Optimizing Implementation of Prostate MRI

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Section of Abdominal Imaging & Nuclear Radiology Department
Objectives

• To review the basic components of a state-of-the-art prostate MRI protocol

• To list resources available and under development to assist in the implementation and optimization of a prostate MRI program
The Evolution of Prostate MRI

J. H. STEYN and F. W. SMITH
Departments of Urology and Nuclear Medicine, Royal Infirmary, Aberdeen

Nuclear Magnetic Resonance Imaging of the Prostate

British Journal of Urology (1982), 54, 726-728

0.04 Tesla Magnet

1980
“At present, MR imaging is the most accurate diagnostic modality for the local staging of carcinoma of the prostate, but for optimal results, multiple sequences and two orthogonal planes of imaging are needed.”
The Evolution of Prostate MRI

Prostate: MR Imaging with an Endorectal Surface Coil

Mitchell D. Schnall, MD, PhD
Robert E. Lenkinski, PhD
Howard M. Pollack, MD
Yutaka Imai, MD
Herbert Y. Kressel, MD

Radiology 1989; 172:570–574

1980
The Evolution of Prostate MRI

Fast Spin-Echo MR Images of the Pelvis Obtained with a Phased-Array Coil: Value in Localizing and Staging Prostatic Carcinoma

AJR 1993;161:601-606

Ruben Kier¹,²
Stephanie Wain³
Robert Troiano¹

1.5 Tesla Magnet

1980 1990
The Evolution of Prostate MRI

The Role of **Intravenous Contrast Enhancement** in Magnetic Resonance Imaging of Prostatic Carcinoma

G. BROWN, D. A. MACVICAR, V. AYTON and J. E. HUSBAND


1980  1990
The Evolution of Prostate MRI

John Kurhanewicz, PhD • Daniel B. Vigneron, PhD • Hedvig Hricak, MD, PhD
Perinchery Narayan, MD • Peter Carroll, MD • Sarah J. Nelson, PhD

Three-dimensional **H-1 MR Spectroscopic Imaging** of the in Situ Human Prostate with High (0.24–0.7-cm³) Spatial Resolution¹

Radiology 1996; 198:795–805
The Evolution of Prostate MRI

Comparison of Quantitative $T_2$ Mapping and Diffusion-Weighted Imaging in the Normal and Pathologic Prostate

Peter Gibbs,* Daniel J. Tozer, Gary P. Liney, and Lindsay W. Turnbull

The Evolution of Prostate MRI

3 Tesla Magnetic Resonance Imaging of the Prostate With Combined Pelvic Phased-array and Endorectal Coils:
Initial Experience

Acad Radiol 2004; 11:863–867

B. Nicolas Bloch, MD, Neil M. Rofsky, MD, Ronaldo H. Baroni, MD, Robert P. Marquis, BS, RT (MR)
Ivan Pedrosa, MD, Robert E. Lenkinski, PhD

1980  1990  2000
The Evolution of Prostate MRI

ESUR prostate MR guidelines 2012

Jelle O. Barentsz · Jonathan Richenberg · Richard Clements · Peter Choyke · Sadhna Verma · Geert Villeirs · Olivier Rouviere · Vibeke Logager · Jurgen J. Fütterer


PI-RADS Version 1
**The Evolution of Prostate MRI**

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

- Minimum acceptable technical parameters
- Standardized lexicon
- Revised scoring system
- Standardized scheme for deriving an overall assessment category
State-of-the-art technique

• Hardware
  – 1.5 or 3.0 T
  – Surface coil with or without ER coil

• Pulse Sequences:
  – Multiplanar T2-WI
  – DWI/ADC
  – DCE T1-WI
  – MRSI (optional – not included in PI-RADS v2)
Prostate MRI Pulse Sequences

• T2-WI
  – Detailed anatomic information – staging
  – Dominant parameter for TZ lesions
Prostate MRI Pulse Sequences

- **T2-WI**
  - Detailed anatomic information – staging
  - Dominant parameter for TZ lesions
• DWI /ADC map
  – Tissue microarchitecture and cellularity
  – Dominant parameter for PZ lesions
  – ADC: Inverse correlation with Gleason score
Prostate MRI Pulse Sequences

- DWI /ADC map
  - Tissue microarchitecture and cellularity
  - Dominant parameter for PZ lesions
  - ADC: Inverse correlation with Gleason score
Prostate MRI Pulse Sequences

- **DCE**
  - Tissue vascularity
  - PCa: poorly formed vessels with ↑ permeability
  - Lesion detection and characterization (limited role)
Abnormality location

Peripheral Zone
- DWI/ADC
  - Score 1: PI-RADS 1 – highly unlikely
  - Score 2
    - DCE -
      - Score 3: PI-RADS 3 – equivocal
    - DCE +
      - Score 4: PI-RADS 4 – likely
  - Score 5: PI-RADS 5 – highly unlikely

Transition Zone
- T2-WI
  - Score 1
  - Score 2
  - Score 3: DWI ≤ 4
  - Score 4: DWI 5
  - Score 5
PI-RADS 1

PI-RADS 2

PI-RADS 3

PI-RADS 4

< 1.5-cm and No EPE

PI-RADS 5

≥ 1.5-cm and/or EPE
Predictions for PI-RADS v2.1 and beyond

✓ Biopsy recommendations

✓ Inclusion of quantitative assessment
  ➢ Likely requires further standardization of technical parameters
  ➢ Radiomics

✓ Inclusion of imaging criteria for other applications
  ➢ Staging
  ➢ Criteria for active surveillance
  ➢ Evaluation of recurrence
Implementation of Prostate MRI Program

Personnel involved

✔ Referring physicians (Urologists, Rad Onc, Med Onc)
✔ Hospital administration/leadership
✔ IT Department
✔ Radiologists/technologists
  • “The Director of Prostate Imaging”*

*Westphalen et al. PMID 28396916
Roles of local champion

- Collaborate with urologists/referring physicians on institutional policies for imaging utilization and in the acquisition and deployment of related technologies
Implementation of Prostate MRI Program

Roles of local champion

- Technologist engagement
  - Ensure consistent and adequate image quality
  - Development of imaging protocols ensuring they meet or exceed the parameters standardized by PI-RADS v2

1. Technical Specifications

   Free-breathing spin echo EPI sequence combined with spectral fat saturation is recommended.

   - TE: ≤90 msec; TR: ≥3000 msec
   - Slice thickness: ≤4mm, no gap. Locations should match or be similar to those used for T2W and DCE
   - FOV: 16-22 cm
   - In plane dimension: ≤2.5mm phase and frequency

*Weinreb et al. (PMID: 26427566)
Implementation of Prostate MRI Program

Roles of local champion

- Radiology engagement
  - Development and use of report templates
  - To assist in the improvement of consistency and accuracy of reports
# Implementation of Prostate MRI Program

## Educational tools

- **Prostate MRI workshop**
  - ACR Education Center, Reston VA
  - 2-day hands-on course 100+ cases and lectures

## Faculty:

<table>
<thead>
<tr>
<th>Name</th>
<th>Institution</th>
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<tbody>
<tr>
<td>Katarzyna Macura MD, PhD</td>
<td>JHU</td>
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<tr>
<td>Jeff Weinreb, MD</td>
<td>Yale</td>
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<td>Claire Tempany, MD</td>
<td>BWH</td>
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<td>Peter Choyke, MD</td>
<td>NIH</td>
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<td>Baris Turkbey, MD</td>
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<td>Andy Rosenkrantz, MD</td>
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<td>Daniel Margulis, MD</td>
<td>Weill Cornell</td>
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<td>Sadhna Verma, MD</td>
<td>CH</td>
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<tr>
<td>Andrei Purysko, MD</td>
<td>Cleveland Clinic</td>
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Implementation of Prostate MRI Program

ACR prostate MR workshop

Course Director:
Katarzyna J. Macura, MD, PhD, FACR
Professor of Radiology, Urology, Oncology
Johns Hopkins University

Program Objectives

At the conclusion of this course, participants will be able to:

- Apply the principles of PI-RADS v2 and the scoring system during the interpretation of mpMRI of the prostate
- Report imaging findings using the standardized format
- Optimize prostate imaging protocols using the mpMRI principles to achieve the best diagnostic performance
- Provide guidance for targeted biopsies of the prostate
- Develop multidisciplinary collaborations and establish a quality assurance program for prostate imaging
Implementation of Prostate MRI Program

Educational tools

• Prostate MRI workshop
  • Radiological Society of North America (Nov/Dec)
  • Society of Abdominal Radiology (March)
Implementation of Prostate MRI Program

Educational tools

- PI-RADS Atlas
- ACR.org
Implementation of Prostate MRI Program

Educational tools

- “Learn Prostate MRI”
- learnprostatemri.com

Dr. Andrew Rosenkrantz is an Associate Professor of Radiology and Urology and Director of Prostate Imaging at the NYU School of Medicine, NYU Langone Medical Center (NYULMC). He completed medical school at Albany Medical College, residency in Diagnostic Radiology at the University of Maryland Medical Center, and fellowship in Body MRI at NYULMC. His primary clinical research interest is the role of MRI in prostate cancer detection and characterization. As part of a multi-disciplinary team, he has researched numerous aspects of the optimization and validation of the acquisition, post-processing, and interpretation of prostate MRI. This research has resulted in over 75 peer-reviewed publications on the topic as well as research awards from the Society of Abdominal Radiology and Society of Computed Body Tomography & Magnetic Resonance. Since 2015, he has served as Co-Chair of the Society of Abdominal Radiology’s Prostate Cancer Disease-Focused Panel; in this role, he led a collaborative expert panel between that society and the American Urological Association to develop a joint consensus statement regarding the role of prostate MRI in the repeat biopsy setting. He also edited a state-of-the-art textbook on the topic (Prostate MRI: A Practical Approach), published by Thieme Medical Publishers in 2016. In addition, he has given over 20 invited lectures on prostate MRI, as well as participated in numerous society-sponsored hands-on prostate MRI educational symposia. Finally, he recently served as the lead investigator of a multi-center trial addressing the reproducibility of PI-RADS version 2 among expert radiologists, and previously as the lead investigator of a grant from the Department of Defense investigating prostate MRI at 7T.
Implementation of Prostate MRI Program

Educational tools

Learn Prostate MRI

Finding: Within the right anterior PZ and TZ is a large region of markedly decreased ADC and increased high b-value signal, with associated focal early enhancement and locally invasive behavior.

T2WI: 5. DWI: 5. DCE: (+). PI-RADS: 5.

MRI/TRUS fusion biopsy: Gleason score 4+3 tumor.
Educational tools

Learn Prostate MRI

PI-RADS 2.0: what is new?

PI-RADS version 2: what you need to know.

Synopsis of the PI-RADS v2 Guidelines for Multiparametric Prostate Magnetic Resonance Imaging and Recommendations for Use.


A practical primer on PI-RADS version 2: a pictorial essay.

Prostate MRI based on PI-RADS version 2: how we review and report.

Commentary regarding the inter-reader reproducibility of PI-RADS version 2.
Rosenkrantz AB, Margolis DJ. Abdom Radiol (NY). 2016 May;41(5):907-9. doi:

PI-RADS Version 2: A Pictorial Update.

Prostate imaging reporting and data system version 2 (PI-RADS v2): a pictorial review.

Review of Prostate Imaging Reporting and Data System version 2.

Opportunities for multiparametric MRI with PI-RADS v2 to make a difference.
Implementation of Prostate MRI Program

Continued improvement

- Informal review and formal case discussions in conferences, tumor boards and periodic radiologic–pathologic correlation
- Feedback mechanism that enables evaluation and interpretative skills and the impact of the technology
What to expect for the future?
PI-RADS v2.1 and beyond (predictions)

✓ Biopsy recommendations
✓ Inclusion of quantitative assessment
  ➢ Likely requires further standardization of technical parameters
  ➢ Radiomics
✓ Inclusion of imaging criteria for other applications
  ➢ Staging
  ➢ Criteria for active surveillance
  ➢ Evaluation of recurrence
ACR Prostate MR Accreditation Program

- Interpreting physician qualification
  - Minimum number of cases per year
  - CME activities

- MR technologist and physicist qualifications

- Reporting
  - PI-RADS and ACR practice parameters for communication of diagnostic findings

- Must have capability to perform or coordinate biopsy planning

- Policy for feedback/follow up on biopsy results
• Advances in hardware and software over the last 3 decades helped establishing MRI as an accurate method for PCa detection

• The development of technical standards for imaging acquisition and reporting have facilitated the utilization of prostate MRI in clinical practice

• Numerous resources are available to assist in the implementation and optimization of prostate MRI
Thank you!