Fluorine-18 Prostate-specific Membrane Antigen-1007 Positron Emission Tomography/Computed Tomography and Multiparametric Magnetic Resonance Imaging in Diagnostics of Local Recurrence in a Prostate Cancer Patient After Recent Radical Prostatectomy

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Clinical Practice Points
- We performed fluorine-18 (18F) prostate-specific membrane antigen (PSMA)-1007 positron emission tomography (PET)/computed tomography (CT) in 1 patient with biochemical recurrence (prostate-specific antigen level, 0.3 ng/mL) after radical prostatectomy.
- Diagnostic certainty using multiparametric magnetic resonance imaging was significantly reduced compared with PET in this case for the detection of local prostate cancer recurrence.
- 18F-PSMA-1007 PET/CT scanning revealed focal intense PSMA uptake in the former right prostatic bed, indicating local recurrence.

Introduction
In recent years, prostate-specific membrane antigen (PSMA) positron emission tomography (PET)/computed tomography (CT), mostly bound to gallium-68 (68Ga), has significantly emerged as the diagnostic tool of choice for primary prostate cancer staging and as an imaging modality for biochemical recurrence.1-4 However, according to recent guidelines, multiparametric magnetic resonance imaging MRI (mpMRI) should be the modality of choice for initial local staging and for assessment of local recurrence.5-7 In addition, although serving as a comparable diagnostic tool for primary staging and as a favorable imaging modality for local recurrence, 68Ga-PSMA PET/CT has the disadvantage of bladder activity, which can be a problem for local recurrence detection.8-10 The novel PET tracer fluorine-18 [18F]-PSMA-1007 has some advantageous characteristics that make it a promising candidate to compete with 68Ga-PSMA PET/CT.11,12 With PET radiopharmacies connected to an on-site cyclotron, 18F-PSMA-1007 can be produced on a large scale.12 Additionally, 18F-PSMA-1007 is primarily eliminated by hepatobiliary excretion owing to its moderate lipophilic characteristics.13 Therefore, almost no bladder activity occurs, providing ideal conditions for evaluation of the prostate bed.11 In the present case
report, we evaluated the advantages of PSMA PET/CT to evaluate a patient with biochemical recurrence and unclear findings on mpMRI.

**Case Report**

In January 2017, prostate cancer (PCa) was diagnosed in a 48-year-old patient. The PCa was Gleason score 3+4 and International Society of Urological Pathology grade 2. The patient underwent radical prostatectomy. The radical prostatectomy specimen revealed pathologic stage T2cN0. The clinical M stage was M0. No adjuvant radiotherapy was administered. The prostate-specific antigen (PSA) level decreased from 7.8 ng/mL preoperatively to 0.1 ng/mL after surgery, indicating biochemical recurrence. Six months later, the patient was referred to our clinic, with a request for imaging using mpMRI owing to an elevated PSA level of 0.3 ng/mL. MRI did not detect any distinct suspicious local tumor growth or lymph node metastases (Figure 1). mpMRI was conducted as described previously using state-of-the-art high b values (b = 0, 1000, and 1500 s/mm²) and T1-weighted dynamic contrast enhancement with 50 time measurements. A smaller contrast-enhanced nodule close to the bladder (Denonvillier fascia) on the right side was noted. However, the certainty of the board-certified radiologist was low, and the finding was reported as unclear. The apparent diffusion coefficient was moderately

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**Figure 1** Multiparametric Magnetic Resonance Imaging Examination of a 48-Year-old Patient 6 Months After Radical Prostatectomy (Gleason Score 7, Stage pT2cN0M0), When the Patient Presented With an Increasing Prostate-specific Antigen Value of 0.3 ng/mL. (A) T2-weighted Images, (B) T1-weighted Images After Dynamic Contrast Enhancement, and (C) Diffusion-weighted Images With Apparent Diffusion Coefficient Map Did Not Reveal Any Recurrence, Including in the Former Prostatic Bed

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**Figure 2** Fluorine-18 Prostate-specific Membrane Antigen (PSMA)-1007 Positron Emission Tomography (PET)/Computed Tomography (CT) Examination of a 48-Year-old Patient 6 Months After Radical Prostatectomy (Gleason Score 7, Stage pT2cN0M0), When the Patient Presented With an Increasing Prostate-specific Antigen Value of 0.3 ng/mL. (A, B) PET and (C, D) Fused PET/CT Images Showed Intense, Focal PSMA Ligand Uptake (Red Arrow) in the Former Right Prostatic Bed With Maximum Standardized Uptake Value of 4.95, Indicating Local Recurrence
decreased. The case was reviewed again, and 2 board-certified radiologists confirmed that the very small contrast-enhancing nodule could be mistaken as postoperative scarring.

For further investigation, the patient underwent PET/CT with the $^{18}$F-labeled PSMA-targeted radiotracer ($^{18}$F)PSMA-1007. PET/CT detected focal PSMA ligand uptake in the former right prostatic bed with a maximum standardized uptake value (SUVmax) of 4.95, indicating clear local PCA recurrence (Figure 2). No metastatic lymph nodes or distant metastases were detected on the PSMA PET/CT scan. Therefore, local stereotactic radiotherapy was initiated, with a PSA decrease confirmed during the treatment.

**Discussion**

Up to 40% of patients undergoing radical prostatectomy for primary treatment of PCA will develop biochemical recurrence.13-17 For these patients, precise localization of recurrent disease and accurate restaging is crucial for adequate treatment selection. However, conventional imaging modalities such as CT or MRI have some limitations in the detection of local disease.18

The role of PET/CT has gradually increased in importance for prostate cancer patients with biochemical relapse.19 $^{18}$F-choline and $^{11}$C-choline as markers of membrane cell proliferation are radiotracers currently widely used in clinical practice. However, some studies have reported low sensitivity and specificity, especially in patients with low PSA values.19 PSMA ligands have been reported to have greater sensitivity and specificity than the choline derivative.20 Nevertheless, the most significant advantage of $^{68}$Ga-Ga-PSMA-11 PET/CT is the sensitive detection of lesions even at low PSA levels, even small lymph node metastases, and bone and visceral metastases owing to the low background signal.4,20 Also, $^{68}$Ga-Ga-PSMA-11 ligands have the disadvantage in the assessment of small local recurrences of excretion by way of the kidneys and high accumulation in the urinary bladder.10 $^{18}$F-PSMA-1007 is an attractive alternative to the Ga-PSMA radioligand, because it has demonstrated better energy and fast, nonunary background clearance, which greatly improves evaluation of the former left prostatic bed.12

An SUVmax of ≤40 and 100 in the bladder for $^{68}$Ga-Ga-PSMA-617 and $^{68}$Ga-Ga-PSMA-11 has been reported, respectively.21,22,23 In contrast, the content of the urinary bladder was an SUVmax of 5 for $^{18}$F-PSMA-1007.11 Performing 18-F-PSMA-1007 PET/CT at very low PSA levels potentially allows for more effective salvage treatment, because the prognosis is improved by the initiation of treatment before the PSA level has exceeded 0.5 ng/mL.12

**Conclusion**

Low urinary clearance of $^{18}$F-PSMA-1007 for PET/CT imaging provides additional diagnostic value in the case of local recurrence after radical prostatectomy that was considered unclear using standard mpMRI.

**References**


