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FDG-PET Versus PSMA-PET: A Patient With Prostate Cancer

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Abstract

A 64-year old male presented to the hospital with a 1-week history of stools with bright red blood. Subsequent colonoscopy with a biopsy revealed a low-lying, moderately differentiated, rectal adenocarcinoma. A pelvic magnetic resonance imaging done afterwards showed a possible T3N1 rectal cancer with intact muscularis mucosa and a singular presacral lymph node enlargement. Furthermore, a suspicious peripheral prostatic enlargement and a possible left iliac crest sclerotic bone lesion were incidentally identified. ^{18}F-FDG (fluorodeoxyglucose) PET (positron emission tomography) scan confirmed a primary FDG avid rectal tumor and a presacral lymph node; however, there was no prostate or iliac crest uptake. A serum prostate-specific antigen performed in the hospital returned with a value of 37 ng/mL, which prompted a prostate biopsy, eventually returning as positive for adenocarcinoma. Consequently, a ^{68}Ga-PSMA PET scan to rule out possible metastatic prostate disease revealed increased PSMA expression in the prostate only. After consultation with the radiologist and nuclear medicine physician who concluded the iliac crest lesion is likely not cancerous, the final diagnosis of T3N1 rectal cancer with simultaneous high-grade prostate adenocarcinoma was declared. This case highlights the low sensitivity of ^{18}F-FDG PET scans for prostate cancer, the need for routine serum prostate-specific antigen screening, and the progression of ^{68}Ga-PSMA PET as a diagnostic tool for prostate cancer.

Keywords

prostate cancer, oncology, radiology

Background

Fluorodeoxyglucose-positron emission tomography (FDG-PET) is a powerful imaging modality used to diagnose various cancers and anatomically localize potential sites of metastasis. Over the last 10 years, it has become part of the standard of care in diagnosing patients with cancer. FDG-PET has an impressively high sensitivity, as high as 97% in lung cancer and 93% in breast cancer recurrence detection. However, the sensitivity of FDG-PET in detecting prostate cancer has been under scrutiny, with the efficacy of its role in diagnosing prostate cancer questioned.[1,2] More recently, PSMA (prostate-specific membrane antigen)-PET has been recognized for its role in diagnosing prostate cancer, with a higher sensitivity when there is increased production of PSMA.[3,4] However, further assessment of PSMA-PET needs to be done in order to establish clear guidelines for PSMA-PET use.

Case Presentation

A 64-year-old male with a past medical history of benign prostatic hyperplasia and recently diagnosed paroxysmal atrial fibrillation presented to the hospital with a complaint of stools with bright red blood for the past 1 week. He was recently started on 5 mg of apixaban twice daily. He was hemodynamically stable with normal electrolytes and blood counts at presentation. The patient had no family history of any colorectal or genitourinary cancer. Colonoscopy with biopsy done shortly after admission demonstrated low-lying, moderately differentiated, adenocarcinoma of the rectum. A subsequent magnetic resonance imaging (MRI) of the pelvis showed T3N1 rectal cancer, with intact muscularis mucosa, and an enlarged presacral lymph node. A suspicious peripheral

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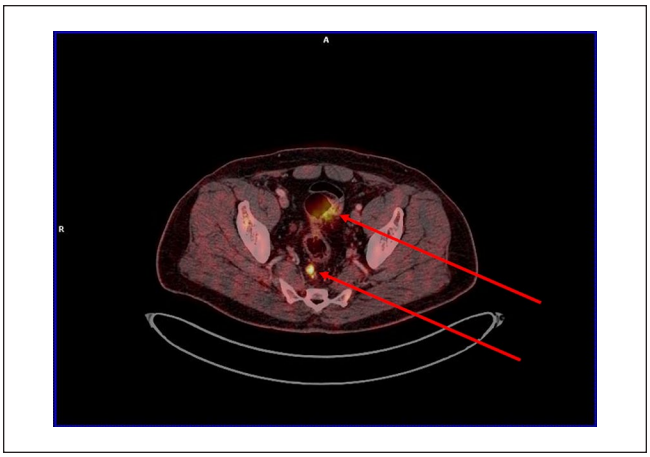

Figure 1. FDG-PET showing increased uptake at site of rectal tumor (top arrow) and presacral lymph node (bottom arrow). While FDG-PET did not pick up any activity in the prostate, it cannot be ruled out that a possible reason for lack of uptake was due to washout from a more intense signal from the rectal lesion as shown in the top arrow.

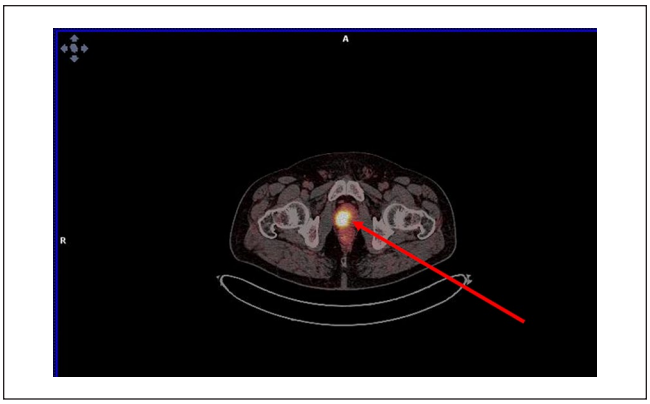

Figure 2. PSMA-PET showing increased uptake in the prostate (red arrow).

prostatic enlargement with a left iliac crest sclerotic bone lesion was incidentally found.

Given the incidental finding of prostatic enlargement and possible sclerotic bone lesion of the left iliac crest appearing quite suspicious, an FDG-PET scan was done and confirmed the primary rectal tumor with a presacral lymph node, but did not reveal any increased uptake in the prostate or iliac crest (Figure 1). Prostate specific antigen (PSA) blood test was subsequently done that was elevated at 37 ng/mL. Due to high suspicion of a new concurrent primary prostate cancer, a biopsy was taken that revealed prostatic adenocarcinoma. PSMA-PET was then performed to identify any potential metastases from this primary site. PSMA-PET revealed increased uptake in the prostate, which was not previously detected by FDG-PET (Figure 2). There was no uptake in the iliac crest (Figure 3). After careful evaluation by the radiologist and nuclear medicine physician, it was determined that given the appearance of the lesion on MRI as calcification with well-defined margins and central necroses and the lack of uptake by PSMA-PET, which is highly sensitive for prostate metastases, the lesion likely represented an intraosseous iliac lipoma instead of a metastasis (Figure 4). On disclosure of the radiologist's diagnosis to the patient, along with an explanation that the differential diagnosis included an intraosseous lipoma as well as sclerotic prostate metastases that would likely present with irregular necrotic margins, the patient ultimately decided not to pursue biopsy understanding this was the most definitive way to rule out metastasis. As a result, primary rectal adenocarcinoma with metastasis to a single presacral lymph node, in addition to concurrent primary prostate adenocarcinoma, was the final diagnosis.

The patient was started on treatment for 2 primary perineal cancers, rectum as well as prostate. He received localized radiation therapy for rectal cancer and is scheduled for a repeat MRI of the pelvis for restaging of his rectal cancer postradiation. For his prostate adenocarcinoma, the decision was made to initiate antiandrogenic medication. If the patient qualifies and if an abdominoperineal resection is completed for the rectal cancer, he plans to undergo full-dose radiation therapy for prostate cancer in concurrence with his antiandrogen treatment.

Discussion

Prostate cancer is the second most common cancer in men worldwide.[5] However, synchronous diagnosis of rectal and prostate cancer is extremely rare.[6] In a Swedish retrospective study of almost 30 000 patients, only 29 patients had synchronous diagnoses between 1995 and 2011.[6] Furthermore, of the 29 patients, 20 of the patients' prostate cancer was diagnosed incidentally when diagnosing and staging for rectal cancer, as in the case we present in this article.[6] Diagnostic modalities of prostate cancer range from simple digital rectal examinations up to ultrasound-guided and CT-guided biopsies. PET scans have recently gained recognition as a promising modality for staging cancer. FDG-PET is the most common form of PET scan used to stage cancers, detect recurrences, and monitor response to therapies. FDG-PET works by detecting increased glucose metabolism in highly active cancerous cells and has a high sensitivity of 97% in lung cancer and 93% in breast cancer, as examples.[5] However, the sensitivity of FDG-PET in detecting prostate cancer is questionable and reports of its efficacy have been quite conflicting. One study of 24 patients with prostate cancer undergoing FDG-PET reported increased uptake in only 1 patient (sensitivity nearing 4.0%).[1] Other studies have reported that FDG-PET has a higher sensitivity of nearly 80%, but only in advanced prostate cancers with high PSA levels or Gleason scores of higher than 7.[2]

Attempting to find an ideal imaging method to identify prostate cancer proves to be challenging due to the complex nature of the disease itself. Prostate cancers demonstrate a

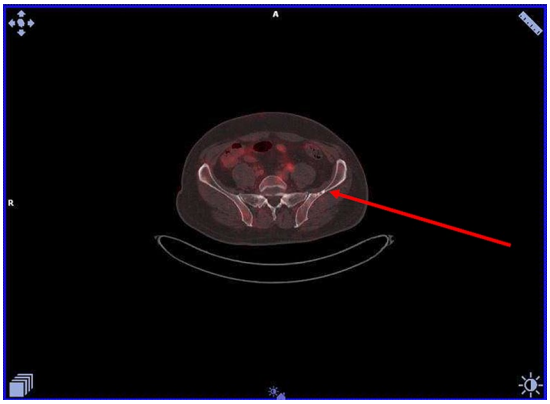

Figure 3. PSMA-PET showing a lesion in the iliac crest (red arrow), but without uptake (yellow).

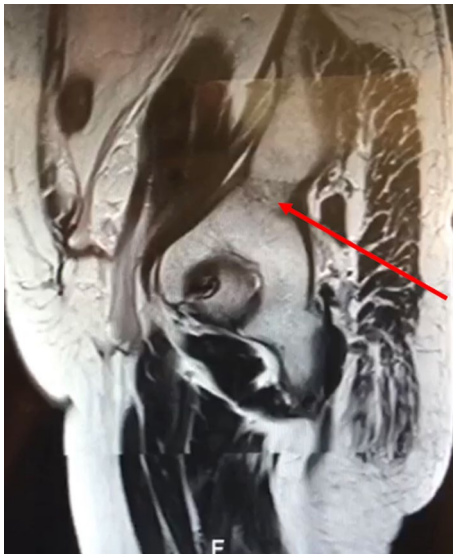

Figure 4. Sagittal MRI showing a left iliac bone lesion, which was classified as an intraosseous lipoma by the radiologist due to defined margin and central necrosis.

wide variety of differentiation with varying degrees of aggressiveness; therefore, the preferred imaging modality should be able to distinguish aggressive markers from the remainder. Additionally, imaging should be sensitive to metastases to both bone and nodal sites as they represent the most common metastases sites.[7]

PSMA is one marker that is elevated in more aggressive types of prostate cancer. PSMA is a transmembrane receptor composed of an internal and external domain, yet its role in the development and progression of prostate cancer has yet to be identified. However, overexpression of this receptor has made it a target for novel imaging modalities. PSMA-PET scans are a form of PET imaging that detects prostate cancer with increased PSMA production. To date, there are no studies comparing FDG-PET and PSMA-PET, yet there are limited studies comparing PSMA-PET to other PET imaging, mainly ^{18}F-choline(FCH)-PET, which showed that PSMA-PET detected more lesions in comparison to the latter with 78 lesions detected in 32 patients versus 56 lesions detected in 26 patients.[3] Other studies also noted that PSMA-PET detected lesions at lower PSA levels compared with FCH-PET with a 50% detection rate at a PSA level as low as 0.5 ng/mL.[4] Last, the recent results of the ProPSMA randomized clinical trial showed that PSMA-PET/CT has superior accuracy with fewer uncertain results than standard CT and bone scan for staging prostate cancer.[8] These positive reports have shed light on PSMA-PET for its potential role in staging prostate cancer.

Previously, there were no clear guidelines for the use of PSMA-PET. In 2017, the Society of Nuclear Medicine and Molecular Imaging and the European Association of Nuclear Medicine collaborated to provide procedure guidelines for prostate cancer imaging using PSMA-PET, based on multicenter experience. Recommendations focused on the use of PSMA in localizing prostate cancer recurrence and for primary staging. With regard to recurrence, it is recommended to use PSMA-PET in particular when PSA levels are low (0.2-10 ng/mL) to localize sites of recurrence, which can subsequently guide salvage therapy. As for primary staging, PSMA-PET has been found to be superior to other forms of imaging including CT and MRI in detecting bone metastasis and lymph node involvement with high-risk disease (ie, PSA $>$20, Gleason score $>$7, clinical staging T2C-3a). However, the benefit of this increased sensitivity to patients' survival remains unclear.[9]

Newer potential applications for PSMA-PET include monitoring response of prostatic metastasis to systemic treatment, attempting targeted biopsy in patients with high suspicion of prostate cancer, and previous negative results, in addition to staging pre- and post-PSMA–targeted therapy. However, these potential applications require more extensive studies to assess PSMA-PET performance in comparison to other currently used modalities.

Author Contributions

All authors have contributed equally to the study.

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Ethics Approval

Our institution does not require ethical approval for reporting individual cases or case series.

Informed Consent

Verbal informed consent was obtained from the patient(s) for their anonymized information.

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