PET/CT and PET using [18F]-FDG in a Patient with Soft Tissue Sarcoma

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Citation

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Abstract

Fluorine-18 Fluordeoxyglucose Positron Emission Tomography (FDG-PET) is a useful tool in monitoring of sarcoma treatment. Recent data demonstrated an increase of tumour uptake with time compared to a decline in inflammatory lesions in dual time PET scanning. We demonstrate a patient with pulmonary masses 6 months after surgical removement of a mediastinal soft tissue sarcoma. Using PET scans 1h and 3h p.i 320 MBq FDG (,i.e. a combined PET/CT using CT-based attenuation correction and a conventional PET with measured attenuation correction), an increased tracer-uptake was observed in a single pulmonary mass, thus leading to the diagnosis of malignancy. Subsequent CT guided biopsy and further clinical follow-up, however, demonstrated the absence of malignancy and showed inflammatory disease instead.

INTRODUCTION

Adult soft tissue sarcoma is a type of cancer originating from the soft tissue including muscles, connective tissues, vessels, joints, and fat. Soft tissue sarcomas are rare in children and adolescents. The prognosis of a patient with adult soft tissue sarcoma depends on factors such as size, histologic grade, stage, and age of the patient. Factors associated with a poorer prognosis are age older than 60 years, tumours with a diameter of >5 cm, and low differentiation. Although well differentiated tumours usually are curable by surgery alone, higher-grade sarcomas are associated with higher local treatment failure rates and increased metastatic potential. [1,2,3,4,5]

Fluorine-18 fluordeoxyglucose Positron Emission Tomography (FDG-PET) is a useful tool in following sarcoma treatment, grading sarcoma, separating benign from malignant masses, selecting biopsy sites, and assessing the extent of sarcomas [6]. Concerning the diagnosis of recurrent disease, literature shows an overall sensitivity of 66 % and specificity of 96 % for FDG-PET (overall patients n=254) [7,8,9,10,11,12]. However, the low anatomical resolution of FDG-PET can be problematic. The intrinsic combination of anatomical and metabolical information as introduced with combined PET/CT [13,14,15] may solve these shortcomings and further improve staging.

The pitfalls of dual time FDG-PET for decision making with respect to therapy will be shown in the following case report.

CASE REPORT

HISTORY AND CLINICAL FINDINGS

A 21-year-old male with a history of a soft tissue sarcoma of the mediastinum who underwent surgery 6 months before was referred to the Department of Nuclear Medicine with newly found pulmonary masses detected by CT and MRI. Prior to further treatment planning, metabolic information was desired for the differentiation of benign and malignant lesions. The physical examination showed a normally developed asymptomatic patient with normal physical examinations. Laboratory results were performed without pathological findings.

COMPUTED TOMOGRAPHY (CT) IMAGING

Preoperative CT-imaging of the thorax had been unremarkable. Two months postoperatively five ill-defined lesions of up to two centimetres in size in Segments 1 and 2 of the left upper pulmonary lobe where identified on a CT-scan. Those lesions decreased in size until 6 months after operation when the next CT was carried out. Due to the reduction in size over time without any cytostatic therapy, the lesions in the left upper pulmonary lobe were characterised as inflammatory. There were no signs of local recurrence in the mediastinal region on the postoperative CT-scans.

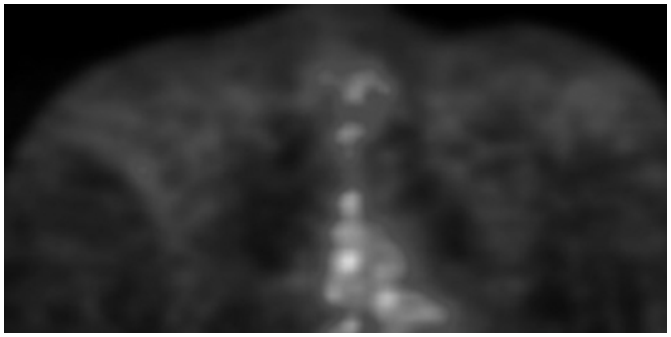
POSITRON-EMISSION TOMOGRAPHY AND

PET/CT

One hour after intravenous injection of 320 MBq [fluorine-18] fluordeoxyglucose (serum glucose at injection 86 mg/dl) a PET scan with attenuation correction was acquired in 3D mode (ECAT HR+, Siemens Medical Solutions, Erlangen, Germany manufactured by CPS, Knoxville TN, USA). Projections from head to proximal femora were obtained. PET showed no pathologies. In particular, there was no pathologic tracer accumulation in the pulmonary lobes (Fig. 1).

Figure 1

Figure 1: PET acquired one hour after intravenous injection of FDG showing no pathologic tracer uptake in the pulmonary lobes.



Three hours after intravenous injection a second scan was acquired using a combined PET/CT system (biograph, Siemens Medical Solutions, Erlangen, Germany) for correlation of functional and morphologic imaging. The biograph consists of a single slice spiral CT and a dedicated PET scanner. The CT data are also used for PET attenuation correction in a 3D mode [15]. In contrast to the first examination, the combined PET/CT scan showed sligthly increased tracer uptake in the upper left lung lobe with a maximum standard uptake value (SUV) of 1.4 and a mean SUV of 1.1 (Fig. 2).

Figure 2

Figure 2: PET acquired three hours after intravenous injection of FDG showing an increased tracer uptake in the upper left lung lobe (arrow).

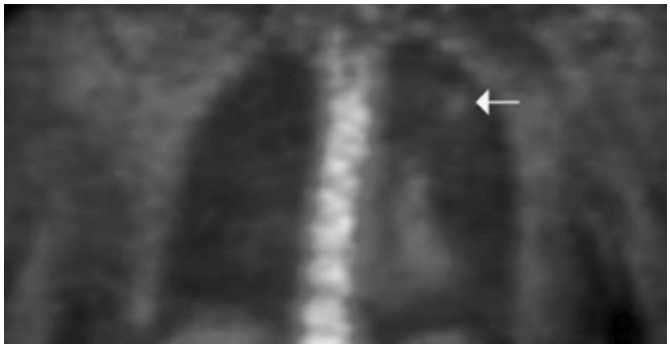
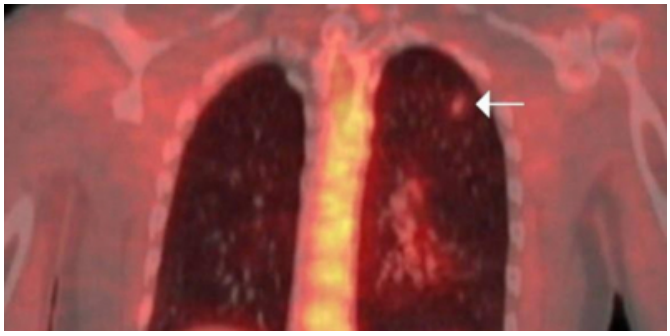


Image fusion with simultaneously acquired fully co-registered CT enabled us to identify increased tracer uptake in one of the pulmonary lesion (Fig. 3).

Figure 3

Figure 3: Image fusion of co-registrated PET and CT images suggesting a pulmonary metastasis in the upper left lobe (arrow).



DISCUSSION

Spiral CT has been shown to be superior to PET in the detection of pulmonary metastases from sarcomas [11,12]. In this case, spiral CT alone had shown no presence of metastatic disease preoperatively. Postoperatively, however, pulmonary lesions were detected on CT imaging of the thorax which were characterised as inflammatory due to a decrease in size on further follow-up. This postoperative finding was confirmed in our first PET (conventional PET) scan one hour post injection, which was diagnosed as completely normal. The second PET study (combined PET/CT) three hours post injection, however, showed discrete uptake in the left upper lobe. The intensity also does not conclusively suggest malignancy, but the uptake coincides with one of the intrapulmonary lesions on CT. In accordance with the published findings by Zhuang et al. [16], who demonstrated an increase of tumour uptake with time

compared to a decline in inflammatory lesions, the combined pattern of CT with early and late co-registrated PET scans was interpreted as a pulmonary metastasis in one of the pulmonary lesions. On the basis of these findings of dual time point PET imaging and PET/CT the decision for definitive histological examination was made. Subsequently, CT-guided biopsies were performed twice showing no malignant cells but inflammatory disease. These findings were supported by an uneventful follow-up course of six months. Thus, dual time PET scanning in this case did not allow to discriminate between benign from malignant disease.

In has to be noted that the difference in the uptake behaviour of the two PET scans could be caused by the specific attenuation corrections used by the PET systems. The combined PET/CT uses a CT-based high-quality attenuation correction [$_{15}$], whereas the images of the conventional PET are based on a measured attenuation file that is sometimes rather noisy. Thus, we suggest that the increased uptake of the late PET might be due to superior attenuation correction, while the uptake was blurred in the first PET due to noise-related attenuation image. This might be the reason for the observed discrepancy that falsely lead to the diagnosis of pulmonary metastasis.

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