Clinical Significance of Retrograde Inferior Vena Cava and Hepatic Vein Opacification during Contrast Enhanced Tri-Phasic CT Abdomen Acquired as Part of F-18 FDG PET CT Scan - Learning Point For Nuclear Medicine Physicians: A Case Report and Literature Survey

Abstract
Hepatic veins and inferior vena cava are opacified during the delayed venous phase on triphasic contrast-enhanced computed tomography (CECT) abdomen scan. However, their early opacification/visualization in the arterial phase is usually due to retrograde flow of intravenous contrast from the right atrium in patients with right-sided heart failure or right ventricular dysfunction. Awareness and recognition of this phenomenon is important for nuclear medicine physicians reporting F18 fluorodeoxyglucose positron emission tomography–computed tomography (FDG PET CT) scan with diagnostic CECT.

Keywords: F-18 FDG PET-CT, hepatic veins, inferior vena cava, retrograde opacification, right ventricular dysfunction, tricuspid regurgitation

Introduction
Hepatic veins and inferior vena cava (IVC) are opacified during the delayed venous phase on triphasic CECT abdomen scan. However, their early opacification in the arterial phase has been reported due to retrograde flow of intravenous (IV) contrast from the right atrium in patients with right-sided heart diseases such as tricuspid regurgitation (TR), pulmonary hypertension, and right ventricular (RV) systolic dysfunction. As diagnostic CECT has become an inherent part of F18 FDG PETCT scans, there is an increasing need to identify and report such incidental findings. We report a case where incidental recognition of this phenomenon on F-18 FDG PET-CT scan led to prompt diagnosis of RV dysfunction followed by emergency intensive care unit (ICU) admission of the patient and appropriate management.

Case Report
A 55-year-old female was diagnosed with carcinoma left breast 10 years back. She underwent modified radical mastectomy, adjuvant chemoradiotherapy and later completed hormonal treatment. She was apparently well till 6 months back when she started experiencing shortness of breath. Her chest X-ray showed right-sided pleural effusion. She was referred for F-18 FDG PET-CT scan by her treating oncologist in view of suspected recurrence. We performed a PET-CECT scan with triphasic CT abdomen on Siemens Biograph Horizon Time-of-Flight PET-CT scanner with 16-slice CT using standard patient preparation and acquisition protocol. The patient’s renal functions were within normal limits, and there were no contraindications to the administration of IV contrast. IV contrast (Iohexol, OMNIPAQUE 350, GE Healthcare) was administered through the peripheral vein in the right arm in the dose of 1 ml/kg at a rate of 3 ml/sec. Arterial phase CT scan was acquired with slice collimation of 1.5 mm in breath-hold after deep inspiration.

PET-CT scan demonstrated few mildly metabolically active and metabolically inactive fibronodular lesions in bilateral lungs which were too small for
characterization, and a short interval follow-up was suggested. There was no definite metabolically active disease in the whole-body survey [Figure 1f]. There was evidence of mild bilateral pleural effusion, mild pericardial effusion, and generalized subcutaneous edema in the regions of the body surveyed [Figure 1]. Another interesting finding which came to notice on arterial phase CT abdomen was the early opacification of hepatic veins and suprahapatic IVC in the arterial phase [Figure 2].

A careful review of literature attributed this particular finding to the retrograde flow of IV contrast from the right atrium to IVC and hepatic veins. A cardiac cause was contemplated, and the patient was examined again. On careful examination, the patient demonstrated signs of heart failure, for example, pedal edema and raised jugular venous pulse. A review of PET-CT scan images also showed evidence of cardiomegaly with dilated chambers [Figure 1e]. The patient was sent back to the referring oncologist with a provisional report. The patient was then immediately referred to the cardiologist, who underwent electrocardiography (ECG) and two-dimensional (2D) echocardiography on the same day. Her ECG showed poor R-wave progression in the anterior chest leads and T-wave inversion in the lead V6. 2D echocardiography showed dilated atrial and ventricular chambers, global left ventricular (LV) hypokinesia, severe LV systolic dysfunction (LVEF: 20%–25%), Grade III LV diastolic dysfunction, RV dysfunction, pulmonary hypertension with dilated IVC, and minimal pericardial effusion. Provisionally, a diagnosis of dilated cardiomyopathy (DCMP) was made. Later on the same day, the patient was admitted to cardiac ICU and was managed conservatively with diuretics, antiplatelets, statins, fluid restrictions, and other cardiac medications. She recovered well and underwent coronary angiography after 3 weeks, which demonstrated normal coronaries.

Discussion

Retrograde opacification of IVC and hepatic veins has been studied sparingly in the past. Omell and Klingensmith(4) described this finding on an IV urogram in a patient with congestive heart failure as early in 1978. However, three research groups reported reflux of IV contrast from the right atrium into the suprahepatic IVC and hepatic veins on CT scan in patients with advanced(2) or chronic(3,5) heart failure. Collins et al.(1) attributed this finding in six patients to severe TR. In a retrospective study by Yeh et al.(6) done on 127 patients, it was reported that retrograde opacification of the IVC or hepatic veins on CT is a specific but insensitive sign of right-sided heart disease at contrast injection rates of ≤3 ml/sec. This study also showed that high injection rate, TR, pulmonary hypertension, and RV systolic dysfunction were independent predictors of retrograde IVC or hepatic vein opacification. In another study by Groves et al.(7) it was reported that early opacification of the IVC or hepatic veins on first-pass CECT almost invariably indicates TR. In the present case also, the finding was attributed to DCMP with RV and LV systolic dysfunction and pulmonary artery hypertension. This finding can be considered as a radiologic counterpart of passive hepatic congestion seen pathologically or tender hepatomegaly found clinically in patients with congestive heart failure. Prompt recognition of this incidental finding avoided invasive aspiration of pleural fluid to rule out recurrence in this case and led to early management of her cardiac failure.

Currently, diagnostic CECT has become an inherent part of F18 FDG PET-CT examinations. Hence, there is an increasing need among nuclear medicine physicians to be more aware of such incidental findings. However, it is important to note here that retrograde filling of IVC and hepatic veins is seen in the arterial phase and would be encountered when triphasic CECT abdomen scan is done along with PET. This finding is not encountered when routine CECT protocols in the venous phase are used along with PET.

Besides reporting such findings, this case report highlights the importance of detailed history taking from patients and clinical examination before proceeding with PET-CT.

Figure 1: (a and b) Axial slices of F-18 FDG PET-CT scan demonstrating bilateral pleural effusion, right more than left (white arrow). (c and d) Mild pericardial effusion (red arrow). (e) A coronal section of fluorodeoxyglucose positron emission tomography–computed tomography fused images showing evidence of cardiomegaly. (f) A maximum intensity projection image of fluorodeoxyglucose distribution which shows an absence of definite metabolically active lesions in the body.
scan procedure. The awareness among nuclear medicine physicians will avoid unnecessary investigations and will help in reaching an early definitive diagnosis.

**Conclusion**

Retrograde opacification of IVC and hepatic veins during arterial phase CT is a rare incidental finding which is a specific but insensitive sign of right-sided heart disease. Nuclear medicine physicians should be aware enough to recognize this incidental yet important finding of cardiological significance.

**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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