

# Pitfalls in interpretation of FDG PET/CT: Septic pulmonary emboli mimicking metastases in a case of gastric carcinoma

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## Abstract

Inflammatory lesions may sometimes show intense tracer uptake and mimic neoplastic lesions on (18) F-fluoro-deoxyglucose (FDG) positron emission tomography/computed tomography (PET/CT). We report one such false positive case on FDG PET/CT, where septic pulmonary emboli (SPE) mimicked pulmonary metastases. A 45-year-old man with stomach cancer had an indwelling central venous catheter (CVC) *in situ* while on neoadjuvant chemotherapy. He underwent FDG PET/CT scan for response assessment and the images revealed multiple, intensely FDG avid, peripheral, lung nodules with feeding vessels, which were suspicious for pulmonary metastases. A day later, the patient developed fever with chills and his blood culture showed bacterial growth (*Enterobacter cloacae*). A provisional diagnosis of SPE from an infected CVC was made. Chemotherapy was withheld, CVC removed, and the catheter tip was sent for bacterial culture. Following a 4-week course of antibiotic treatment, the patient became afebrile. Culture from the CVC tip grew the same organism, as was seen earlier in the patient's blood culture, thus pin-pointing the source of infection in our case. Diagnosis of SPE was clinched when follow-up CT chest done after completion of antibiotic course showed complete resolution of the lung lesions.

**Key words:** Central venous catheter; FDG PET/CT; septic pulmonary emboli

## Introduction

18F-fluorodeoxyglucose (FDG) positron emission tomography (PET) has become an integral part of the management protocol for patients with cancer, where it is used for initial staging, assessment of response to therapy, as well as for detection of recurrent disease. As is seen with other imaging techniques, there are certain pitfalls in the

interpretation of PET and PET/computed tomography (CT) studies. It is important that physicians interpreting PET/CT are aware of the potential pitfalls, so that the impact of these pitfalls is minimized and the interpretation is accurate.<sup>[1]</sup> Awareness of the potential causes that may lead to false positive or negative findings is essential for the interpreter to avoid misreading a scan. Here, we describe one such false

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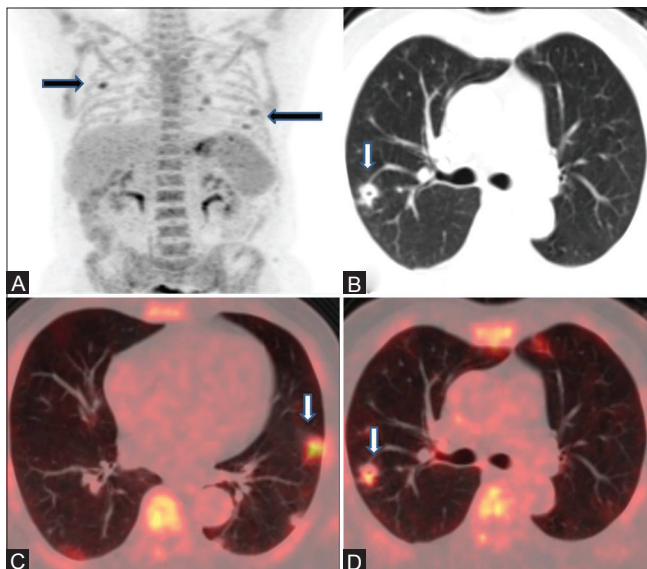
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positive case on FDG PET/CT, where an inflammatory lung pathology mimicked pulmonary metastases.

## Case Report

A 45-year-old male patient with biopsy-proven adenocarcinoma of the stomach underwent a baseline FDG PET/CT scan for staging workup, which revealed metabolically active disease involving the distal esophagus, gastroesophageal junction (GEJ), and proximal stomach with metastases to the perigastric, mesenteric, paracaval, and pre-aortic lymph nodes. There were no pulmonary lesions or distant metastases elsewhere detected at this stage. The patient was planned for definitive therapy with neoadjuvant chemotherapy (NACT) to be followed by surgery, with a curative intent. On completion of three cycles of NACT with cisplatin, epirubicin, and 5-fluorouracil, the patient was referred for a repeat FDG PET/CT scan for response evaluation and re-assessment of the disease status. Patient had no history of preceding fever, cough, or other respiratory complaints. PET/CT scan revealed complete resolution of the nodal lesions and significant reduction in the extent as well as metabolic activity of the primary lesion in the stomach and GEJ. In addition, there were multiple, well-defined, FDG avid, 1–3 cm sized, pulmonary nodules randomly distributed over both the lungs, raising a suspicion of pulmonary metastases [Figure 1]. The lesions revealed moderately high FDG uptake [maximum standardized uptake value (SUVmax) of 6.23.] On CT images, most of the lesions exhibited a “feeding vessel” sign and some of the lesions showed early cavitation within.

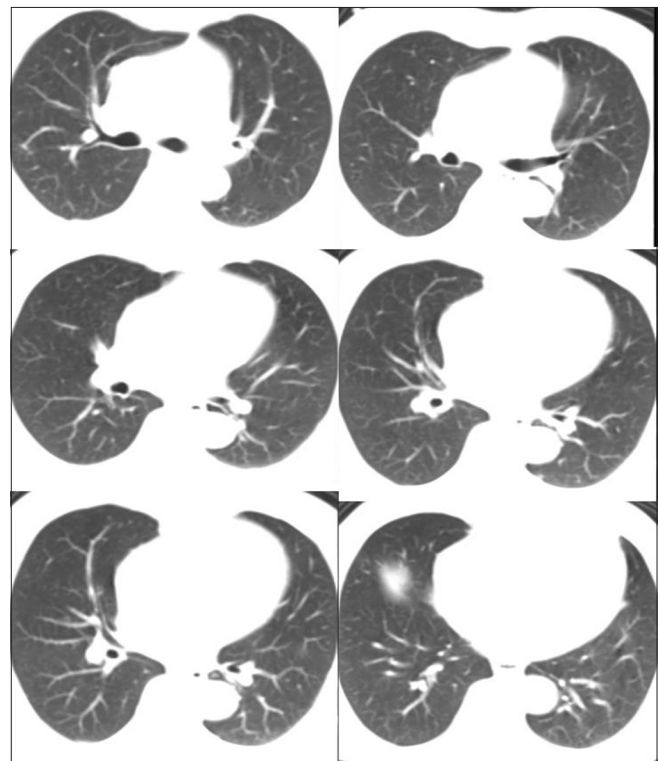


**Figure 1 (A-D):** (A-D) Standard FDG-PET/CT acquisition in a follow-up case of carcinoma stomach. PET whole body 3D MIP image (A) shows multiple FDG avid foci (black arrows) in the thoracic region. Axial CT (B) and fused PET-CT (C, D) images of the thorax reveal multiple, peripherally located, FDG avid, pulmonary parenchymal nodules (white arrows). The larger lesion in the right lung exhibits a “feeding vessel” sign and shows cavitation within

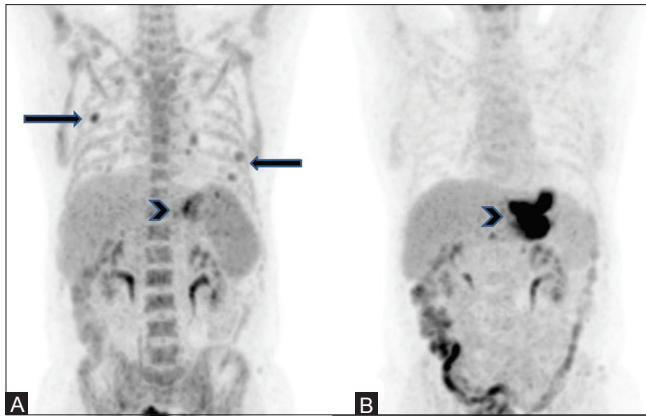
Correlation was sought with a hemogram, which revealed normal total as well as differential leucocyte count. At this stage, interpretation of the PET/CT findings was progressive disease with development of pulmonary metastases.

The patient developed fever on the second day following the PET/CT scan and gave history of chills following flushing of the indwelling central venous catheter (CVC). A blood culture was asked for, which showed growth of *Enterobacter cloacae*. CVC infection was suspected and the catheter was removed. Taking into account the clinical profile and blood culture results, the PET/CT findings were reviewed and a provisional diagnosis of septic pulmonary emboli (SPE) was made. Further chemotherapy was withheld. Patient was put on intravenous antibiotics for 4 weeks, following which his fever subsided and blood culture became sterile. The tip of the removed CVC was sent for bacterial culture, which grew *E. cloacae* (the same organism that was found in the blood culture), confirming the source of bacteremia. Chest CT done after completion of antimicrobial therapy revealed complete resolution of the lung lesions [Figure 2].

Planned chemotherapy was continued thereafter. Repeat FDG PET/CT done on completion of NACT revealed absence of any FDG avid pulmonary lesions, whereas the primary disease in the stomach showed progression [Figure 3].



**Figure 2:** Follow-up CT chest done after antibiotic therapy. Representative axial images (in lung window), reveal complete resolution of the lung lesions that were noted in the earlier scan



**Figure 3 (A and B):** Whole body PET, 3D MIP images, before (A) and after (B) antibiotic therapy. Image (A) shows multiple FDG avid foci in the region of thorax (arrows) and minimal FDG uptake in the stomach (arrowhead) representing metabolically active local disease. Image (B) reveals absence of any FDG avid focus in the thorax, where-as a large FDG avid lesion is seen in the region of stomach (arrowhead), indicating progression of the primary disease in the stomach

To our knowledge, this is the first report of FDG PET/CT imaging findings of SPE in a case of known malignancy with an indwelling CVC being the source of infection.

## Discussion

Although FDG-PET/CT imaging has achieved great success in the evaluation of malignant disorders, the modality is not specific for the diagnosis of cancer.<sup>[2]</sup> Uptake of FDG in living cells is determined by the cellular metabolic rate and the number of glucose transporters present in the cells.<sup>[3-6]</sup> Apart from tumors, activated inflammatory cells also demonstrate increased expression and upregulation of glucose transport receptors.<sup>[7,8]</sup> A number of studies have reported presence of high FDG uptake in infective and inflammatory lesions, both acute and chronic.<sup>[2,9-12]</sup> Infectious diseases (mycobacterial, fungal, bacterial), sarcoidosis, radiation pneumonitis, and postoperative inflammation have been observed to show intense FDG uptake on PET scan.<sup>[12-14]</sup> Often, inflammatory lesions produce FDG uptake patterns that are indistinguishable from those of cancer, leading to false positive results, in patients with a known or suspected malignancy.<sup>[11-15]</sup>

SPE is an uncommon disorder in which infection originating at an extrapulmonary site is transported to the lungs via the bloodstream. Microorganisms embedded in thrombin get mobilized from the nidus of infection and lodge in pulmonary arteries leading to infarction and metastatic abscess formation. The most common sources of infection include infected heart valves, thrombophlebitis, and infected indwelling venous catheters or pacemaker wires.<sup>[16]</sup> Clinical symptoms of SPE are usually nonspecific and commonly include one or more out of fever, cough, hemoptysis, shortness of breath, and chest pain. Occasionally, an active

extrapulmonary focus of infection may be obvious at the time of presentation.<sup>[17]</sup> Cancer patients on chemotherapy often have indwelling CVC *in situ* for long durations. This coupled with frequent occurrence of immunosuppression and neutropenia in such patients predisposes them to SPE.

High FDG uptake is generally accepted to be associated with malignant lesions. In a patient with known malignancy undergoing FDG PET scan, finding of multiple FDG avid, discrete, pulmonary nodules with “feeding vessels” is highly suggestive of pulmonary metastases. Presence of multiple pulmonary metastases upstages the disease to an “inoperable” stage, nearly ruling out the probability of a complete cure for the patient.

As is evident from the findings in our case, SPE can closely mimic metastases, with the pulmonary lesions showing high metabolic activity on FDG PET and exhibiting a morphology akin to metastatic deposits on CT. Presence of high FDG uptake in SPE has been documented by a number of authors and is attributed to the high glycolytic rate of activated macrophages and polymorphs that are abundantly present in most inflammatory lesions.<sup>[18-20]</sup>

In a patient with known malignancy undergoing FDG PET scan, if multiple FDG avid pulmonary nodules are detected as a new finding, high index of suspicion must be maintained to rule out the possibility of septic emboli and to avoid a catastrophic mistake of labeling these lesions as metastases. Clinical inputs (history of fever, chills, respiratory symptoms, an obvious site of extrapulmonary infection) and hemogram results when integrated with the imaging findings can aid in providing vital clues that point towards the diagnosis of SPE. Clinical indicators that favor SPE are history of concurrent febrile illness, neutropenia, and a positive blood culture confirming the presence of bacteremia.

Cook *et al.* studied the clinical course and imaging features in 14 patients of SPE and concluded that SPE presented with variable, often nonspecific clinical and radiographic features and the diagnosis was usually suggested by the presence of a predisposing factor, febrile illness, and CT findings of multiple, peripheral, nodular lung infiltrates, with or without cavitation.<sup>[21]</sup> Kuhlman *et al.* reviewed CT scans of 18 patients with documented SPE and concluded that, in an appropriate clinical setting, characteristic CT features of septic emboli can suggest the correct diagnosis.<sup>[22]</sup> Rossi *et al.* have opined that, on CT, the most characteristic features of SPE include discrete pulmonary parenchymal nodules with cavitation, which often exhibit lower lobe predominance and presence of nodule-feeding vessels. In addition, subpleural heterogeneous wedge-shaped opacities may also be identified in a majority of patients with SPE.<sup>[23]</sup>

Although the phenomenon of “mixed” response to chemotherapy (where some of the cancerous lesions show

regression while other lesions show progression) is well known, a patient with known cancer on chemotherapy developing new FDG avid lesions at a distant site while the pre-existing disease shows regression should alert the interpreting physician to the possibility of an unrelated pathology (e.g., infection or inflammation) as the cause of new lesions.

## Conclusion

SPE is a rare condition that may mimic pulmonary metastases on FDG PET/CT imaging, especially in a patient with a known malignancy. Indwelling CVC is a predisposing factor and can act as a source of infected emboli in such cases. In cancer patients with indwelling CVC, if FDG avid pulmonary nodules are detected, high index of suspicion should be maintained to rule out SPE. Clinical profile and hemogram can provide vital clues that point towards an infective etiology. Analysis of CT morphology of the lesions is critical for arriving at the correct diagnosis. CT features most characteristic of SPE include discrete, peripheral, pulmonary nodules of varying sizes, with cavitation and presence of additional subpleural wedge-shaped opacities. A positive blood culture confirms presence of bacteremia and resolution of lung lesions following antimicrobial therapy, clinches the diagnosis of SPE.

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## Conflicts of interest

There are no conflicts of interest.

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