</td>
<td>84-87</td>
<td>83-88</td>
</tr>
<tr>
<td>PPV</td>
<td></td>
<td>38-43</td>
<td>64-68</td>
<td>61-70</td>
</tr>
<tr>
<td>NPV</td>
<td></td>
<td>83-88</td>
<td>91-93</td>
<td>94-95</td>
</tr>
<tr>
<td>Accuracy</td>
<td></td>
<td>69-71</td>
<td>82-85</td>
<td>83-87</td>
</tr>
</tbody>
</table>

Tumors >0.5cc

JJ Futterer et al, Radiology 2006;241:449-458
DCE MRI

Advantages:
• direct depiction of tumor vascularity
• may obviate the use of endorectal coil

Disadvantages:
• unsatisfactory depiction of transitional zone cancer in patients with hypervascular benign prostatic hyperplasia
• no consensus with regard to the best acquisition protocol and the optimal perfusion parameter for differentiating cancer from normal tissue
Overall Status: Prostate MRI

- Various MR imaging techniques can provide improved cancer detection and localization, as well as information regarding the biologic behavior, volume, and staging of cancers for individualized therapy.

- However, each technique has one or more limitations, such as no standard parameters, or low accuracy in the central region of the gland.

- No randomized large study has been performed to compare the techniques, and there has been no report with regard to which technique is best in a specific clinical situation.
MRI of Prostate

- Vas Deferens (vasa deferens)
- Seminal Vesicle (surface view)
- Seminal Vesicle (cutaway view)
- Base of prostate
- Apex of prostate
- Prostatic urethra
MRI of Prostate

Rigid Endorectal Coil

T2-Weighted Images
Review of Recent Prostate MR Literature

- ISMERM 2006 Abstracts
- ISMERM 2007 Abstracts
- Recent papers
Overview of ISMRM 2006 Abstracts:

• Coils (#113, 170, 171, 176, 1757, 2593):
  1. Endorectal Coils:
     – Less sensitive to motion artifacts
     – Require much more time for positioning
     – Require medical expertise to position
     – May require pharmaceutical intervention for bowel/anal preparation
     – More sensitive to susceptibility artifacts
     – Higher SNR
Overview of ISMRM 2006 Abstracts:

- Coils (#109, 172, 176, 1802):
  1. Endorectal Coils:
     - Several groups reported inflating these coils with perfluorocarbons - reductions in artifacts.
     - One group inflated with barium - similar reductions in artifacts
Overview of ISMRM 2006 Abstracts:

• Coils:
  2. Surface Coils:
    – More sensitive to motion artifacts
    – Better tolerance by patients
    – Easier to position
    – No pharmaceutical intervention required
    – Less sensitive to susceptibility artifacts
Overview of ISMRM 2006 Abstracts:

- Coils (#109, 170, 1757):
  2. Surface Coils:
     - Many of the studies at 3T were concerned with showing that endorectal coils were not necessary at higher field strength
     - General Consensus: increased SNR at 3T counters the loss of SNR of surface coils

Abstract #170
Overview of ISMRM 2006 Abstracts:

• Imaging Methods:
  – Consensus (#109, 116, 1760): At least two of the following imaging methods required for reasonable sensitivity and specificity:
  • T2, DWI, DTI, DCEMRI, MRSI
  – There was no comparison of all these methods.
  – T2 found to vary in normal PZ over time. (Abstract #3335)
Overview of ISMRM 2006 Abstracts:

- **Diffusion Weighted Imaging (#87, 114, 174, 178, 1615, 2246-9, 3330, 3338, 3343, 3485)**
  - No standard diffusion parameters used.
  - ADC improves sensitivity/specificity, but not enough to use ADC alone
Overview of ISMRM 2006 Abstracts:

- **Diffusion Tensor Imaging**
  - FA and RA in PZ and CG show some promise for diagnosing
  - No consensus!
  - DTI in prostate seems to be in its infancy!

*Figure 1. Corresponding ex vivo sRA map (A) and H & E stains (B) with PCa and BPH outlined in blue and red, respectively. The high diffusion anisotropy region in the top left quadrant of the histology slide (D) was further examined at 20 × magnification (C).*

Abstract #174
Review of Recent Prostate MR Literature

- ISMRM 2006 Abstracts
- ISMRM 2007 Abstracts
- Recent papers
Summary of ISMRM 2007 Abstracts

• Statistics:
  – Total of 58 abstracts read
  – 7 abstracts used animals,
  – 5 used human biopsies ex vivo,
  – 1 examined brachy seeds only
  – remainder (45) were human in vivo
Summary of ISMRM 2007 Abstracts

• Animal studies:
  – field strengths of 4.7T, 7T, 3T, 500MHz
  – Topics covered:
    • Vascular and metastatic characteristics dependent on tumour implantation site
    • Measurement of tumour volume and/or metabolite concentrations using MRI/MRSI
    • Affects of ADT on metabolites
    • Different perfusion characteristics of different sized contrast agents
Summary of ISMRM 2007 Abstracts

• Biopsies:
  – All 5 abstracts used magic angle spinning
  – Topics covered:
    • Used TOCSY to resolve overlapping choline-containing compounds and ethanolamine
    • Identified a previously unknown polyunsaturated fatty acid as linoleic acid found only in cancer
    • Elevation of all peaks associated with choline-containing compounds, lactate, and alanine were elevated in cancer
    • Post-radiation tissues (healthy and cancer) have lower concentrations of citrate and polyamines than untreated.
Summary of ISMRM 2007 Abstracts

• Human - Field Strengths
  – 1 study at 7T
  – 12 studies at 3T
  – 27 studies at 1.5T
  – 5 studies don’t specify, but it’s safe to assume that they were at 1.5T
  – There were no studies comparing 1.5T to 3T, unlike last year’s abstracts!
Summary of ISMRM 2007 Abstracts

• Human - Coils
  – 22 studies used endorectal coils (4 of these were at 3T)
  – 11 studies used non-endorectal coils - typically phased array coils (6 of these were at 3T, 1 was at 7T)
  – 1 study compared endorectal to phased array (all at 1.5T) - showed that SNR is higher with endorectal
  – 11 didn’t specify, but most likely endorectal (2 of these were at 3T)
Summary of ISMRM 2007 Abstracts

• Human - Gold Standard
  – 13 studies used whole mount/step section
  – 2 studies used transurethral resection (TURP)
  – 16 used biopsy only
  – 13 studies either used no gold standard or did not state use of a gold standard
Summary of ISMRM 2007 Abstracts

• Human - Summary of Themes Covered

1. Developing methods for comparing images to pathology:
   • Using morphing techniques to register the histopathology to the MR images
   • Scanned whole prostate in vivo and ex vivo and then matched these to pathology

2. Characterising affects of anti-androgen therapy and chemotherapy
   • Differences in ADC, metabolite peaks after ADT
   • ADC’s different in tumours that respond to chemo than those that don’t respond
Summary of ISMRM 2007 Abstracts

• Human - Summary of Themes Covered
  3. Determination of cut-off values for ADC and metabolite concentrations that can be used to separate normal from benign from malignant
  • Despite these attempts, there’s still a lot of overlap
  4. Testing of various MR methods (ADC, T2) for better diagnosis of difficult to diagnose cases (eg. Patients with intermediate PSA’s or those with repeated negative biopsies, BPH)
Summary of ISMRM 2007 Abstracts

• Human - Summary of Themes Covered

5. “Odds and Ends”
   • Implementation of CPMG instead of FSE to avoid PSF artifacts in FSE
   • Comparison of contrast images, ADC, FA, T2 to Gleason score, PSA levels
   • Improved quantitation of spectra using modeling
   • 3D reconstruction of prostate to assist robotic biopsy
   • Improved saturation of signal from outside prostate to reduce lipid contamination in spectra
Summary of ISMRM 2007 Abstracts

• Human - General Comments
  – There are a number of studies examining DWI, DTI, DCE MRI. While they may have slightly different methods than previously published results, their results are not significantly better.
  – Summarising these abstracts is quite difficult this year because it is obviously a field in its infancy (no general consensus for direction that the research should go, many topics covered), but there is much interest!
Human - General Comments

- The debate about whether to use endorectal coils or other coils at higher fields only appeared in one abstract, although comments were made in other abstracts. General consensus seems to be that it would be nice to avoid endorectal, but it’s hard to give up the SNR!
Registration of MR images to Pathology (Morgan, et al, deSouza)

– Pathologist defined ROIs

– Morphing algorithm used to warp histopathology to picture of fresh specimen and then to T2 image.

– Pathologist defined ROI could be applied to DW images.
• Spectroscopy (Tessem et al. Kurhanewicz)
  – Malignancy associated with glycolytic flux (production of lactate and alanine)
  – Significant increases in lactate and alanine in tumours
  – Implications for hyperpolarised $^{13}$C imaging with pyruvate (pyruvate $\rightarrow$ lactate and alanine)
Review of Recent Prostate MR Literature

- ISMRM 2006 Abstracts
- ISMRM 2007 Abstracts
- Recent papers
Overview of Papers - Reviews:

- “Teaching Moment”

- Choline and Creatine are elevated in cancer
- Citrate is reduced
- \([(\text{Choline + Creatine}) / \text{Citrate}]\) is diagnostic
Overview of Papers - Reviews:


- MRI and MRSI:
  - Tumour diameter >0.5cm for reasonable accuracy.
  - Assessment of SVI: sensitivity = 20% - 80%, specificity = 92% - 98%
  - Inability to distinguish normal from malignant after androgen deprivation or radiation therapy

- Anatomy Assessed by Endorectal MRI:
  - “In general, most agree that gadolinium enhancement is not helpful for either prostate cancer localization or staging. However, the development and use of macromolecular contrast media may prove useful in the future.”
Overview of Papers - Reviews:


– Imaging for lymph Node Metastases:
  • CT and MRI: sensitivity=36%, specificity=97%
  • Super-paramagnetic nanoparticles show promise

– Future Directions:
  • Use of high field strengths
  • Novel spectroscopic markers (polyamines, spermine)
  • MRI-guided biopsy and treatment
  • Use of molecular probes
Overview of Papers - Coils:

- Purpose: Compare 1.5T endorectal to 3T 6-channel external phased array cardiac receiver coil.
- Images ranked by 2 radiologists according to image quality and diagnostic accuracy

**FIGURE 1.** A and B, Multifocal intracapsular prostate cancer. With both erMRI (A) and 3 T MRI (B), 2 focal hypointense nodules are evident in the peripheral zone (arrows). The capsule is well depicted in both images, although it is clearer with erMRI.

- Conclusion: “… the image quality provided by 3T MRI is almost the same yielded by erMRI, without the patient discomfort and the costs related to the endorectal device.”
Overview of Papers - DCE and DWI:

- Hypothesis: DCE and DWI combined provide higher diagnostic sensitivity than each technique alone

<table>
<thead>
<tr>
<th>Imaging Technique</th>
<th>Sensitivity</th>
<th>Specificity</th>
</tr>
</thead>
<tbody>
<tr>
<td>ADC</td>
<td>54%</td>
<td>100%</td>
</tr>
<tr>
<td>DCE</td>
<td>59%</td>
<td>74%</td>
</tr>
<tr>
<td>ADC + DCE</td>
<td>87%</td>
<td>74%</td>
</tr>
</tbody>
</table>

Hypothesis Table:

<table>
<thead>
<tr>
<th>Technique</th>
<th>ADC (10⁻³ mm²/second)</th>
<th>Ktrans (minutes⁻¹)</th>
<th>v0</th>
<th>Max. Conc. (mM)</th>
<th>Max. Enh.</th>
<th>OT (minutes)</th>
<th>Mean. Grad.</th>
</tr>
</thead>
<tbody>
<tr>
<td>PZ</td>
<td>1.5730 ± 0.2700</td>
<td>0.596 ± 0.560</td>
<td>0.382 ± 0.148</td>
<td>0.274 ± 0.115</td>
<td>1.218 ± 0.245</td>
<td>0.741 ± 0.133</td>
<td>1.008 ± 0.659</td>
</tr>
<tr>
<td>CG</td>
<td>1.3750 ± 0.1670</td>
<td>0.596 ± 0.288</td>
<td>0.443 ± 0.084</td>
<td>0.314 ± 0.069</td>
<td>1.431 ± 0.190</td>
<td>0.733 ± 0.090</td>
<td>1.004 ± 0.311</td>
</tr>
<tr>
<td>PCa</td>
<td>0.9930 ± 0.1580</td>
<td>1.263 ± 0.544</td>
<td>0.326 ± 0.131</td>
<td>0.257 ± 0.099</td>
<td>1.463 ± 0.218</td>
<td>0.644 ± 0.089</td>
<td>2.297 ± 1.023</td>
</tr>
</tbody>
</table>

Table 1: Average Values (Mean ± SD) of Mean Diffusivity and DCE MRI Parameters

- a, bPCa significantly different than PZ (P < 0.001).
- c, dPCa significantly different than CG (P < 0.001).
- eCG significantly different than PZ (P < 0.05).
- fPCa significantly different than CG (P < 0.05).

ADC = mean diffusivity, Max. Conc. = maximum concentration of Gd-DTPA, Max. Enh. = maximum enhancement, OT = onset time, Mean Grad. = mean gradient, PZ = normal peripheral zone (DW MRI: N = 18, DCE MRI: n=24), CG = normal central gland (N = 18), PCa = tumour (DW MRI: N = 18, DCE MRI: N = 24).
Overview of Papers - DWI:

- Pickles et. al. JMRI 23:130 (2006)
- Purpose: Use ADC to distinguish normal tissue and tumours in PZ and CG at 3T.

![Diffusion Imaging of the Prostate at 3.0T](image)

**Figure 2.** Box plot of tumor and PZ against ADC, demonstrating the intersubject variability of ADC.

<table>
<thead>
<tr>
<th>Group (T$_0$)</th>
<th>Tumor Mean ± SD</th>
<th>Patient PZ Mean ± SD</th>
<th>Volunteer PZ Mean ± SD</th>
<th>Volunteer CG Mean ± SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>This study (3T)</td>
<td>1.38 ± 0.22</td>
<td>1.95 ± 0.50</td>
<td>1.60 ± 0.25</td>
<td>1.27 ± 0.14</td>
</tr>
<tr>
<td>Hosseinzadeh et al (10) (1.5T)</td>
<td>1.27 ± 0.37</td>
<td>1.61 ± 0.26</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chan et al (9) (1.5T)</td>
<td>1.43 ± 0.35</td>
<td>1.61 ± 0.37</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gibbs et al (8) (1.5T)</td>
<td>2.73 ± 0.70</td>
<td>3.43 ± 0.69</td>
<td>1.25 ± 0.23</td>
<td>1.17 ± 0.18</td>
</tr>
<tr>
<td>Issa (7) (1.5T)</td>
<td>1.38 ± 0.52</td>
<td>1.82 ± 0.53</td>
<td>1.91 ± 0.46</td>
<td>1.63 ± 0.30</td>
</tr>
</tbody>
</table>

*ADC values x $10^{-3}$ mm$^2$/second.
Overview of Papers - DTI:

- Purpose: Compare DWI and DTI in tumours and normal tissue at 3T using torso phased-array coil and parallel imaging.

Using a cut-off of $1.45 \times 10^{-3}$mm$^2$/s for mean diffusivity:
Sensitivity = 84%, Specificity = 80%
Overview of Papers - Spectroscopy:

- Fact: MRI/S abnormalities may not be clearly demarcated and often merge gradually into areas of normal peripheral zone T2 or metabolism
- Purpose: To establish size criteria for true-positive MRI/S assessment.
- Conclusion: If MR determined transverse diameter is >2x pathology diameter, tumour should be considered chance-detected.

Example: Tumour diameter on MR = 13mm, on Pathology = 2mm
Overview of Papers - Non-PZ Cancer:

  
  Purpose: To assess T2 MRI for diagnosis of TZ tumours.
  
  Considered: 1) homogeneity of T2 SI, 2) ill-defined margins; 3) lack of capsule; 4) lenticular shape; 5) invasion of anterior fibromuscular stroma

  
  Purpose: To assess MRI for diagnosis of SVI.
  
  Factors best predictive of SVI:
  1) Tumour at base that extends beyond capsule; 2) low signal intensity within SV; 3) loss of normal architecture.
Staging
Detection
MRI Techniques

- Endorectal coil
- T2 weighted imaging
- 3T
- Ferumoxtran-10
- Proton spectroscopy
- Diffusion weighted imaging
- DCE MRI
- T2* (“BOLD”) MRI
Ferumoxtran-10

- Combidex, Sinerem, AMI-7227, AMI-227, BMS 180549
- Iron oxide crystalline core 4-6 nm covered by low molecular weight dextran (30nm)
- Phase III trials still underway
- NOT APPROVED AGENT
# Prostate Cancer

n=80 patients

<table>
<thead>
<tr>
<th>Size</th>
<th>USPIO</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>45</td>
</tr>
<tr>
<td>Specificity</td>
<td>78</td>
</tr>
<tr>
<td>NPV</td>
<td>67</td>
</tr>
<tr>
<td>Accuracy</td>
<td>65</td>
</tr>
<tr>
<td>PPV</td>
<td>60</td>
</tr>
</tbody>
</table>

- Nodes 5-10mm Sensitivity: 29% vs 96%
- Nodes <5mm Sensitivity: 0% vs 41%

Prognostication
Patient Specific Therapy Modulation

Harisinghani et al NEJM 2003

p<0.001
Node Mapping for IMRT
Staging - Summary

- erMRI is useful for staging patients at high risk of extraprostatic disease extension (ECD) and likely intermediate risk as well
- erMRI is not indicated for staging patients with low risk of ECD
- In the future Ferumoxtran-10 may play an important role in nodal assessment for *prognostication and patient tailored therapy modulation (IMRT or LND)*
Staging
Detection
Prostate Cancer Detection

MRI aided TRUS biopsy localization

PSA

TRUS Bx

Cancer

HGPIN/ASAP

Normal

Surgery or Rads

Microfocus cancer
Detection - Summary

- Further study is needed
- Tumors under 0.2cc are poorly detected
- There may be a role for MRI in patients at high risk with 2 prior negative TRUS biopsies for localization
- MRI should be considered in studies involving minimally invasive therapies