Breast MRI and $^{18}$F FDG PET/CT in the management of breast cancer

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Goals: $^{18}$F FDG PET/CT is used for diagnosis, staging and establishing the response to therapy in various malignancies, including breast cancer (BC). Dedicated breast MRI (BMRI) is gaining a role in the management of BC patients (pts), demonstrating high sensitivity and specificity for detection of small lesions. We were therefore prompted to review our experience with PET and BMRI in BC.

Methods: This is a retrospective study of 21 women with BC, 30–76 years old, who had BMRI and whole-body FDG PET/CT at our institution from Jun 2002 to May 2005. A total of 6 patients (group A) had BMRI and PET/CT in the preoperative period and 15 patients (group B) had BMRI and PET/CT after surgery. Reinterpretation of the imaging studies for accuracy and data analysis from medical records were performed. Results: For group A, BMRI identified breast lesions in 4 patients, while PET/CT was able to identify breast lesions in 5 patients. All these were proven to be malignancy on pathology examination. In group B, BMRI detected recurrent breast lesions in 8 patients, with 88.9% sensitivity and 83.3% specificity. In the same patient population, PET/CT was 33.3% sensitive and 91.7% specific. As a whole body examination, PET/CT revealed metastatic disease in 6 patients (100% sensitive and 90% specific). Overall, sensitivities and specificities for breast disease detection were 85.7% and 85.7% for BMRI, and 75% and 92.3% for $^{18}$F FDG PET/CT. Conclusions: As expected, BMRI is more sensitive than PET/CT in the detection of breast lesions. However, PET/CT as a whole-body examination changed the management of disease by detection of distant lesions in 6 of the 21 patients. Our study suggests that $^{18}$F FDG PET/CT and BMRI should be considered as complimentary imaging tools in the pre- and postoperative work-up of patients diagnosed with breast cancer.

Key words: breast cancer, $^{18}$F FDG, PET/CT, MRI

INTRODUCTION

In the United States, breast cancer is the most common non-skin cancer and the second leading cause of cancer-related death in women. The National Cancer Institute estimates a total of 212,930 new cases of breast cancer (211,240 in women) in 2005 and 40,870 total deaths from breast cancer (40,410 in women) for the same year.¹

Breast cancer strikes women of all ages, races, ethnicities, socioeconomic strata, and geographic locales.² Cancer staging is essential in determining the choice of therapy, as well as a patient’s prognosis and chances for survival.³ $^{18}$F fluoro-2-deoxyglucose (FDG) positron emission tomography (PET) fused with computed tomography (CT) provides the ability to combine functional and morphologic information in a single study, thus becoming a powerful imaging modality for diagnosis, staging and establishing the response to therapy in various malignancies, including breast cancer. Likewise, dedicated breast magnetic resonance imaging (MRI) is gaining a major role in the diagnosis and management of breast cancer patients, demonstrating high sensitivity and specificity for detection of small lesions, especially in patients at high...
risk for breast cancer. But whether to request both studies prior to therapy or opt only for one, remains a subject of debate. We were therefore prompted to review our experience with PET and MRI in breast cancer.

**MATERIALS AND METHODS**

This is a retrospective study of 21 women with breast cancer, 30-76 years old (average: 52 ± 13.5), who had breast MRI and whole-body 18F FDG PET/CT at our institution from June 1st, 2002 to May 31st, 2005. The study was performed with the Institutional Review Board approval. The inclusion criteria were proven diagnosis of breast cancer, 30-76 years old (average: 52 ± 13.5), who had the PET/CT studies were acquired with a Biograph LSO PET/CT scanner (Siemens/CTI, Knoxville, TN). The system consists of a dual-slice, spiral CT (Siemens Somatom Emotion) in tandem with an ACCEL PET and is optimized for use in whole-body oncology. Data were obtained in 3D mode, with attenuation correction calculated from coregistered CT images. Images were acquired 60 minutes after i.v. injection of an average dose of 550 MBq of 18F FDG. The images were interpreted on a Windows NT-based computer system, with a Siemens/Syngo user interface.

Dynamic contrast-enhanced breast MRI was performed on a 1.5 T magnet with multichannel capability (Siemens Symphony, Medical Solutions, Erlangen, Germany), using a standard 4 channel phased-array breast coil (Siemens coil or MRI Devices coil, Invivo, Orlando, Florida) with the patient in the prone position. A localizer sequence was obtained. This was followed by a axial TSE T2-weighted (4-5 m sec with a power injector (Medrad, Indianola, Pa.) and after a 20 second delay, five post-contrast volumes were obtained. The PET/CT studies were performed for accuracy. The PET/CT and breast MRI were reviewed and their results were recorded. Reinterpretation of the studies by a board certified Nuclear Medicine physician and a board certified radiologist was performed for accuracy.

The PET/CT studies were acquired with a Biograph LSO PET/CT scanner (Siemens/CTI, Knoxville, TN). The system consists of a dual-slice, spiral CT (Siemens Somatom Emotion) in tandem with an ACCEL PET and is optimized for use in whole-body oncology. Data were obtained in 3D mode, with attenuation correction calculated from coregistered CT images. Images were acquired 60 minutes after i.v. injection of an average dose of 550 MBq of 18F FDG. The images were interpreted on a Windows NT-based computer system, with a Siemens/Syngo user interface.

**RESULTS**

A total of 6 patients (group A) had breast MRI and PET/CT in the preoperative period (3-78 days, average: 25 days) and 15 patients (group B) had breast MRI and PET/CT as follow-up after surgery (4-175 days, average: 51.3 days). The interval between the PET/CT and breast MRI ranged 2-188 days (average: 52.7 days). The age at diagnosis ranged 30-72 years (average: 52 ± 17) in group A and 38-76 years (average: 52 ± 19) in group B. This difference has no statistical significance (p values of 1.0).

For group A (imaging studies prior to surgery), MRI identified breast lesions in 4 patients, while PET/CT was able to identify breast lesions in 5 patients. All these were proven to be malignancy on pathology examination. In the same group, 18F FDG PET/CT detected axillary metastases in 1 patient, but missed them in another, with sensitivity of 33.3% and specificity of 66.7%. There were no patients with distant metastases noted on the whole-body PET/CT exam.

In group B, breast MRI detected recurrent breast lesions in 8 patients, with 88.9% sensitivity (95% CI: 56.5-98) and 83.3% specificity (95% CI: 43.6-96.9). In the same patient population, PET/CT was 33.3% sensitive and 91.7% specific. Axillary lymph nodes metastases were seen on PET/CT in a single patient. As a whole-body lexicon. Morphologic analysis of lesions (masses, foci, and regions) was performed assessing for size, shape, margins, and homogeneity of enhancement. Lesions that were not round or oval, with irregular borders, and heterogeneous or rim enhancement were considered more suspicious. Kinetic analysis was performed for the lesion of interest in the early (1-2 minutes after injection) and late enhancement (5-6 minutes after contrast injection). Masses (>5 mm) that showed at least 50% increase in signal intensity early were considered more suspicious unless there was a benign correlate at mammography, ultrasound, or unenhanced MR imaging. Foci (<5 mm) that showed at least 50% increase in signal intensity early, with washout kinetics late were also considered more suspicious. Regional enhancements with at least 50% increase in signal intensity early were considered more suspicious for malignancy. Segmental, linear, or clumped enhancement was considered suspicious for ductal carcinoma in situ (DCIS), regardless of kinetics. Enhancement in contiguity with the primary tumor was considered suspicious, regardless of size or morphology. Lesions that did not meet any of these kinetic or morphologic criteria were usually considered benign or probably benign.

Specificities and sensitivities for breast cancer and metastases detection using PET/CT and MRI were calculated using the pathology results (17 patients) or follow-up evidence of disease progression (4 patients) as the gold standard. Confidence interval (CI) estimations were performed using the Wilson score method.