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CASE REPORT

Focal Pulmonary ^{18}F-fluorodeoxyglucose Accumulation Without Corresponding Computed Tomography Abnormalities due to Intravenous Injection Passing Through the Lower Limb Varicose Veins

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ABSTRACT

A 58-year-old woman with bilateral lower limb varicose veins and Burkitt lymphoma underwent positron-emission tomography/computed tomography (PET-CT) to exclude lymphoma relapse. PET-CT images did not show any suspicious lesion suggestive of malignancy. However, intense ^{18}F-fluorodeoxyglucose (FDG) uptake focus was detected in the left lung without a corresponding CT abnormality. Follow-up PET-CT 7 weeks later showed disappearance of the ^{18}F-FDG–avid left lung focus, although another new ^{18}F-FDG–avid focus without a corresponding CT abnormality was detected in the right lung. It is possible that these artefacts were due to ^{18}F-FDG–avid microembolus formations, probably related to intravenous ^{18}F-FDG injection into the left foot passing through the varicose veins of the leg. Care should be taken to avoid misinterpreting PET-CT images should a similar situation be encountered in the future.

Key Words: *Fluorodeoxyglucose F18; Lung; Positron-emission tomography; Tomography, X-ray computed; Varicose veins*

中文摘要

靜脈注射^{18}F-氟脫氧葡萄糖經曲張的下肢靜脈誘發藥物局灶性肺沉積而電腦斷層掃描無相應異常

龔本霆、黃治平、歐陽定勤、唐卓敏

一名患雙側下肢靜脈曲張和Burkitt淋巴瘤的58歲女性，接受正電子發射斷層掃描/電腦斷層掃描（PET-CT）以排除淋巴瘤復發。PET-CT圖像並無顯示任何惡性可疑灶，但檢測到左肺有^{18}F-氟脫氧葡萄糖（FDG）強烈濃聚，而CT掃描無相應異常。七星期後隨訪PET-CT顯示左肺^{18}F-FDG濃聚灶消失，但右肺發現另一全新^{18}F-FDG濃聚灶無伴相應CT掃描異常。該假象可能起因於^{18}F-FDG微栓子的形成，形成原因或許與往左足靜脈注射的^{18}F-FDG流經左腿曲張的靜脈有關。假如將來遇到類似的情況，應小心避免誤讀PET-CT圖像。

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INTRODUCTION

Fluorodeoxyglucose (FDG) positron-emission tomography/computed tomography (PET-CT) plays an important role in management of patients with malignancies in the 21st century. To achieve accurate PET-CT interpretation, it is necessary to be aware of false-positive findings such as physiological FDG uptake, normal variants, and other artificial conditions. This report is of incidental focal ^{18}F-FDG accumulation without abnormal CT findings in the lung parenchyma of a patient with a history of Burkitt lymphoma and bilateral varicose veins. The markedly ^{18}F-FDG–avid accumulation had disappeared by the time of the follow-up PET-CT scan performed 7 weeks later, while a new ^{18}F-FDG–avid focus had appeared in the contralateral lung field. In both PET-CT studies, successful intravenous injection was performed at the first attempt via the lower limbs with the varicose veins, with no evidence of paravenous injection. To the authors' knowledge, this is the first report of such an artefact in a patient with ^{18}F-FDG passing through the varicose veins after injection into the foot. This report illustrates an example of potential false-positive PET-CT interpretation of an artefact that may be wrongly interpreted as a pathological entity.

CASE REPORT

A woman presented with a history of a right breast mass in 1989, which was clinically stage IA. The biopsy revealed Burkitt lymphoma, and she was treated with six courses of chemotherapy, followed by external radiation therapy to the right breast. Complete disease remission was achieved for more than 20 years. The same patient, who was then 58 years old, presented with bilateral lower limb varicose veins and was referred to the Nuclear Medicine Unit, Queen Elizabeth Hospital, Hong Kong on 24 May 2011 for PET-CT to exclude a suspected relapse. In the same month, she had attended the Hong Kong Eye Hospital for prolonged unresolved right upper eyelid erythema. The patient was afebrile and all laboratory investigations were unremarkable, including serum lactate dehydrogenase.

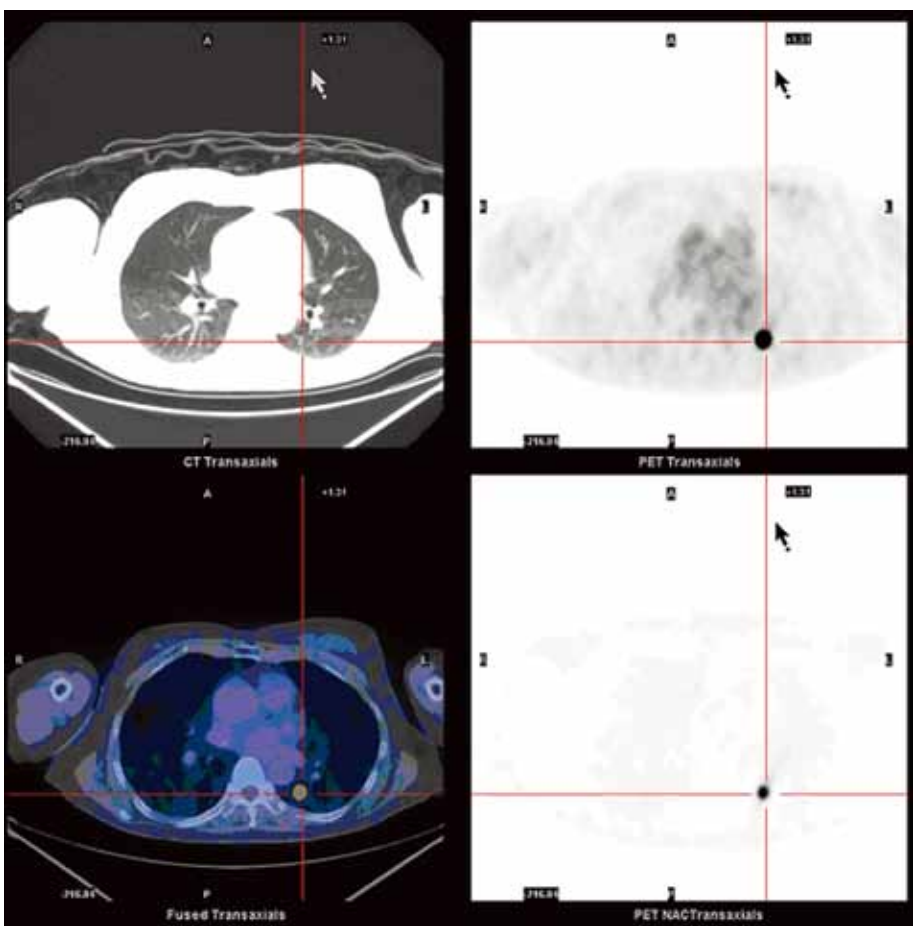

Figure 1. A transaxial image of 18F-fluorodeoxyglucose (FDG) positron-emission tomography/computed tomography shows a solitary pulmonary focus with intense ^{18}F-FDG uptake at the superior segment of the left lower lobe, with a maximum standardised uptake value of up to 45.3. There was no corresponding computed tomography abnormality.

Following the PET-CT protocol at the Queen Elizabeth Hospital, all patients fasted for at least 6 hours before intravenous ^{18}F-FDG 370 MBq injection is administered. Scanning is initiated 60 minutes after administration of ^{18}F-FDG. Images are taken from the head to the proximal thigh with the Discovery LS PET-CT scanner (GE Healthcare, Cleveland [OH], USA), with a spatial resolution of 6.6 mm in the centre of the field of view. Seven bed positions are performed, with 3 minutes per bed position. For a delayed image, the scan takes 5 minutes per bed position to partially compensate for the count decay. CT is performed for attenuation correction and lesion localisation. The obtained images are reconstructed using the ordered subsets expectation maximisation iterative reconstruction algorithm. Regions of interest are drawn for ^{18}F-FDG uptake quantification on visible lesions with increased uptake, and the maximum standardised uptake value (SUVmax) is semi-quantitatively analysed with the following equation:

$$SUV = A/(ID/BW)$$

where A represents the decay- and attenuation-corrected activity in tissue (MBq/ml), ID represents the injected dose of ^{18}F-FDG (MBq), and BW represents the patient's body weight (g)

For this patient, PET-CT did not show any suspicious hypermetabolic lesion suggestive of malignancy. However, a solitary pulmonary focus with intense ^{18}F-FDG uptake was incidentally detected at the superior segment of the left lower lobe of the lung (Figure 1). The SUVmax was 45.3. There was no corresponding CT abnormality. Intravenous ^{18}F-FDG injection was performed via the left foot as the patient refused intravenous injection in an upper limb. A delayed regional thoracic PET-CT image was acquired 3 hours later on the same day. The markedly ^{18}F-FDG–avid pulmonary focus remained static in position, with a slight interval increase in SUVmax up to 50.0 (Figure 2). Microembolus formation was suspected. Interval follow-up PET-CT was arranged for 7 weeks later.

In the follow-up PET/CT on 13 July 2011, the

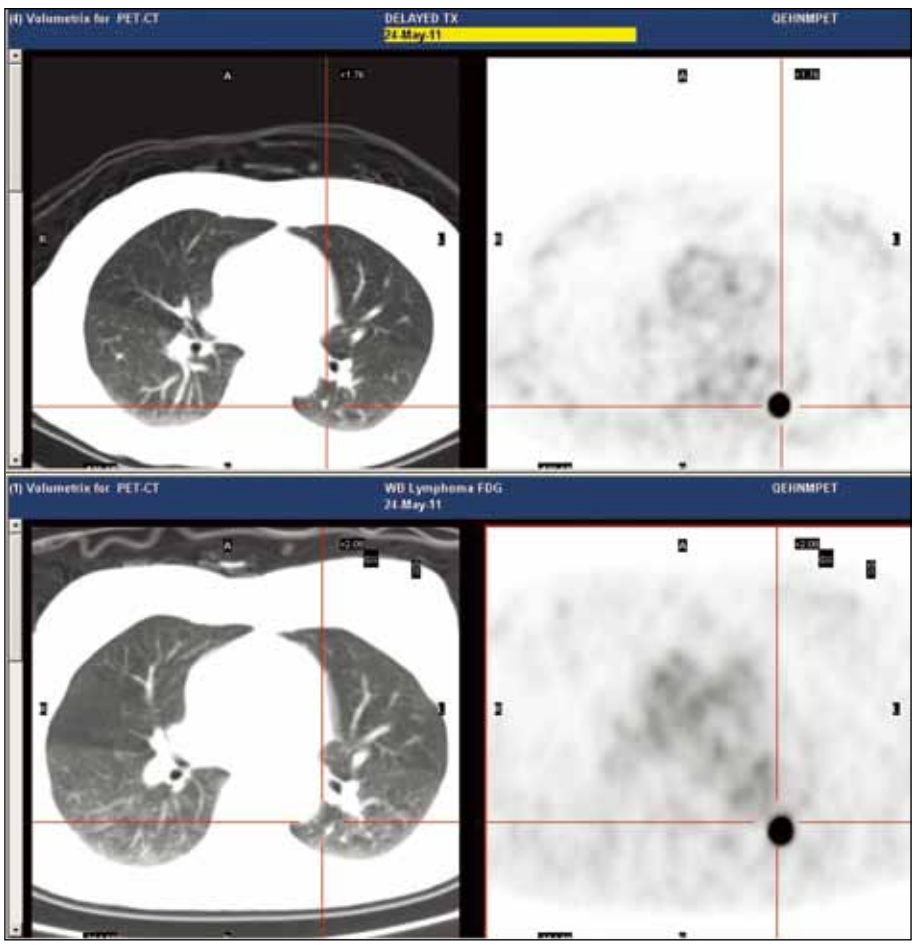

Figure 2. The markedly ^{18}F-fluorodeoxyglucose–avid pulmonary focus at the superior segment of the left lower lobe remains static in position in delayed thoracic positron-emission tomography/computed tomography (upper image) and shows a slight interval increase in maximum standardised uptake value of up to 50.0. There was no corresponding computed tomography abnormality.

^{18}F-FDG–avid uptake focus at the superior segment of the left lower lobe of the lung had disappeared. However, another new solitary ^{18}F-FDG–avid uptake focus was detected at the right upper lobe of the lung, with an SUVmax up to 14.0 (Figure 3). There was no corresponding CT abnormality. Intravenous ^{18}F-FDG injection had been performed via the left foot again as the patient refused intravenous injection in an upper limb. No other hypermetabolic lesion was noted elsewhere. There was no pathological evidence of Burkitt lymphoma relapse. To date, the patient has no clinical signs of relapse of Burkitt lymphoma.

Right upper eyelid biopsy after the first PET-CT scan showed sebaceous carcinoma. The patient underwent full-thickness excision of the right upper eyelid sebaceous cell carcinoma on 22 June 2011.

DISCUSSION

Clinical utility of ^{18}F-FDG PET-CT has greatly advanced in the 21st century. PET-CT is one of the most effective and non-invasive imaging modalities, particularly in the field of oncology. The major benefit of integrated PET-CT is its unique ability to offer simultaneous anatomical and functional information. However, there are potential pitfalls for PET-CT misinterpretation, including ^{18}F-FDG uptake in benign lesions or normal variants related to a patient's clinical history.[1,2] Misalignment between PET and CT resulting from time lag between scans or patient repositioning should also be noted.[3] This patient had artefacts of incidental ^{18}F-FDG accumulation in the lung parenchyma with no corresponding abnormality on CT. The absence of a structural pulmonary lesion seen by CT should alert the physician that the corresponding markedly ^{18}F-FDG–avid focus is likely to be an artefact rather than an additional pathological entity. One of the most likely possibilities to account for this interesting finding could be microembolus formation during the injection process. The markedly ^{18}F-FDG–avid microembolus could reach and deposit in the small vascular structures of the lung parenchyma.[4,5] Indeed, microembolus formation remains one of the known complications of venous catheterization.[6,7] A thrombus

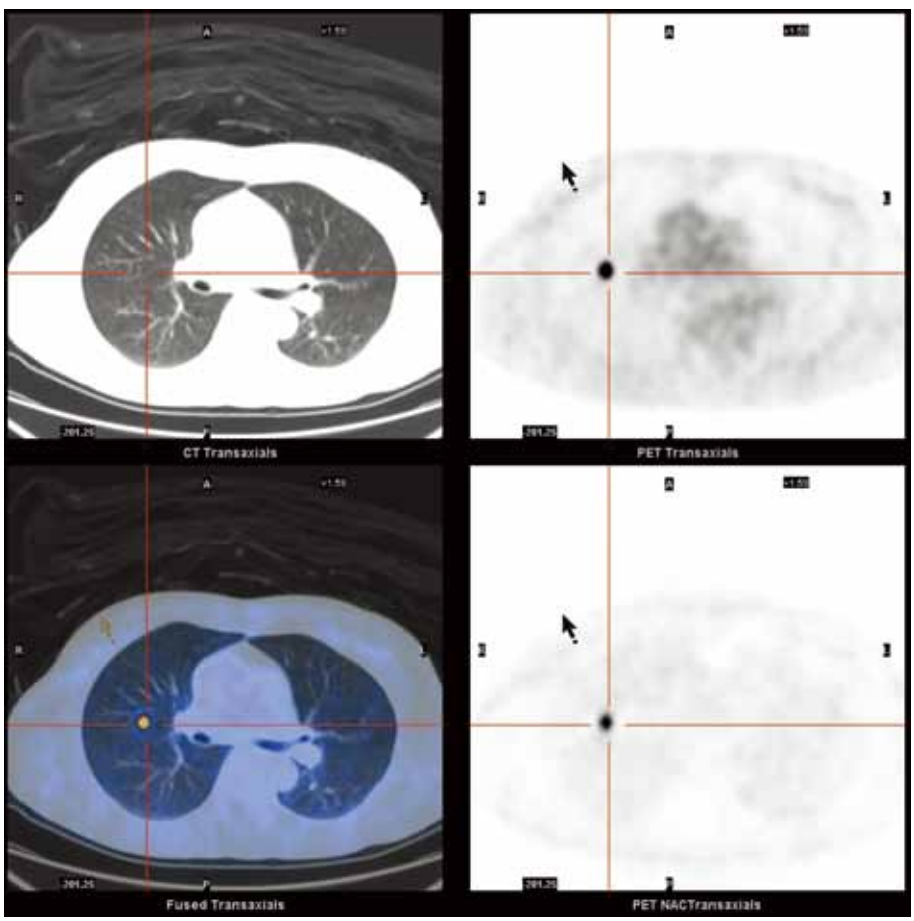

Figure 3. A transaxial image of the follow-up ^{18}F-fluorodeoxyglucose (^{18}F-FDG) positron-emission tomography/computed tomography shows a new solitary ^{18}F-FDG–avid uptake focus in the right upper lobe with a maximum standardised uptake value up to 14.0. There was no corresponding computed tomography abnormality.

contains trapped and activated blood platelets, which are activated by thrombin[8] with increased translocation of glucose transporter 3 (GLUT-3) into the platelets' plasma membrane from the intracellular vesicles. For this reason, intense ^{18}F-FDG uptake in a microembolus is attributed to increased translocation of GLUT-3.

A dedicated image of the injection site in the follow-up PET-CT demonstrated increased ^{18}F-FDG uptake by the lower limb varicose veins (Figure 4). Varicose veins are a well-recognised cause of increased ^{18}F-FDG uptake.[9] This patient had a history of bilateral lower limb varicose veins, which is a known risk factor for venous thromboembolism.[10,11] Although the underlying cause of the markedly ^{18}F-FDG–avid microembolus formations in this patient could not be exactly ascertained, in the absence of paravenous injection it is likely that microembolus formation originated from previously formed vascular thrombi, probably caused by phlebitis or reduced blood flow rate through the varicose veins. The microembolus subsequently became detached from the vascular walls and reached the pulmonary circulation.[12] It is possible that ^{18}F-FDG–avid microembolus may arise from the tracer travelling through the varicose veins, as illustrated by this patient. Although this theory is unconfirmed, it may be one of the causes of this artefact. Further studies are required to delineate the underlying causes of this rare and interesting phenomenon. To prevent erroneous image interpretation, ^{18}F-FDG injection that may pass through varicose veins should be avoided.

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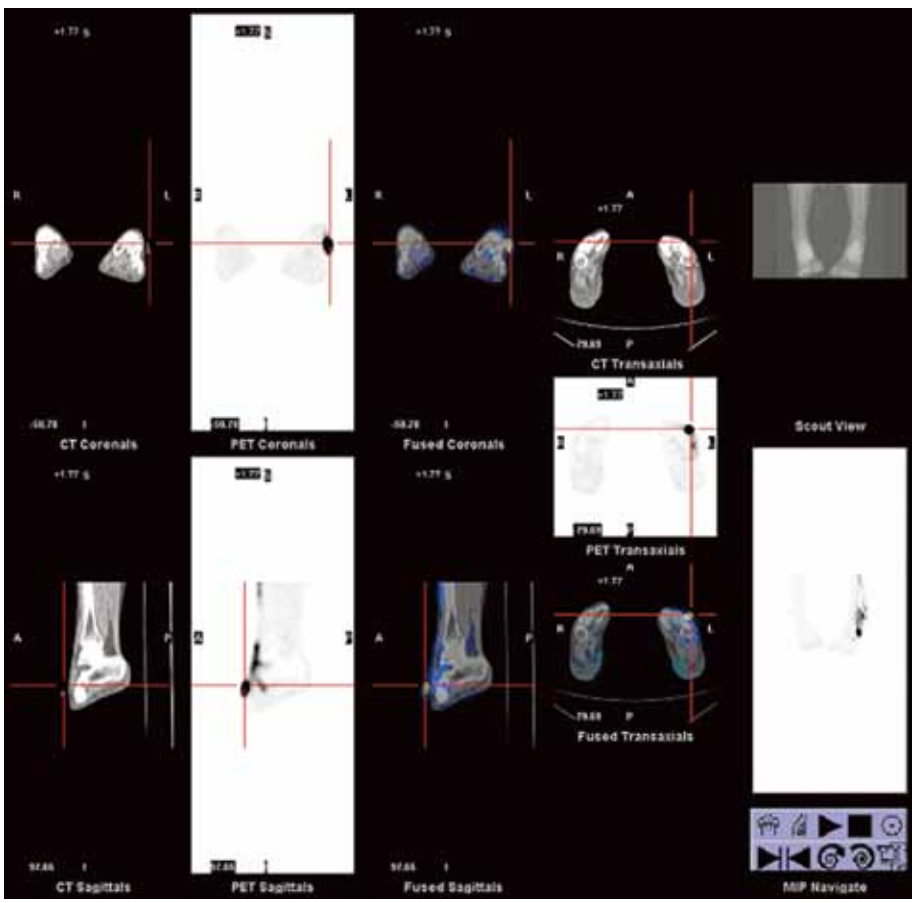

Figure 4. Image of the injection site demonstrates increased ^{18}F-fluorodeoxyglucose uptake along the lower limb varicose veins despite absence of paravenous injection.

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