Benign Causes of Diffusion Restriction Foci in the Peripheral Zone of the Prostate: Diagnosis and Differential Diagnosis

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Disclosure Statement

The authors have no actual or potential conflicts of interest in relation to this presentation.
Goals and Objectives

• Discuss key multiparametric MRI (Mp-MRI) features of benign causes of diffusion restriction foci in the peripheral zone (PZ) of the prostate

• Describe the clues that help distinguish benign causes of diffusion restriction foci from prostate carcinoma (PCa)

• Present pathologically proven examples
Introduction

• Prostate cancer is the most frequently diagnosed form of noncutaneous cancer in men

• American Cancer Society estimates about 220,800 new cases of prostate cancer for 2015

• Second leading cause of cancer death in men (27,540 deaths estimated for 2015)

• Approximately 1 in 6 men will be diagnosed with prostate cancer during their lifetime
Introduction

• Current clinical screening methods such as PSA testing or TRUS guided prostate biopsies for PCa lack sensitivity and specificity

• Multiparametric MRI has emerged as an important tool in the diagnosis of PCa

• Many benign entities can demonstrate diffusion restriction in the PZ that mimic PCa and create diagnostic challenges
Introduction

• Examples of benign diffusion restriction foci in the PZ include
  - Prostatitis
  - Hypertrophic nodule
  - Normal displaced central zone
  - Pseudolesion at the midline of the peripheral zone
  - Hemorrhage
  - Thickened surgical capsule
  - Prominent periprostatic fat
  - Enlarged neurovascular bundle

• In this poster, we will discuss MR findings of benign diffusion restriction foci in the PZ of the prostate

• The poster will focus on the clues that help differentiate these mimics from prostate cancer

• The target audience for this poster is radiologists
Outline

I. Key MRI Features of Prostate Cancer at the PZ

II. Key MRI Features of Benign Causes of Diffusion Restriction Foci in the PZ

- Chronic Prostatitis
- Hypertrophic Nodule
- Normal Displaced Central Zone
- Pseudolesion at the Midline of the Peripheral Zone
- Hemorrhage
- Thickened Surgical Capsule
- Prominent Periprostatic Fat
- Enlarged Neurovascular Bundle

III. Summary and Clinical Implications
Key MRI Features of PCa at the PZ

• T2WI: PCa shows a round or ill-defined low signal intensity focus (Fig. 1A and 2A).

• Diffusion Weighted Imaging (DWI) – ADC Map: PCa has a lower ADC value (dark) than normal prostate tissue. A lesion with very low ADC value at the PZ is strongly suggestive of PCa (Fig. 1B and 2B). ADC values correlate well with PCa Gleason scores.

• Dynamic Contrast Enhanced MRI (DCE): PCa shows an area with rapid contrast wash in and wash out. Typically, PCa is a focus with the earliest and strongest enhancement in the prostate (Fig. 1C and 2C).
Prostate Cancer at the Peripheral Zone

Figure 1 – PCa Gleason score 7 at the left mid peripheral zone. A) Axial T2 shows a large low signal lesion with mass effect at the left mid PZ (arrow). There is evidence of extracapsular tumor extension (curved arrow). B) ADC map shows low ADC value of the lesion (arrow). C) DCE demonstrates rapid contrast wash in and wash out of the lesion (arrow).
Prostate Cancer at the Peripheral Zone

Figure 2 – PCa Gleason score 9 at the left mid PZ. A) Axial T2 shows a large low signal lesion with mass effect at the left mid PZ (arrow). B) ADC map shows low ADC value of the lesion (arrow). There is evidence of extracapsular tumor extension (curved arrow). C) DCE demonstrates rapid contrast wash in and out of the lesion (arrow).
Chronic Prostatitis

• Chronic prostatitis is a very common cause of elevated PSA levels

• Features that mimic prostate cancer:
  – Focal low T2 signal area in the PZ
  – Rapid contrast wash in and out on DCE
  – Diffusion restriction

• Key clues for differentiation include:
  – No contour deformity adjacent to low T2 signal region (geographic appearance) (Fig. 3A)
  – Ill-defined or linear margins on T2WI
  – DWI-ADC map more mild compared with PCa (Fig. 3B)
  – DCE may show bilateral symmetric enhancement (Fig. 3C)
Figure 3 – Prostatitis in a patient with PSA of 3.7. A) Axial T2WI shows low T2 signal intensity in the left mid PZ without contour deformity (arrow). B) ADC map demonstrates mild diffusion restriction in the PZ (arrow). C) DCE shows bilateral symmetric enhancement (arrows). Targeted biopsy confirmed chronic inflammation and not a tumor.
Hypertrophic Nodule in the PZ

- Hypertrophic nodules may appear in the PZ, commonly arising from the central gland.

- Features that mimic prostate cancer:
  - Low T2 signal intensity (Fig. 4A and 4B)
  - Low ADC value (Fig. 4C)
  - Rapid contrast wash in and out

- Key clues for differentiation include:
  - Nodules are generally rounded or spherical in shape with a very sharp contour and are more well defined than PCa (Fig. 4A)
  - There is usually a layer of normal prostate tissue between the nodule and prostate capsule (Fig. 4A). In contrast, PCa often extends to the capsule (Fig. 1A and 2B)
Hypertrophic Nodule in PZ

Figure 4 – Hypertrophic nodule at the left mid PZ mimicking PCa. A) Axial T2WI shows a well defined low signal lesion at the left mid PZ (arrow). The arrowhead indicates a layer of normal prostate tissue between the lesion and capsule. B) Sagittal T2WI shows the well defined lesion (arrow). C) ADC map shows low ADC value of the lesion (arrow). Biopsies confirmed no prostate cancer.
Normal Displaced Central Zone

• When the transitional zone is enlarged, the central zone may be displaced to the base of the prostate

• Features that mimic prostate cancer:
  – Homogeneous low T2 signal intensity (Fig 5A)
  – May have low ADC value (Fig. 5C)

• Key clues for differentiation include:
  – The displaced central zone is well defined
  – May be symmetric bilaterally on all sequences with classic location at the level of the ejaculatory ducts
  – The central zone does not enhance rapidly (Fig. 5D)
Normal Displaced Central Zone

Figure 5 - Displaced central zone at the left base PZ mimicking PCa. The patient had elevated PSA to 12 and had 3 negative TRUS guided prostate biopsies. A) and B) T2WI show a well defined low signal area at the left base PZ (arrow) just inferior to the seminal vesicle (SV). C) ADC map shows decreased ADC value of the area (arrow). D) DCE shows no significant contrast enhancement of the area (arrow). MRI guided biopsy confirmed normal prostate tissue.
Pseudolesion at the Midline of the PZ

- At the midline of the PZ, it is common to have a low T2 signal focus
- It is believed that fusion of the prostatic capsule and fascia at this region is responsible for the low T2 signal focus

- Features that mimic prostate cancer:
  - Low T2 signal focus (Fig. 6A)
  - May show diffusion restriction (Fig. 6B)

- Key clues for differentiation include:
  - The low T2 signal focus is at the midline
  - The contour of the prostate at the focus is concave
  - No dynamic contrast enhancement (Fig. 6C)
Figure 6 – Pseudolesion at the midline of the PZ. The patient had elevated PSA to 8 and had multiple negative TRUS biopsies. A) Axial T2 shows a low T2 signal intensity region at the midline of the PZ (arrow). B) ADC map shows low ADC value of the region (arrow). C) DCE demonstrates no enhancement (arrow). MRI guided biopsy confirmed no cancer.
Hemorrhage

• Prostate hemorrhage following TRUS guided prostate biopsy is common
• 8 weeks delay is recommended for a prostate MRI study following biopsy

• Features that mimic prostate cancer:
  – Low T2 signal intensity (Fig. 7A)
  – May show diffusion restriction (Fig. 7B)
  – May show abnormal enhancement

• Key clues for differentiation include:
  – Mild signal intensity on ADC map compared to PCa
  – Milder changes on DCE compared to PCa
  – High T1 signal intensity (Fig. 7C)
Figure 7 – Hemorrhage at the left apex of the PZ. The patient had elevated PSA to 12.5 and had multiple negative TRUS biopsies. A) Axial T2 shows a low T2 signal intensity region in the left apex of the PZ (arrow). B) ADC map shows mild low ADC value of the region (arrow). C) Axial T1 shows high signal intensity focus in the same region (arrow).
Thickened Surgical Capsule

- Proliferation and thickening of the fibromuscular layer between the transitional and peripheral zone, often from outward pressure from the development of BPH

- Features that mimic prostate cancer:
  - Low T2 signal intensity
  - Decreased ADC (Fig. 8B)

- Key clues for differentiation include:
  - Band-like or crescentic shape (Fig. 8A)
  - No dynamic contrast enhancement (Fig. 8C)
  - Located at the junction of the PZ and central gland
Figure 8 – Thickened left surgical capsule. The patient had elevated PSA to 12.5 and had prior negative TRUS biopsies. A) Axial T2 shows low T2 signal of a thickened band-like layer between the left transitional and peripheral zone (arrow). B) ADC map shows low ADC value of the corresponding region (arrow). C) DCE shows no enhancement of the region (arrow).
Prominent Periprostatic Fat

• Prominent periprostatic fat is very common along the prostate capsule

• Features that mimic prostate cancer:
  – May show significant diffusion restriction (Fig. 9B)

• Key clues for differentiation include:
  – High T2 signal intensity (Fig. 9A)
  – Adjacent to but outside the prostate
  – No dynamic contrast enhancement
Figure 9 – Prominent periprostatic fat. The patient had a PSA of 8.7 and prior negative TRUS biopsies. A) Axial T2 shows high T2 signal focus near the left apex of the peripheral zone (arrow). B) ADC map shows low ADC value of the corresponding focus (arrow).
Enlarged Neurovascular Bundle

- Neurovascular bundle (NVB) includes the nervous plexus, arteries, veins, and additional smaller nerve branches.
- Proximity of the NVB to the peripheral zone can create a challenge in assessing for focal peripheral zone lesions.

- Features that mimic prostate cancer:
  - Decreased T2 signal intensity (Fig. 10A & B)
  - Decreased signal on ADC map (Fig. 10C)

- Key clues for differentiation include:
  - Typical location along the lateral margin of the PZ
  - Discrete rounded appearance on an axial slice and more tubular morphology when tracked across multiple slices
  - May have delayed venous enhancement due to small venous structures
Figure 10 – Enlarged neurovascular bundle. The patient had a PSA of 8.7 and prior negative TRUS biopsies. A) Axial T2 shows low T2 signal foci along the right base lateral aspect PZ (arrow). B) Coronal T2 shows tubular structures with low T2 signal intensity along the right lateral aspect (arrow). C) ADC map shows low ADC value of the corresponding foci along the right base PZ (arrow).
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<th>Benign Causes of Diffusion Restriction Foci in the PZ</th>
<th>Key Clues in Differentiation</th>
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<tr>
<td>Chronic Prostatitis</td>
<td>• Ill-defined margins with no contour deformity</td>
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<td></td>
<td>• Slight diffusion restriction</td>
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<td></td>
<td>• Mild, usually symmetric, contrast wash-in and wash-out</td>
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<td>Hypertrophic Nodule in the PZ</td>
<td>• Round shape with well-defined margins</td>
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<td>• Layer of normal tissue between nodule and prostate capsule</td>
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<td>Normal Displaced Central Zone</td>
<td>• Commonly symmetric and at the level of ejaculatory ducts</td>
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<td></td>
<td>• No or minimal rapid contrast wash-in and wash-out</td>
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<tr>
<td>Pseudolesion at the Midline of the PZ</td>
<td>• Midline location with concave contour of the prostate at the focus</td>
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<td></td>
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<td>Enlarged Neurovascular Bundle</td>
<td>• Tubular appearance on at least one plane</td>
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<td>• Located along lateral margins of the PZ</td>
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Summary and Clinical Implications

- A wide variety of benign entities at the PZ can have diffusion restriction on Mp-MRI and mimic prostate cancer.
- Knowledge of the key MR features of these mimics will help distinguish them from prostate cancer.
- A correct diagnosis is important to help guide clinical management and avoid unnecessary intervention.
References

- Rosenkrantz AB, Taneja, SS. Radiologist, be aware: ten pitfalls that confound the interpretation of multiparametric prostate MRI. AJR 2014; 202: 109-120.

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