Common pitfalls in multi-parametric MRI of the prostate

Content

- Learning objective
- Background
- PI-RADS v2 diagnostic algorithm
  - Peripheral zone lesion
  - Transitional zone lesion
- Pitfalls
  - Normal anatomic structures mistaken as cancer
  - Benign pathology that mimic cancer
- Conclusion

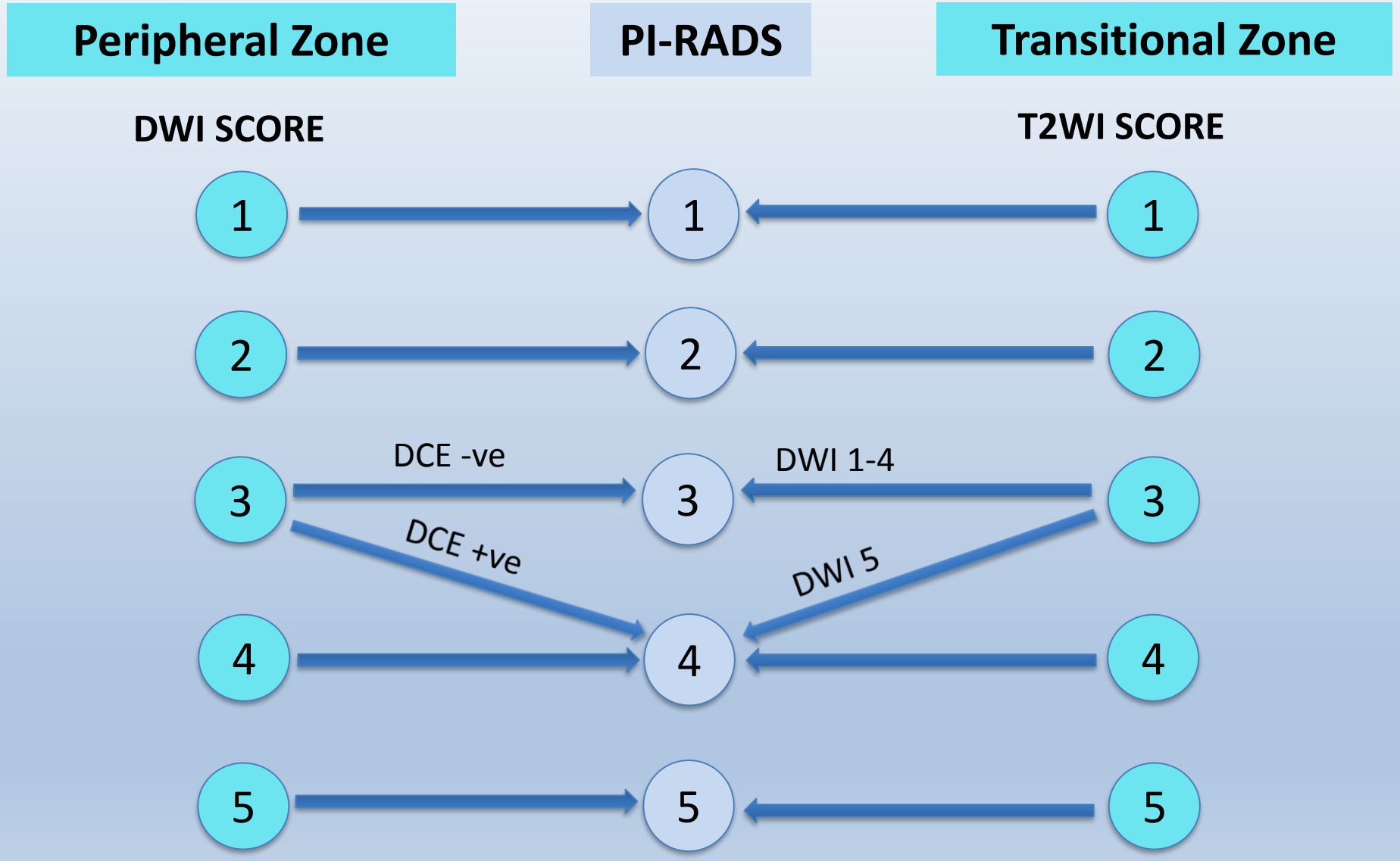
Learning objectives

- Illustrate the common diagnostic pitfalls that can occur in interpretation of multi-parametric MRI of the prostate utilizing the PI-RADS version2 system.

Background

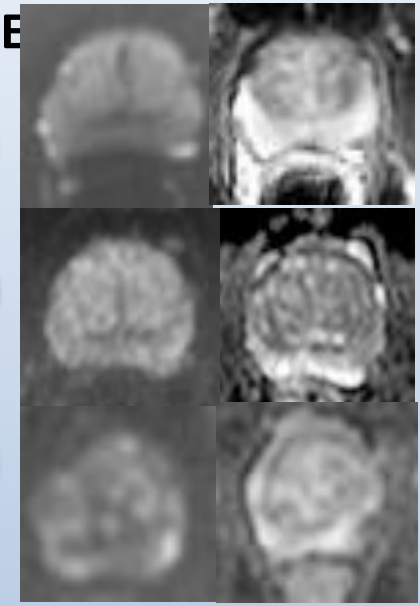
- The PI-RADS system was developed to standardize the interpretation and reporting of mpMRI prostate examinations. Although PI-RADS version 2 has greatly enhanced the interpretation of multiparametric MRI with clarification of use compared with the first version, some limitations are still present.
- Descriptors for each PI-RADS score are qualitative and are therefore open to subjective interpretation. A number of normal anatomic structures and benign abnormalities may have features fulfilling a PI-RADS score of 3 or above.
- We present a collection of common pitfalls in the interpretation of prostate mpMRI encountered in our daily practice.

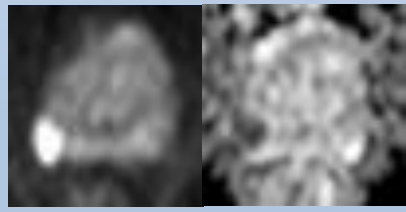
PI-RADSv2

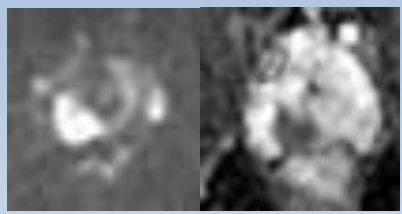

Peripheral Zone
PI-RADS
Transitional Zone
DWI SCORE
T2WI SCORE
1
2
3
4
5
DCE -ve
DCE +ve
DWI 1-4
DWI 5

PI-RADSv2

PI-RADS	Peripheral Zone Lesion	DWI SCORE
FINAL SCORE		
1	No abnormality	1
2	Indistinct ↓ signal on ADC	2
3 (DCE -ve)	Focal mild/moderate ↓ signal on ADC & iso/mildly ↑ signal on high b-value DWI	3
4 (DCE +ve)	Focal marked ↓ signal on ADC & marked ↑ signal on high b-value DWI Max dimension < 1.5cm	4
5	Focal marked ↓ signal on ADC & marked ↑ signal on high b-value DWI Max dimension ≥ 1.5cm OR invasive	5



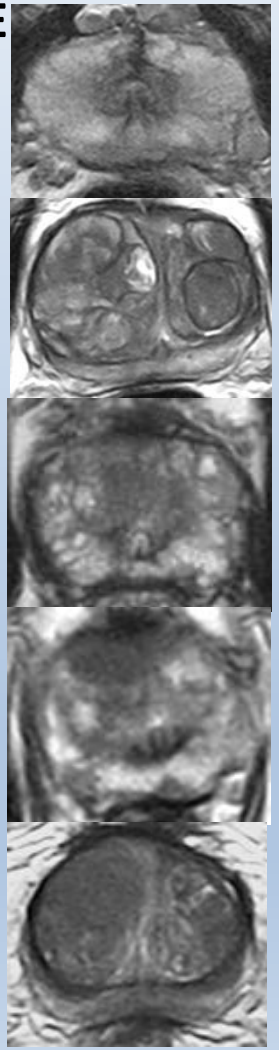




PI-RADSv2

PI-RADS | **Transitional Zone Lesion**

FINAL SCORE		T2WI SCORE
1	No abnormality	1
2	Circumscribed hypointense or heterogeneous nodules (BPH)	2
3 (DWI 1-4)	Heterogeneous signal intensity with obscured margins	3
4 (DWI 5)	Lenticular or non-circumscribed homogenous, moderately hypointense Max dimension < 1.5cm	4
5	Lenticular or non-circumscribed homogenous, moderately hypointense Max dimension ≥ 1.5cm OR invasive	5



Normal anatomic structures mistaken as cancer

- Central zone
- Anterior fibromuscular stroma
- Peri-prostatic vein

Central zone

- Pitfall:
  - Due to the low glandular tissue present in the central zone, the central zone exhibits low signal intensity on both T2-weighted image and ADC map
- Tips:
  - Symmetric appearance of the central zone at the base of prostate
  - Tear-drop shaped hypointensity on either side of the midline on coronal image – the “moustache sign”

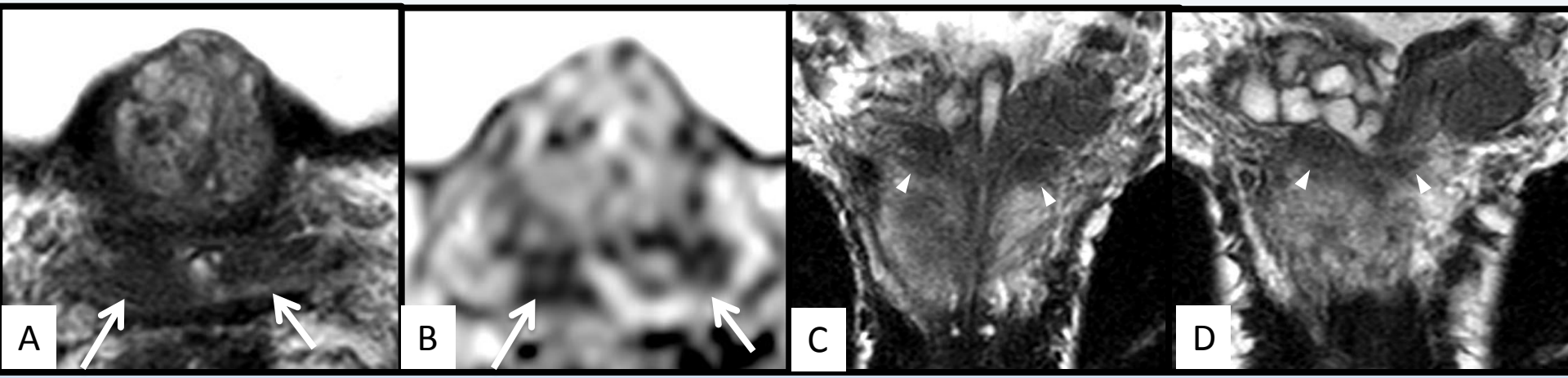


Figure 1. Central zone

Axial T2W image (A) show bilateral hypointense areas at the base (arrows) with low signal on ADC map (B) that may be mistaken as peripheral zone cancer. Consecutive coronal T2W images (C, D) show the typical tear-drop appearance of the central zone (arrow heads), consistent with the “moustache” sign.

Anterior fibromuscular stroma

- Pitfall:
  - Due to its compact muscle and fibre composition, the anterior fibromuscular stroma has markedly low T2 and ADC signals
  - When it is bulky, it may mimic anterior transition zone cancer because of its lentiform morphology, low T2 signal and low ADC value
- Tips:
  - Lack of restricted diffusion and hypervascularity due to its fibrous nature

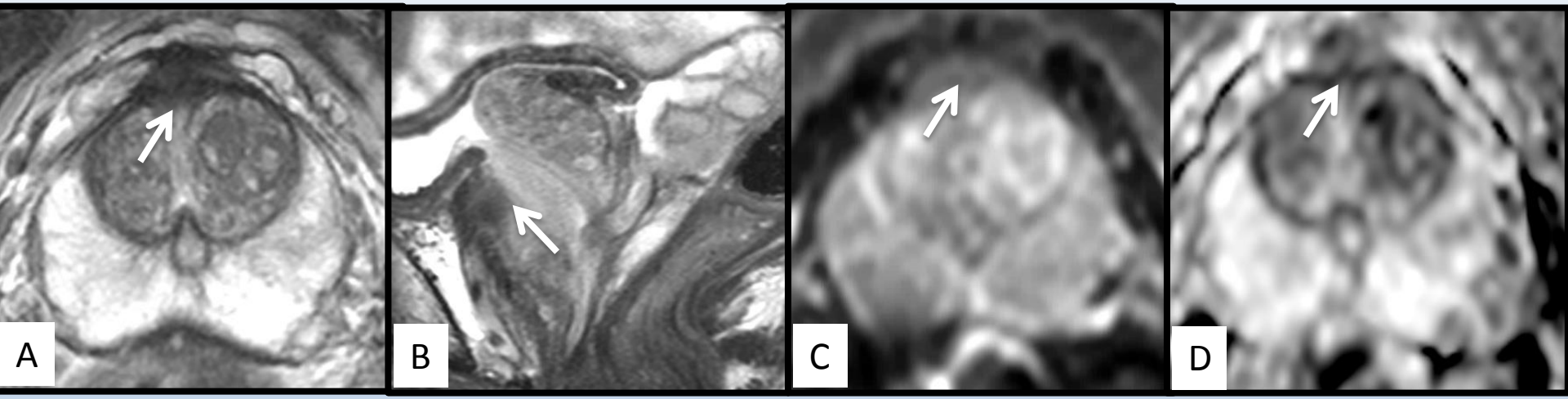


Figure 2. Anterior fibromuscular stroma.
Axial and sagittal T2 weighted image (A, B) shows a non-circumscribed moderately hypointense area (arrow) in the anterior aspect of the gland. No diffusion restriction on high b-value DWI (C) and indistinctly hypointense on ADC map.
According to PI-RADS v2 system, the T2 and DWI scores are 4 and 2 respectively. As T2 is the dominant sequence in the transition zone, the overall PI-RADS category is 4.

Target biopsy shows no evidence of malignancy.

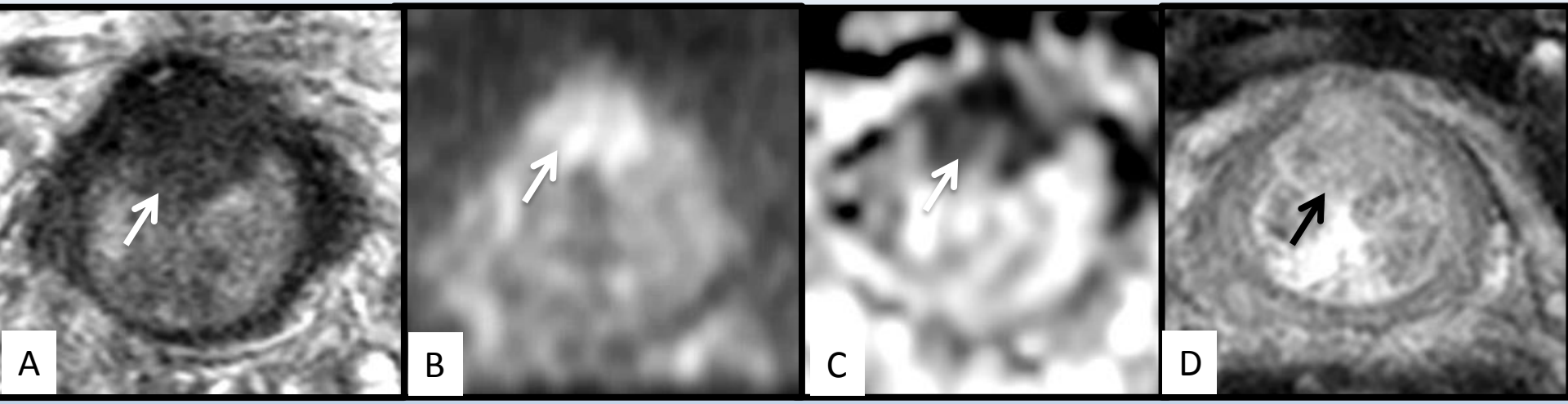


Figure 3. Anterior transition zone cancer (for comparison with Fig 2)
Axial T2 weighted image (A) shows a non-circumscribed homogenous moderately hypointense lesion (arrow) in the anterior transition zone with invasion of the anterior fibromuscular stroma. It is markedly hyperintense on high b-value DWI (B) and hypointense on ADC map (C). Moderate enhancement on DCE (D).
According to the PI-RADS v2 system, the T2 and DWI scores are 5. Overall PI-RADS category is 5. Biopsy proven prostate cancer.

Peri-prostatic vein

- Pitfall:
  - Peri-prostatic veins can show low signal intensity on T2-weighted image and ADC map depending on the velocity and turbulence of blood movement.
  - They may have a discrete rounded appearance when viewed en face on axial slices and erroneously considered a lesion within the peripheral zone at the apex.
- Tips:
  - Careful examination of the sections above and below the venous structure can help demonstrate continuity with the remainder of the periprostatic venous plexus.

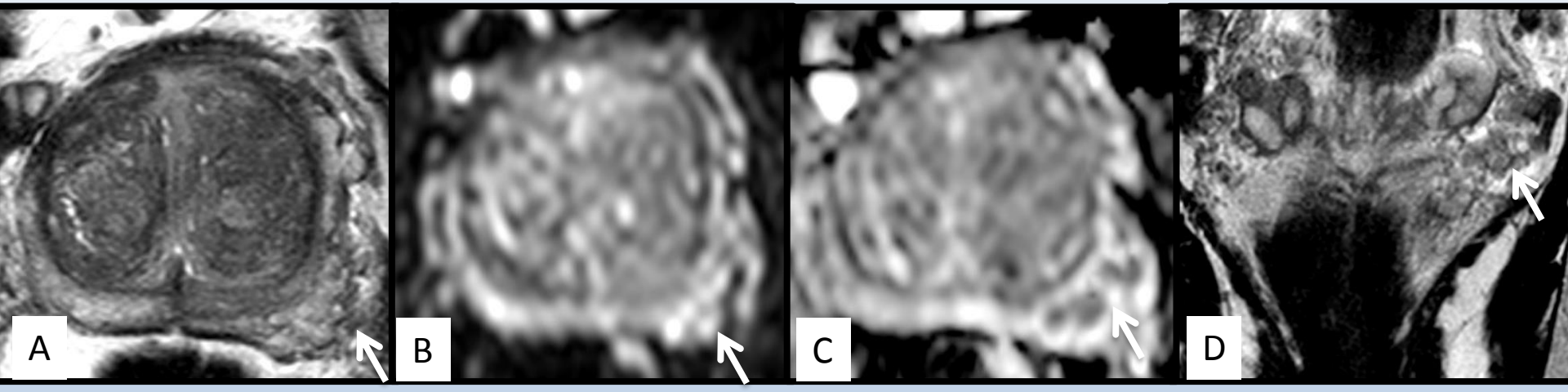


Figure 4. Peri-prostatic varicosities
Axial T2 weighted image (A) shows hypointensity in left peripheral zone with “extra-capsular extension” (arrow). There is mild hyperintensity on high b-value DWI (B) and moderate hypointensity on ADC map (C).
It could be mistaken as left peripheral zone cancer with extra-prostatic extension (i.e. PI-RADS 5); however, reviewing consecutive images and the coronal T2 weighted image (D) would reveal that the abnormality is located outside the gland and correspond to peri-prostatic venous plexus.

Benign pathology that mimic cancer

- Stromal nodule
- Ectopic BPH nodule
- Bacterial prostatitis
- Granulomatous prostatitis
- Atrophy
- Calcification

Stromal nodule

- Pitfall
  - Stromal BPH nodules demonstrate low T2 signal intensity due to the presence of sclerotic and fibrous elements
  - They also demonstrate restricted diffusion and early enhancement on DCE
- Tips:
  - Look for encapsulated appearance on T2 which is the dominant sequence for evaluation of the transition zone

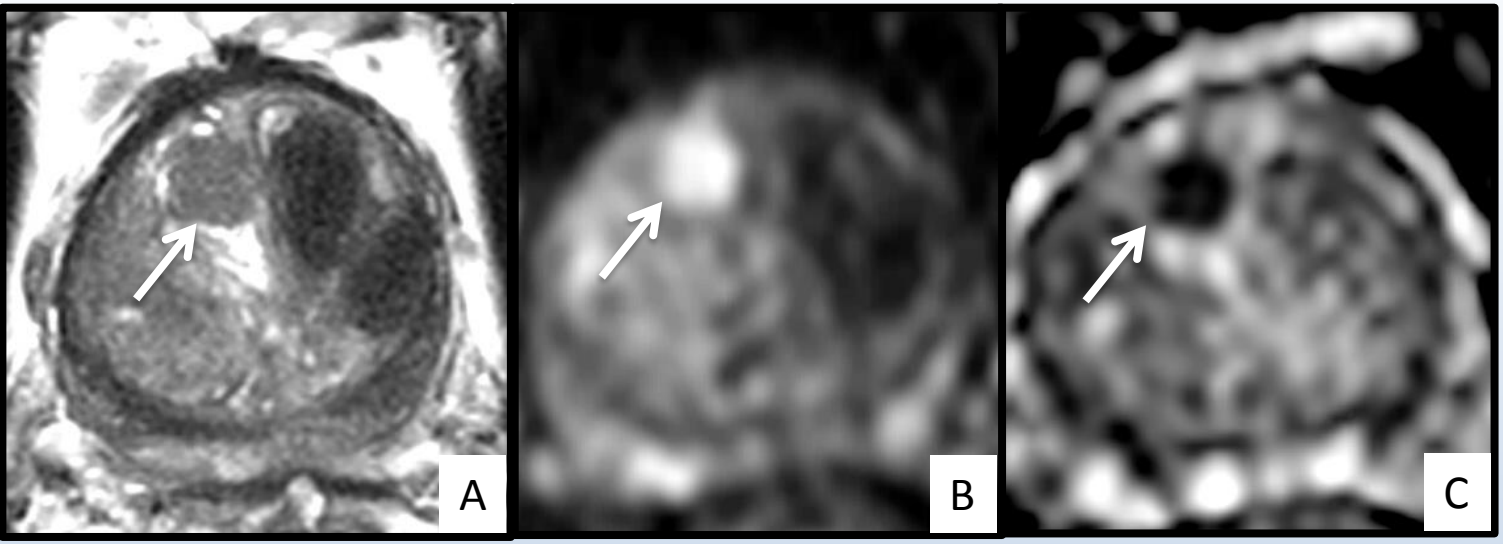


Figure 5. Stromal nodule

Axial T2 weighted image (A) shows a discrete non-circumscribed homogeneous moderately hypointense nodule in the right anterior transition zone, with marked restricted diffusion on high b-value DWI (B) and markedly hypointense on ADC map (C).
According to the PI-RADS v2 system, the scores for both T2 and DWI are 4; the overall PI-RADS category is 4.

Target biopsy shows no evidence of malignancy.

Ectopic BPH nodule

- Pitfall
  - Although BPH nodules mostly occur in the transition zone, they sometimes arise in the peripheral zone. They may also demonstrate restricted diffusion and positive DCE.
- Tips
  - Internal heterogeneity with T2 high signal
  - Presence of a pseudocapsule

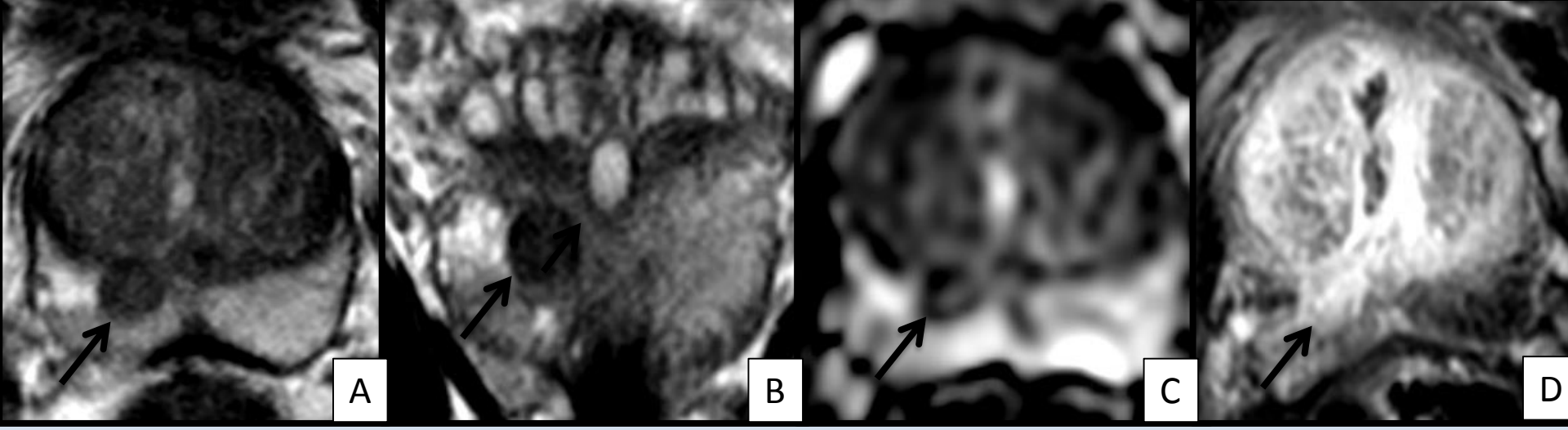


Figure 6. Ectopic BPH nodule.

Axial and Coronal T2 weighted images (A, B) show a circumscribed, homogeneous moderately hypointense lesion (arrow) in the right peripheral zone, which is markedly hypointense on ADC map (C) compared to the adjacent peripheral zone, and show rapid wash-in on DCE (D).
According to the PI-RADS v2 system, the T2, DWI and DCE scores are 4, 4, +, respectively; the overall PI-RADS category is 4.

Target biopsy shows no evidence of malignancy.

Bacterial prostatitis

- Pitfall
  - Prostatitis often leads to low T2 signal intensity with mild to moderate restricted diffusion in the peripheral zone.
- Tips
  - The morphology is often linear, wedge-shaped or diffuse with indistinct margins.
  - The degree of low T2 signal and diffusion restriction tend to be less than that in prostate cancer. Use of internally validated ADC threshold may be useful for differentiation

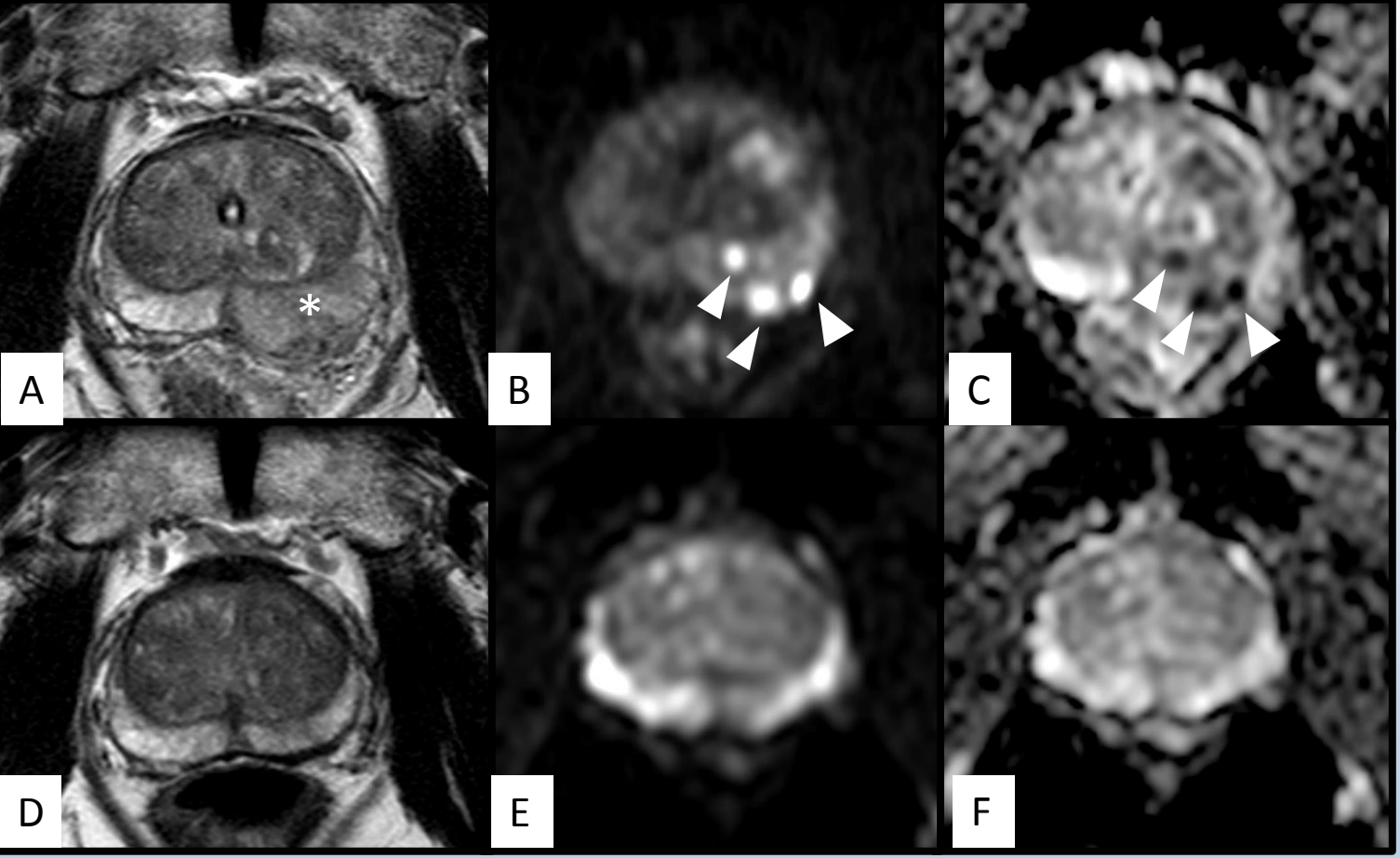


Figure 7. Prostatitis.

First row (A to C): Axial T2 weighted image (A) shows diffuse mild T2 hypointensity and swelling of the left peripheral zone without a focal lesion. There are 3 foci (arrow heads) of marked restricted diffusion on high b-value DWI (B) and marked hypointensity on ADC map (C).
According to the PI-RADS v2 system, the T2 and DWI/ADC scores are 2 and 4 respectively. Since DWI is the dominant sequence in the peripheral zone, the overall PI-RADS category is 4.

Second row (D to F): Follow up MRI with the corresponding sequences in the same patient showing resolution of the signal abnormalities. The spontaneous resolution supports prostatitis.

Granulomatous prostatitis

- Pitfall
  - Non-necrotic granulomatous prostatitis appears as an area of hypointensity in the peripheral zone on T2-weighted image, associated with diffusion restriction and with wash-in on DCE.
  - Florid granulomatous prostatitis may even demonstrate extra-prostatic extension
- Tips
  - Often impossible to differentiate from cancer by imaging alone; high index of suspicion if patient has known TB or previous BCG therapy for bladder cancer

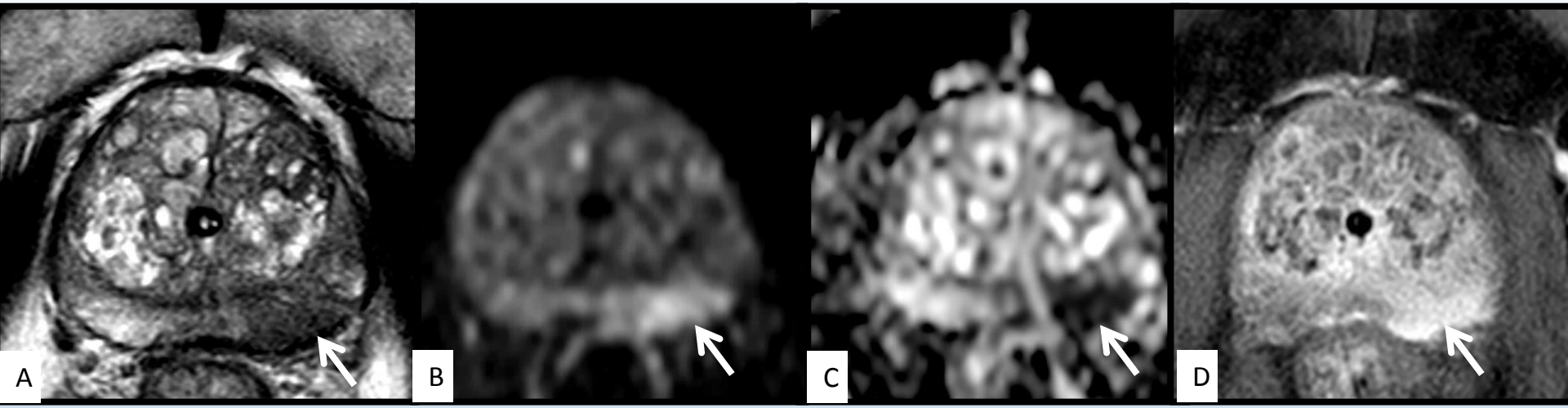


Figure 8. Granulomatous prostatitis.

Axial T2 weighted image (A) shows a non-circumscribed rounded moderate hypointensity in the left peripheral zone, with moderate restricted diffusion on high b-value DWI (B) and marked hypointensity on ADC map (C). DCE is positive (D).
According to the PI-RADS v2 system, the T2, DWI and DCE scores are 3, 4, +, respectively. Since DWI is the dominant sequence in the peripheral zone, the overall PI-RADS category is 4.

Target biopsy of the left peripheral zone lesion shows granulomatous prostatitis.

Atrophy

- Pitfall
  - Atrophy appears as a focal or geographic area of low T2 signal intensity with moderate restricted diffusion and enhancement.
- Tips
  - Volume loss and contour retraction are usually present
  - The degree of diffusion restriction is usually less marked than cancer. Use of internally validated ADC threshold may be useful for differentiation

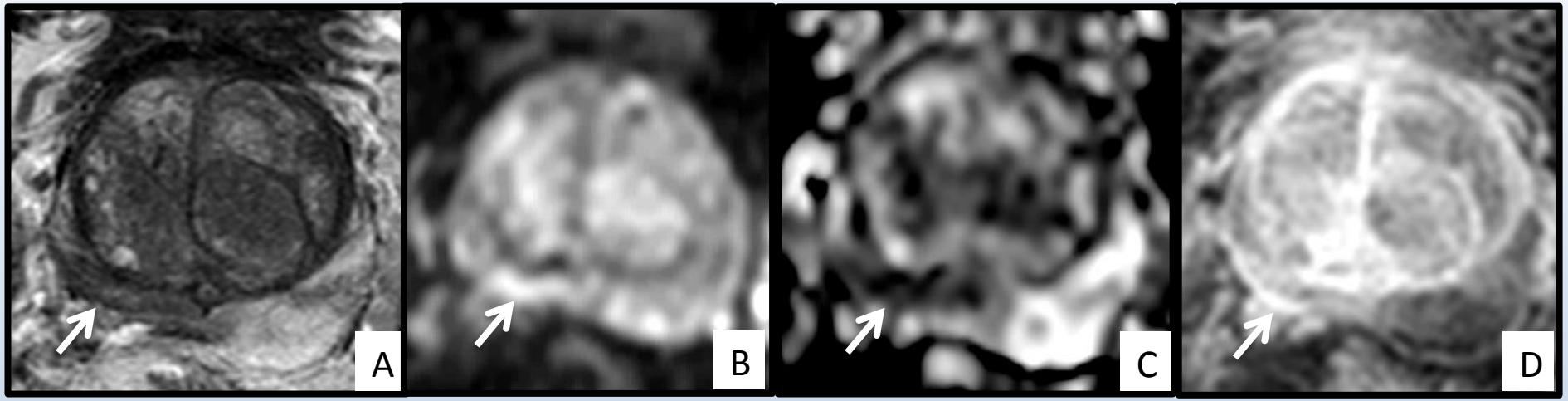


Figure 9. Prostatic atrophy.

Axial T2 weighted image (A) shows diffuse mild hypointensity in the right peripheral zone with volume loss and contour retraction (arrow), associated with mild hyperintensity on high b-value DWI (B) and moderate hypointensity on ADC map (C). There is moderate enhancement on DCE (D) compared to the contralateral peripheral zone.
According to the PI-RADS v2 system, the T2, DWI and DCE scores are 2, 3, +, respectively. Since DWI is the dominant sequence in peripheral zone, the overall PI-RADS category is 3.

Calcification

- Calcification can form within the prostate due to concreted prostatic secretions or amylaceous bodies, usually in the transition zone.
- Tips:
  - Owing to the diamagnetic effect of calcium, calcification has low signal intensity on all pulse sequence including T2 weighted and ADC images, as well as DWI at all b-values.

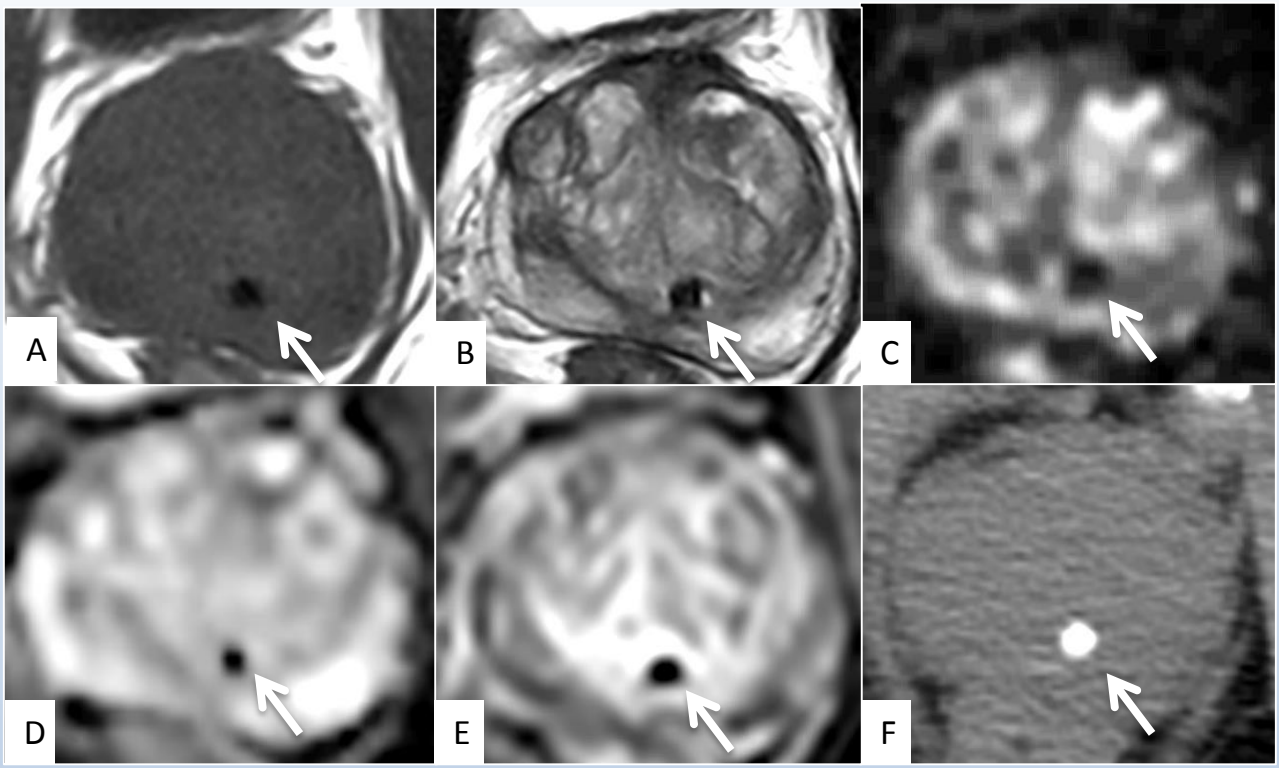


Figure 10. Calcification.

A markedly hypointense focus (arrow) is present in the left posterior transition zone on all pulse sequences, including T1-weighted (A), T2-weighted (B), DWI (C), ADC (D), DCE (E) images.
CT (F) confirms it to be an intra-prostatic calcification.

Conclusion

- Normal anatomic structures and benign pathology can mimic cancer on multiparametric prostate MRI.
- Radiologists need to be aware of these pitfalls and apply discretion when utilizing PI-RADS version 2 in order to avoid misdiagnosis.