

Breast Cancer Case Study #17

Clinical History

A female patient with a history of breast carcinoma underwent a right mastectomy in 1988. A recent CT scan showed a 1 cm nodule in the left adrenal gland. She presented for evaluation of suspected local regional recurrence and was referred for an ^{18}F NaF PET bone scan.

Imaging Findings

^{18}F NaF WHOLE-BODY TOMOGRAPHIC BONE IMAGING: 9/24/08

INDICATION: RESTAGING BREAST CANCER

COMPARISON: CT SCAN

TECHNIQUE*: The patient was injected with 9.6 mCi of ^{18}F sodium fluoride intravenously and whole body PET acquisition was performed followed by low-dose non-contrast coregistration CT.



Fig. 1

IMAGING FINDINGS: There were several areas of arthritis-related uptake, including facet and uncovertebral joints in the cervical spine and facet joints in the thoracic spine, AC joints, and right acetabular margin. Other areas of arthritic uptake were present in the knees and ankles.

There was a single focus of suspicious activity located in the right aspect of the sacrum, in the medullary bone, near but not directly involving the sacroiliac joint. This small focus corresponded to an area of slight bone sclerosis on the coregistration CT scan.

No lytic disease was apparent.

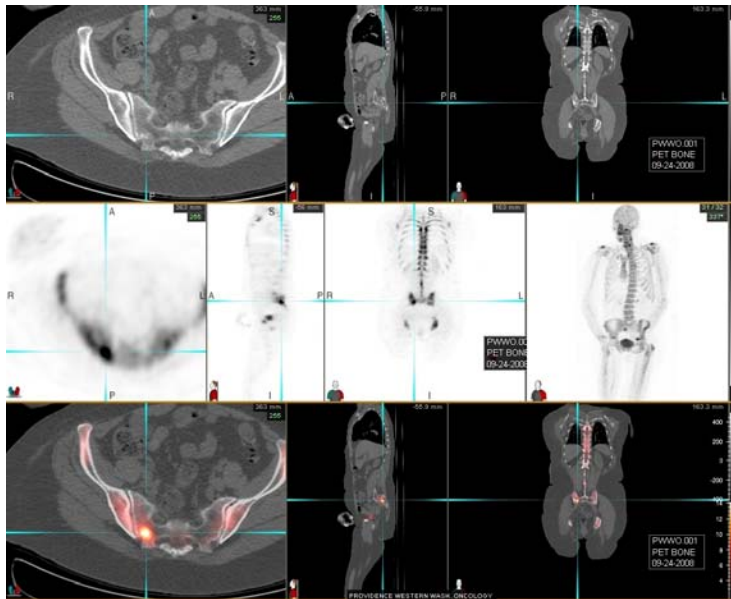


Fig. 2

There was physiological activity present in the urinary collecting systems. Review of the coregistration CT scan revealed a soft tissue mass high in the right axilla, 1 cm left adrenal nodule, mild dependant atelectasis in the right lung base, and a central venous catheter.

Small nodules seen on a prior diagnostic CT scan in the right lung were poorly visualized.

^{18}F NaF BONE SCAN IMPRESSION:

1. There was a single suspicious focus of activity present in the right aspect of the sacrum, which may represent metastatic disease.
2. Multiple additional foci of elevated uptake were noted, consistent with arthritis-related disease.
3. Additional findings on the coregistration CT scan as noted above including a mass high in the right axilla and a left adrenal nodule.
4. An FDG PET•CT scan may be useful in further staging, if clinically indicated.

¹⁸F FDG PET•CT TUMOR IMAGING: 9/26/08
 INDICATION: RESTAGING BREAST CANCER
 COMPARISON: ¹⁸F NaF WHOLE BODY TOMOGRAPHIC BONE IMAGING of 9/24/08

TECHNIQUE*: The patient was injected with 11.7 mCi of ¹⁸F FDG intravenously. Following a standard uptake period, a non-contrast CT scan was acquired, followed by a PET scan along the length of the body from approximately the base of the skull to the mid thigh. The non-contrast CT was used for anatomic localization and photon attenuation correction of the PET scan. The patient's blood glucose was 95 mg/dL at the time of injection.

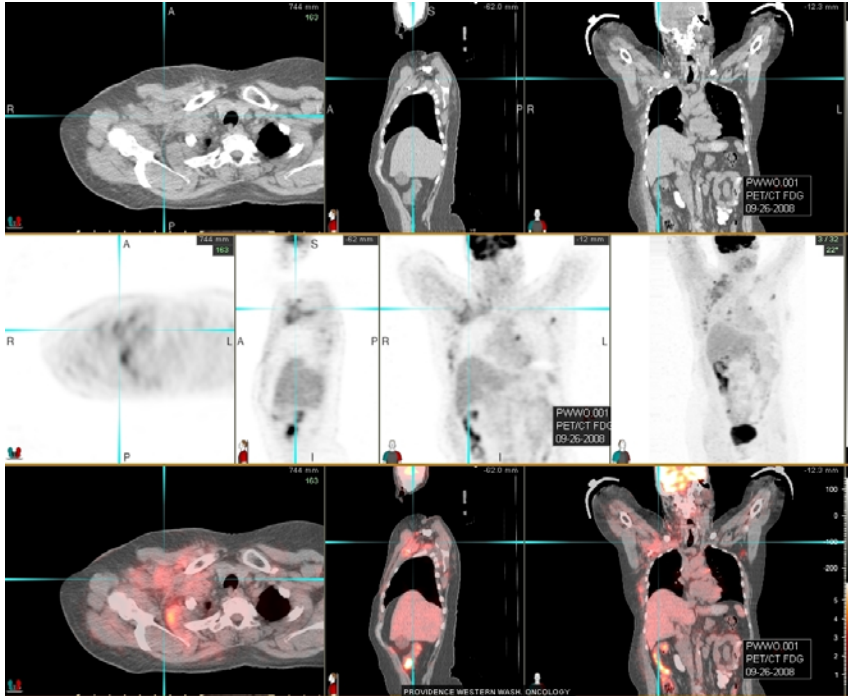


Fig. 3

IMAGING FINDINGS: There was normal physiologic uptake in the oropharyngeal tissues.

The 1 cm nodule in the left adrenal gland, which was noted on previous co-registration CT scan, showed no abnormal FDG uptake.

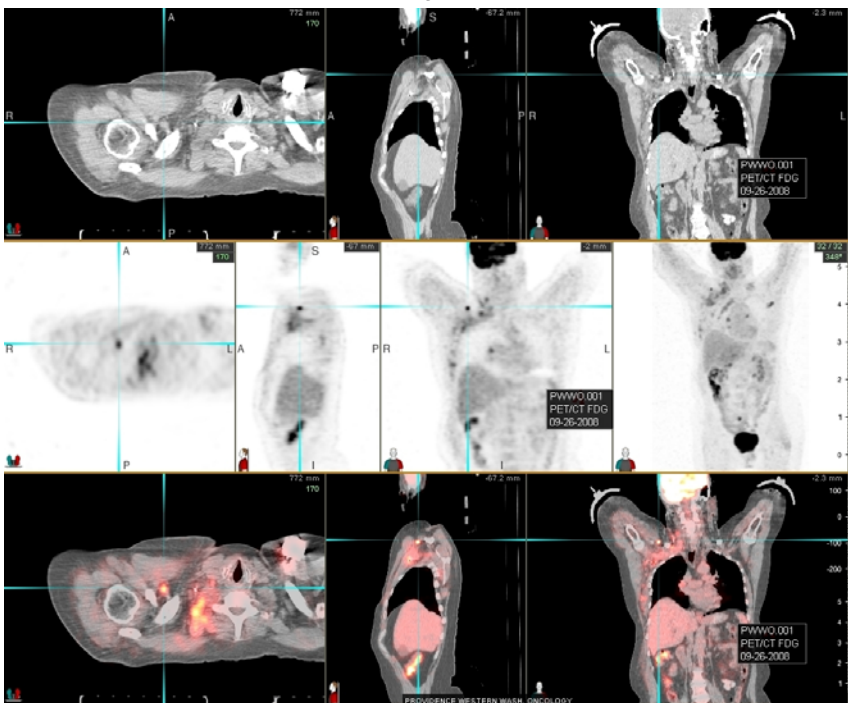


Fig. 4

At the site of the known infiltrating mass high in the right axilla and brachial plexus region, there was diffuse and mildly-elevated FDG uptake with an SUV of 4.

There was superimposed benign muscular uptake in the right paraspinal musculature in the upper chest and base of the neck. There was somewhat more intense uptake in a 1 cm node adjoining the coracoid process, SUV maximum 5.3. There was additional uptake in borderline prominent right axillary nodes, SUV maximum 4.1.

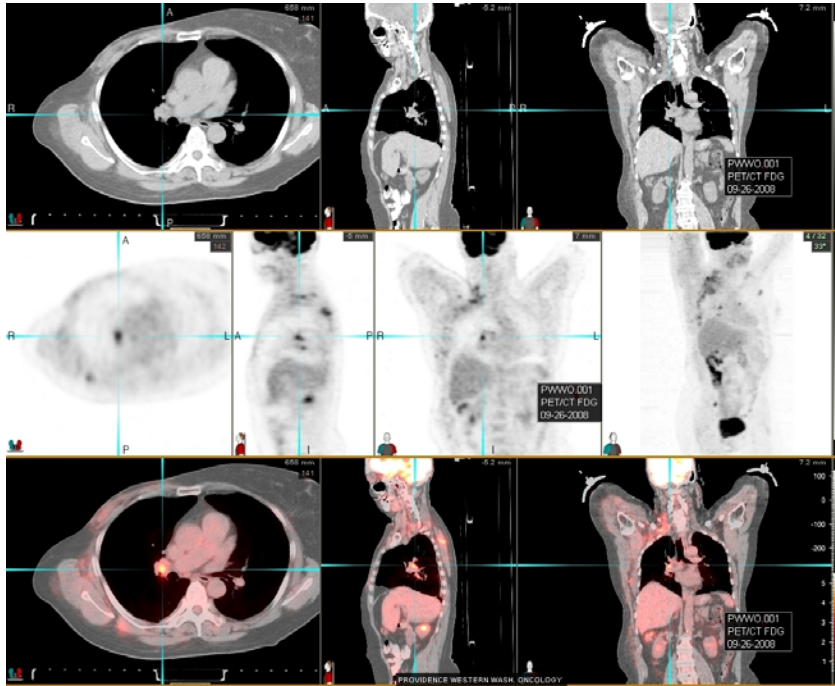


Fig. 5

There was uptake in the small nodes in left AP window and right superior and inferior hilum, which likely represented additional areas of nodal metastasis.

No abnormal pulmonary activity was seen.

The coregistration CT scan demonstrated a tiny nodule in the periphery of the right upper lobe, as seen on the recent diagnostic CT scan. It was PET-negative, but well below the limits of PET resolution. Therefore, it was too small for reliable evaluation and a follow-up CT scan was recommended.

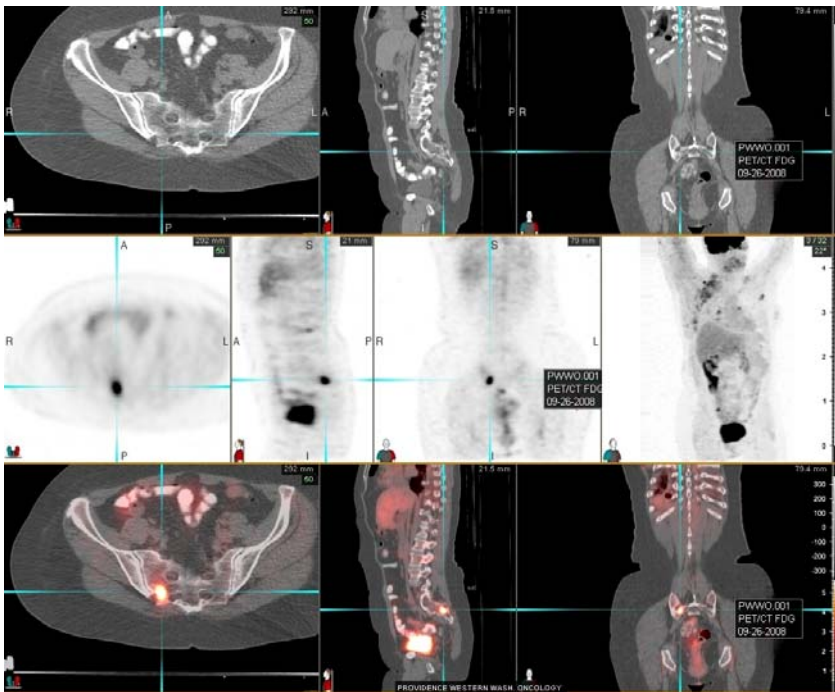


Fig. 6

There was normal physiological uptake present in the liver, spleen, urinary tissues and bowel, without significant hypermetabolic changes.

There was a focal hypermetabolism in the posterolateral aspect of the right sacrum at the site of suspected disease on the 09/24/08 bone scan.

IMPRESSION:

1. Relatively low-level elevated FDG uptake in known infiltrative mass high in the right axilla, consistent with recurrent breast neoplasm.
2. Hypermetabolic changes in a node adjoining the right shoulder girdle and another in the left axilla, consistent with metastasis; additional small volume metastatic disease in the right hilum and left AP window area nodes.
3. Hypermetabolic bone lesion in the right sacrum, consistent with metastasis as seen on recent bone scan.
4. Fairly prominent muscular uptake over the right upper chest, without abnormality on coregistration CT, most likely representing benign muscular activity.
5. PET-negative 1 cm left adrenal nodule, consistent with benign adenoma.
6. PET-negative right upper lobe peripheral pulmonary nodule, but is too small for reliable evaluation on PET and attention on follow-up CT studies is recommended.

Diagnosis

The PET-negative 1 cm left adrenal nodule, that was positive on CT findings, was consistent with benign adenoma. Hypermetabolic changes in a node adjoining the right shoulder girdle and another in the left axilla, were consistent with metastasis. The hypermetabolic bone lesion in the right sacrum, was consistent with metastasis as seen on the bone scan.

Treatment

Chemotherapy was initiated, and a three-month follow-up scan was scheduled to assess the response to treatment.

Imaging Findings

¹⁸F FDG PET•CT TUMOR IMAGING: 12/23/08

INDICATION: BREAST CANCER MONITOR TREATMENT RESPONSE

COMPARISON: PET•CT scan 9/26/2008

CLINICAL HISTORY: Female patient with history of breast carcinoma and a right mastectomy in 1988. The PET•CT scan, three months earlier, revealed positive nodes with right axillary recurrence, nodal metastases and sacral bony metastases. The patient received chemotherapy, and was referred for a PET•CT scan to monitor the treatment response.

TECHNIQUE*: The patient was injected with 10.6 mCi of ¹⁸F FDG intravenously. Following a standard uptake period, a non-contrast CT scan was acquired, followed by a PET scan along the length of the body from approximately the base of the skull to the mid thigh. The non-contrast CT was used for anatomic localization and photon attenuation correction of the PET scan. The patient's blood glucose was 95 mg/dL at the time of injection. Dilute oral contrast was administered.

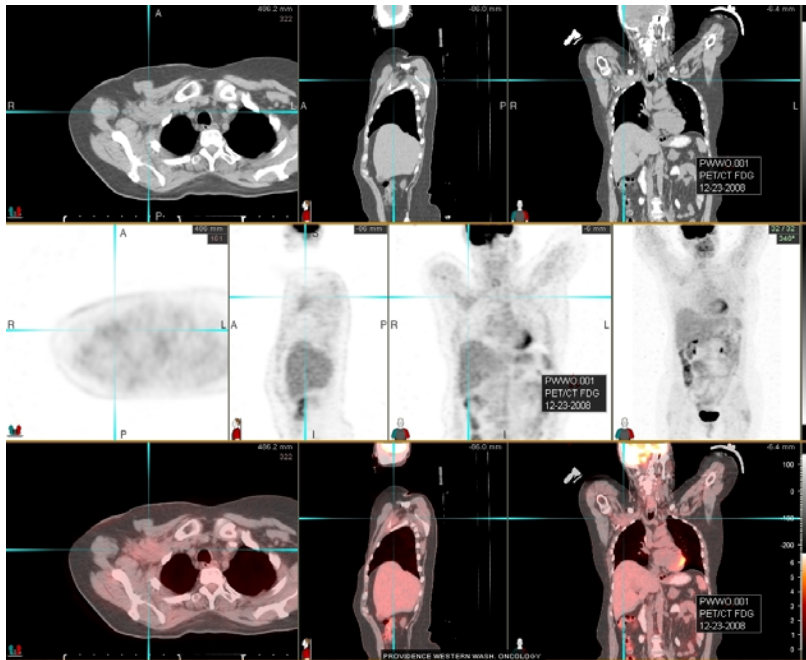


Fig. 7

IMAGING FINDINGS: Since September 2008, there had been marked improvement, with resolution of nearly all the previously described hypermetabolic changes including infiltrative disease in the right axilla, bilateral axillary nodal disease and hilar nodal disease. There was faint residual uptake present in the right axilla adjoining surgical clips from a previous axillary dissection. The SUV had decreased from 3.8 in this region to 1.9. There was no evidence of noteworthy elevated pulmonary activity. Mediastinal blood pool activity was within normal limits. CT demonstrated evidence of prior right mastectomy. Small subpleural pulmonary nodules noted on prior diagnostic CT were grossly unchanged.

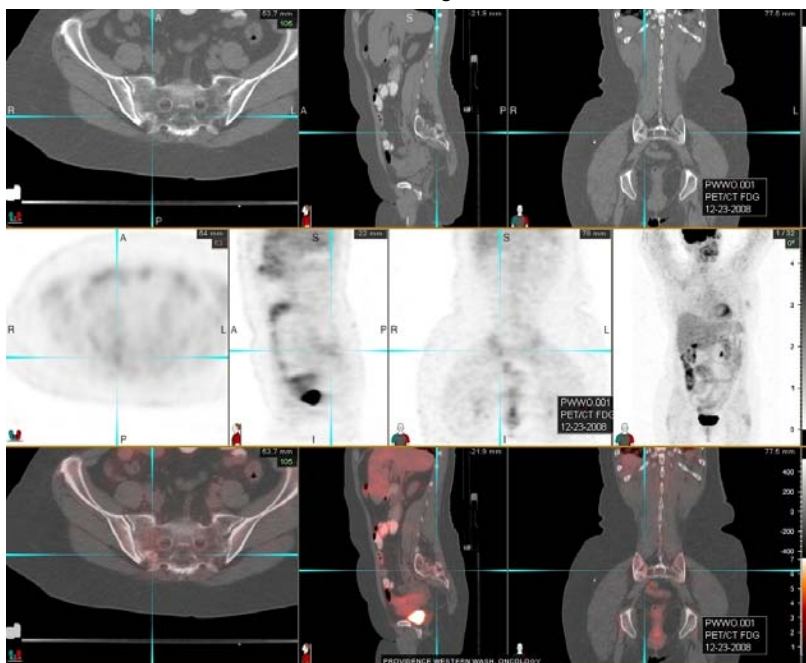


Fig. 8

There was normal physiologic activity present in the liver, spleen, urinary tissues and bowel, without significant hypermetabolism. CT demonstrated a small hiatal hernia and previous hysterectomy.

The previously identified hypermetabolic lesion in the right aspect of the sacrum had resolved. CT demonstrated no change in focal bony sclerosis identified at this site. The remainder of the musculoskeletal uptake was within normal limits.

IMPRESSION:

1. Near complete resolution of hypermetabolic changes involving the right axilla, bilateral axillary nodes, and hilar nodes with minimal residual FDG localization to the right axilla. This could be due to small volume residual tumor or inflammatory changes at the site of the treated tumor. Attention on follow-up studies is recommended.
2. Resolved hypermetabolic metastasis in the right sacrum with no change in residual focal bony sclerosis.
3. No sign of new disease.

Discussion

The most prevalent cancers in the United States are commonly associated with metastatic bone disease and the exclusion of metastatic bone disease is required prior to the initiation of potentially curative therapy.

The standard diagnostic method since the 1970's is planar or SPECT scintigraphy using ^{99m}Tc labeled polyphosphonates. Studies by Schirrmester et al. demonstrated that planar bone scintigraphy was 80-90% sensitive in the detection of peripheral skeletal metastases, but as low as 20-40% sensitive in the detection of vertebral metastases.¹

Evaluation of metastatic bone disease is possible using FDG PET. FDG accumulates in all cells relative to increased glucose metabolism. Soft tissue as well as bony metastatic sites can demonstrate FDG uptake, making precise anatomic localization of lesions difficult.

^{18}F NaF is preferentially deposited at sites of high bone turnover and remodeling, and bone metastases are seen indirectly because uptake depends on skeletal reaction to the tumor. Tracer kinetics depend on both regional blood flow and osteoblastic activity^{2,3} with bone uptake two times higher and faster blood clearance than ^{99m}Tc labeled polyphosphonates⁴, resulting in superior bone to background ratio.

^{18}F NaF PET has the ability to offer an improved whole body tomographic technique for assessing the presence and extent of bone metastases and has the potential to influence referring physician adoption by introducing the diagnostic utility of molecular imaging for the common clinical problem of evaluating metastatic bone disease.

In this case, the NaF PET•CT bone scan accurately revealed a blastic metastasis in this breast cancer patient. The FDG PET•CT scan performed 2 days later, showed the same bone metastasis plus other pathology, which provided the doctor with more complete information to successfully treat the patient. The three-month follow-up PET•CT scan, post chemotherapy, showed near complete resolution of all.

Data courtesy of Ronald Smith, MD, Providence Western Washington Oncology, Lacey, Washington

References:

1. Schirrmester, H et al. Sensitivity in detecting osseous lesions depends on anatomic localization: planar bone scintigraphy versus ^{18}F PET. J Nucl Med 1999; 40:1623-1629.
2. Harmer, C L et al. The value of fluorine-18 for scanning bone tumours. Clin Radiol 1969; 20:204-212.
3. Holsti, L R, Patomaki, L K. ^{18}F scanning of primary and metastatic bone tumours. Ann Med Intern Fenn 1967; 56:131-135.
4. Schirrmester, H et al. Early detection and accurate description of extent of metastatic bone disease in breast cancer with fluoride ion and positron emission tomography. J Clin Oncol. 1999; 17(8):2381-2389.

* Any of the protocols presented herein are for informational purposes and are not meant to substitute for clinician judgment in how best to use any medical devices. It is the clinician that makes all diagnostic determinations based upon education, learning and experience.