Transarterial Chemoembolization for Hepatocellular Carcinomas in Watershed Segments: Utility of C-Arm Computed Tomography for Treatment Planning

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Editor:

Navigating tortuous, overlapping vessels and assessing complete geographic uptake of lipiodol in a hepatocellular carcinoma (HCC) treated with selective transhepatic arterial chemoembolization are becoming two of the most useful roles of C-arm computed tomography (CT). Digital subtraction angiography (DSA) alone is limited in its ability to discern multiple segmental arteries supplying a single tumor in the setting of corkscrew vessels, which are commonly observed in advanced cirrhosis. Projectional imaging is limited by its two-dimensionality, carrying the inherent risk of overestimating complete and circumferential lipiodol uptake in an HCC at the time of treatment. This risk is of particular importance in anatomic regions along segmental boundaries or "watershed" regions, where tumors may receive a dual arterial supply from both the right and the left hepatic arteries regardless of tumor size (1). We describe the impact C-arm CT can have on determining a dual blood supply in watershed region tumors and, more importantly, its ability to portray incomplete treatment at the time of the procedure itself. An exemption from obtaining informed consent was provided by the institutional review board for this retrospective report. All data were handled in compliance with the Health Insurance Portability and Accountability Act.

CASE 1

A 54-year-old woman with a history of cryptogenic cirrhosis presented with a solitary 2-cm nodule in segment 6a of the liver. Tumor location and poor performance status precluded radiofrequency ablation and resection, so chemoembolization was performed. Superselective catheterization was planned to minimize hepatocellular damage in this patient with poor hepatic reserve. The procedure was performed in a single-plane angiography suite capable of C-arm CT (AXIOM Artis dTA ceiling mounted system with DynaCT; Siemens, Forchheim, Germany). Contrast enhanced C-arm CT images were obtained with the catheter positioned in the common hepatic artery using iodinated contrast agent diluted to 150 mg/mL concentration (50%) (Omnipaque 300, Mallinckrodt, St. Louis, Missouri) injected at a rate of 2 mL/s for a total of 24 mL.

Tumor enhancement was observed on DSA imaging, but severe tortuosity and overlapping of the segmental arteries prevented identification of subsegmental blood supply to this small tumor (**Fig, a**). When C-arm CT was performed, the tumor was easily identified at the junction of segments 4a and 8. Three-dimensional reconstructions also identified a dual arterial supply from the segment 8 branch arising from the anterior right hepatic artery and from the segment 4 (middle) hepatic artery, arising from the main right hepatic artery (**Fig, b**). After superselective catheterization and angiography of the segment 4a artery, the chemoembolic emulsion was administered until stasis was achieved. Anteroposterior and oblique radiographs showed dense and uniform round accumulation of lipiodol in the tumor (**Fig, c**). However, based on the information gathered from our initial C-arm CT images, a branch of the segment 8 artery was selectively catheterized, and C-arm CT with superselective contrast agent injection showed retention of lipiodol exclusively in the ventral half of the tumor with persistent perfusion of the dorsal portion (**Fig, d**). Additional chemoembolic emulsion was administered in the segment 8 branch, and follow-up C-arm CT confirmed complete lipiodol uptake in the entire tumor. Follow-up cross-sectional imaging at 2 months and 6 months showed no evidence of residual disease.

CASE 2

Surveillance magnetic resonance (MR) imaging in a 75-year-old woman with a history of hepatitis C and cirrhosis and previously treated HCC showed a new 2.5-cm tumor in the anteromedial portion of segment 8. DSA and contrast-enhanced C-arm CT were performed, as described previously, to identify the vascular supply to the tumor. The segment 8 vessel was catheterized, and superselective chemoembolization of segment 8 was performed. Similar to the previous case, incomplete treatment along the medial aspect of the tumor was recognized on the completion C-arm CT scan, with lipiodol retention only in the lateral two-thirds of the tumor as a result of a dual blood supply from both segment 8 and 4 arteries. Patient discomfort precluded us from selecting and treating the segment 4 arterial supply in the same session, but the patient returned for completion

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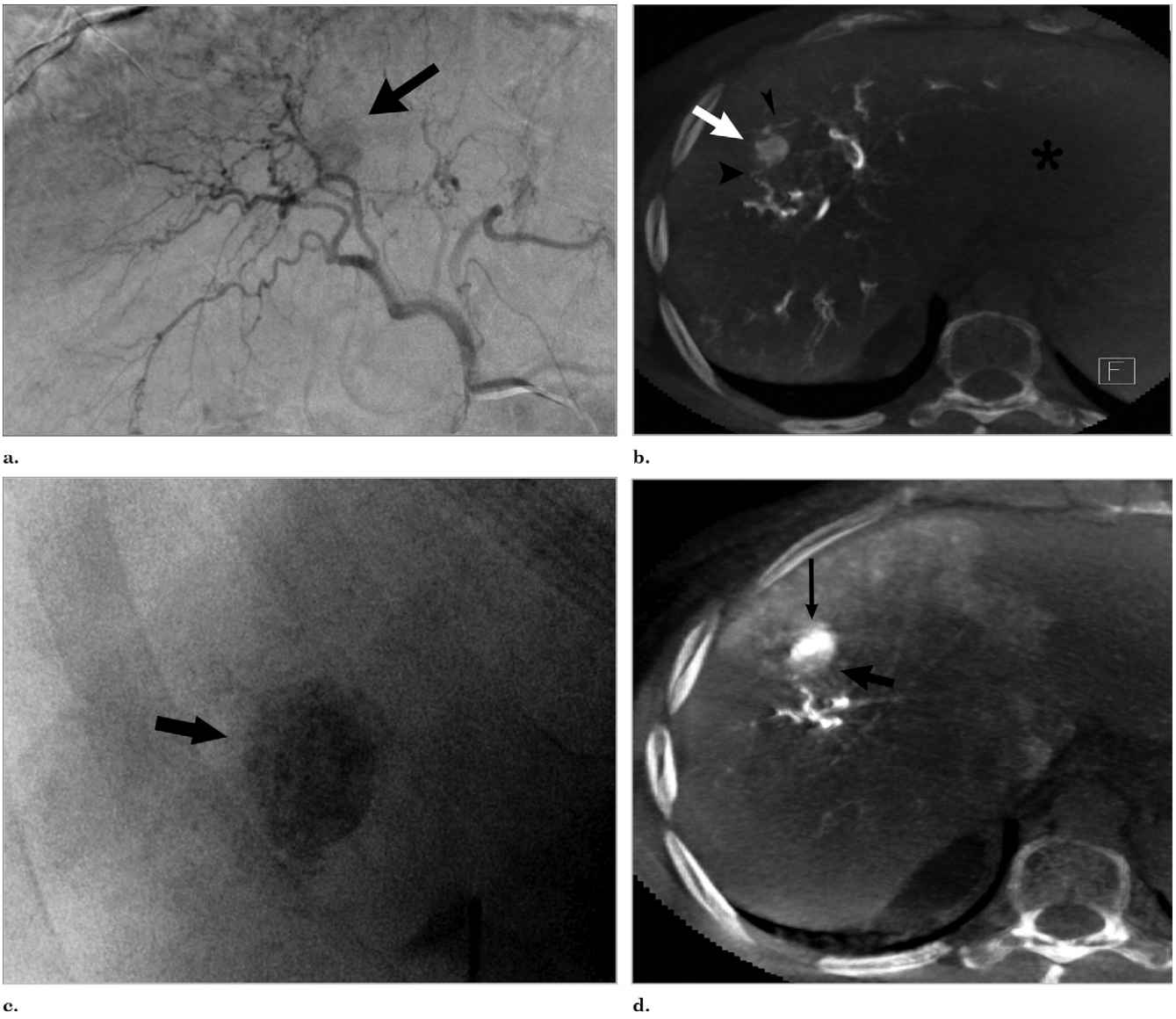

Figure. Watershed HCC in a 54-year-old woman with cryptogenic cirrhosis. DSA image **(a)** in 30-degree right anterior oblique projection during contrast agent injection into the proper hepatic artery revealed a 1.4-cm tumor in segment 4a (arrow). Contrast-enhanced C-arm CT **(b)** with injection in the proper hepatic artery identified the tumor (arrow). A dual arterial supply from the right (thick arrowhead) and the middle (thin arrowhead) hepatic arteries was clearly portrayed. Segment 2 was supplied by a replaced left hepatic artery and was not enhanced on this injection (asterisk). Radiograph **(c)** obtained after treatment of segment 4 showed apparent complete uptake in the tumor (arrow). Contrast-enhanced C-arm CT **(d)** performed during selective catheterization of the segment 5/8 artery after treatment of segment 4 showed dense lipiodol staining of the anterior half of the tumor (thin arrow). However, the posterior half did not show lipiodol uptake and showed persistent contrast enhancement (thick arrow).

treatment after a short recovery period. Follow-up cross-sectional imaging at 3 months showed no evidence of residual disease.

Hepatic segmentation described by Couinaud and Bismuth is based on portal architecture and hepatic venous drainage dividing the right and the left hemiliver into segments. The most striking variability in Couinaud segmentation is the arterial supply to segment 4 and the medial aspect of segment 8. Because segment 4 belongs to the left hemiliver, arterial supply to segment 4 is normally derived from the left hepatic artery. However, in 10%–30% of cases, the dominant supply to segment 4 is from the right hepatic artery or from a dual supply involving both the left and the right hepatic arteries (1). Similarly, the medial portions of segment 8 bordering segment 4 and segment 1, although some may not consider these true watershed areas, can have a bilobar arterial supply. Delineation of arterial supply to watershed regions plays a crucial role during hepatic resection and partial liver transplantation and is well described in the surgical literature (2). However, superselective chemoembolization of segment 4 lesions is not always treated with the same degree of scrutiny (1).

Cross-sectional imaging performed during injection of contrast medium in the hepatic artery has been shown to be

useful during chemoembolization procedures but has been difficult to incorporate into clinical workflow. C-arm CT using flat panel detectors can produce three-dimensional images using the same angiographic unit as used for DSA (3,4), simplifying the process. The advantages of C-arm CT are of particular importance in patients with lesions in the watershed regions, where identifying multiple tumor-supplying vessels and assessing completeness of lipiodol uptake are difficult using projectional imaging alone. Although use of C-arm CT can increase the single-procedure radiation dose to the patient, complete treatment of a tumor may allow avoidance of subsequent procedures, resulting in a net decrease in radiation and nephrotoxic contrast medium exposure (5).

In conclusion, the use of C-arm CT during superselective chemoembolization can provide critical information, especially for tumors in watershed territories served by a bilobar segmental supply. Evaluation of completeness of lipiodol uptake can trigger interrogation of additional vessels if indicated, increasing the operator's confidence of definitive treatment.

REFERENCES

1. Oran I, Memis A. The watershed between right and left hepatic artery territories: findings on CT scans after transcatheter oily chemoembolization of hepatic tumors. A preliminary report. Surg Radiol Anat 1998; 20:355–360.
2. Erbay N, Raptopoulos V, Pomfret EA, Kamel IR, Kruskal JB. Living donor liver transplantation in adults: vascular variants important in surgical planning for donors and recipients. AJR Am J Roentgenol 2003; 181:109–114.
3. Tognolini A, Louie JD, Hwang GL, Hofmann LV, Sze DY, Kothary N. Utility of C-arm CT in patients with hepatocellular carcinoma undergoing transhepatic arterial chemoembolization. J Vasc Interv Radiol 2010; 21: 339–347.
4. Hirota S, Nakao N, Yamamoto S, et al. Cone-beam CT with flat-panel-detector digital angiography system: early experience in abdominal interventional procedures. Cardiovasc Intervent Radiol 2006; 29:1034–1038.
5. Kothary N, Abdelmaksoud MH, Tognolini A, et al. Imaging guidance with C-arm CT: prospective evaluation of its impact on patient radiation exposure during transhepatic arterial chemoembolization. J Vasc Interv Radiol 2011; 22:1535–1543.

Bronchopleural Cutaneous Fistula after Pulmonary Radiofrequency Ablation: Treatment with Low-Adherent Paraffin Gauze Dressing

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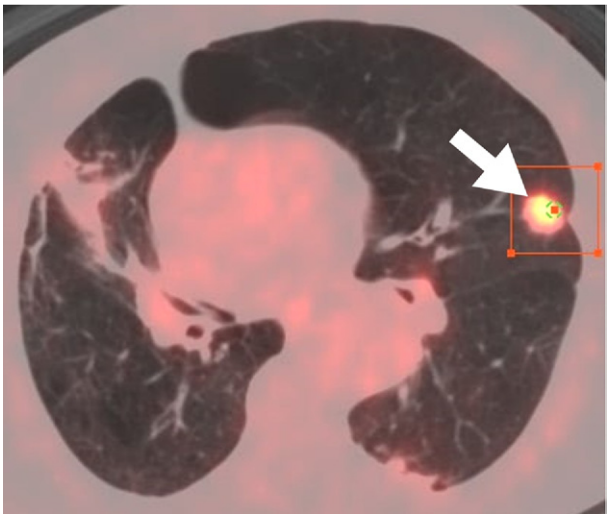

Figure 1. Axial PET/CT image of biopsy-proven squamous cell carcinoma in a 79-year old man. The image shows increased uptake (standardized uptake value of 9.3) within the nodule (arrow).

Editor:

The commonest complications of radiofrequency (RF) ablation of the lung include pneumothorax, pleural effusions, and pneumonia. In this report, we describe management of an unusual bronchopleural cutaneous (BPC) fistula in a patient with primary lung cancer.

A 79-year-old man admitted with a lower respiratory tract infection was found to have a 2-cm nodule in his left upper lobe on chest radiography. His background medical history was significant for chronic obstructive pulmonary disease (Global Initiative for Obstructive Lung Disease stage II) with a 60–pack-year smoking history. Thoracic computed tomography (CT) confirmed a 1.9 × 1.8-cm spiculated nodule in the left upper lobe and no mediastinal or hilar lymphadenopathy. Findings of bronchoscopy and bronchoalveolar lavage were negative for malignancy. Spirometry revealed a forced expiratory volume in 1 second of 1.2 L (57% predicted). A positron emission tomography (PET)/CT scan demonstrated increased fluorodeoxyglucose uptake within the nodule, with a maximum standardized uptake value of 9.3 and no abnormal fluorodeoxyglucose uptake elsewhere (**Fig 1**). Percutaneous CT-guided lung biopsy revealed squamous-cell carcinoma. After multidisciplinary discussion,

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