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FDG-PET/CT findings of sarcomatous transformation in neurofibromatosis: a case report

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We herein report FDG-PET/CT findings of sarcomatous transformation in a patient with neurofibromatosis type 1 (NF-1). About 5% of patients with NF-1 develop sarcomatous transformation of a malignant peripheral nerve sheath tumor which arises from plexiform neurofibromas and is often associated with a poor prognosis. Morphologic imaging techniques such as Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) are the standard methods to define the anatomic extent of the tumor, although tumor heterogeneity prevents reliable differentiation between benign and malignant lesions. The degree of fluoro-deoxyglucose (FDG) uptake correlates with histologic grade in neurogenic tumors in NF-1 patients. Our patient had a huge mass in the left gluteus area with a large nearly circular focus of increased FDG uptake in the tumor. The mass had a photopenic center. The maximum Standard Uptake Value (SUV_{max}) of this mass was 6.6. There was CT evidence of invasion of the left iliac wing, left acetabulum, and left superior pubic ramus; however there was no increased FDG uptake in these areas on the PET study. We surmised that the high FDG uptake indicated a high grade sarcoma, which was confirmed histologically. There was also a focal region of increased uptake in the L5 vertebral body, correlating with the CT hypodense lesion, with 2.9 SUV_{max}. FDG-PET/CT can identify sarcomatous change from benign neurogenic tumor with minimal misregistration, and can also detect metastatic disease. This case illustrates the importance of evaluating both metabolic and morphologic abnormalities to be able to formulate a proper treatment plan. This information can be obtained in a single session, using PET/CT.

Key words: FDG-PET/CT, neurofibromatosis, sarcomatous transformation, malignant peripheral nerve sheath tumor

INTRODUCTION

NEUROFIBROMATOSIS-1 (NF-1, von Recklinghausen's disease) is an autosomal dominant disease, which has characteristic clinical features including café au lait spots, neurofibromas, iris Lisch nodules, and skinfold freckling. About 5% of patients with NF-1 develop malignant peripheral nerve sheath tumors (MPNST) which arise from plexiform neurofibromas and often have a poor prognosis.[1,2] MPNST may metastasize widely to sites including lung, brain, liver, bone, lymph nodes and skin. For optimal management, it is important to evaluate tumor extension and histological grading. Magnetic Resonance Imaging (MRI) and Computed Tomography (CT) are the standard methods to define the anatomic extent of the tumor, although tumor heterogeneity prevents reliable differentiation between benign and malignant lesions.[3] The utility of Positron Emission Tomography (PET) with fluoro-deoxyglucose (FDG) is well established, and plays an important role in detecting, characterizing, and monitoring various tumors. Malignant soft tissue tumors have high glucose metabolic rates, and can be visualized as areas of intense uptake using FDG-PET.[4–6] Recent advances in technology allow acquisition of both anatomic

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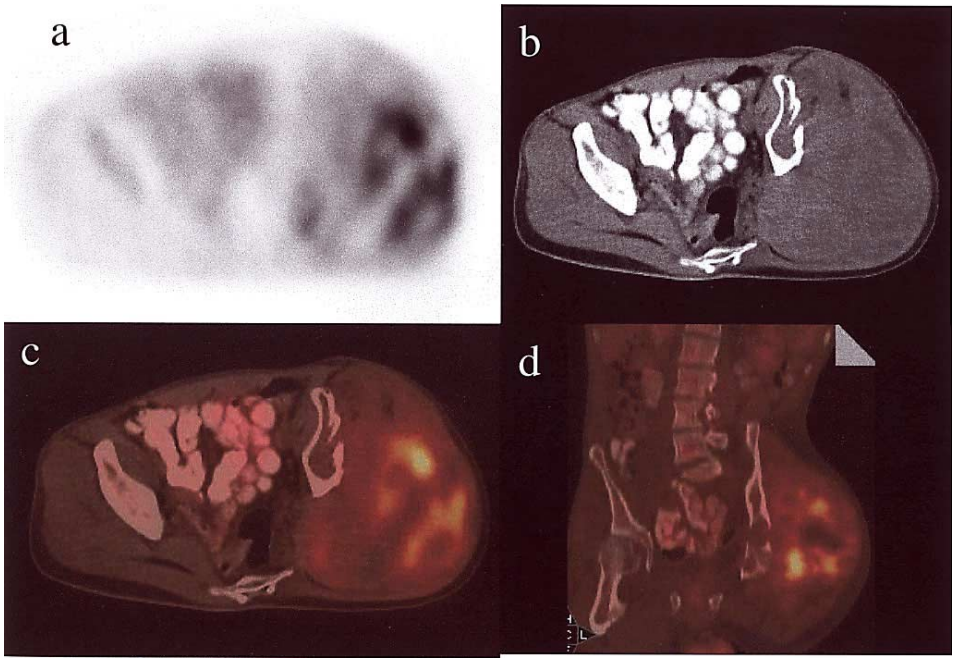

Fig. 1 A 28-year-old male patient with a history of neurofibromatosis developed sarcomatous transformation in a left gluteus mass. a: FDG-PET image, b: CT image, c: fused PET/CT image, d: coronal view of PET/CT image. There is a large nearly circular focus of increased FDG uptake in the left gluteus musculature. The mass has a photopenic center. SUV_{max} of this mass is 6.6. There is CT evidence of invasion of the left iliac wing, left acetabulum, and left superior pubic ramus with no increased FDG uptake in these areas on the PET image.

and metabolic information in a single session using combined PET/CT systems. Here, we describe FDG-PET/CT findings of sarcomatous transformation in a NF-1 patient.

CASE REPORT

Patient

A 28-year-old male with a history of neurofibromatosis was referred to our institution for further evaluation and treatment. This patient had noted some discomfort in the left buttocks area for about a year. He also noted a firm mass in the area of the left hip. He had increasing pain in that area and felt gradual increasing weakness in the left leg. The patient had an MRI scan which demonstrated a mass in the left lateral gluteus from the mid iliac to just below the greater trochanter level. His father and uncle had been diagnosed with neurofibromatosis.

FDG-PET/CT scan

The study was performed with the patient in the fasting state. Prior to injection of 370 MBq FDG, the patient's blood glucose level was measured at 100 mg/d*l*. Following administration of 750 m*l* of 5% iodine-based oral contrast and after an uptake time of 90 minutes, imaging from the top of the head to the soles of feet was performed on a PET/CT (Biograph, Siemens, IL, USA) with PET imaging in 3D-mode. Before PET imaging, the CT was completed for attenuation correction and anatomic localization purposes. The system has a 2-slice helical CT scanner. The patient breathed freely during the entire study. The total examination time on the table was approximately 30 minutes.

FDG-PET/CT findings

There was a large nearly circular focus of increased FDG uptake in the left gluteus musculature. The mass had a photopenic center. SUV was calculated as follows: SUV = tissue concentration (kBq/m*l*)/injected FDG dose (kBq)/body weight (g). The maximum Standard Uptake Value (SUV_{max}) of this mass is 6.6. There was CT evidence of invasion of the left iliac wing, left acetabulum, and left superior pubic ramus; however there was no increased FDG uptake in these areas on the PET image (Fig. 1). There was also a focal region of increased uptake in the L5 vertebral body correlating with the CT hypodense lesion (Fig. 2). SUV_{max} of this lesion was 2.9.

Pathological findings

The biopsied specimen from the mass was diagnosed as a high grade sarcoma, and even with a limited amount of tissue, this was strongly suggested to be a malignant peripheral nerve sheath tumor (MPNST).

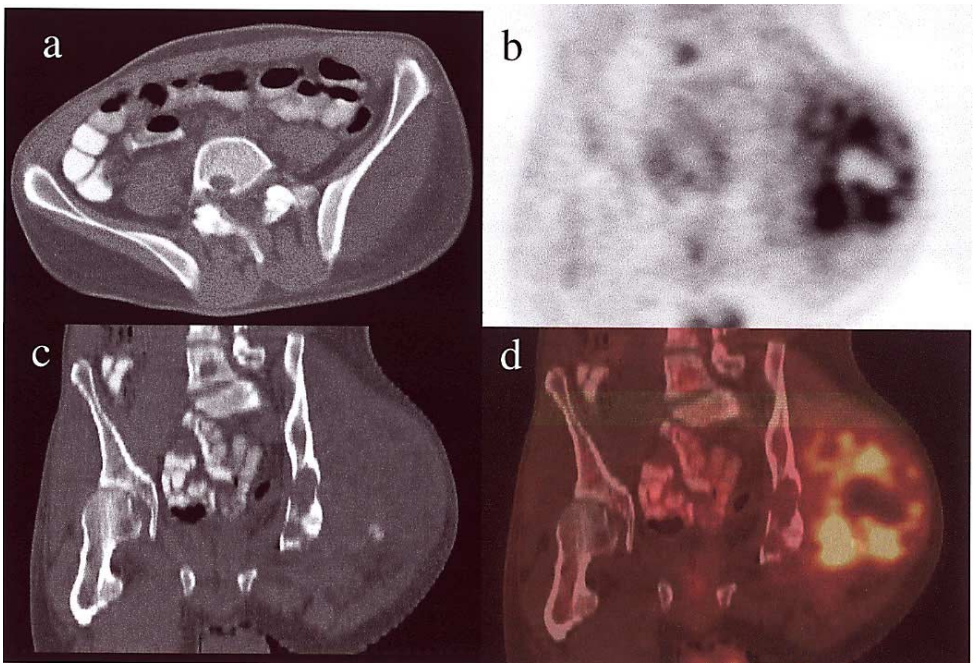

Fig. 2 Metastatic lesion is L5. a: axial CT image, b: coronal FDG-PET image, c: coronal CT image, d: coronal fused PET/CT image. Corresponding to low density lesion on CT, FDG uptake is seen with 2.9 SUV_{max}.

DISCUSSION

In patients with NF-1, sarcomatous transformation from plexiform neurofibroma to MPNST is often difficult to diagnose clinically. This transformation is suspected when clinical features such as pain, increase in size of the lesion, and neurological deficit develop, but these findings can also be observed in benign lesions. Conventional imaging modalities such as CT and MRI are useful in detecting the tumor and its extension, but sometimes do not help to distinguish malignant soft tissue tumors from benign ones.[3] FDG-PET images depict tumor glucose metabolism according to cell metabolic activity, and are superior at distinguishing benign from malignant tissues. The degree of FDG uptake generally correlates with histological grading, with greater FDG uptake in high grade soft tissue tumors.[4–6] Some benign tumors can show high FDG uptake, and prebiopsy or preoperative diagnosis is sometimes difficult.[5] Cardona reported that quantitative evaluation, using an SUV_{max} with cut-off 1.8, is useful in discriminating benign from malignant neurogenic tumors.[4] The mass of our patient showed 6.6 SUV_{max} making it very likely it was a malignant lesion, which was supported by pathologic examination of a biopsy specimen.

With the recent evolution of technology, both morphologic and metabolic information can be obtained using a combined PET/CT system in a single session. Co-registration error between morphologic and metabolic imaging is minimized, and the examination time is shortened by using the CT data for attenuation correction. The examination time on the PET/CT table for this patient was 30 minutes from the top of the head to toes. We observed a huge mass involving pelvic bones on the CT part of the PET/CT images, and heterogeneous intense FDG uptake in the tumor. Interestingly, bone involvement was quite obvious on CT, but there was less FDG uptake in this area. We obtained these findings with minimal fusion error. Though we do not have any information about post-contrast MRI or CT imaging for this patient, it has been reported that faint peritumoral enhancement was observed on post-contrast MR images in patients with intraosseous MPNST.[7] We surmise that this part of the lesion represents a devascularized area. There remains some possibility that cell degeneration in the bone may be different from that of other soft tissues. Further evaluation is necessary to define the discrepancy between FDG uptake and CT evident tumor invasion in the bone. PET/CT findings are likely to be helpful for biopsy planning in such heterogeneous tumors when PET/CT is performed prior to treatment. In our case, biopsy was performed prior to PET/CT. In cases in which PET/CT follows biopsy, PET/CT may be useful for confirmation of the adequency of the biopsy site and for replanning the subsequent biopsy when the first biopsy showed a sampling error. PET/CT is also useful for identification of distant disease. We detected a site of focal uptake in the lumbar spine which had been unsuspected and almost certainly represented a metastatic lesion. This lesion has not been confirmed histologically.

In conclusion, FDG-PET/CT can identify sarcomatous change from benign neurogenic tumor, display the heterogeneity in the tumor and can also detect metastatic disease. It illustrates the importance of evaluating both metabolic and morphologic abnormalities in a single session to be able to formulate the optimal treatment plan.

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