Iodized Oil Accumulation in Hypervascular Hepatocellular Carcinoma after Transcatheter Arterial Chemoembolization: Comparison of Imaging Findings with CT during Hepatic Arteriography

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PURPOSE: To compare the degree of tumor enhancement seen on computed tomography (CT) during hepatic arteriography (CT/HA) performed before transcatheter arterial chemoembolization (TACE) versus that determined based on the accumulation of iodized oil seen on CT images obtained after TACE in patients with hypervascular hepatocellular carcinoma (HCC) and evaluate the discrepancy in findings between the two imaging modalities (more or less oil accumulation after TACE compared with enhancement on CT/HA).

MATERIALS AND METHODS: CT/HA, TACE, and iodized oil CT after TACE were performed in 69 patients with 83 hypervascular HCCs with use of an interventional CT system. The degree of contrast enhancement of the lesion on CT/HA and the iodized oil accumulation on unenhanced CT after TACE were compared.

RESULTS: Among 83 HCCs, the degree of enhancement on CT/HA before TACE corresponded to the iodized oil accumulation on CT in 56 (67.5%). Fifteen of 83 HCCs (18%) showed incomplete or poor accumulation of iodized oil despite good enhancement on CT/HA images. Twelve of 83 HCCs (14.5%) showed moderate or complete accumulation of iodized oil despite poor or no enhancement on CT/HA images. In particular, in two patients with occluded portal veins, iodized oil did not accumulate in the tumor despite good visualization on CT/HA.

CONCLUSIONS: Although iodized oil accumulation in hypervascular HCCs correlates with the degree of lesion enhancement on CT/HA in most cases, a discrepancy may occur in a substantial number of cases, which likely affects the prediction of therapeutic effects in hypervascular HCCs.

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Abbreviations: CT/AP = computed tomography during arterial portography, CT/HA = computed tomography during hepatic arteriography, DSA = digital subtraction angiography, HCC = hepatocellular carcinoma, TACE = transcatheter arterial chemoembolization

HEPATOCELLULAR carcinoma (HCC) is the most common malignancy in the cirrhotic liver. At the time of diagnosis, many patients have large or multiple tumors that are not amenable to surgical resection (1). Even patients with tumors that appear resectable may have severe comorbidities from chronic liver diseases that preclude excision.

Transcatheter arterial chemoembolization (TACE) with iodized oil mixed with anticancer drug(s) and gelatin sponge particles is now performed worldwide for nonoperable HCCs because they are usually hypervascular except for some well-differentiated HCCs (2,3). Superselective TACE is gaining acceptance as a way to minimize collateral damage to the functioning liver and to maximize tumoricidal efficacy, but increased selectivity could result in incomplete treatment (3,4). Therefore, it is important to carefully plan TACE procedures before treatment. Computed tomography (CT) during hepatic arteriography (CT/HA) with an interventional CT system that combines helical CT with a digital subtraction angiography (DSA) unit is a useful technique (5) to evaluate the feeding arteries of HCCs and predict the embolized or damaged surrounding hepatic parenchyma be-

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fore treatment. At our institution, CT/HA is usually performed in all patients with HCC before TACE. Moreover, immediately after performing TACE, we obtain CT images with iodized oil to evaluate the degree of iodized oil accumulation in the tumor and predict the therapeutic effects of TACE (6). The degree of enhancement of the lesion on CT/HA usually corresponds to that of iodized oil accumulation on the CT images obtained after TACE. Complete or compact accumulation of iodized oil, resulting in sufficient tumor-necrotizing efficacy (6), may be seen in hypervascular HCC, which is well enhanced on CT/HA images (5). However, we have encountered cases with discrepant imaging findings between CT/HA and iodized oil CT performed after TACE. For instance, iodized oil accumulation in the tumor was not recognized on post-TACE CT, probably resulting in poor therapeutic effects, in some hypervascular HCCs that were well enhanced on CT/HA.

In this study, we prospectively compared the degree of tumor enhancement seen on CT/HA before treatment and that based on accumulation of iodized oil on CT images after TACE in patients with hypervascular HCCs, and evaluated the frequency and mechanism of any discrepancies in findings between CT/HA and iodized oil CT, affecting the prediction of therapeutic effects in hypervascular HCC.

MATERIALS AND METHODS

Subjects

Sixty-nine patients with cirrhosis with 83 confirmed nodular-type, hypervascular HCCs ranging from 12 mm to 50 mm in diameter (mean, 26 mm ± 13) who underwent segmental or subsegmental TACE at our institution between November 2000 and July 2002 were included in this study. The patients ranged in age from 41 to 86 years (mean, 62 y ± 24). There were 54 men and 15 women. Eight patients had underlying hepatitis B infection and 58 had hepatitis C. Three patients had no recognized risk factors for HCC. All patients underwent helical CT (Somatom Plus or Volume Zoom; Siemens, Erlangen, Germany) and magnetic resonance (MR) imaging (1.5-T Magnetom Vision; Siemens) with multiphasic dynamic study after intravenous bolus administration of contrast material before TACE. Confirmation of HCC was based on the typical appearance that is characterized as early arterial enhancement on arterial-dominant phase, washout on portal phase, and capsular enhancement on delayed-phase images on dynamic CT and MR imaging in 64 of 83 lesions (7,8). The remaining 19 lesions were diagnosed by percutaneous transhepatic biopsies ($n = 11$) and increased serum levels of α-fetoprotein (normal, <10 ng/mL) or protein induced by vitamin K absence or antagonist–II (normal, <40 mAU/mL; $n = 8$). Hypervascularity of HCCs was determined by arterial enhancement on dynamic CT/MR and/or CT/HA. Seventy-one of 83 HCCs showed nodular early enhancement on the arterial-dominant phase of dynamic CT or MR imaging. In the remaining 12 HCCs, hypervascularities of the lesion were confirmed by CT/HA before treatment. Hypovascular HCCs that did not show arterial enhancement on dynamic CT/MR or CT/HA were excluded from this study. Diffuse-type HCCs were also excluded because the degree of iodized oil accumulation may not be effectively evaluated as a result of diffuse distribution of the tumors. Lesion diameters were measured on CT or MR imaging. Fifty-seven patients had a solitary lesion, 10 had two lesions, and two had three lesions. With respect to the stages of cirrhosis, 37 patients had Child-Pugh class A disease, 20 had class B disease, and 12 had class C disease (9). The study received protocol approval from the institutional ethics committee. Each patient provided written consent after having been fully informed about the study protocol.

Angiographic and CT/HA Examinations

All examinations and treatments were performed with an interventional CT system (Somatom Plus 4 and Multistar Top; Siemens). Serial angiographic examinations and CT/HA before TACE were performed in all patients as follows. A 4-F angiographic catheter (Cobra or Matsunaga type; Medikit, Tokyo, Japan) was first inserted into the superior mesenteric artery and an arterial portogram was obtained to assess the patency of the portal vein. CT during arterial portography (CT/AP) was then performed with interventional CT to evaluate the accurate numbers and locations of lesions as previously reported (10,11). A vasodilator (10 μg alprostadil) was used in all patients to obtain high-quality portographic and CT/AP images (11). Next, celiac angiography was performed to evaluate the general vascular anatomy. A catheter was then inserted into the common or proper hepatic artery and hepatic arteriography was performed with DSA. After careful evaluation of the feeding arteries and surrounding vascular anatomy, a 3-F microcatheter (Renegade; Boston Scientific Japan, Tokyo, Japan) was inserted into the 4-F catheter, which remained in the proximal hepatic artery and was selectively advanced into the feeding artery as deep as possible. For the superselective insertion of microcatheters, repeat angiography with DSA was used.

After the microcatheter was inserted into the segmental or subsegmental feeding arteries, CT/HA was performed. During a single breath-hold, 150 mgI/mL contrast material (Iopamiron 150; Nihon-Schering, Tokyo, Japan) was injected into the hepatic arterial microcatheter for the duration of the scan. The rate of injection was 0.5 or 2.0 mL/sec, adjusted according to the flow rate of the hepatic artery observed during DSA and to minimize reflux into the gastroduodenal artery. After a 5-second delay, scanning was performed from a cephalad-to-caudad direction with an 8-mm slice thickness at a speed of 10 mm/sec with table increments. A total of 10–20 mL of contrast material was injected. The images obtained were immediately reviewed by two experienced interventional radiologists, who confirmed that the segment to be embolized could fully cover the lesion.

TACE Technique

After DSA and CT/HA, 2–3 mL of 0.5% lidocaine was intraarterially injected to prevent pain and vasospasm. TACE was then performed by injecting a mixture of iodized oil (Lipiodol Ultra Fluid; Mitsui Seiyaku, Tokyo, Japan) and anticancer drugs (doxorubicin; Adriamycin; Kyowahakko, Tokyo,

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