Comparison of PI-RADS v2 and v1 classification of lesions detected on mpMRI with pathologic correlation

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INTRODUCTION

Prostate Imaging and Reporting and Data System: PI-RADS

- Version 1 (v1) published by the ESUR in 2012
- Provided guidelines for multiparametric MRI (mpMRI) indications, acquisition, and a structured reporting system
INTRODUCTION

Overview of PI-RADS Version 1 scoring system

- Each lesion given a score from 1-5 for each of T2, DWI/ADC, T1WI dynamic contrast enhanced (DCE), MR spectroscopy sequences, and extraprostatic disease
- An overall score assigned on Likert scale (1-5) based on likelihood of clinically significant disease

Significant step towards standardizing reporting, however not without limitations

- Overall score subjective and not clearly related to the scoring of individual sequences
- Criteria for scoring within individual sequences somewhat vague
- Heterogeneity of scoring may be confusing for clinicians
INTRODUCTION

Recent Introduction of PI-RADS v2
- Introduced at RSNA 2014 and published on ACR website
- “designed to promote global standardization and diminish variation in the acquisition, interpretation, and reporting of prostate mpMRI”
- Evolving document, work in progress

Highlights of PI-RADS v2 scoring system changes
- Outlines more specific morphologic criteria for T2 and DWI scoring, with images provided as examples
  - Contrast-enhanced scoring now dichotomous
  - Removed scoring MR spectroscopy
- Assigns an overall score based on individual sequence scores
  - More heavily weighted towards T2 and DWI for transition zone and peripheral zone lesions respectively
- Updates recommended MR acquisition parameters
### PI-RADS v2

#### T2: Peripheral Zone (PZ)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>DWI (PZ and TZ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Uniform hyperintense signal intensity (normal)</td>
<td>1 No abnormality (i.e. normal) on ADC and high b-value DWI</td>
</tr>
<tr>
<td>2</td>
<td>Linear or wedge-shaped hypointensity or diffuse mild hypointensity, usually indistinct margin</td>
<td>2 Indistinct hypointense on ADC</td>
</tr>
<tr>
<td>3</td>
<td>Heterogeneous signal intensity or non-circumscribed, rounded, moderate hypointensity Incl’ others that do not qualify as 2, 4, or 5</td>
<td>3 Focal mildly/moderately hypointense on ADC and isointense/mildly hyperintense on high b-value DWI.</td>
</tr>
<tr>
<td>4</td>
<td>Circumscribed, homogenous moderate hypointense focus/mass confined to prostate and &lt;1.5 cm in greatest dimension</td>
<td>4 Focal markedly hypointense on ADC and markedly hyperintense on high b-value DWI; &lt; 1.5 cm in greatest dimension</td>
</tr>
<tr>
<td>5</td>
<td>Same as 4 but ≥1.5cm in greatest dimension or definite extraprostatic extension/invasive behavior</td>
<td>5 Same as 4 but ≥1.5cm in greatest dimension or definite extraprostatic extension/invasive behavior</td>
</tr>
</tbody>
</table>

#### T2: Transition Zone (TZ)

<table>
<thead>
<tr>
<th></th>
<th>Description</th>
<th>DCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Homogeneous intermediate signal intensity (normal)</td>
<td>(-) no early enhancement, or diffuse enhancement not corresponding to a focal finding on T2 and/or DWI or focal enhancement corresponding to a lesion demonstrating features of BPH on T2WI</td>
</tr>
<tr>
<td>2</td>
<td>Circumscribed hypointense or heterogeneous encapsulated nodule(s) (BPH)</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Heterogeneous signal intensity with obscured margins Includes others that do not qualify as 2, 4, or 5</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Lenticular or non-circumscribed, homogeneous, moderately hypointense, and &lt;1.5 cm in greatest dimension</td>
<td>(+) focal, and earlier than or contemporaneously with enhancement of adjacent normal prostatic tissues, and; corresponds to suspicious finding on T2W and/or DWI</td>
</tr>
<tr>
<td>5</td>
<td>Same as 4, but ≥ 1.5cm in greatest dimension or definite extraprostatic extension/invasive behavior</td>
<td></td>
</tr>
</tbody>
</table>

#### Overall PZ

<table>
<thead>
<tr>
<th>DWI</th>
<th>T2W</th>
<th>DCE</th>
<th>PI-RADS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Any</td>
<td>Any</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Any</td>
<td>Any</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Any</td>
<td>+</td>
<td>3</td>
</tr>
<tr>
<td>4</td>
<td>Any</td>
<td>Any</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Any</td>
<td>Any</td>
<td>5</td>
</tr>
</tbody>
</table>

#### Overall TZ

<table>
<thead>
<tr>
<th>T2W</th>
<th>DCE</th>
<th>DWI</th>
<th>PI-RADS</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Any</td>
<td>Any</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Any</td>
<td>Any</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Any</td>
<td>≤4</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Any</td>
<td>Any</td>
<td>4</td>
</tr>
<tr>
<td>5</td>
<td>Any</td>
<td>Any</td>
<td>5</td>
</tr>
</tbody>
</table>
INTRODUCTION

Our experience with prostate mpMRI

• Started reporting using PIRADS v2 scoring in December 2014
• Most common indications for MRI
  – previous negative biopsy but clinically concerned
  – on active surveillance
• Many patients undergo subsequent MRI/TRUS guided fusion prostate biopsy
• In general, PI-RADS 1/2 not biopsied, PI-RADS 4/5 biopsied, PI-RADS 3 case dependent (often will be biopsied)
INTRODUCTION

Hypothesis

• PI-RADS v2 scoring system improves specificity and sensitivity for positive fusion biopsy result in MRI detected lesions compared to v1
• Secondary outcomes:
  – Improved inter-rater reliability
  – Extrapolate how it could alter biopsy practices
MATERIALS AND METHODS

Retrospective analysis of MRIs from Nov 2012 – Sep 2014
  – 100 consecutive patients who had mpMRI and fusion biopsy

MRI parameters: T2, DWI/ADC (b0, 500, 1000), DCE, 1.5T, no endorectal coil

Each biopsied lesion re-classified using PI-RADS v2 scoring
  – 2 readers (1.5 years and 10+ years reading prostate MRI), blinded to pathology, 20% of patients double read by reader 2
  – PI-RADS v1 score provided by original reader recorded

Correlation made to biopsy histopathology
  – Subgroup of clinically significant cancers (Gleason 7 or greater) also recorded
RESULTS

100 patients included
Nov 2012 – Sep 2014

205 lesions biopsied
mean 2.1 per patient

166 (81.1%)
transition zone lesions

113 (55.1%)
same or ±1 such that no change in management

7 (3.4%)
upgraded from PI-RADS ≤3 to 4/5

85 (41.4%)
downgraded from PI-RADS ≥3 to 1/2

Good interrater reliability
K = 0.611

5 biopsy +ve
(2 x GI 3+3, 3 ≥GI 7)

2 biopsy -ve

4 biopsy +ve
(all GI 3+3)

81 biopsy –ve

.PI-RADS v1 reported 0.44-0.526)
RESULTS

All clinically significant cancers scored ≥PI-RADS 3
  – 28/48 were clinically significant (i.e. Gleason 7 and greater)
  – After rescoring with v2 – 23/28 were PI-RADS 4 or 5, 5 were PI-RADS 3, none were PI-RADS ½
  – Preliminary results also suggest increasing PI-RADS score correlates with increasing cancer significance (size and Gleason grade)

Improved specificity and positive predictive value for V2 in a score of PI-RADS 4/5 predicting clinically significant cancer

<table>
<thead>
<tr>
<th></th>
<th>PI-RADS V1</th>
<th>PI-RADS V2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sensitivity</td>
<td>81.5%</td>
<td>82.1%</td>
</tr>
<tr>
<td>Specificity</td>
<td>58.4%</td>
<td>85.4%</td>
</tr>
<tr>
<td>Positive Predictive Value</td>
<td>22.9%</td>
<td>46.9%</td>
</tr>
<tr>
<td>Negative Predictive Value</td>
<td>95.4%</td>
<td>98.8%</td>
</tr>
</tbody>
</table>
CASE EXAMPLES

Right apex transition zone lesion downgraded from PI-RADS 4 to 2.

Biopsy +ve
CASE EXAMPLES

Left midgland transition zone lesion downgraded from PI-RADS 4 to 3.

Biopsy -ve
Left midgland peripheral zone lesion, unchanged PI-RADS 5

Biopsy +ve
DISCUSSION

Significantly improved specificity and NPV with similar PPV and sensitivity for positive fusion biopsy

- 85 (41.4%) fewer lesions would have been biopsied without missing a clinically significant cancer

Better inter-rater reliability for PI-RADS 2 vs reported for PI-RADS 1 = more consistency between readers, improved standardization of interpretation

Implications for patient care
- More consistency for urologists = MRI more reliable for guiding patient management
- Fewer unnecessary biopsies
DISCUSSION

Limitations

• PPV remains modest (ie. Still many false positives)
  — still overcalling many lesions (perhaps due to being overcautious with regards to indeterminate lesions)
  — Anecdotally, whether to call something 3 or 4 on T2 is the most difficult

• DWI acquired based on PI-RADS 1 technical parameters (“high” b-value 1000)

• Fusion biopsy result does not always accurately reflect underlying pathology
  — Targets can be missed by biopsy, and cancer may exist within the gland not identified on MRI

• Our population mostly consists of anterior and TZ lesions, peripheral zone lesions underrepresented
FUTURE DIRECTIONS

• Further validation needed
  – Larger sample size
  – Correlation to whole mount pathology
  – Other technical parameters (3T, endorectal coil, DWI b 1400)

• Impact on patient outcome and cost-effectiveness.
REFERENCES


THANKS!