PI-RR: The Prostate Imaging for Recurrence Reporting System for MRI Assessment of Local Prostate Cancer Recurrence After Radiation Therapy or Radical Prostatectomy—A Review

Jorge Abreu-Gomez, MD[1], Adriano Basso Dias, MD, Sangeet Ghai, MD

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The purpose of this article is to review clinical application of the Prostate Imaging for Recurrence Reporting (PI-RR) system. This system, released in 2021, represents international consensus-based guidelines for the acquisition, interpretation, and reporting of multiparametric MRI performed to detect locally recurrent prostate cancer after radiation therapy or radical prostatectomy. The system reduces variability through use of a standardized and structured reporting approach whereby the overall level of suspicion of recurrence is classified on a 5-point scale. The overall suspicion score is derived from 5-point scales for assessing DWI and dynamic contrast-enhanced (DCE) imaging. Separate scales for both DWI and DCE imaging are provided for evaluation after radiation therapy and after radical prostatectomy. These scales account for the relation between detected abnormalities and the location of the primary tumor on pretreatment imaging. T2-weighted imaging is also assessed on a 5-point scale and is useful for anatomic imaging but does not influence the overall score. Initial retrospective studies have shown promising results with respect to the reproducibility and accuracy of PI-RR in detecting locally recurrent tumor.

Prostate cancer (PCa) is the fourth most commonly diagnosed malignancy worldwide and accounts for 4.7% of all cancer-related deaths [1]. Among men in the United States, PCa is the most commonly diagnosed cancer and the second most common cause of cancer-related death, accounting for 34,500 estimated deaths in 2022 [2]. Radical prostatectomy (RP) and radiation therapy (RT) continue to serve as the primary curative-intent treatments of localized PCa [3–5], although focal therapy is increasingly used as a treatment option for intermediate-risk localized PCa [6–11].

Between 27% and 53% of patients who undergo RP or RT have a subsequent increase in PSA level [12]. The frequency of a posttreatment increase in PSA level depends on the stage of the primary tumor and the type of treatment administered [13, 14]. The criteria for considering a posttreatment increase in PSA to represent biochemical recurrence (BCR) vary on the basis of the type of therapy and reference guidelines. European Association of Urology (EAU) guidelines define a persistent PSA level after RP as a detectable PSA level greater than 0.1 ng/mL observed 4–8 weeks after RP and indicate that persistence of PSA may represent persistent local disease, preexisting metastasis, or residual benign prostatic tissue [15]. The EAU guidelines define BCR after RP as an increase in PSA level to more than 0.4 ng/mL [15]. The American Society for Radiation Oncology (ASTRO)/American Urological Association (AUA) guidelines define BCR after RP as a PSA level of 0.2 ng/mL or higher on two consecutive measurements [16]. The NCCN guidelines include three criteria for BCR after RP: PSA level that does not decrease to undetectable (i.e., persistent neoplastic disease); PSA level that is initially undetectable but becomes detectable and increases on two or more measurements (i.e., recurrent neoplastic disease); and persistently low PSA level attributed to a benign cause (e.g., prolonged PSA metabolism or residual benign prostatic tissue) rather than to neoplastic disease [17]. Specifically, a persistently low PSA level is attributed to residual benign prostatic tissue if the RP surgical margins were negative and the postoperative PSA velocity is favorable.

After RT, BCR is defined in the Phoenix criteria as an absolute increase in PSA level by 2 ng/mL above the PSA level nadir (i.e., the lowest posttreatment value) [18, 19]. This definition is recognized in the EAU, ASTRO/AUA, and NCCN guidelines.

An increase in PSA level after RP or RT can be due either to local disease confined to the prostate or prostate bed or to metastatic disease. Accurate differentiation of these possibilities is crucial for directing salvage treatment.

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[1]All authors: Joint Department of Medical Imaging, University Health Network, Mount Sinai Hospital and Women's College Hospital, University of Toronto, 610 University Ave, Ste 3-920, Toronto, ON M5G 2M9, Canada. Address correspondence to J. Abreu-Gomez (j.abreugomez@mail.utoronto.ca, @jorgeandresabr2).

The EAU guidelines do not include performing multiparametric MRI (mpMRI) after RP, but they do include performing both mpMRI and PET/CT after RT [15]. The recommendation for imaging after RP may change if future research shows that mpMRI can accurately localize disease in the prostatectomy bed and depict the relation between suspicious findings and adjacent organs to guide potential local salvage ablative therapies. In comparison, the ASTRO/AUA and NCCN guidelines state that prostate MRI is usually indicated in patients with BCR after RP to assess for local recurrence [16, 17].

In 2019, Van den Broeck et al. [20] proposed a risk profile for stratifying patients who undergo curative-intent therapy as being at low or high risk of development of BCR [20]. Patients with International Society of Urological Pathology (ISUP) grade group disease less than 4 on pretreatment biopsy, a PSA doubling time after RP of more than 1 year, or an interval to BCR after RT of more than 1.5 years are considered at low risk of BCR. Patients with a lesion in ISUP grade group 4 or greater on pretreatment biopsy, a PSA doubling time after RP of 1 year or less, or an interval to BCR after RT of 1.5 years or less are considered at high risk of BCR. In 2022, Panebianco and Turkbey [21] proposed a risk-adapted pathway for detecting recurrence that incorporated imaging. Those authors suggested initial assessment by mpMRI for patients with a low-risk posttreatment profile, regardless of pretreatment risk category. For patients with a high-risk posttreatment profile, the pretreatment risk category may alter the initial imaging assessment. Specifically, an initial mpMRI examination is recommended to assess for local recurrence in patients with a low-risk pretreatment profile (ISUP grade group 1, PSA level ≤ 10 ng/mL). However, initial PSMA PET/CT is recommended for patients with intermediate-risk disease (ISUP grade group 2 or 3, PSA level 10–20 ng/mL) or high-risk disease (ISUP grade group ≥ 4, PSA level ≥ 20 ng/mL) pretreatment profile, given that these patients are more likely to have systematic disease and therefore may not be candidates for local salvage treatments.

This background highlights the key role of mpMRI in the assessment for local recurrence in patients at low risk after RP or RT, particularly after RT to assist early delivery of local salvage therapies. In 2021, an international expert panel published consensus-based guidelines for the acquisition, interpretation, and reporting of mpMRI examinations performed for the detection of local recurrence of PCa after RT or RP. The algorithm is termed the Prostate Imaging for Recurrence Reporting (PI-RR) system and its aim is to reduce variability through standardization and structured reporting [22]. Results of initial studies indicate that PI-RR is a reproducible and accurate approach to MRI-based evaluation of the treated prostate [23, 24].

MRI Acquisition

PI-RR includes recommendations for use of MRI equipment, patient preparation, and imaging protocols that are similar to those recommended in PI-RADS version 2.1 (v2.1) [25, 26]. However, PI-RR also includes specific considerations for local recurrence. For instance, PI-RR indicates that after RP, T2-weighted imaging be performed in all three anatomic planes (axial, sagittal, and coronal) [22]. In comparison, PI-RADS v2.1 indicates that it is acceptable to obtain T2-weighted images in two planes (axial and either sagittal or coronal). Moreover, PI-RR indicates that the FOV encompass the most common sites of recurrence, including the vesicourethral anastomosis, the seminal vesicle or retrovesical bed, and the bladder neck [22, 27]. In addition, PI-RR calls for performing at least one large-FOV sequence (either T1-weighted imaging or DWI) to assess for the presence of lymph nodes or bone lesions that are suspicious for metastatic disease [22].

HIGHLIGHTS

- *PI-RR is used to standardize interpretation and reporting of prostate MRI performed after RT or RP. It is not designed for assessment after focal treatment.*
- *Scores assigned to lesions on DWI and DCE are combined to determine the overall score for indicating the likelihood of local recurrence.*
- *Knowledge of the location of the primary tumor on pretreatment imaging impacts scoring with PI-RR and is crucial for optimal MRI interpretation.*

Background on PI-RR Scoring

PI-RR is a rule-based scoring system designed to detect local recurrence of PCa. The multiparametric approach to evaluating the prostate gland or prostate bed incorporates findings on T2-weighted imaging (e.g., lesion location, size, and shape), DWI (e.g., restricted diffusion), and dynamic contrast-enhanced (DCE) imaging (e.g., early enhancement). The likelihood of malignancy is scored on a 5-point scale, as in other validated scales, such as PI-RADS, LI-RADS, and TIRADS. A score of 1 corresponds to a lesion with very low likelihood of recurrence; 2, low likelihood of recurrence; 3, equivocal or uncertain likelihood of recurrence; 4, high likelihood of recurrence; and 5, very high likelihood of recurrence. The criteria for determining the score were developed through a series of panel discussions based on expert opinion informed by the best available scientific evidence.

Recurrence After Radiation Therapy

RT is a clinically applied whole-gland treatment of localized clinically significant PCa [5, 12]. External-beam RT (EBRT) delivers radiation to the prostate from an external source through photons or protons, depending on the desired dose and local availability [28]. Contemporary computer-assisted planning systems typically allow use of stereotactic body RT, a type of EBRT that delivers a high radiation dose of one to five fractions with better safety margins than conventional RT [29]. Stereotactic body RT delivers highly targeted radiation that is limited to the prostate while avoiding excess dose to adjacent tissues [28, 30]. MRI-guided RT is a novel method of EBRT in which real-time MRI monitoring is performed during the treatment session to achieve selective dose delivery while sparing healthy tissues. MRI-guided RT requires access to MRI-compatible treatment equipment and is not suitable for claustrophobic patients [31]. Brachytherapy is an alternative technique for administering RT in which multiple seeds that emit radiation are placed within the prostate, avoiding use of an external radiation source. The two primary types of brachytherapy are low-dose-rate therapy and high-dose-rate therapy. Low-dose-rate therapy is commonly used to manage low-risk PCa and en-

tails permanent implantation of small radioactive titanium seeds in the prostate. High-dose-rate therapy entails temporary placement of radioactive seeds that emit a high radiation dose. High-dose-rate therapy allows accurate dosimetry with modulation of the position of the implanted seeds and of the duration of seed placement [32]. High-dose-rate therapy can be used for whole- or partial-gland radiation, achieving better dose distribution with fewer side effects in comparison with EBRT [33].

Although PCa is usually multifocal, evidence indicates that the largest tumor focus within the prostate (i.e., the index lesion) typically has the highest Gleason grade of any tumor focus and accounts for posttreatment prognosis, development of metastatic disease, and disease progression [34–36]. After RT, disease most commonly recurs at the site of the index lesion [28, 30, 37]; as described later (see PI-RR Assessment After Radiation Therapy), this proximity is a hallmark in determining the overall PI-RR score. Comparison with pretherapy imaging findings or knowledge of the primary disease site is essential for optimal assessment.

RT induces anatomic changes in the prostate, including a decrease in gland size, diffuse low signal intensity on T2-weighted imaging, and poor differentiation between zones and between benign and malignant tissue. Because of these changes, T2-weighted imaging has limited utility in assessment for local recurrence [28, 38]. Nonetheless, a recurrent tumor may appear on T2-weighted imaging as a nodular hypointense area relative to adjacent prostatic tissue [38]. Additionally, after brachytherapy, the implant seeds may be visualized as signal voids scattered throughout the prostate. On T2-weighted imaging, careful attention to regions of the prostate that are remote from the seeds can guide assessment for recurrence.

After RT, high-b-value DWI shows decreased signal intensity of the prostate, although this change is less pronounced than the decrease observed on T2-weighted imaging [38]. Recurrent tumors exhibit restricted diffusion similar to that of the original tumor. Susceptibility artifact related to low-dose brachytherapy seeds can hinder assessment for recurrence on DWI [27].

On DCE imaging, recurrent tumors typically exhibit hypervascularity due to neovascularization and increased tissue permeability [39]. Parenchymal fibrotic changes induced by RT decrease the vascularity of prostatic tissue, potentially increasing conspicuity of a hypervascular recurrence [38]. However, imaging performed soon after RT may show increased vascularity throughout the prostate due to RT-related inflammatory changes, leading to false-positive interpretations. Thus, MRI should not be performed in the first 3 months after RT [22].

PI-RR Assessment After Radiation Therapy

In assessment for recurrence after RT, DWI and DCE imaging both are considered dominant sequences that jointly determine the overall score [27, 28, 38, 40]. T2-weighted imaging is reserved for anatomic localization and comparison with pretreatment imaging [22]. Like assessment of the treatment-naïve prostate in PI-RADS v2.1, PI-RR includes separate 5-point scales for assessment of findings on T2-weighted imaging and DWI. Unlike PI-RADS v2.1, however, PI-RR introduces a 5-point scale for assessing DCE imaging on the basis of the distribution (diffuse or heterogeneous vs focal or masslike) and timing (early vs delayed) of prostatic enhancement. Also unlike PI-RADS v2.1, PI-RR incorporates the relation between a lesion and the primary tumor location on pretreatment imaging as a key determinant of assigned scores. A lesion identified with PI-RR can serve as a biopsy target after RT.

Figure 1 shows the algorithm for deriving the overall PI-RR score after RT. The overall score after RT represents the highest score assigned on either DWI or DCE imaging. However, the overall score may be upgraded from 4 to 5 if early enhancement and restricted diffusion are present in the same location. Figures 2–4 show examples of lesions assigned a score of 4 or 5 according to PI-RR in patients who have undergone prior RT. The lesion in Figure 4 received a score of 5 based on the upgrading rule.

Recurrence After Radical Prostatectomy

RP is currently used to treat localized clinically significant PCa primarily in young patients, though it may be used in older patients who do not have comorbidities [38, 41]. Various guidelines indicate a role of prostate MRI to assess for local recurrence in patients with BCR after RP. MRI is warranted particularly in patients likely to have an isolated local recurrence rather than metastatic disease after RP. Such patients include those with late BCR after RP, a prolonged PSA doubling time (> 6 months), or low PSA velocity [40, 42].

After RP, MRI may show a range of postsurgical changes in the prostate bed. For example, after RP, as many as 20% of patients have seminal vesicle remnants [43, 44] or residual glandular tissue (which may produce PSA). Such findings can mimic recurrent disease on T2-weighted imaging but generally do not represent restricted diffusion or early enhancement [3, 38].

Knowledge of the most common sites of recurrence after RP is important to facilitate accurate recurrence detection. After RP, recurrence is common around the vesicourethral anastomosis, the seminal vesicle bed or rectovesical area, and the bladder neck [27].

On T2-weighted imaging, recurrence after RP may appear as a nodular or plaquelike area of lobulated or semicircumferential soft tissue that is slightly hyperintense in relation to the pelvic muscles [45]. However, T2-weighted imaging findings are nonspecific. High signal intensity on high-b-value DWI or low signal intensity on the ADC map may help differentiate findings on T2-weighted imaging from fibrosis or granulation tissue. Assessment of DWI after RP may be limited by susceptibility artifact from surgical clips [38], thus requiring careful correlation with other sequences [45, 46].

DCE imaging is a critical sequence for recurrence detection, because the images may show a postoperative recurrence in the absence of a corresponding finding on T2-weighted imaging or DWI [27, 46]. In addition, the detection of early enhancement helps to differentiate a finding suspicious for local recurrence from progressively enhancing fibrous tissue that is commonly present postoperatively [27, 28, 30, 38, 47].

After RP, suspicious findings should be reported according to clock position with the vesicourethral anastomosis as the clock center [22].

PI-RR Assessment After Radical Prostatectomy

PI-RR upholds the importance of DCE imaging after RP, deeming DCE imaging to be the sole dominant sequence in this setting [22]. As in assessment of DCE imaging after RT, in PI-RR a 5-point scale is used to assess DCE imaging after RP on the basis of the en-

hancement pattern and location of a lesion. T2-weighted images are also scored on a 5-point scale, although this sequence is used primarily for assessing anatomic landmarks and does not contribute to determining the overall score. DWI is likewise scored on a 5-point scale. Although DWI is not a dominant sequence in determining the overall score after RP, a DWI score of 4 or greater after RP can upgrade an overall score from 2 to 3 or from 3 to 4 [22]. Figures 5–7 show examples of lesions assigned a score of 4 or 5 according to PI-RR in patients with prior RP. The lesion in Figure 7 received a score of 4 on the basis of the upgrading rule.

Additional Considerations

In a retrospective multireader study reported on in 2022, Pecoraro et al. [23] assessed the reproducibility and diagnostic performance of PI-RR and found excellent reproducibility of the PI-RR overall score (intraclass correlation coefficient, 0.87) and moderate-to-high AUC (range, 0.77–0.92). Across four readers, a PI-RR score of 3 or greater after RT was associated with 71–81% sensitivity for recurrence and 74–93% specificity. After RP, a PI-RR score of 3 or greater was associated with sensitivity of 59–83% and specificity of 87–100%. Finally, the PPV of a PI-RR score of 3 or greater after either RT or PR was high, allowing high confidence in local recurrence suspected on MRI. In that study, all readers were highly experienced, limiting the generalizability of the results to the community setting.

In a single-center retrospective study of the use of PI-RR after RP, Ciccarese et al. [24] found excellent interobserver agreement ($\kappa = 0.884$, $p < .001$) between two readers with 5 and 10 years of experience in mpMRI. In that study, a PI-RR score of 3 or greater had high sensitivity (84.6%) and PPV (73%) for recurrence but low specificity (33.3%). The results suggested that the performance of PI-RR is influenced by PSA level, detection rates being higher among patients with a PSA level greater than 0.6 ng/mL.

Local recurrences after RT may be treated by local salvage therapy. Despite being challenging to obtain, histologic proof of recurrence may be required before administration of local salvage therapy given the potential morbidity of such therapies [4]. In this scenario, mpMRI can be used to guide targeted biopsy and help confirm the presence of local recurrence [48].

Application of PI-RR is impacted by an ongoing paradigm shift in the imaging workup of BCR through the clinical adoption of PET performed with novel radiotracers, including FDA-approved PSMA tracers (e.g., ^{68}Ga-PSMA-11 and ^{18}F-piflufolastat [^{18}F-DCFPyL]). As with mpMRI, the diagnostic performance of PSMA PET/CT depends on PSA level. However, the rate detection of BCR with PSMA PET/CT remains high at low PSA levels. The detection rate is as high as 63% among patients with a PSA level of 0.5–1.0 ng/mL and 34–40% among patients with a PSA level less than 0.5 ng/mL [49, 50]. PSMA PET/CT is also useful for identifying extrapelvic nodal and distant metastatic disease (including oligometastatic disease), which can potentially be treated with metastasis-directed therapies [49–52]. However, urinary excretion of PSMA with subsequent activity in the bladder and urethra can obscure local recurrence in the prostate or prostate bed, resulting in a moderate detection rate for local recurrence of PSMA PET/CT not combined with mpMRI [53]. This limitation can be mitigated by the use of fusion PET/MRI (whether through a hybrid PET/MRI system or through retrospective fusion of separate mpMRI and PET/CT examinations) to improve local assessment. Complementary reporting systems for PSMA PET for BCR have been proposed for both staging (e.g., Prostate Cancer Molecular Imaging Standardized Evaluation [PROMISE]) [54] and lesion characterization (e.g., PSMA Reporting and Data System [PSMA-RADS]) [55]. These systems rely on the integration of PSMA uptake on PET with lesion characteristics on CT or MRI. Additional integration of the PI-RR algorithm should further aid imaging assessment for local disease.

PSA level is unreliable in monitoring for local recurrence after focal therapy for PCa given a variable reduction in prostate volume after such treatment. Thus, mpMRI is particularly useful to evaluate for recurrence after focal therapy [56, 57]. Indeed, mpMRI is routinely used for surveillance after focal therapy and has been endorsed in consensus recommendations [58, 59]. However, PI-RR does not apply to assessment for new or recurrent disease after focal therapy, given a lack of robust evidence or consensus opinion regarding such evaluation. An adapted PI-RR scoring system specifically for mpMRI assessment after focal therapy would be of immense utility given a recurrence rate as high as 40% within 2 years after focal therapy [11]. Paxton et al. [60] found high sensitivity of mpMRI for detection of late recurrence after focal therapy (mean posttherapy follow-up, 49 months). In their study, biopsy revealed recurrent disease in 83% of patients with restricted diffusion and 63% of those with hyperenhancement at the treatment site. Moreover, the combination of restricted diffusion and early enhancement had PPV of 100%. In addition, an ongoing multicenter prospective trial (NCT04773821) is being conducted to investigate the performance of mpMRI for detection of PCa recurrence after focal therapy. In that trial, Likert scores will be assigned to categorize suspicion of recurrence in both the treated and the untreated regions of the prostate.

Conclusion

Development of the PI-RR system is an important milestone in efforts to reduce variability in the acquisition, interpretation, and reporting of mpMRI performed to assess for local recurrence after RT or RP. Initial retrospective studies have shown promising results with respect to the reproducibility and accuracy of the system in detection of local recurrence. Future multicenter prospective studies that include readers with varying levels of experience and expertise are required for further validation and to guide clinical adoption.

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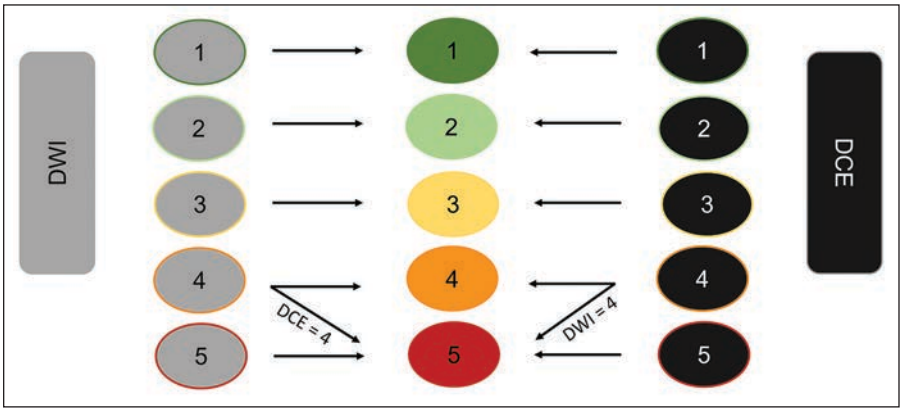

Fig. 1—Schematic shows algorithm for deriving overall score in assessment for local recurrence after radiation therapy (RT), according to Prostate Imaging for Recurrence Reporting system. Left column of ovals reflects DWI score from 1 to 5; right column of ovals reflects dynamic contrast-enhanced (DCE) imaging score from 1 to 5. After RT, both DWI and DCE imaging are dominant scores, and overall score (center column) reflects higher score in these two sequences. When score of 4 is assigned on both DWI and DCE imaging, final score can be upgraded to 5 if focus of restricted diffusion and focus of early enhancement are in same location.

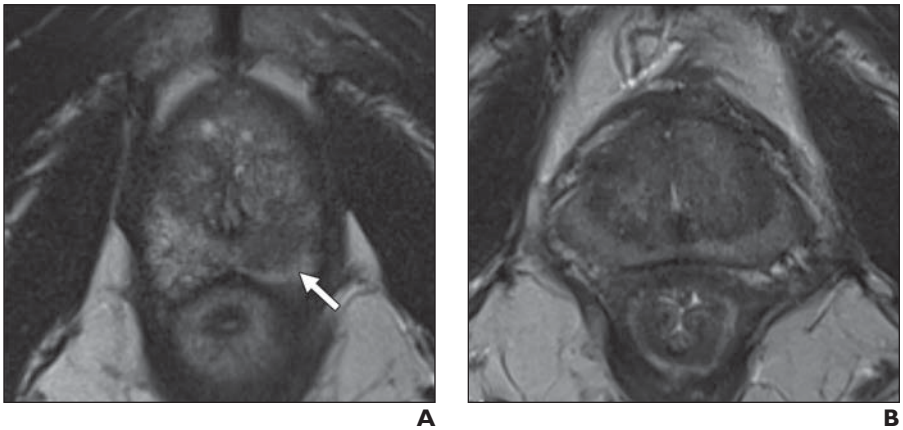

Fig. 2—74-year-old man with history of International Society of Urological Pathology (ISUP) grade group 3 prostate cancer treated by external-beam radiation therapy (RT) and high-dose-rate brachytherapy with subsequent increase in PSA level to 1.47 ng/mL. Overall score is 4 after RT according to Prostate Imaging for Recurrence Reporting system.
A, Axial T2-weighted pretreatment MRI shows primary tumor (*arrow*) in left posteromedial and posterolateral peripheral zone (PZ).
B, Axial T2-weighted posttreatment MRI shows diffuse hypointensity of PZ consistent with post-RT changes. No discrete focal lesion is evident. T2-weighted imaging score is 2.
(Fig. 2 continues on next page)

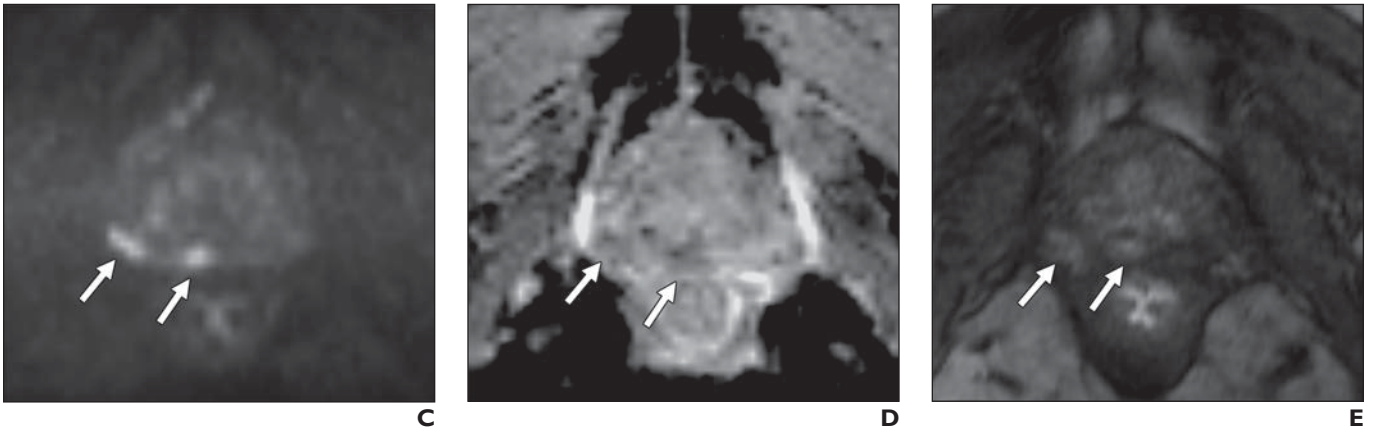

Fig. 2 (continued)—74-year-old man with history of International Society of Urological Pathology (ISUP) grade group 3 prostate cancer treated by external-beam radiation therapy (RT) and high-dose-rate brachytherapy with subsequent increase in PSA level to 1.47 ng/mL. Overall score is 4 after RT according to Prostate Imaging for Recurrence Reporting system.
C, Axial high-b-value posttreatment DWI shows two markedly hyperintense foci (*arrows*) in right mid posteromedial and posterolateral PZ, not at site of primary tumor.
D, Axial ADC map from posttreatment MRI shows corresponding mild, but not marked, hypointensity (*arrows*). DWI score is 3.
E, Early dynamic contrast-enhanced (DCE) image from posttreatment MRI shows corresponding focal early enhancement in both foci (*arrows*). DCE imaging score is 4. After RT, DWI and DCE imaging both are dominant sequences, and overall score reflects higher score in these two sequences. Thus, overall score of 4 was assigned. Targeted biopsy of both lesions revealed prostate cancer in ISUP grade group 4 and mild RT effects.

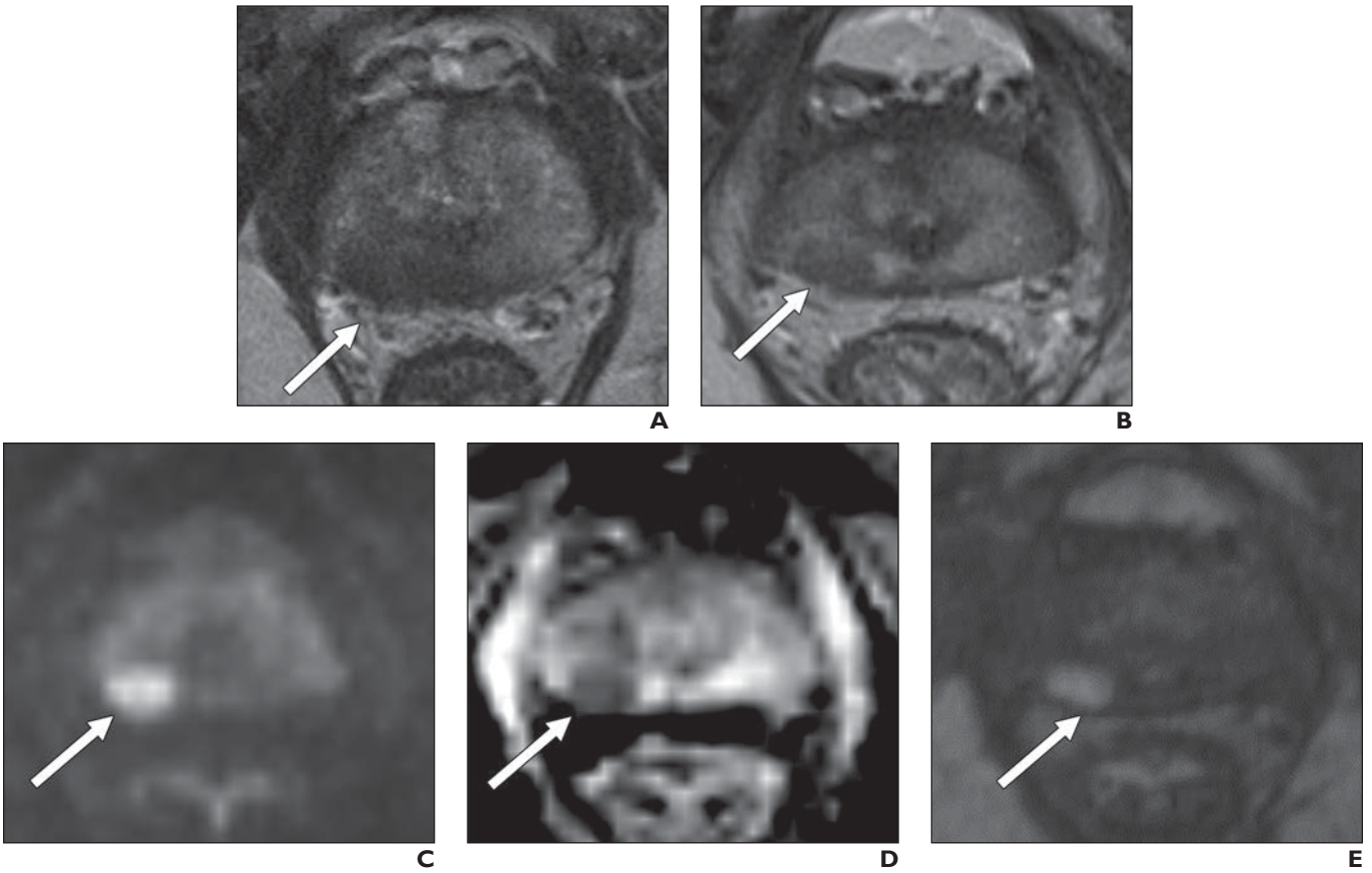

Fig. 3—76-year-old man with history of International Society of Urological Pathology (ISUP) grade group 2 prostate cancer (PCa) treated by external-beam radiation therapy (RT) with subsequent increase in PSA level to 1.76 ng/mL. Overall score is 5 after RT according to Prostate Imaging for Recurrence Reporting system.
A, Axial T2-weighted pretreatment MRI shows primary tumor (*arrow*) in right posteromedial peripheral zone.
B, Axial T2-weighted posttreatment MRI shows markedly hypointense focus (*arrow*) in right posteromedial peripheral zone corresponding to site of primary tumor. T2-weighted imaging score is 5.
C, Axial high-b-value DWI from posttreatment MRI shows corresponding marked hyperintensity (*arrow*).
D, Axial ADC map from posttreatment MRI shows corresponding marked hypointensity (*arrow*). DWI score is 5.
E, Early dynamic contrast-enhanced (DCE) image from posttreatment MRI shows corresponding early enhancement (*arrow*). DCE imaging score is 5. After RT, DWI and DCE imaging both are dominant sequences, and overall score reflects higher score in these two sequences. Thus, overall score of 5 was assigned. Targeted biopsy of lesion revealed PCa in ISUP grade group 2.

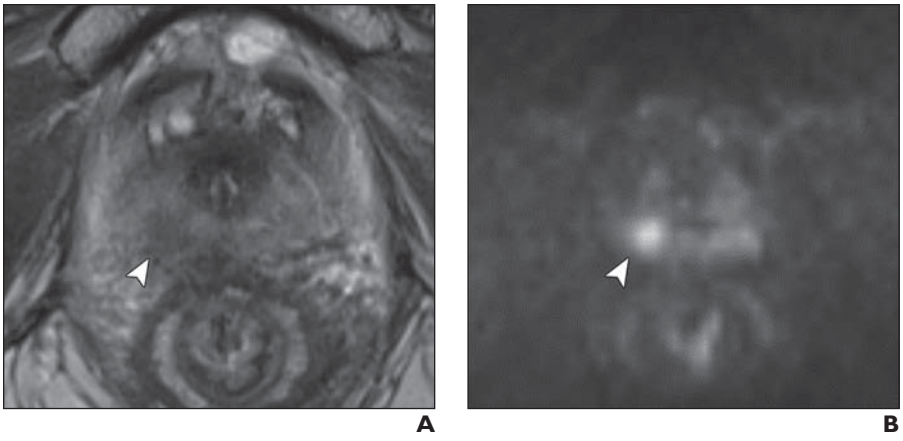

Fig. 4—78-year-old man with history of International Society of Urological Pathology (ISUP) grade group 2 prostate cancer (PCa) treated by external-beam radiation therapy (RT) and MRI-guided RT with subsequent increase in PSA level to 5.0 ng/mL. Overall score is 5 after RT, obtained according to rule for upgrading from score of 4 to score of 5 according to Prostate Imaging for Recurrence Reporting system. No prior imaging was available to allow comparison with site of primary tumor.
A, Axial T2-weighted image shows focal moderately hypointense lesion (*arrowhead*) in right posteromedial apical peripheral zone. T2-weighted imaging score is 4.
B, Axial high-b-value DWI shows corresponding marked hyperintensity (*arrowhead*).
C, Axial ADC map shows corresponding marked hypointensity (*arrowhead*). DWI score is 4.
D, Early dynamic contrast-enhanced (DCE) image shows corresponding early enhancement (*arrowhead*). DCE imaging score is 4. After RT, DWI and DCE both are dominant sequences, and overall score reflects higher score in these two sequences. However, score of 4 on both DWI and DCE imaging is upgraded to overall score of 5 if restricted diffusion and early enhancement are present in same location. Thus, overall score of 5 was assigned. Targeted biopsy of lesion revealed PCa in ISUP grade group 2.

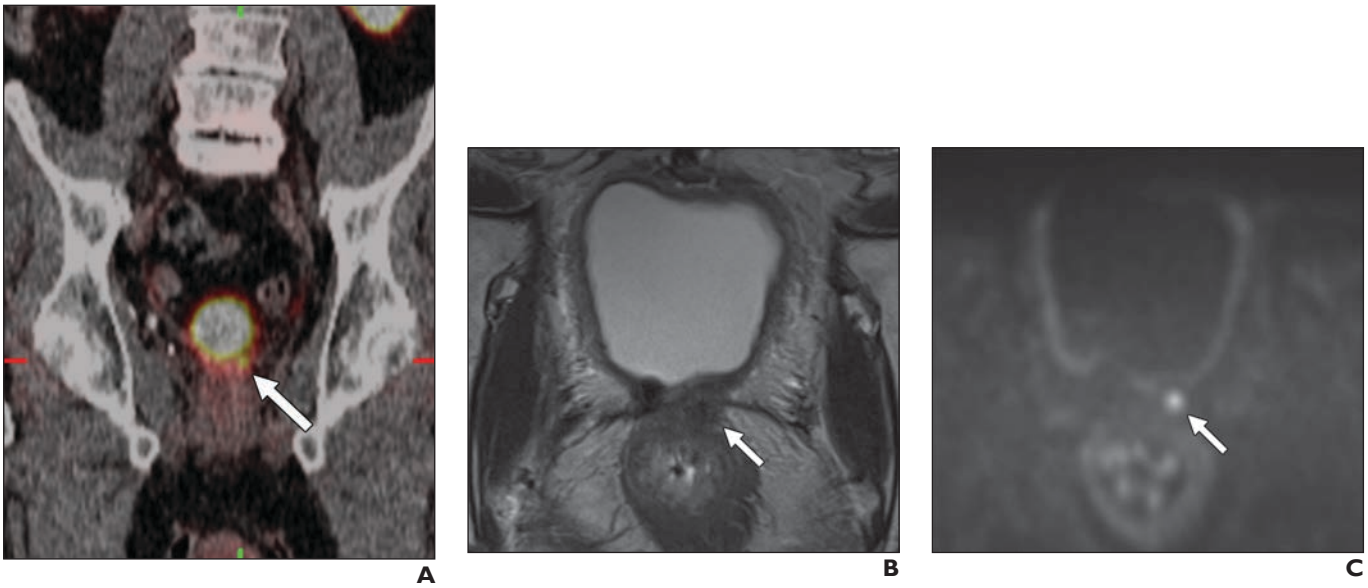

Fig. 5—62-year-old man with history of International Society of Urological Pathology grade group 2 prostate cancer treated by radical prostatectomy (RP) with subsequent increase in PSA level to 0.4 ng/mL. No preoperative imaging was available to allow comparison with location of primary tumor. Overall score is 4 after RP, according to Prostate Imaging for Recurrence Reporting system.
A, Coronal fused PSMA PET/CT image shows focus of moderate uptake (*arrow*) in left prostatic bed in proximity to bladder. Lesion is moderately suspicious for local tumor recurrence. No definite CT correlate was identified. Prostate MRI was advised for further characterization.
B, Axial T2-weighted MRI obtained after **A** shows asymmetric focal, slightly hyperintense lesion (*arrow*) in left prostatic bed. T2-weighted imaging score is 4.
C, Axial high-b-value DWI shows corresponding focal marked hyperintensity (*arrow*).

(Fig. 5 continues on next page)

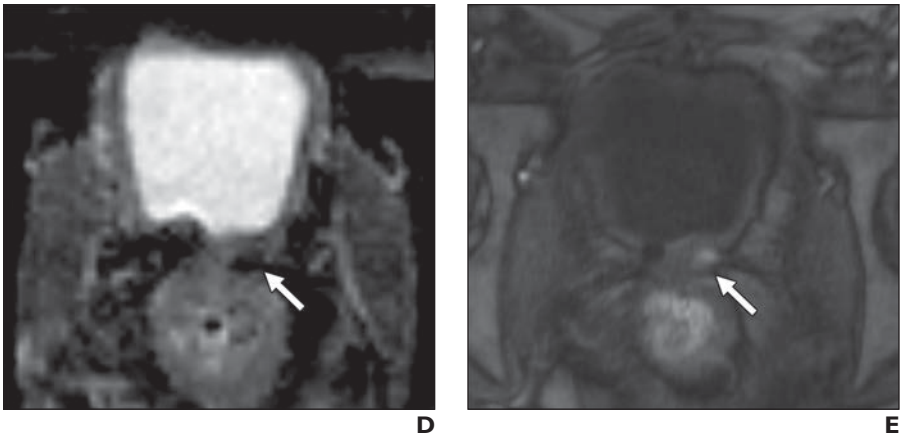

Fig. 5 (continued)—62-year-old man with history of International Society of Urological Pathology grade group 2 prostate cancer treated by radical prostatectomy (RP) with subsequent increase in PSA level to 0.4 ng/mL. No preoperative imaging was available to allow comparison with location of primary tumor. Overall score is 4 after RP, according to Prostate Imaging for Recurrence Reporting system.
D, Axial ADC map shows marked hypointensity (*arrow*). DWI score is 4.
E, Early dynamic contrast-enhanced (DCE) image shows corresponding early enhancement (*arrow*). DCE imaging score is 4. After RP, DCE imaging is dominant sequence in determining overall score. Thus, overall score of 4 was assigned. After multidisciplinary discussion, patient was treated by salvage radiation therapy given absence of extraprostatic disease on previous PSMA PET/CT.

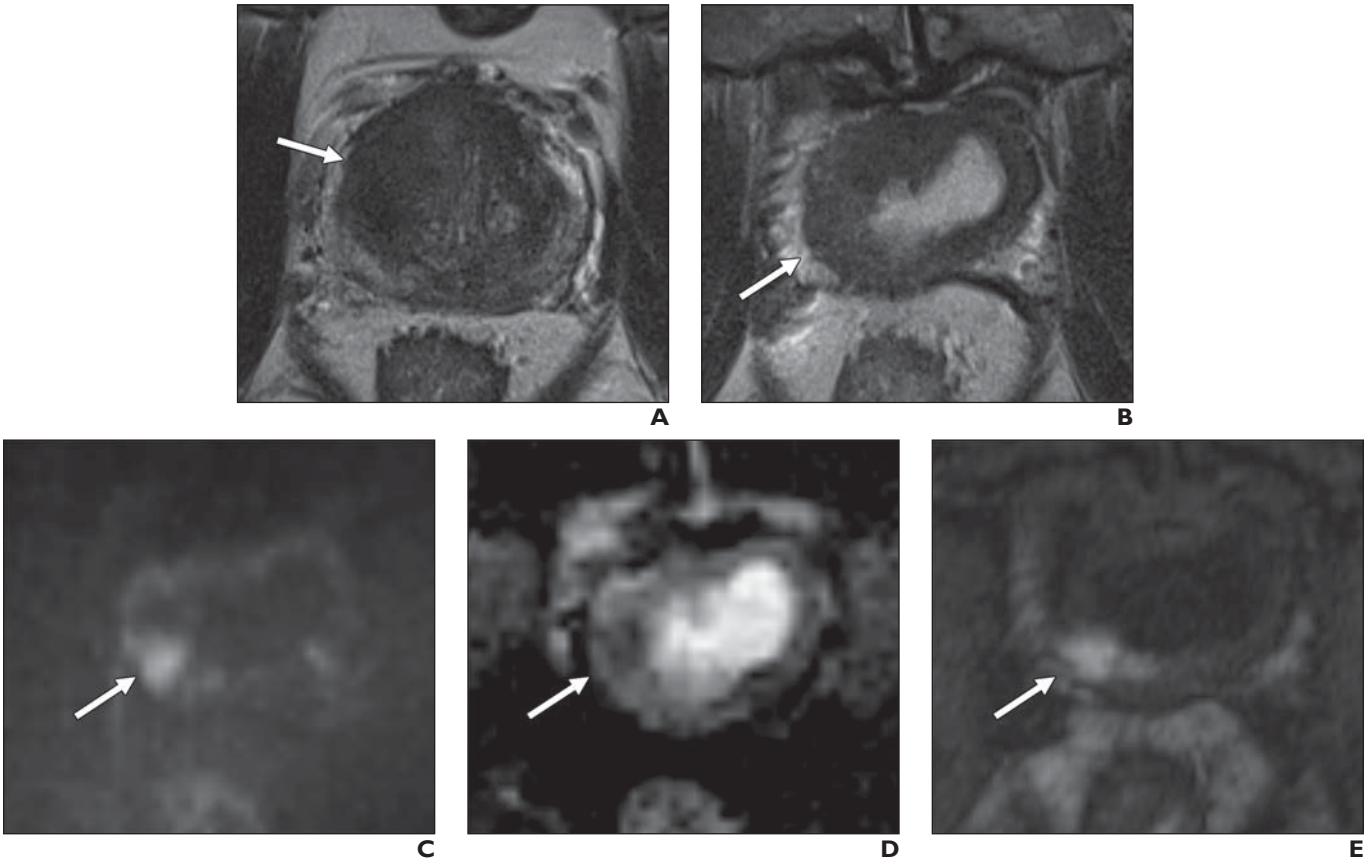

Fig. 6—66-year-old man with history of International Society of Urological Pathology (ISUP) grade group 1 prostate cancer (PCa) in right transition zone (TZ) treated by radical prostatectomy (RP) with positive surgical margins and subsequent increase in PSA level to 0.43 ng/mL. Overall score is 5 after RP, according to Prostate Imaging for Recurrence Reporting system.
A, Axial T2-weighted pretreatment MRI shows primary tumor (*arrow*) in right TZ.
B, Axial T2-weighted posttreatment MRI shows asymmetric masslike hyperintensity (*arrow*) in right posterolateral aspect of urinary bladder in proximity to anastomosis and ipsilateral to primary tumor. T2-weighted imaging score is 5.
C, Axial high-b-value DWI shows corresponding nodular marked hyperintensity (*arrow*).
D, Axial ADC map shows corresponding marked hypointensity (*arrow*). DWI score is 5.
E, Early dynamic contrast-enhanced (DCE) image shows corresponding early enhancement (*arrow*). DCE imaging score is 5. After RP, DCE imaging is dominant sequence in determining overall score. Thus, overall score of 5 was assigned. Targeted biopsy revealed PCa in ISUP grade group 2.

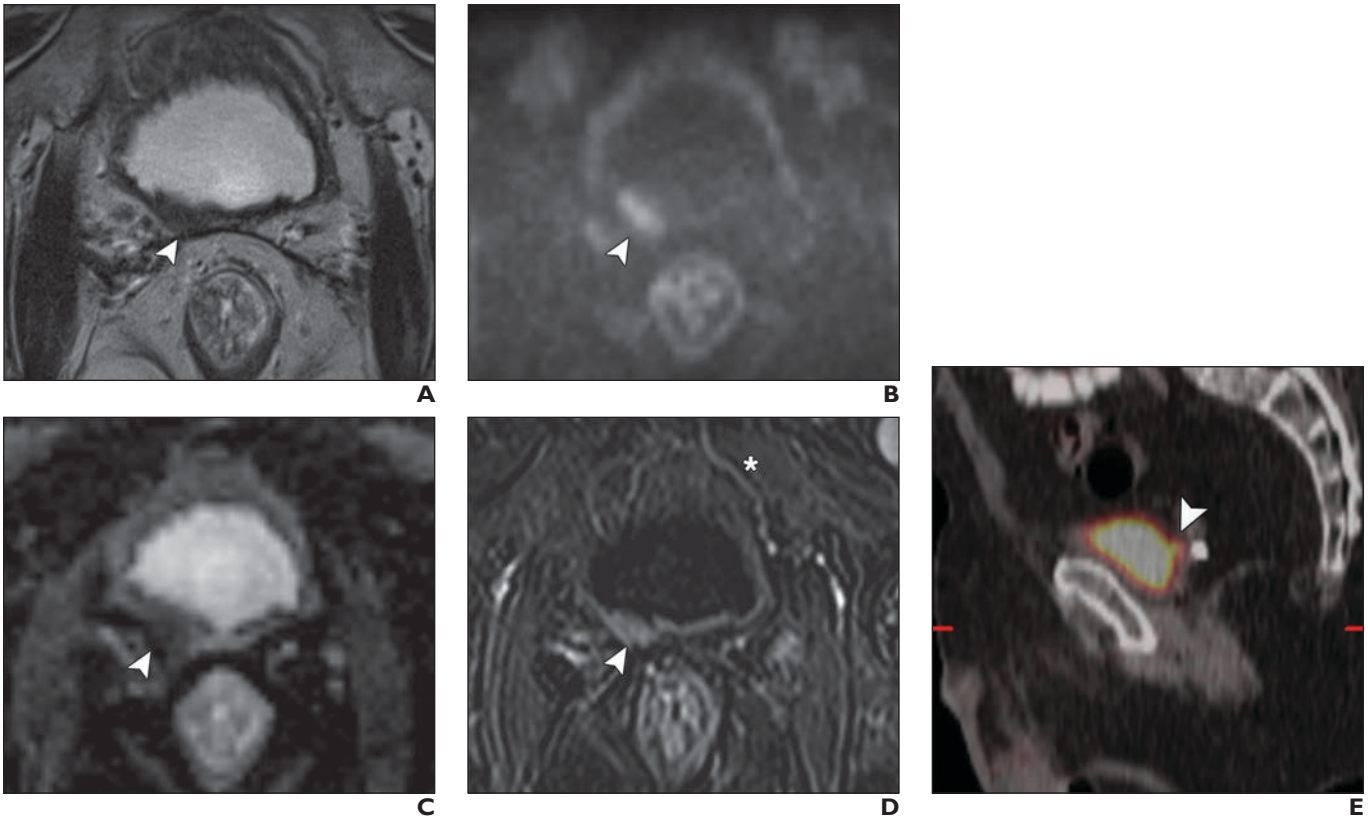

Fig. 7—78-year-old man with history of International Society of Urological Pathology grade group 3 prostate cancer treated by radical prostatectomy (RP) with subsequent increase in PSA level to 1.0 ng/mL. No prior imaging was available to allow comparison with location of primary tumor. Overall score is 4 after RP, obtained according to rule for upgrading from score of 3 to score of 4 in Prostate Imaging for Recurrence Reporting system.
A, Axial T2-weighted image shows asymmetric focal, slightly hyperintense lesion (*arrowhead*) in right seminal vesicle bed inseparable from adjacent bladder wall. T2-weighted imaging score is 4.
B, Axial high-b-value DWI shows corresponding nodular marked hyperintensity (*arrowhead*).
C, Axial ADC map shows corresponding marked hypointensity (*arrowhead*). DWI score is 4.
D, Axial delayed dynamic contrast-enhanced (DCE) image shows corresponding delayed enhancement (*arrowhead*); enhancement of perivesical vein (*asterisk*) also is evident. DCE imaging score is 3. After RP, DCE imaging is dominant sequence in determining overall score. However, score of 3 on DCE imaging is upgraded to overall score of 4 if DWI score is 4 or higher. Thus, overall score of 4 was assigned.
E, Sagittal fused PSMA PET/CT image obtained after **A–D** shows uptake (*arrowhead*) immediately posterior to bladder and anterior to surgical clip. Patient was treated with salvage radiation therapy after multidisciplinary discussion given absence of extraprostatic disease on PSMA PET/CT.

(Editorial Comment starts on next page)

Editorial Comment: Posttreatment Prostate MRI Is Not "RAD"… It's "PIRRfect"

Standardization of the performance, interpretation, and reporting of radiologic tests has been crucial to improving the value of medical imaging since BI-RADS was proposed by the American College of Radiology (ACR) in 1986 [1]. Comparable recommendations now exist for myriad imaging tests with increasing adoption by other medical societies as standards for patient management. PI-RADS, developed jointly by the ACR, the European Society of Urogenital Radiology (ESUR), and the AdMeTech Foundation and now at version 2.1, is one such standard [2]. PI-RADS has become the international standard for MRI examinations performed for detection of clinically significant primary prostate cancer. It serves as the basis for numerous clinical trials that have yielded level 1 evidence establishing the importance of prostate MRI.

PI-RADS was not designed for detection or characterization of residual or recurrent disease in the treated prostate. To this end, in a subsequent ESUR initiative, Panebianco et al. [3] developed Prostate Imaging for Recurrence Reporting (PI-RR). This new system leverages established techniques in PI-RADS version 2.1 while incorporating information regarding the original location of the tumor on pretreatment imaging and the heightened role of dynamic contrast-enhanced imaging after treatment. PI-RR allows a qualitative straightforward assessment that is similar to PI-RADS but tailored for the treated prostate.

As with PI-RADS, the assessment and reporting recommendations of PI-RR were released before being established with published data. As this review shows, the system is poised to undergo rigorous validation, as also occurred for PI-RADS. Early retrospective studies of PI-RR have shown excellent interrater reproducibility and promising diagnostic performance. The impact of increasing availability of PSMA radioligands for PET (e.g., ^{18}F-piflufolastat) on the role of PI-RR remains to be seen. Regardless, the presence of an established uniform method of assessment and reporting is certain to improve the perceived value of prostate MRI in the posttreatment setting.

Daniel J. A. Margolis, MD
Weill Cornell Medical College
New York, NY
djm9016@med.cornell.edu

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