Case Report

The hot embolus of ^{18}F-fluorodeoxyglucose

ABSTRACT

Scanning oncological patients with ^{18}F-fluorodeoxyglucose (^{18}F-FDG) for their disease staging, evaluation of treatment response, and monitoring/management has become a standard of care. The use of the radioactive fluorine in the FDG molecule helps establish cell/tissue lines high on glucose consumption and hence metabolically active. Abnormalities are detected on the scan as areas of increased uptake. However, these areas of increased (hot) uptakes do not necessarily translate into a pathological finding. A comprehensive knowledge of the uptakes of the tracer and the potential "pitfalls" that may be associated with them should be known and kept in mind during scan reading. One such pitfall is the "hot clot" or "pulmonary emboli," and we report two such cases encountered at our setup and discuss their causes and how they should be identified and avoided.

Keywords: False-positive finding, hot emboli, hot clot, imaging pitfall

BACKGROUND AND INTRODUCTION

Positron emission tomography-computed tomography (PET-CT) scanning is an established diagnostic tool in the oncological setup for the staging, evaluation of treatment response, and monitoring/management of the patients. The use of the radioactive fluorine in the ^{18}F-fluorodeoxyglucose (^{18}F-FDG) molecule helps establish cell/tissue lines high on glucose consumption and hence metabolically active.[1]

As the uptake of the FDG is not specific for malignant tissue and is taken up by various physiological and benign disease processes as well, a comprehensive knowledge of these uptakes and potential "pitfalls" associated with the scanning should be kept in mind during reading of the scans.[2]

One such pitfall is the "hot clot" or "pulmonary emboli."[3,4]

Presented below are two patients that were referred to our department for routine staging and restaging/treatment response of their disease conditions and were found to have focal FDG uptake in the lung parenchyma with no structural lesion on the CT scan. They were rescanned with special attention being given to proper injection technique of the radiotracer, and regional images of the chest were acquired under the same protocol as before.

CASE REPORTS

Case 1

A 28-year-old male, a known case of lymphoma, was sent for a pretreatment baseline scan. With a 4-h fasting, the blood glucose was 89 mg/dl; scan was done after 60 min of delay from the time of injection. In addition to the findings associated with the primary disease, a focal area of increased metabolic activity was seen in the apical segment of the right lobe with no CT correlate [Figure 1a]. This area was assessed to be artifactual with a strong possibility for a hot emboli (clot) and the patient was recalled with a delay of 4 days, and a rescan of the thorax was performed under same circumstances, with special attention being given to proper injection technique of

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the radiotracer. The follow-up scan showed no visualization of the previously noted uptake in the apical segment of the right lobe, confirming a hot emboli (clot) anomaly [Figure 1b].

Case 2

A 43-year-old male, a diagnosed case of squamous cell carcinoma of the right lateral aspect of the tongue, status post chemotherapy, was scanned for treatment response. His blood glucose was 100 mg/dl following a 4-h fast and scanning was performed 65 min after radiotracer administration. Again, in addition to the findings for his primary disease, a focal area of increased metabolic activity was seen in the middle lobe of the right lung with no CT correlate [Figure 2a]. Again, this was suspected to be a hot emboli (clot) and the patient was recalled after a week, and a rescanning of the thorax was done under similar circumstances once again, with special attention being given to a proper injection of the radiotracer. The follow-up scan, as before, showed no demonstration of the previously noted activity in the middle lobe of the right lung, confirming a hot emboli (clot) anomaly [Figure 2b].

DISCUSSION

FDG uptake tracer in the lung can be the result of various causes which include infection, inflammation, and metastases; all these are invariably associated with structural abnormality on CT.[5]

Under certain conditions, however, an area of tracer accumulation may be in evidence in the lung parenchyma without any evidence of any CT correlate. These uptakes are considered "hot clot" artifact and may lead to false-positive results if the corresponding CT images are not taken into consideration. The CT portion of the PET-CT is important to the scanning as it enables anatomical localization of lesions showing metabolic activity on PET scan.[6-8]

The etiology of this "hot clot"/"emboli" has been attributed to a fault in the injection technique of the radiotracer. It occurs due to agglutination of FDG by erythrocytes during FDG injection. This results in microemboli in the pulmonary vasculature, which create focal FDG uptake on PET images but no nodules on CT images. Microemboli develop due to blood aspiration into the injector, but paravenous injection and high-speed injection may also be the possible causes. The blood clots lodge into the pulmonary parenchyma.[6]

Microemboli develop due to agglutination of FDG by erythrocytes which, when injected, are caught in the small pulmonary arterioles, leading to their transient obstruction which then appears as a focal area of tracer uptake in the lung

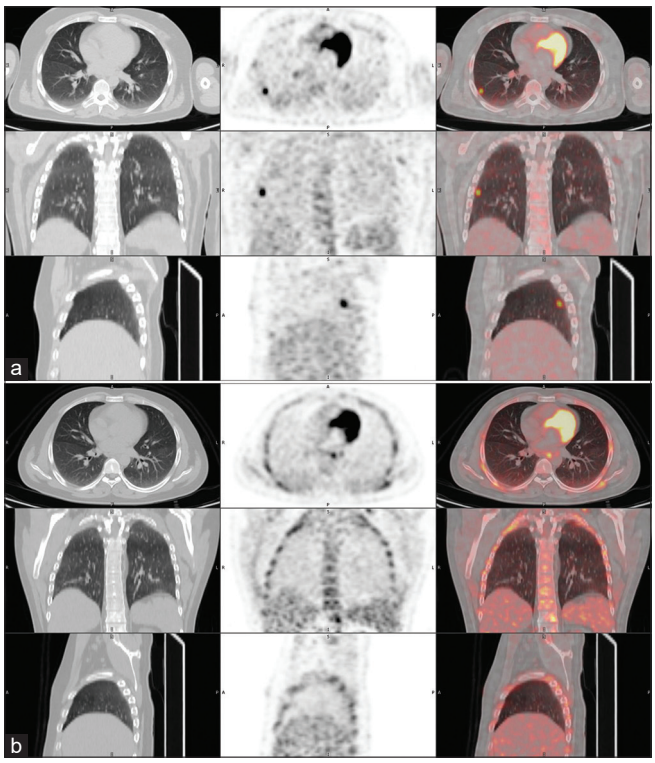

Figure 1: (a) Hot clot/emboli identified in the apical segment of the right lobe of the lung; (b) Rescan of the patient after 4 days showing no evidence of the previously noted activity in the right lung

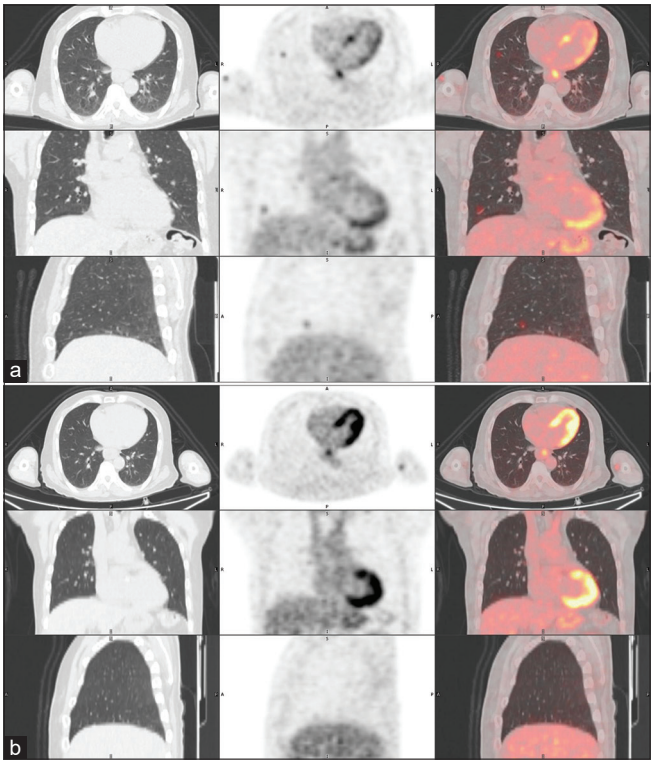

Figure 2: (a) Hot clot/emboli identified in the middle lobe of the right lobe of the lung; (b) Rescan of the patient after 4 days showing no evidence of the previously noted activity in the right lung

parenchyma with no CT correlate. This may be mistaken for pulmonary metastasis, leading to upstaging the disease.[4,6]

To make a diagnosis of hot-clot artifact, there must be focal FDG uptake in the lung with no CT correlate. The maximum standardized uptake value of the lesion must be high and should disappear on repeat scanning with a proper injection technique. Absent metabolic activity in lesions seen on CT may be due to low FDG avidity, treated lesions, small lesions that are sub-centimeter sized that are beyond the resolution of PET scan, or partial-volume effect.[7]

Other causes of focal metabolic activity on PET images without a CT counterpart have also been given. Mis-registration of PET and CT images is also a reason for mismatch between the findings on these two modalities. Misalignment may occur at lung bases, diaphragm, and upper abdomen due to breathing movements. Shallow breathing is recommended to achieve optimal image fusion during PET-CT acquisition.[3]

No movement artifact was seen in these scans. FDG uptake disappeared on CT scanning.

In addition to the above-discussed causes, cases of iatrogenic embolism have also been reported in literature.[9]

CONCLUSION

Hot-clot artifact is important in FDG PET-CT scanning, especially in oncological patients, as it may lead to false-positive diagnosis of pulmonary metastases and subsequently upstage of the disease, thereby altering management paradigms.

It is important that this cause of false positivity be recognized and corrected with proper injection technique to avoid extravasation and blood aspiration into the injector.

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent forms. In the form the patient(s) has/have given his/her/their consent for his/her/their images and other clinical information to be reported in the journal. The patients understand that their names and initials will not be published and due efforts will be made to conceal their identity, but anonymity cannot be guaranteed.

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Conflicts of interest

There are no conflicts of interest.

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