Dynamic Contrast Enhanced MRI in the Diagnosis of Prostate Cancer: Added Value and Pitfalls

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Disclosure

- None
Teaching Points

• To discuss the added value of dynamic contrast-enhanced (DCE) imaging in the diagnosis of prostate cancer (PCa) at multiparametric magnetic resonance imaging (mp-MRI)

• To describe common and uncommon pitfalls in its interpretation

• To emphasize strategies and MR imaging clues to avoid these mistakes
Introduction

- Prostate cancer is the most frequently diagnosed form of noncutaneous cancer in men
  - It accounts for 25% of all cancers (180,890 American men per year)
  - It is the second leading cause of cancer death in men (26,120 per year)
- Approximately 1 in 7 men will be diagnosed with PCa during their lifetime
- Recent advances of prostate mp-MRI have significantly improved accuracy in the diagnosis of PCa
Mp-MRI is excellent for detection, localization and staging of PCa

However, no single MRI sequence is sufficient to characterize PCa

There are many misconceptions and diagnostic challenges related to interpretation of findings at DCE-MRI

- Controversy exists regarding continued use of DCE imaging in routine prostate mp-MRI protocols

Experience in performing both mp-MRI of the prostate and US/MR fusion-guided prostate biopsies at our medical center helped us recognize the importance of DCE imaging in avoiding interpretative errors at mp-MRI
Introduction

• Added value of DCE-MRI includes but is not limited to
  ➢ Role as the most important sequence in diagnosis of recurrent PCa
  ➢ Crucial imaging evidence of the presence of otherwise subtle primary PCa in some cases (particularly for lesions in the transitional zone)
  ➢ Increased confidence in the diagnosis of PCa
  ➢ Help distinguishing PCa from its mimics

• Mistakes in interpretation of DCE imaging include but are not limited to
  ➢ Overrating enhancing foci at DCE imaging
  ➢ Misinterpreting enhancement of normal anatomic structures and benign processes as suspicious lesions

• The added value of DCE imaging with imaging clues and strategies for avoiding mistakes in its interpretation will be emphasized with many targeted biopsy-proven examples
Outline

• **Added value of DCE-MRI**
  A. Role as the most important sequence in diagnosis of recurrent PCa
  B. Crucial imaging evidence of the presence of otherwise subtle primary PCa in some cases
    ➢ Particularly for lesions in the transitional zone
  C. Increased confidence in the diagnosis of PCa
  D. Help distinguishing PCa from its mimics

• **Mistakes in interpretation of DCE imaging**
  A. Overrating enhancing foci at DCE imaging
  B. Misinterpreting enhancement of normal anatomic structures and benign processes as suspicious lesions
Added Value of DCE-MRI
A. Role as the most important sequence in diagnosis of recurrent PCa

Following radical prostatectomy

• Recurrent PCa in the surgical bed following radical prostatectomy is common, occurring in 23 to 42%

• Early detection of focal recurrence is crucial because these recurrences can be treated by external radiation with a good response

• Recurrent PCa at T2WI has a slightly higher T2 signal intensity than that of adjacent musculature

• DCE yields important information since the majority of recurrences show rapid contrast wash in and wash out

  ➢ Abnormally enhancing area should be considered suspicious for tumor regardless of whether it has corresponding abnormality at T2WI and DWI
Recurrent PCa in the surgical bed. The patient is s/p radical prostatectomy with slowly rising PSA of 2.8. Axial T2 (A) shows a soft tissue mass (arrow) with slightly high T2 signal intensity. DCE (B) demonstrates the lesion in the surgical bed (arrow) with contrast wash in and out.
Added Value of DCE-MRI

A. Role as the most important sequence in diagnosis of recurrent PCa

Following external beam radiation therapy

- Recurrent PCa in patients after radiation therapy is common, ranging from 25 to 63%
- Accurate localization of recurrent local tumor allows for the possibility of reducing the target volume with salvage radiation therapy
- Diffusely low T2 signal intensity and indistinctness of normal zonal anatomy of prostate create diagnostic difficulty, particularly at T2WI
- The recurrence is;
  - Commonly seen in the same location as the pre-treatment tumor
  - Appears as a mass-like low T2 signal intensity nodule
  - Demonstrates diffusion restriction and abnormal enhancement
Recurrent PCa in the left apex. The patient is s/p external beam radiation therapy with recent elevation of PSA to 2.4. Axial T2 (A), DCE (B) and ADC map (C) demonstrate a lesion in the left apex (arrows) with nodular low T2 signal intensity (A), abnormal contrast wash in and out (B) and diffusion restriction (C), concerning for PCa. Targeted biopsy confirmed recurrent PCa Gleason score 7.
Added Value of DCE-MRI
A. Role as the most important sequence in diagnosis of recurrent PCa

Following brachytherapy

- T2WI and ADC maps are degraded by the radiation seeds
- In addition, diffusely low T2 signal intensity and indistinctness of normal zonal anatomy of prostate present diagnostic difficulty, particularly at T2WI
- DCE is the single most important sequence in diagnosis of recurrence in these patients
  - Demonstrates rapid contrast wash in and wash out in the lesion
Added Value of DCE-MRI
Recurrent PCa following brachytherapy

Recurrent PCa in the anterior aspect of the left central gland. The patient is s/p brachytherapy with recent elevation of PSA to 1.7. DCE (A) demonstrates a lesion in the anterior aspect of left central gland (arrow) with contrast wash in and out. Axial T2 (B) shows no focal abnormality (arrow). DWI (not shown) was not helpful. MRI guided biopsy confirmed recurrent PCa Gleason score 7.
Added Value of DCE-MRI

B. Crucial imaging evidence of the presence of otherwise subtle primary PCa in some cases

- Particularly for lesions in the transitional zone (TZ)
  - In some cases, lesions in TZ do not have typical features at T2WI and DWI
  - DCE may be the key sequence in diagnosis
    - Early, asymmetric enhancement with wash out
68-year-old male with elevated PSA of 8.2 and multiple prior TRUS-guided prostate biopsies. (A) Axial T2WI shows a mildly hypointense area involving the apex TZ bilaterally (arrow). (B) ADC map shows minimal diffusion restriction of the area (arrow). Findings at T2WI and ADC are not very concerning for PCa. (C) DCE demonstrates marked enhancement with washout of the area (arrow), highly suspicious for PCa. US/MRI fusion-guided biopsy of the area in the apex confirmed PCa, Gleason score 7.

Added Value of DCE-MRI
Crucial imaging evidence of the presence of otherwise subtle primary PCa
C. Increased confidence in the diagnosis of PCa

47-year-old male with elevated PSA of 6.7 and 2 prior TRUS-guided prostate biopsies. (A) Axial T2WI shows a subtle hypointense area involving the apex TZ bilaterally (arrow). (B) ADC map shows minimal diffusion restriction of the area (arrow). Findings at T2WI and ADC are concerning for PCa, but the confidence is not high. (C) DCE demonstrates marked enhancement with washout of the area (arrow), highly suspicious for PCa. US/MRI fusion-guided biopsy of the area in the apex confirmed PCa, Gleason score 7 (4+3).
Added Value of DCE-MRI
D. Help distinguishing PCa from its mimics

- There are many mimics of PCa that may have imaging features similar to PCa at T2WI and DWI, creating a diagnostic challenge
- DCE can play a very important role in differentiating these mimics from PCa
  - Displaced central zone
  - Hypertropic anterior fibromascular stroma
  - Granulomatous prostatitis
  - Ejaculatory duct
Displaced central zone at the right base TZ mimicking PCa. The patient had elevated PSA of 7.2. (A) Axial T2WI shows a low signal area at the right base TZ (arrow) lateral aspect at the level of the ejaculatory ducts (angled arrow). (B) ADC map shows low ADC value of the area (arrow). (C) DCE shows no significant contrast enhancement of the area (arrow), helping differentiate this area from PCa. MRI/US fusion guided biopsy confirmed normal prostate tissue.
Asymmetric and hypertrophic fibromuscular stroma mimicking PCa. The patient had elevated PSA of 11. Axial (A) and coronal (B) T2WI demonstrate a very low T2 soft tissue mass in the right anterior aspect of the TZ (arrow) off the midline. ADC map (C) shows diffusion restriction (arrow) of the mass, mimicking PCa. DCE (D) shows no enhancement of the mass, not supportive of PCa. MRI guided biopsy confirmed benign fibromuscular stroma.
69-year-old male with elevated PSA of 4.1 and no prior TRUS-guided prostate biopsy. (A) Axial T2WI shows a hypointense lesion in the left apex PZ (arrow). (B) ADC map shows diffusion restriction of the lesion (arrow), concerning for PCa. (C) DCE demonstrates no enhancement with washout of the lesion (arrow), not supportive of the suspicion of PCa. US/MRI fusion-guided biopsy of the lesion in the left apex confirmed granulomatous prostatitis.
Ejaculatory duct in a patient with elevated PSA of 7.8 and 2 prior TRUS-guided prostate biopsies. (A) Axial T2WI shows a hypointense lesion in the midline of PZ (arrow). (B) ADC map shows diffusion restriction of the focus (arrow), concerning for PCa. (C) DCE demonstrates no enhancement with washout of the focus (arrow), not supportive of the suspicion of PCa. US/MRI fusion-guided biopsy of the focus confirmed no cancer.
Mistakes in interpretation of DCE imaging

A. Overrating enhancing foci at DCE imaging

- Vividly enhancing foci in the PZ or TZ may be seen in PCa
- However, overrating enhancing foci may lead to an incorrect diagnosis of PCa
  - PI-RADS v2 downgrades the importance of DCE
- An area with rapid contrast wash-in and –out at DCE in an untreated prostate is common
  - If the area has typical MR imaging features of PCa at T2WI and DWI
    - Area should be considered suspicious for tumor
  - If the area does not have abnormality at DWI and/or T2WI
    - Area should not be considered suspicious for tumor
    - Findings are usually due to prostatitis
- To avoid mistakes, always keep in mind
  - For PZ PCa, DWI/ADC map is the key imaging sequence
  - For TZ PCa, T2WI is the key imaging sequence
Chronic Prostatitis in a patient with PSA of 13.  (A) Axial T2WI shows low T2 signal intensity in the bilateral mid PZ without contour deformity (arrows).  (B) DCE shows bilateral focal enhancement (arrows), concerning for PCa.  (C) ADC map demonstrates mild diffusion restriction in the PZ (arrows). Targeted biopsy confirmed chronic inflammation, not a tumor.
Mistakes in interpretation of DCE imaging

B. Misinterpreting enhancement of normal anatomic structures and benign processes as suspicious lesions

- Vividly enhancing foci in the PZ or TZ may represent normal anatomic structures and benign processes such as hypertrophic nodules or post biopsy hemorrhage.
- Familiarity with the imaging features of these anatomic structures and benign processes is the key to making the distinction.
- If the abnormality is only identified on DCE in an untreated prostate without abnormal findings on T2WI and DWI, PCa is often not present.
Hypertrophic nodule in the right TZ mimicking PCa. (A) Axial T2WI shows a low signal nodule in the right TZ (arrow) with well-defined capsule (arrowheads), which helps to exclude PCa. (B) DWI shows the area with diffusion restriction (arrow). (C) DCE demonstrates rapid contrast wash in and out of the area (arrows). MRI/US fusion guided biopsy confirmed no cancer.
Post biopsy hemorrhage in left PZ in a patient with PSA of 14 and recent TRUS Bx.  
(A) Axial T2WI shows low T2 signal intensity in the left mid PZ (arrow).  
(B) DCE shows focal enhancement with wash out in left mid PZ (arrow), concerning for PCa.  
(C) ADC map demonstrates mild diffusion restriction of the area (arrow).  
(D) Axial T1 shows increased T1 signal intensity of the area, consistent with hemorrhage.
Summary and Clinical Implications

- DCE-MRI is an important component of the mp-MRI approach to the diagnosis of PCa.
- If we are familiar with its potential value and pitfalls, DCE-MRI provides useful information for making the diagnosis of PCa, distinguishing PCa from other diagnoses, and evaluating the severity, location, and extent of primary and recurrent PCa.
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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