Radiologic Contributions to the Prostatitis Phenotyping Network

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Agenda

• **Overview of the Prostate**
  – Anatomy Overview
  – Anatomy on Imaging

• **Prostatitis**
  – Introduction and Subtypes
  – Diagnostic Challenges of Chronic Prostatitis/Chronic Pelvic Pain Syndrome

• **Patient Presentations**
  – Index, Comparison, and Companion Cases
  – ACR Appropriateness Criteria
  – Differential Diagnoses

• **Future of Imaging in Prostatitis**
  – Current Role of Imaging in Prostate Pathology
  – Future of Imaging in Prostatitis
Overview of the Prostate: Anatomy

- Glandular (2/3) and fibromuscular (1/3) organ lying inferior to the bladder
  - Surrounded by 2-3mm capsule
  - Supported anteriorly by the puboprostatic ligaments and inferiorly by the urogenital diaphragm
  - Contains posterior urethra
  - Perforated posteriorly by ejaculatory ducts

Prostate Anatomy Continued

• Zonal Anatomy
  – Peripheral*, Central*, Transition*, and Anterior Fibromuscular Zones
  *Glandular Zones

• Lobar Anatomy
  – Anterior, Posterior, Lateral, and Median Lobes
  – No longer accepted

• Pathologic Distinctions
  – BPH occurs almost exclusively in the transition zone centrally
  – Prostatic cancer occurs mostly in the peripheral zone (70%)

Prostate Anatomy: Axial Transrectal Ultrasound

PZ: Peripheral Zone
U: Urethra
CZ: Central Zone
A: Anterior
R: Right
L: Left

Prostate Anatomy on CT and MRI

Axial Contrast Enhanced CT

Axial T2-Weighted MR


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Prostatitis: Introduction

• Diagnosis and Clinical Presentation
  – Classified into several distinct categories
  – Acute forms are often diagnosed on basis of positive infectious cultures
  – Diagnosis of chronic forms rely on the presentation of pelvic or perineal pain, typically lasting for longer than 3 months; can be bacterial or noninfectious
  – Meares-Stamey “Four-Glass Test” can aid in diagnosis

• Etiology and Pathogenesis
  – Most sufferers have no identifiable pathogen on repeated cultures
  – Remaining cases are typically caused by Proteus, Enterobacter, Klebsiella, and Pseudomonas

Prostatitis: A Closer Look

• Classified into four types
  – Acute, Chronic (CP), Chronic Nonbacterial/Chronic Pelvic Pain Syndrome (CPPS), Asymptomatic Nonbacterial Prostatitis
  – Prevalence in population is estimated to be 12%; CP/CPPS is the most common form (up to eight times more common than other forms)
  – Prostatic abscess is a common complication of prostatitis
  – Acute Prostatitis is diagnosed clinically and treated without imaging

• CP/CPPS is a heterogeneous condition
  – Clinical presentation varies from patient to patient
  – Symptoms tend to fluctuate within a single patient
  – Several etiologic mechanisms (infection, inflammation, etc.)
  – There is overlap in presentation with other chronic pain disorders

CP/CPPS: A Closer Look

• Diagnostic Challenges
  – Given heterogeneous nature of CP/CPPS, reliable and accurate phenotyping and diagnosis has been difficult to achieve
  – Objective measures have the potential to further characterize CP/CPPS. Examples include:
    • mRNA levels
    • Proteomic patterns
    • Imaging: Transrectal Ultrasound (TRUS), Computed Tomogram (CT), Magnetic Resonance (MRI)

• Imaging’s Role
  – Generally underutilized in the evaluation of benign conditions, including CP/CPPS
  – Current emphasis is on studies that provide indirect information about the prostate (DRE, Retrograde Urethrography, Cystourethroscopy)
  – Clinically, however, TRUS and CT are the most informative studies of the prostate, while MRI allows us to visualize the interior structure of the prostate

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Patient Presentation: Index Case

• HPI
Patient Mr. S is a 76-year-old man recently s/p laparoscopic bilateral hernia repair who presents with urinary retention. A Foley catheter was placed for post-op urinary retention 1.5 weeks prior with a failed voiding trial 5 days ago. He complains of one day of decreased catheter output.

• Physical Exam
Unremarkable except for fever to 101.5 F and palpated full suprapubic region.

• Labs and Studies
-Creatinine = 1.3
-Elevated WBC (21.1 K/ul) with 93.9% Neutrophils
-Urine: Nitrite positive with many bacteria and WBCs
### ACR Criteria: Menu of Tests

#### Clinical Condition:
**Obstructive Voiding Symptoms Secondary to Prostate Disease**

**Variant 2:**

**Increased blood urea nitrogen (BUN) and/or creatinine.** (See the ACR Appropriateness Criteria® for “Renal Failure”).

<table>
<thead>
<tr>
<th>Radiologic Procedure</th>
<th>Rating</th>
<th>Comments</th>
<th>RRL*</th>
</tr>
</thead>
<tbody>
<tr>
<td>US pelvis (bladder and prostate) transabdominal</td>
<td>8</td>
<td>To evaluate for residual urine and prostate size and bladder wall thickness.</td>
<td>O</td>
</tr>
<tr>
<td>US kidney retroperitoneal</td>
<td>8</td>
<td>To evaluate for hydronephrosis. To exclude calculi. Can be used in association with US.</td>
<td>O</td>
</tr>
<tr>
<td>X-ray abdomen</td>
<td>3</td>
<td></td>
<td>☓</td>
</tr>
<tr>
<td>US pelvis (prostate) transrectal</td>
<td>2</td>
<td>Can assess prostate size by transabdominal US. Resisitive indices (RI) have been shown to be elevated in BPH and to decrease after transurethral vaporization of the prostate, suggesting that RI can be used to evaluate severity of BPH and to monitor therapy.</td>
<td>O</td>
</tr>
<tr>
<td>MRI pelvis without contrast</td>
<td>2</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>X-ray voiding cystourethrography</td>
<td>2</td>
<td>Consider in men younger than age 50 with symptoms.</td>
<td>☓</td>
</tr>
<tr>
<td>X-ray intravenous urography</td>
<td>1</td>
<td>Other studies better for evaluating same structures.</td>
<td>☢️</td>
</tr>
<tr>
<td>X-ray retrograde urethrography</td>
<td>1</td>
<td>Does not assess prostate size.</td>
<td>☢️</td>
</tr>
<tr>
<td>MRI pelvis without and with contrast</td>
<td>1</td>
<td></td>
<td>O</td>
</tr>
<tr>
<td>CT abdomen and pelvis without contrast</td>
<td>1</td>
<td>Not indicated.</td>
<td>☢️</td>
</tr>
<tr>
<td>CT abdomen and pelvis with contrast</td>
<td>1</td>
<td></td>
<td>☢️</td>
</tr>
<tr>
<td>CT abdomen and pelvis without and with contrast</td>
<td>1</td>
<td></td>
<td>☢️</td>
</tr>
</tbody>
</table>

**Rating Scale:** 1, 2, 3 Usually not appropriate; 4, 5, 6 May be appropriate; 7, 8, 9 Usually appropriate

*Relative Radiation Level*
# Staff Suspected Pyelonephritis

## Clinical Condition:

### Variant 2:

Complicated patient (e.g., diabetes or immunocompromised or history of stones or prior renal surgery or not responding to therapy).

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<tr>
<td>CT abdomen and pelvis without and with contrast</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT abdomen and pelvis with contrast</td>
<td>8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>US kidneys and bladder retroperitoneal with KUB</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CT abdomen and pelvis without contrast</td>
<td>6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MRI abdomen and pelvis without and with contrast</td>
<td>6</td>
<td>See statement regarding contrast in text under “Anticipated Exceptions.”</td>
<td></td>
</tr>
<tr>
<td>MRI abdomen and pelvis without contrast</td>
<td>4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray voiding cystourethrogram</td>
<td>3</td>
<td>Not part of initial evaluation but may be used subsequently to demonstrate clinically suspected reflux.</td>
<td></td>
</tr>
<tr>
<td>Tc-99m DMSA scan kidney</td>
<td>3</td>
<td>Cannot differentiate renal parenchymal disease from perinephric process.</td>
<td></td>
</tr>
<tr>
<td>X-ray abdomen and pelvis (KUB)</td>
<td>2</td>
<td>Does not provide sufficient information by itself to guide therapy.</td>
<td></td>
</tr>
<tr>
<td>X-ray intravenous urography</td>
<td>2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>X-ray antegrade pyelography</td>
<td>1</td>
<td>Not an initial study.</td>
<td></td>
</tr>
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</table>

**Rating Scale:** 1,2,3 Usually not appropriate; 4,5,6 May be appropriate; 7,8,9 Usually appropriate

Mr. S: Axial CT of Pelvis

3.8 x 3.5 x 4.0 cm area of hypoattenuation along the peripheral zone ascending from the apex to the mid gland

Mild periprosthetic fat stranding

Marked prostatic enlargement (5.4 cm x 6.5 cm in AP and transverse dimensions)
Mr. S: Coronal CT of Abdomen

3.8 x 3.5 x 4.0 hypoattenuation along the peripheral zone ascending from the apex to the mid gland

Marked prostatic enlargement (5.4 cm x 6.5 cm in AP and transverse dimensions)

Mild periprostatic fat stranding
Mr. S: Color Doppler TRUS (CDU)

Hypoechoic spherical structure with irregular walls and interspersed hyperechoic debris [*] concerning for a multiloculated abcess

Color Doppler Ultrasonography (CDU) demonstrates increased color flow at the margin and surrounding hypoechoic zone, with no signals in the nearly anechoic pockets [*] within the multiloculated structure.
Mr. S: Differential Diagnosis

• **Area of Hypoattenuation in Prostate on CT**
  – Abscess, Cystic Mass (including Mullerian Duct Cyst), Chronic Prostatitis, Benign Cystic Hyperplasia, Prostatic Tuberculosis

• **Diffusely Enlarged Prostate**
  – Benign Prostate Hyperplasia (BPH), Prostate Carcinoma, Chronic Prostatitis

• **Hypoechoic Region on TRUS**
  – Abscess, Cystic Mass, Chronic Prostatitis, Pancreatic Carcinoma

Now that we have examined an echoic structure with low flow on CDU concerning for prostatic abscess, let’s compare to CDU of prostatic carcinoma
TR-CDU reveals 1.0 cm x 1.1 cm rounded hypoechoic nodule with increased color flow.
TRUS: Prostate Carcinoma vs. Abscess

• Prostatic Abscess
  – Hypoechoic
  – Well defined or irregular wall (irregular typically associated with prostatitis)
  – CDU reveals Perilesional vascularity

• Prostate Carcinoma
  – Hypoechoic (typically in peripheral zone) or heterogenous (in high grade malignancies)
  – Ill-defined borders
  – CDU reveals vascularity within the lesion

Mr. S: Refined Differential

• Recall Patient Presentation
  – Urinary obstruction with UTI and febrile to 101.5F

• Significant Imaging
  – Area of Hypoattenuation on CT in the setting of diffusely enlarged prostate and periprostatic fat stranding
  – TRUS-CDU reveals hypoechoic zone with perilesional vascularity

• Refined Differential
  – Chronic Prostatitis, Prostatic Abscess, BPH
TRUS-guided drainage was ordered to further characterize the mass and also to serve as therapy
Mr. S: TRUS-Guided Drainage

TRUS-guided aspiration of abscess reveals an echogenic 18-gauge needle inserted into the abscess pocket.
TRUS-Guided Drainage Report

• Drainage Results
  – Needle Deployed into three separate fluid pockets
  – 12 cc of very thick viscous purulent material was aspirated
  – Post-drainage imaging did not demonstrate any further fluid pockets

• Aspirate Characterization
  – Gram Stain: Polymorphonuclear Leukocytes and Gram Negative Rods
  – Culture: Pan-sensitive Klebsiella Pneumoniae

• Final Diagnosis
  – Prostatitis complicated by prostatic abscess
Given our working understanding of prostatitis and prostatic abscess on imaging, let’s look at some more examples
T2 MR Prostate reveals an enlarged central gland, with a heterogenous swirled appearance and multiple well-defined nodules [*]

Diffuse enhancement throughout the peripheral gland, with no evidence of focal lesion
Companion Patient No.3 and No.4: Prostatitis on TRUS

Patient No. 3 Axial TRUS

Axial TRUS displays hypoechoic nodular pattern of chronic prostatitis [*]

Patient No. 4 Axial TRUS

Axial TRUS shows multifocal hypoechoic changes in the peripheral zone [*]

Companion Patients No. 5 and No. 6: Prostatic Abscess on TRUS

Patient No. 5 Axial TRUS

TRUS demonstrates a poorly defined hypoechoic zone with a nearly anechoic center [*]

Patient No. 6 TR-CDU

Color Doppler Ultrasound shows increased flow at the zone surrounding the hypoechoic structure, with no signals in the anechoic center


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Role of Imaging in Prostate Pathology

• **Prostate Carcinoma**
  - Clinical management continues to be very controversial (screening, diagnostic tests, pretreatment evaluation)
  - Imaging plays less of a role in early detection and is more geared towards diagnosis, staging, and treatment planning

• **Other Prostate Perturbations**
  - Although numerous other ailments involving the prostate cause significant morbidity, they receive little attention in the imaging literature
  - Examples include: CP/CPPS, Benign Prostatic Hyperplasia, Other Malignancies

• **A Review of the Menu of Tests**
  - Includes: TRUS (including guided biopsies), Endorectal MR, Spectroscopy, CT, Bone Scintigraphy

Future of Imaging in Prostatitis

• State of Chronic Prostatitis
  – Heterogeneous nature creates unique challenges in diagnosis and classification
  – There is an absence of objective measures
  – Comprehensive understanding needed for continued diagnostic and therapeutic understanding

• The Future Imaging in Prostatitis
  – Imaging continues to contribute to the understanding and diagnosis of prostatitis (and common complications, such as prostatic abscess)
  – Radiologic studies can contribute to emerging compilation networks of genomic, proteomic, and metabolomic data in eliciting an accurate phenotype and characterization of CP/CPPS

Summary

• Prostatitis is a heterogeneous clinical entity
  – Diagnosis is difficult to make
  – Imaging is currently underutilized

• Imaging can aid in diagnosing prostatitis
  – TRUS, CDU, MRI, CT

• The phenotyping of prostatitis relies on multiple modalities
  – Imaging can provide an objective measure and aid in developing phenotyping networks
References 1


References 2


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