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Focal hepatic uptake along the falciform: False positive for malignancy on 18F-FDG-PET in a lymphoma patient with superior vena cava obstruction

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We present a case of focal increased intrahepatic radiotracer activity on 18F-fluorodeoxyglucose positron emission tomography (FDG-PET) in a patient with lymphoma and superior vena cava (SVC) obstruction, a false positive for malignancy. Contrast-enhanced computed tomography (CT) demonstrated an enhancing region of geographic focal hypoattenuation in the liver along the falciform, corresponding to the region of increased radiotracer activity on FDG-PET, with marked narrowing of the superior vena cava and resultant collateral venous pathways to the portal vein via paraumbilical veins. CT followup demonstrated stability of the hepatic abnormality, and no lesion was evident on ultrasound, suggesting that the finding on PET-CT represented a false positive for malignancy in this patient with known SVC obstruction. In patients with SVC obstruction, radiologists should consider this phenomenon of anomalous hepatic uptake along the falciform as a source of possible false positives for malignancy on PET.

Case report

A 32-year-old man presented to the emergency department complaining of pleuritic chest pain, productive cough, shortness of breath, and facial swelling. Contrast-enhanced chest CT demonstrated a large anterior mediastinal mass and lymphadenopathy with resultant severe narrowing of the superior vena cava (Fig. 1). There was a geographic region of poorly defined hypoattenuation involving segment IV of the left lobe of the liver, without evidence of architectural distortion or mass effect, on pulmonary arterial phase postcontrast images (Fig. 2). The differential diagnosis for this lesion included focal fatty infiltration versus metastatic disease; however, malignancy was considered less likely given the shape, location, and lack of mass effect related to the lesion.

Open biopsy of the mediastinal mass yielded a diagnosis of large B-cell lymphoma. The patient underwent six cycles of chemotherapy (CHOP, Rituxan). Followup chest CT performed during treatment three months later demonstrated a slight reduction in the size of the anterior mediastinal mass, with some improvement in the degree of SVC compression. CT also demonstrated internal thoracic collaterals (Fig. 3) and paraumbilical veins in the region of the falciform ligament (Figs. 4, 5). Note was also made of a prominent azygos/hemiazygos system (Figs. 1, 3). There was abnormal parenchymal enhancement involving hepatic segment IV in the region of the falciform ligament (Figs. 4, 5), corresponding to the previously noted hypoattenuating region on the first CT. This enhancement was thought to represent a pseudolesion related to collateral blood flow, given the evidence of collateralization and nonmasslike appearance. Two months later, the patient underwent evaluation with abdominal ultrasound, which demonstrated mildly increased echogenicity of the liver diffusely without evidence of focal mass to correlate with the findings on CT.

Fewer than three months after the followup CT, the patient underwent FDG-PET, which demonstrated intense FDG uptake in the anterior mediastinal mass, consistent

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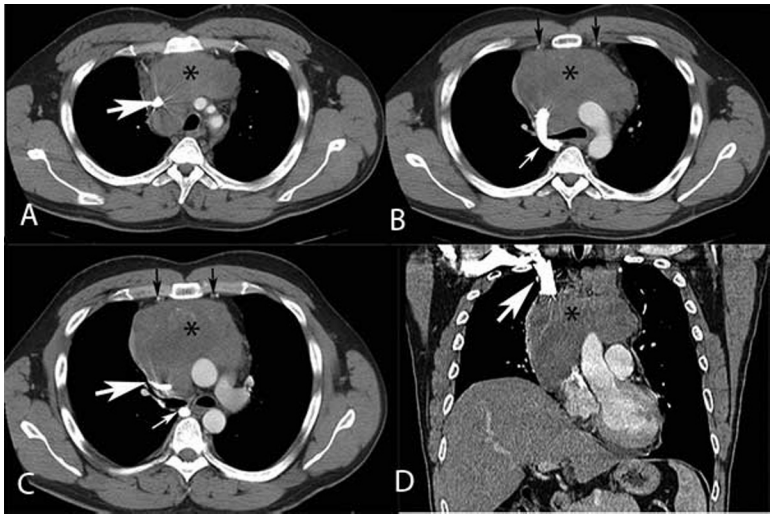

Figure 1. Initial thoracic CT of a 32-year-old man with SVC obstruction secondary to biopsy-proven large B-cell lymphoma. Images were obtained in arterial contrast phase following intravenous administration of 80 mL Omnipaque 350 via the right upper extremity. Figs 1A-C were obtained in the axial plane, and D is a coronal reconstruction. The images reveal a large anterior mediastinal mass (black star, A-D) narrowing of the SVC (thick white arrows, A, C, D), a prominent azygos vein (thin white arrows, B, C) and mild prominence of the internal thoracic veins (black arrows, B, C).

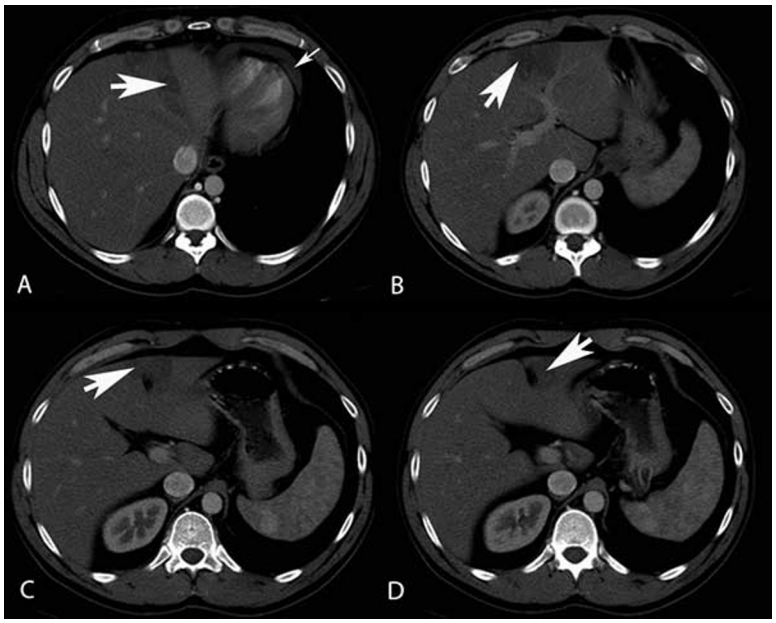

Figure 2. Axial images are from the same study as Fig. 1, also in early phase of contrast enhancement, windowed for improved definition of the hepatic parenchyma. There is a geographic area of low attenuation involving segment IV of the left lobe of the liver (thick white arrows, A-D). Incidental note is made of a pericardial effusion (thin white arrow, A).

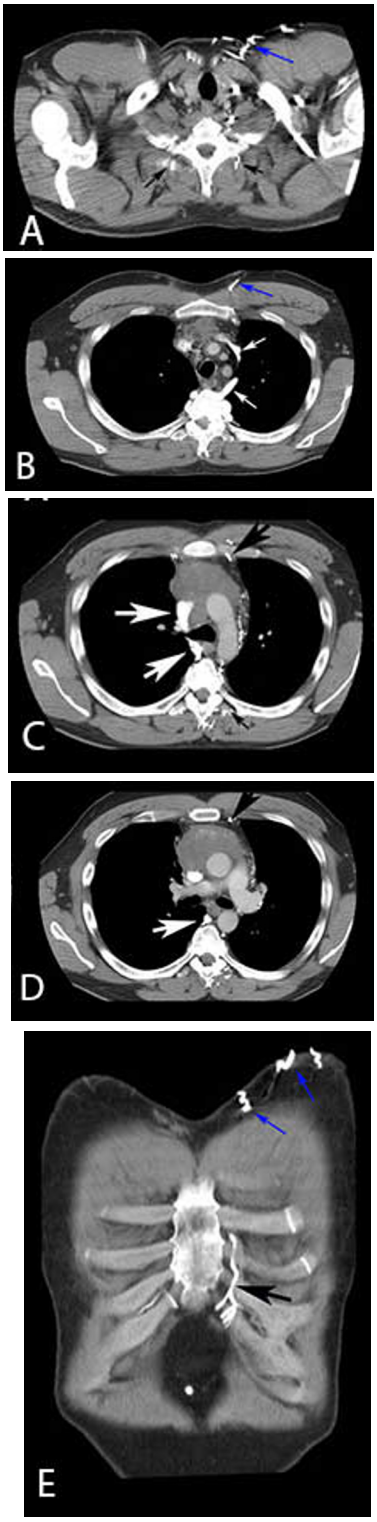

Figure 3. Followup contrast-enhanced CT evaluation performed three months after the initial CT, following 6 cycles of chemotherapy. Axial, contrast-enhanced CT was obtained in portal venous phase following intravenous injection of 80 mL Omnipaque 350 via the left upper extremity with coronal reconstruction (E). There are multiple prominent collateral veins including: chest wall (blue arrows, A, B, E), paravertebral (small black arrows, A, C), prominent azygos (thick white arrows, C, D), hemiazygos (thin white arrows, B), and internal thoracic collaterals (thick black arrows, C-E).

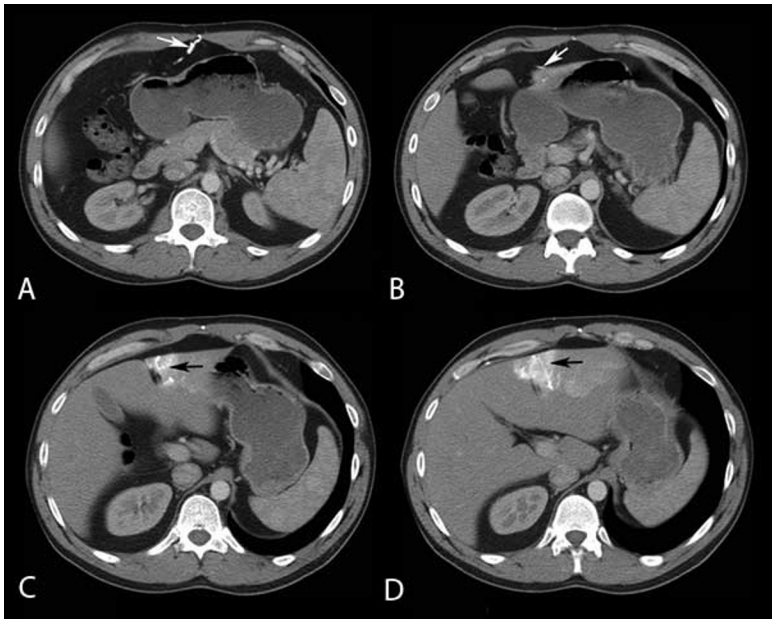

Figure 4. Axial, contrast-enhanced portal venous phase CT images from the same study as Fig 3, obtained more inferiorly. There is recanalization of the paraumbilical vein (white arrows, A, B), draining to the anterior liver, resulting in hyperenhancement of segment IV of the left lobe of the liver, correlating with the region of hypoattenuation seen on the prior CT (black arrows, C, D).

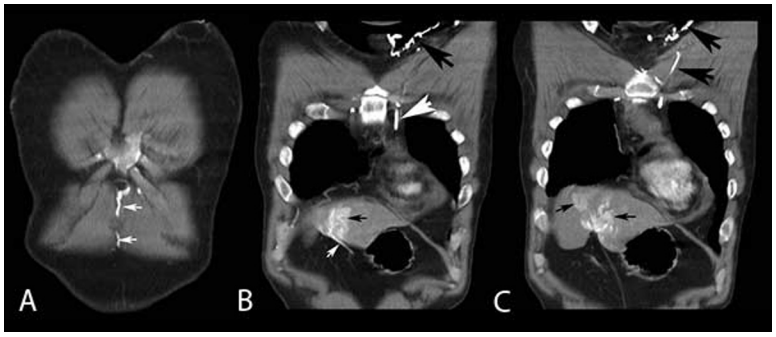

Figure 5. Coronal reconstructions of the contrast-enhanced portal venous phase CT images in Figs. 3 and 4, using 80mL Omnipaque 350 i.v. via the left upper extremity. The thin white arrows indicate the recanalized paraumbilical vein (A, B). There is hyperenhancement along the falciform ligament (thin black arrows, B, C). The thick black arrows indicate chest wall collaterals (B, C) and the thick white arrow indicates the internal thoracic vein (C).

with the patient's known lymphoma (maximum standardized uptake value, SUVmax, 9.4) (Fig. 6b). Besides the known mediastinal lymphoma, the only other concerning PET finding was focally increased FDG accumulation of moderate intensity corresponding to a poorly defined 2.5-x-3.0cm hypoattenuating region toward the inferior aspect of segment IV of the left lobe of the liver adjacent to the falciform ligament, with SUVmax of 5.0 (Fig. 6). The differential for focally increased hepatic activity generally includes misregistration artifact from diaphragmatic motion and metabolic activity within the adjacent bowel (which had been confidently excluded in this case, as there was no evidence of misregistration, no nearby bowel activity of sufficient intensity to account for the hepatic finding, and the focal increased hepatic activity conformed to the shape of the liver in three planes and on the MIP, corresponding to the finding on CT) versus primary or secondary hepatic neoplasm, most likely metastatic lymphoma in this case. When interventional radiology (IR) was consulted for liver biopsy and reviewed the CT findings, IR strongly concurred with the CT interpretation favoring a benign etiology for the CT finding, which had been stable in size for three months, likely related to collateral blood flow, prompting the question, "Could the focal abnormal increased FDG uptake on PET also be due to collateral blood flow, rather than a hypermetabolic mass?" A literature search identified one published report in the thoracic imaging literature of focal liver uptake in this same region on FDG-PET in two lung cancer patients with SVC obstruction (1). Given the previously reported PET finding and the CT features favoring benignity of the lesion, liver biopsy was deferred in favor of CT followup, which thereafter documented stability of the hepatic finding for 14 months (Fig. 7) and favored a nonmalignant etiology.

Discussion

In patients with SVC obstruction, areas of focal increased hepatic blood flow secondary to collateralization and systemic-portal venous shunting have been well documented. The result of this shunting has previously been demonstrated as abnormal enhancement on contrast-enhanced CT and as focal increased radiotracer uptake on nuclear medicine Tc-99m sulfur colloid scan, sometimes referred to as the "focal hepatic hot spot" sign (2, 3, 4-6). This finding of focal hepatic enhancement or focal increased radiotracer activity is thought to be due to high concentrations of injected contrast or radiopharmaceuticals delivered to the left portal or subcapsular liver veins via collateral flow. There are several potential collateral pathways in SVC obstruction. These include the internal thoracic vein to the portal vein via the umbilical or paraumbilical veins, leading to focal flow to the liver in the region of the falciform ligament (7). There are also the lateral thoracic veins, superficial veins, azygos-hemiazygos, and paravertebral collateral systems (6-8).

In this patient with lymphoma, contrast-enhanced CT demonstrated obstruction of the SVC with internal thoracic collaterals to the anterior paraumbilical vessels as well as azygos/hemiazygos and paravertebral collateralization. On early pulmonary arterial-phase CT, a focal nonmass-like area of hypoattenuation was noted adjacent to the falciform ligament, which demonstrated avid enhancement

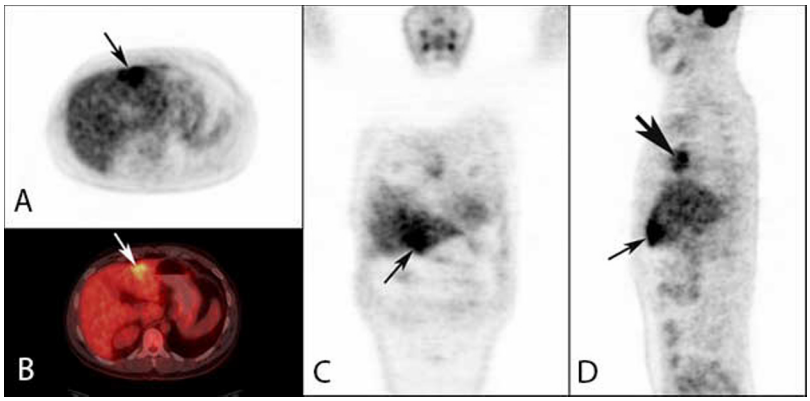

Figure 6. PET-CT was performed with oral contrast, approximately 1 hour after intravenous administration of 17.7 mCi of F-18 FDG via the left upper extremity. A, C, and D are PET images (in axial, coronal, and sagittal projections, respectively);B is an axial fused PET-CT image. Moderate focal FDG accumulation is seen along the falciform ligament, predominantly involving the inferior aspect of segment IV when compared to the previous anatomic imaging studies (thin arrows, A-D), SUV max was 5.0. Given the presence of SVC obstruction with collateralization in this patient, these findings were felt to be a false positive in this patient due to abnormal radiotracer delivery related to the vascular shunting. D demonstrates focal, intense FDG accumulation (SUV max 9.4) within the anterior mediastinum (thick black arrow), consistent with the patient's known lymphoma.

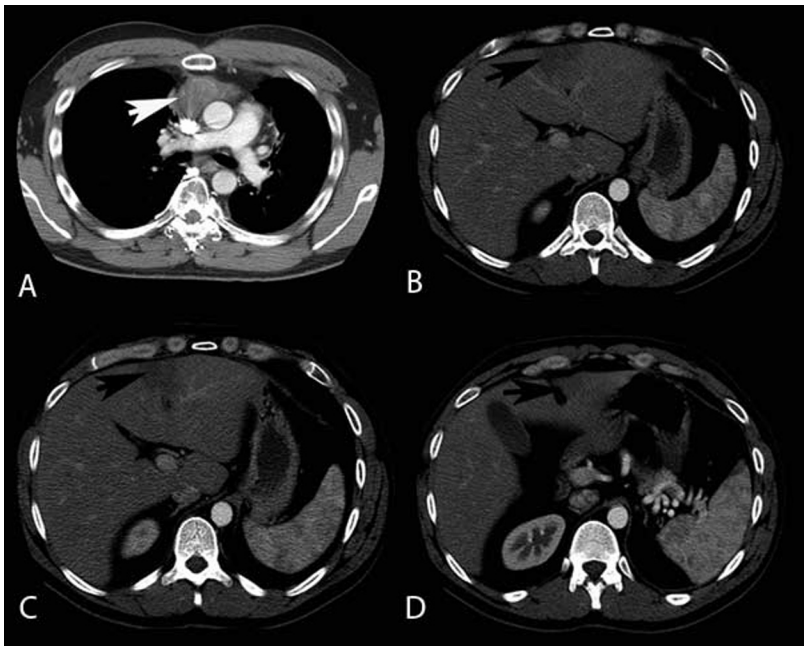

Figure 7. Additional followup, contrast-enhanced CT was performed 14 months after the initial CT. These axial images were obtained in early arterial contrast phase following the administration of 80mL of Omnipaque-350 intravenous contrast via the right upper extremity. During this time, there was interval decrease in the size of the mediastinal mass (white arrow, A). A persistent region of parenchymal hypoattenuation was again seen involving segment IV of the left lobe of the liver (B-D). Stability of this hepatic finding over time lends support to the hypothesis that the increased PET activity associated with this lesion was nonmalignant in etiology.

during the portal venous phase. Subsequent PET then demonstrated focal increased FDG uptake in this same region. It is important to remember that the liver has been reported to be frequently involved in patients with non-Hodgkin's lymphoma (9). Indeed, in a patient being staged for known malignancy without SVC obstruction, focally increased FDG accumulation at a site of abnormal attenuation/enhancement on CT would have high specificity for malignancy. FDG-PET has a reported specificity of between 90% and 96% for liver metastases from gastrointestinal primaries (10-12). Hence, it is important for interpreters of PET to be aware of this phenomenon in patients with SVC obstruction as a potential false positive mimicking hepatic malignancy.

If further imaging evaluation to confirm false positive due to SVC obstruction is desired, the PET study could be repeated using an intravenous injection site on the lower extremity (for example, in a foot vein). The initial passage of concentrated radiotracer from the lower extremity via the nonobstructed inferior vena cava (rather than from upper extremity via collaterals bypassing the obstructed superior vena cava) would not be expected to reproduce a false positive hepatic finding due to SVC obstruction. This result has been confirmed using Tc-99m sulfur colloid in a patient with mediastinal mass due to metastatic breast cancer. Injection via the right antecubital fossa revealed a warm spot within the anterior liver, but no focal hepatic uptake with injection of the dorsum of the right foot (5).

In the case of our patient, IR did not feel that a repeated PET/CT was needed for patient management and therefore opted to spare him the additional cost and radiation. After documented continued stability of the hepatic finding on CT for a total of 14 months, the patient was lost to followup. Considering the stability and the other features in this patient, it is thought very likely that the hepatic PET finding was also benign, related to the collateral blood flow of SVC obstruction. In a patient with SVC obstruction and isolated focal hepatic activity on FDG-PET along the falciform, interpreters of PET should consider this artifact in the differential.

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