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Case Presentation
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A Case Report Evaluated the Internal Properties of a Breast Cancer Lesion Using Digital PET/CT

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Abstract

A novel digital PET/CT system has improved image quality to detect small lesions compared with conventional OSEM-based reconstruction. As for breast cancer, the evaluation of the primary site has been limited in conventional PET/CT due to its low sensitivity and specificity. The novel digital PET/CT system has been shown to increase the detection and visualization of internal properties for breast cancer due to its higher spatial resolution.

Here we report a case of 56-year-old woman with right-sided breast cancer in which heterogeneous ^{18}F-FDG accumulation demonstrated on digital PET/CT system. She presented to our medical center with a palpable mass in her right breast. She had no previous or family history of breast or ovarian cancer. The PET images showed marked focal ^{18}F-FDG uptake in the upper inner aspect of the right breast with heterogeneous intratumoral ^{18}F-FDG accumulation. The clinical staging was T2N1M0 Stage II. Right modified radical mastectomy was performed. Numerous tumor cells identified histopathologically with hematoxylin and eosin staining matched the site of marked ^{18}F-FDG accumulation on the PET images, and fibrotic or cystic sites with fewer tumor cells matched sites of 18F-FDG hypo-accumulation. A novel digital PET/CT images enabled evaluation of internal cellular properties that may be related to prediction of prognosis.

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Introduction

Evaluation of the primary site of breast cancer by conventional ^{18}F-FDG PET/CT has previously been limited due to its low sensitivity and specificity [1-3]. However, the development of PET/CT system, which includes a digital PET/CT system and reconstruction algorithms, has been shown to increase the detection and visualization of internal properties for breast cancer due to its higher spatial resolution [4]. Here we report a case of breast cancer in which heterogeneous ^{18}F-FDG accumulation demonstrated on digital PET/CT correlated with intratumoral heterogeneity histopathologically.

Case Presentation

A 56-year-old Japanese woman presented to our medical center with a palpable mass in her right breast. She had no previous or family history of breast or ovarian cancer. Elastic hard mass was palpable in her right breast. Mammography and ultrasound revealed a lobulated shaped mass in the breast and multiple enlarged lymph nodes in the right axilla suspicious of breast cancer with multiple axillary lymph node metastases. The internal echo was homogeneous on ultrasound. The MRI appearance was of a lobulated mass surrounded by slight rim and septal enhancement within the tumor. Biopsy of the lesion revealed invasive ductal carcinoma.

The patient underwent ^{18}F-FDG PET/CT of the right breast and axillary lesions as part of the preoperative work-up. Scanning was performed using a digital PET/CT scanner (Discovery MI; GE Medical Systems, Milwaukee, WI) about 60 min after the intravenous administration of 5.49 MBq/kg of ^{18}F-FDG. PET was performed from the skull base to the proximal thigh with the patient in the supine position; the patient was then moved into the prone position using a hand-made breast positioning device, and single-bed PET/CT was performed of the breast region alone. The CT and PET acquisition parameters were as follows. Non-contrast whole-body and additional regional CT scans were obtained at 120 kV with automatic dose modulation, and PET was performed with acquisition time of 2.10 min per bed position in three-dimensional mode. The PET images were then reconstructed using Q.Clear (GE Medical Systems; β=400) with attenuation correction. The

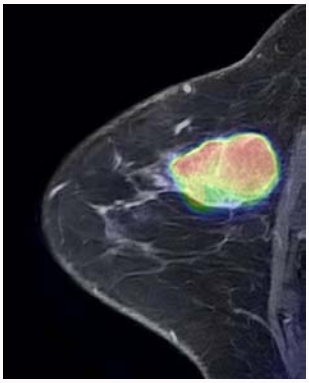

Figure 1: Fusion image of PET and MRI images. The PET image shows heterogeneous ^{18}F-FDG accumulation in the breast tumor.

interval between the two PET/CT scans was 17 min. The images revealed marked focal ^{18}F-FDG uptake with SUVmax of 27.9 that corresponded to the breast lesion identified on other modalities. The tumor appeared heterogeneous accumulation on PET image (Figure 1). No distant metastases were detected. The clinical staging was T2N1M0 Stage II. Right modified radical mastectomy was performed. Histological analysis revealed invasive ductal carcinoma, mixed type, with pleomorphic carcinoma components. The histological appearance was of a mixed tumor with solid and cystic components bounded by fibrous septa. Areas with abundant tumor cells in the lesion identified with Hematoxylin and Eosin (HE) staining and with Ki-67 staining matched the site of marked ^{18}F-FDG accumulation seen on the PET images, and fibrotic or cystic sites corresponded with areas of hypo-^{18}F-FDG accumulation seen on the PET images (Figure 2).

Discussion

In the present case of invasive ductal carcinoma, the tumor demonstrated heterogeneous accumulation on PET that correlated to intratumoral heterogeneity histopathologically.

The role of PET/CT in breast cancer has been the pre-treatment systemic staging of locally advanced breast cancer. Several breast cancer guidelines have not recommended PET/CT for women with apparent early-stage breast cancer or even for those with operable stage III breast cancer [1]. The use of PET/CT for imaging primary breast lesions is hampered by its low spatial resolution, which reduces its sensitivity by missing small lesions; in addition, it is less sensitive than sentinel lymph node biopsy for assessing axillary lymph node involvement. The low prevalence of distant metastases in these patients and the relatively high risk of false-positive findings are considered to detract from the usefulness of PET/CT for distant staging in these patients [2].

The development of dedicated Breast PET (dBPET) systems has enabled detailed high-resolution imaging by setting the detector close to breast lesion. An association between baseline tumor glycolytic activity and tumor biology have been reported. Masumoto et al. reported that intratumoral heterogeneity on dBPET can predict the malignancy grade of breast cancer [3]. They considered that such intratumoral heterogeneity could not be demonstrated on conventional PET/CT. However, the dBPET is specialized for breast scan, it cannot obtain whole-body image at same equipment.

Advances in PET/CT technology have improved image quality and the ability to detect small lesions. In a previous study, the quantitation and detectability of sub-centimeter spheres was higher with a digital PET/CT system compared with conventional OSEM-based reconstruction [4]. In the present case of invasive ductal carcinoma, PET/CT imaging acquired with a digital PET/CT system demonstrated heterogeneous 18F-FDG accumulation. A marked abundance of tumor cells identified within the lesion histopathologically with HE staining matched the region of marked 18F-FDG accumulation identified on the PET images, and fibrotic and cystic sites matched those of ^{18}F-FDG hypo-accumulation. It is known that US and MRI have high tissue resolution; however, the present case shows the ability of digital PET/CT to evaluate the internal properties of tumors.

In conclusion, we report a case of invasive ductal carcinoma that demonstrated heterogeneous ^{18}F-FDG accumulation on novel digital PET/CT that correlated to histopathological intratumoral heterogeneity. Digital PET/CT imaging shows potential for evaluating the internal properties of a lesion and may enable prognostic prediction.

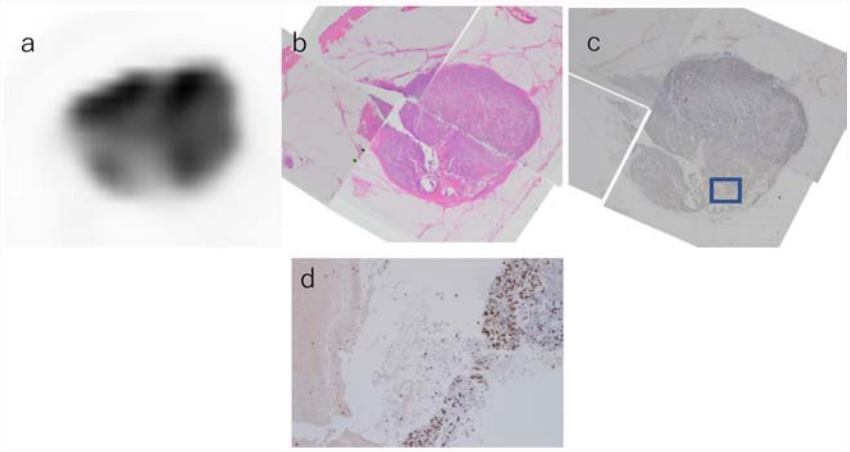

Figure 2: Comparison of a PET image with the corresponding stained specimens. Intratumoral heterogeneous ^{18}F-FDG distribution is seen in the PET image (a). Hematoxylin and eosin staining (b) shows invasive ductal carcinoma. A marked abundance of tumor cells within the lesion is seen with hematoxylin and eosin and with Ki-67 staining (c, d) that matches areas of marked ^{18}F-FDG accumulation on the PET images. Fibrotic and cystic sites that do not contain tumor cell lesions match the sites of ^{18}F-FDG hypo-accumulation.

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