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False-positive ^{18}F-fluorodeoxyglucose positron emission tomography/computed tomography in a patient with metallic implants following chondrosarcoma resection

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Abstract. Positron emission tomography (PET) with fluorine-18-labeled fluorodeoxyglucose (^{18}F-FDG) has been used for the staging and evaluation of recurrence in cancer patients. We herein report a false-positive result of ^{18}F-FDG PET/computed tomography (CT) scan in a patient following chondrosarcoma resection and metallic implanting. A 35-year-old male patient with chondrosarcoma of the left iliac bone underwent radical resection, metal brace implanting and radiotherapy. A high uptake of ^{18}F-FDG was observed in the metallic implants and adjacent tissue during PET/CT scanning in the 5th year of follow-up. Tissue biopsy and follow-up examination identified no tumor recurrence or infection at these sites, suggesting that the results of ^{18}F-FDG PET/CT must be interpreted with caution in cancer patients with metallic implants.

Introduction

Fluorine-18-labeled fluorodeoxyglucose (^{18}F-FDG) positron emission tomography (PET)/computed tomography (CT), which combines molecular with structural imaging, is a highly sensitive and specific modality for detecting primary tumors and metastatic lesions compared with magnetic resonance imaging (MRI), CT and bone scintigraphy (1). ^{18}F-FDG PET/CT has been successfully used for the diagnosis, staging and assessing the recurrence of cancer (2); it has also contributed in distinguishing malignant osteochondromas and evaluating tumor grade in chondrosarcoma (3,4). However, a high FDG uptake may be observed in the metallic implant and adjacent tissue following chondrosarcoma resection. We herein report such a false-positive result of ^{18}F-FDG PET/CT scan, which was identified by biopsy of the tissue adjacent to the implants and follow-up examination in this patient. To the best of our knowledge, no reports have yet been published on the effect of metallic artifacts on PET/CT detection in cancer patients.

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Case report

A 37 year-old man was diagnosed with low-grade chondrosarcoma of the left iliac bone, involving part of the adjacent muscle and soft tissue. The tumor was radically resected and a titanium alloy brace was implanted in the left pelvis in August 23, 2000. A second excision was performed following tumor relapse adjacent to the implant, which was detected by CT scanning in December, 2004. R1 resection margin was confirmed by pathological assessment and the patient underwent radical three-dimensional conformal radiotherapy of the left pelvis with a clinical target volume of 6-MV X-rays, with a total dose of 64 Gy/32 fr. This patient was regularly followed up with physical and imaging examinations, according to the follow-up schedule. ^{18}F-FDG PET/CT scanning was performed in February, 2010, 5 years after the radiotherapy. High FDG uptake [maximum standardized uptake value (SUV_{max}) = 10.3] was found in the soft tissue surrounding the metallic implants (Fig. 1). Tumor relapse was suspected on PET/CT imaging. Multiple biopsies of tissues adjacent to the implants was performed in July, 2010. The pathology results revealed the presence of fibrous tissue, without inflammation or tumor recurrence. The false-positive result of the PET/CT examination was confirmed by tissue biopsy in this patient at the 5-year follow-up examination (Fig. 2). The titanium alloy brace was removed from the left pelvis at another hospital and marked fibrosis surrounding the implants was detected during surgery in October, 2015 (data not shown). The patient remains alive and disease-free, with a good performance status and no complaints during follow-up.

Discussion

The uptake of ^{18}F-FDG by tissues is related to the glycolytic activity of the tissue during PET scanning (5,6). PET/CT

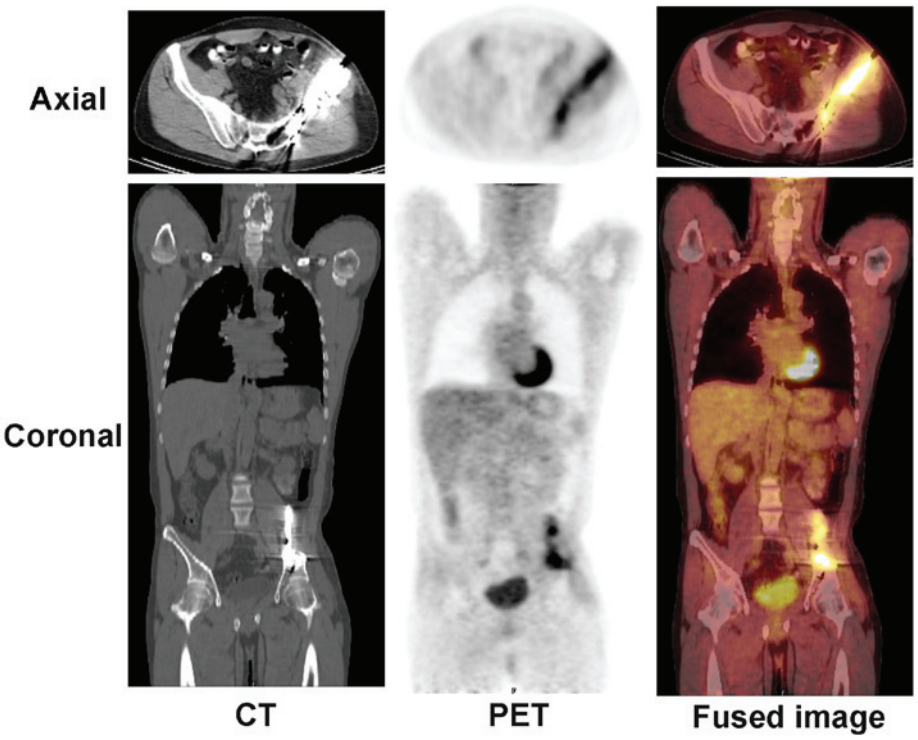

Figure 1. Increased uptake of fluorodeoxyglucose (maximum standardized uptake value = 10.3) of adjacent metallic implants in the left pelvis 5 years after recurrent chondrosarcoma resection (February, 2010). The co-registered PET and CT image facilitated the utilization of CT-based attenuation correction for PET. CT, computed tomography; PET, positron emission tomography.

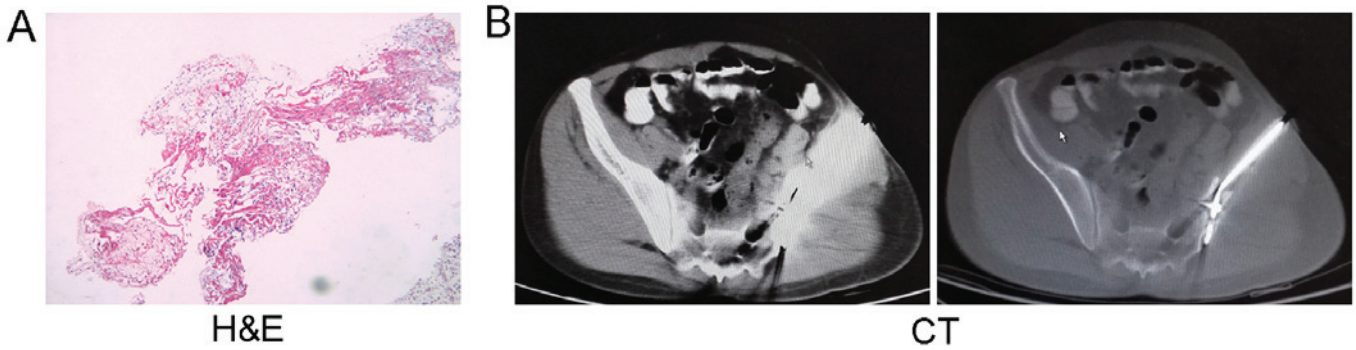

Figure 2. Result of biopsy of tissue adjacent to the artifacts and conventional computed tomography (CT) scan at 10 years of follow-up following resection of chondrosarcoma of the left iliac bone. (A) Pathological examination revealed the presence of fibrous tissue adjacent to the metallic implant. (B) Axial CT scanning of the pelvis on May 21st, 2015. Right panel, soft tissue window; left panel, bone window. The structures surrounding the implants on CT scanning were the same as in February, 2010.

imaging combines anatomical and functional images. Whole-body FDG-PET/CT scanning is widely used as a diagnostic and evaluating tool in patients with malignant tumors. Metallic implants are often used in patients in oncological surgery. MRI and CT scanning often display a compromised image quality in patients with metallic implants. Therefore, FDG-PET/CT plays an important role in detecting recurrent tumors in the vicinity of the artifacts in patients with cancer. Implant-associated infection and inflammation may also develop in certain patients postoperatively (7). Increased FDG uptake may also be associated with benign conditions, such as infection and inflammation (8,9). However, in this patient, the pathological examination identified no tumor recurrence or infection of the soft tissue adjacent to the artificial implants. The deceptively high uptake of the implants and adjacent tissue may be related to the artifacts in the left pelvis of this patient. It was previously reported that uninfected vascular metallic grafts resulted in FDG uptake for years, with SUVmax ranging from 2 to 4.2 (10). However, the SUVmax of the implants and adjacent tissue was 10.2 in this patient. The CT beam hardening metallic implants leads to enhanced or diminished radiotracer uptake, resulting in a 'dark streak' or 'starburst' appearance on CT images. The acquisition of PET images facilitates the utilization of CT-based attenuation correction for PET, which may lead to variable degrees of bias in the measures of FDG uptake *in vivo*. Dark streak artefacts cause signal loss and lead to an underestimation of the SUV. The starburst zones lead to attenuation overestimation, leading

to an artificial increase of the SUV (11-14). The attenuation overestimation of metallic artefacts in CT images may account for the strong absorbance during PET imaging in this patient. Thus, the positivity of FDG-PET/CT should be interpreted with caution in cancer patients with metallic artifacts.

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