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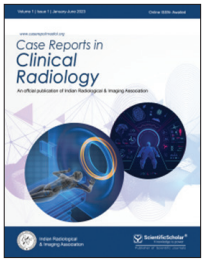

Case Series

Pulmonary hot-clot artifacts mimicking as metastatic lung lesions in 18F-fluorodeoxyglucose positron emission tomography/computed tomography – A case series

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ABSTRACT

Significant rise in oncological patients everyday led to demand for 18F-fluorodeoxyglucose (18F-FDG) positron emission tomography/computed tomography (PET/CT) scan for tumor staging, evaluation of treatment response, and monitoring/management which have become a standard of care. Basic knowledge on the physiological tracer uptakes, normal variants, and benign processes in PET/CT will help in differentiating hot-clot/pulmonary microemboli artifacts from metastasis in lungs. We have encountered four such cases at our setup with different clinical history and would like to discuss on its importance in reporting and not to overcall it as lung metastasis.

Keywords: FDG PET/CT, FDG PET/CT Artifacts, FDG PET/CT Pitfall, Hot emboli, Hotclot artifact, Microembolism, False positive

INTRODUCTION

^{18}F-fluorodeoxyglucose (18F-FDG) positron emission tomography/computed tomography (PET/CT) scan has come to widespread use for various indications in everyday clinical practice for methodical assessment and channelized treatment according to the characterization and stage of the lesion. As PET/CT plays a key role in oncological evaluation of a patient, accurate scanning and interpretation are crucial. An artifact is a substance or structure that was not present originally in the object and is seen in the image being taken by any modality.[1] Artifacts also may be generated with the fusion images after acquisition from PET/CT in addition to the artifacts found in each of the separate modalities. It is essential for radiologists interpreting PET/CT to be aware of these artifacts and pitfalls and techniques to mitigate them. One such artifact is hot-clot sign, in which there is significant focal accumulation of FDG in the lung parenchyma in the absence of corresponding CT abnormalities and leads to false positive reporting. In this case series, we report five such cases with hot-clot artifact mimicking metastasis with different primary malignancy. Repeat study showed disappearance of such abnormal uptake in lung parenchyma.

CASE SERIES

Case 1

A 73-year-old male patient underwent 18F-FDG PET/CT scan for metastatic workup of moderately differentiated carcinoma of rectum. The study showed an intense hypermetabolic lung nodule located in posterior segment of the right upper lobe with SUVmax – 4.23. Corresponding CT images showed no structural abnormality [Figure 1]. A repeat 18F-FDG PET/CT scan was performed after a brief interval of 10 days from the first study revealed no abnormal hypermetabolism in the previous intense focus of FDG activity.

Case 2

A 31-year-old lady patient underwent 18F-FDG PET/CT scan for mediastinal lymph nodal mass with cervical lymphadenopathy in suspicion of a primary mass lesion. The study revealed conglomerate lymph nodes in cervical, axillary, and mediastinum with tiny focus of abnormal FDG uptake in the medial basal segment of the right lower lobe (SUVmax – 4.36) [Figure 2]. As there was no evidence of any pulmonary nodules in corresponding CT images, biopsy was deferred and a follow-up FDG PET/CT scan was done after a short interval of 5 days which showed complete resolution of the FDG focus in the right lower lobe [Figure 3].

Case 3

An 18-month-old baby came for 18F-FDG PET/CT with a biopsy proven spindle cell neoplasm in the ethmoid sinus. Scan showed a focal increased FDG uptake in lateral basal segment of the right lower lobe with SUVmax – 1.74 and no changes in the CT images [Figure 4]. An interval scan after 8 days revealed no abnormal FDG focus in lung parenchyma.

Case 4

A 51-year-old male patient underwent for 18F-FDG PET/CT scan for response assessment of stage IV carcinoma tongue after a course of chemoradiotherapy. The study revealed partial response to treatment with moderate reduction of the previous lesions and cervical lymphadenopathy. However, a hot focuses in the anterior segment of the left upper lobe [Figure 5] (SUVmax – 4.81) with no anatomical lung nodule correlation. Another scan performed after 7 days revealed no such hot spot in lung parenchyma.

Case 5

An old lady aged 72 years came for evaluation of anterior mediastinal mass with 18F-FDG PET/CT scan. Scan showed a lobulated FDG avid lobulated mass lesion in the anterior mediastinum along with enlarged hilar lymph nodes. Unusual small hot spot seen in the lateral basal segment of the right lower lobe with an SUVmax – 3.40 with no corresponding air space opacity/inflammatory changes on CT [Figure 6]. No focal lesions in repeat PET/CT scan after a short interval.

Table 1 shows summary of cases

DISCUSSION

^{18}F-FDG uptake in lung parenchyma occurs due to various pathologies such as infection, inflammation, systemic

Table 1: Summary of Cases.

Case list	Details	Findings	Artifact/Lesion
CASE 1	73-year-old patient for metastatic workup of moderately differentiated carcinoma of rectum	Hypermetabolic lung nodule located in posterior segment of the right upper lobe.	ARTIFACT
CASE 2	31-year-old lady patient for mediastinal lymph nodal mass with cervical lymphadenopathy in suspicion of a primary mass lesion	Tiny focus of abnormal FDG uptake in the medial basal segment of the right lower lobe	ARTIFACT
CASE 3	18-month-old baby came with a biopsy proven spindle cell neoplasm in the ethmoid sinus	Focal increased FDG uptake in lateral basal segment of the right lower lobe	ARTIFACT
CASE 4	51-year-old male patient for response assessment of stage IV carcinoma tongue after a course of chemoradiotherapy	Hot focus in the anterior segment of the left upper lobe	ARTIFACT
CASE 5	72-year-old lady came for evaluation of anterior mediastinal mass with 18F-FDG PET/CT scan	Lobulated FDG avid lobulated mass lesion in the anterior mediastinum along with enlarged hilar lymph nodes. Unusual small hot spot seen in the lateral basal segment of the right lower lobe	ARTIFACT

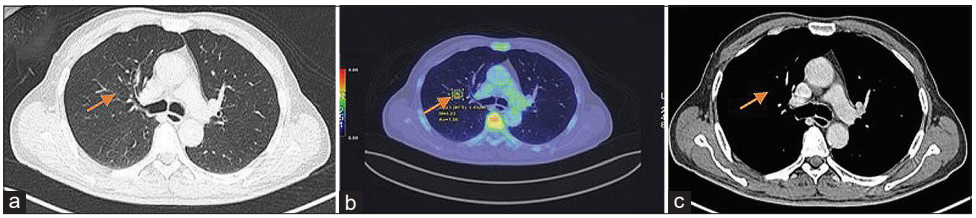

Figure 1: Lung window image (a), axial fused image (b), and CECT image in mediastinal window (c) from FDG PET/CT of 73-year-old male, show a hypermetabolic lung focus in the posterior segment of right upper lobe without anatomic correlation in lung or mediastinal window (orange arrow), consistent with an FDG avid microembolus.

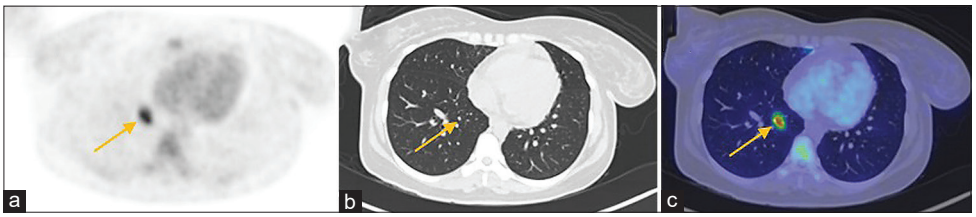

Figure 2: MIP PET image (a), CT scan lung window (b) and axial fused image (c) from FDG PET/CT of a 31-year-old lady who had mediastinal and cervical lymphadenopathy, showed an intense focus of metabolic activity in the right lower lobe without any abnormality in the lung window (yellow arrow), consistent with a hot clot.

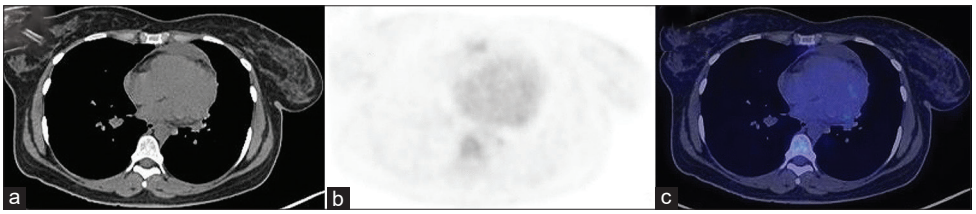

Figure 3: CT image in mediastinal window (a), MIP PET image (b), and axial fused image (c) of follow up imaging made after 5 days interval revealed no such hypermetabolic focus in the same site which proves again to be a temporary hot clot.

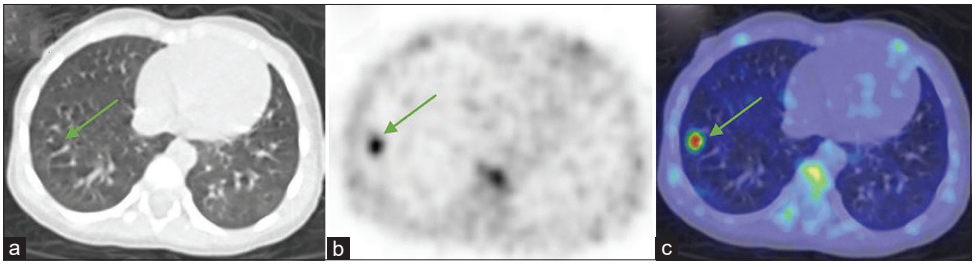

Figure 4: Lung window axial image (a), MIP PET image (b), and axial fused image (c) from FDG PET/CT of a 1-year-old baby with proven ethmoidal spindle cell neoplasm who underwent FDG PET to rule out any other metastasis, showed hypermetabolic hot spot in MIP PET and fused PET/CT images in the right lower lobe without anatomic correlate (corresponding to green arrow).

diseases, primary lung carcinomas, and secondary metastatic lesions from different primary carcinomatous source, along with presence or absence of mediastinal lymphadenopathy which is associated with definitive structural findings on CT. Under rare occurrences, focal area of tracer accumulation is evident in lung parenchyma without corresponding structural abnormalities which are called as hot-clot sign/artifact. This can be attributed to two main reasons – it can either be due to an inflammatory vascular microthrombus or due to iatrogenic microembolism caused by faulty radiotracer injection technique.

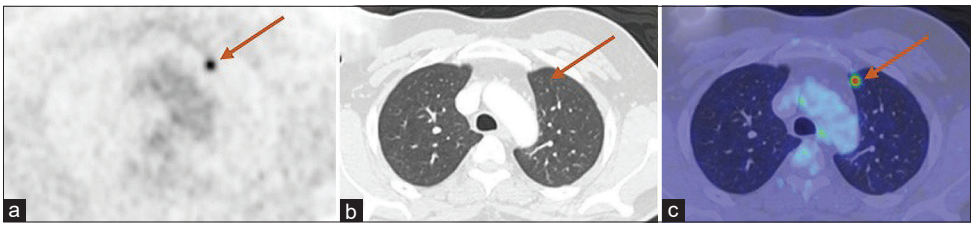

Figure 5: MIP image (a), CT scan axial image in lung window (b), and axial fused image in lung window (c), from FDG PET/CT of 51-year-old man, showed an increased metabolism in anterior segment of left upper lobe without any abnormality in CT scan (brown arrow), suggestive of hot clot sign.

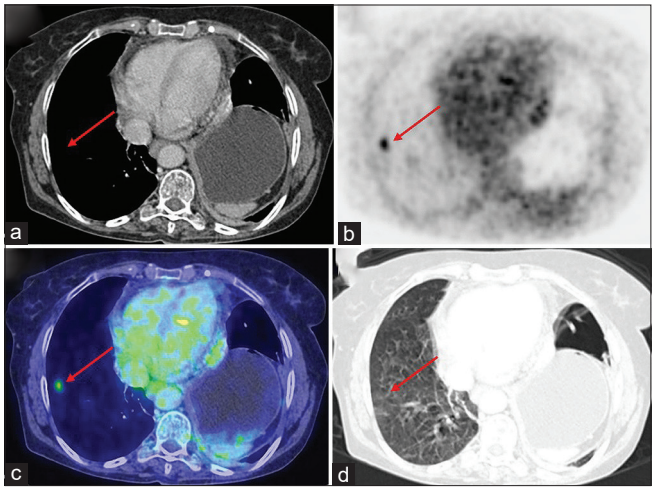

Figure 6: CT scan image (a), MIP image (b), axial fused image (c), and axial CT scan image in lung window (d) from FDG PET/CT of 72 years female showed an unusual hypermetabolic focus in the lateral basal segment of right lower lobe without any focal lesion in mediastinal as well as lung window (red arrow), suggestive of FDG-avid microembolus.

Pathophysiology of the micro-embolism is active thrombus formation at the site of vascular injury or during aspiration of blood into the needle hub prior to radio-tracer injection. Higher affinity of activated platelets to FDG consequently agglutinates FDG to microthrombus. Microembolus, then, gets lodged in the distal capillary lung bed in the lung parenchyma and creates a focus of FDG uptake without corresponding parenchymal lesions/structural abnormality on CT images. To minimize this artifact, a secure intravenous line access is required to prevent paravenous/high-speed handheld injection and to avoid aspiration into the needle hub. Flushing of intravenous access is also necessary before injecting radiotracer to the patient.[2,3]

A misalignment between PET and CT image planes can be another reason for mismatching. Lungs frequently display the misalignment due to inappropriate breath control of PET and CT images during scan. Shallow breathing helps achieve an optimal image fusion during the PET/CT acquisition.[4]

Diagnosis of hot-clot artifact is based on three important factors: first, a focal or multiple intense FDG uptake spots without any structural CT abnormality, second, it should be located in the peripheral aspect independent to other lesions (if any) without any coinciding CT findings, and finally, disappearance of the focal intense metabolic activity on rescanning.[5]

Understanding about the hot-clot artifact which is specific to PET/CT is scarce. Karantanis *et al*. proved that intense FDG foci progresses to more peripheral location on repeated scan which is performed after 30 min from the initial scan, thus excluding any actual parenchymal lung abnormality.[6] \ Ha *et al*. reported three cases of Hot-clot artifact, in which a single patient had five such hot spots which showed complete resolution on repeat scan.[7] Few other literatures also proved that rescanning at later date (few days to few weeks) helps eliminating the artifact from real metastatic lesions.[8,9]

CONCLUSION

Awareness about hot-clot sign/artifacts prevents misdiagnosing which leads to erroneous upstaging of tumor causing mismanagement of oncological patients. Therefore, mindfulness about proper injection techniques with indwelling intravenous cannula and avoiding aspiration into the needle hub can prevent micro-embolism helps reducing false reporting and mismanagement. Follow-up scan is preferred to differentiate artifacts from parenchymal lesions.

TEACHING POINTS

1. Proper injection technique with indwelling intravenous catheter can prevent this artifact.
2. Follow-up scan differentiates hot-clot artifact from real parenchymal lesions.

MCQs

1. What type of artifact is Hot-clot artifact?
   a. Patient related
   b. Instrument related
   c. Radiotracer related
   Answer Key: c
2. What is the interval time to differentiate the hot-clot from a real parenchymal lesion?

a. Repeat scan immediately after the 1st scan
b. After few days or weeks
c. Repeat within 48 h of the 1st scan

Answer Key: b

Declaration of patient consent

The authors certify that they have obtained all appropriate patient consent.

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Conflicts of interest

There are no conflicts of interest.

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