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## Abstract

Computed tomographic arteriography (CTA) was performed in 30 patients with hepatocellular carcinoma (HCC). Detection of HCC by CTA was compared with that of conventional celiac or hepatic arteriography. CT scanning was performed immediately, 30 seconds and 1 min after an injection of 5 to 10 ml of contrast medium into the common or proper hepatic artery. Repeated infusions allowed whole liver sections to be visualized. HCC was localized in 28 of the 30 patients by conventional arteriography, with CTA detecting the masses in 27 of the 28 patients. CTA imaging presented the tumor mass in 1 of the 2 patients missed by arteriography. Conventional arteriography delineated the boundaries of HCC in 15 (50%) of the 30 patients. CTA clearly delineated the masses in 26 (87%) of the 30 patients including 11 patients in which the tumor borders were obscure by conventional arteriography. HCC lesions smaller than 1 cm in diameter were detected only by CTA in 6 (20%) of the patients. It was concluded that CTA is both useful and necessary in the demarcation of small HCC masses.

**KEYWORDS:** computed tomographic arteriography, hepatocellular carcinoma, hepatic arteriography, contrast enhancement

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## COMPUTED TOMOGRAPHIC ARTERIOGRAPHY IN THE DIAGNOSIS OF HEPATOCELLULAR CARCINOMA

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*Abstract.* Computed tomographic arteriography (CTA) was performed in 30 patients with hepatocellular carcinoma (HCC). Detection of HCC by CTA was compared with that of conventional celiac or hepatic arteriography. CT scanning was performed immediately, 30 seconds and 1 min after an injection of 5 to 10 ml of contrast medium into the common or proper hepatic artery. Repeated infusions allowed whole liver sections to be visualized. HCC was localized in 28 of the 30 patients by conventional arteriography, with CTA detecting the masses in 27 of the 28 patients. CTA imaging presented the tumor mass in 1 of the 2 patients missed by arteriography. Conventional arteriography delineated the boundaries of HCC in 15 (50 %) of the 30 patients. CTA clearly delineated the masses in 26 (87 %) of the 30 patients including 11 patients in which the tumor borders were obscure by conventional arteriography. HCC lesions smaller than 1 cm in diameter were detected only by CTA in 6 (20 %) of the patients. It was concluded that CTA is both useful and necessary in the demarcation of small HCC masses.

*Key words :* computed tomographic arteriography, hepatocellular carcinoma, hepatic arteriography, contrast enhancement.

Patients with hepatocellular carcinoma (HCC) are easily diagnosed by such non-invasive diagnostic imaging techniques as ultrasonography (US) and computer assisted tomography (CT). The number of patients submitted for surgical resection of small HCC tumors is increasing. However, postoperative recurrences are not rare. The number, localization, and extent of HCC must be vigorously determined to prevent recurrences and to properly establish the prognosis. Computed tomographic arteriography (CTA) was introduced in 1976 (1), and has been applied since to the evaluation of arteriovenous malformation of the brain (2), cerebrovascular obstructive disease (3), aneurysm of the thoracic aorta (4), and hepatoma (5, 6). In this paper, this powerful technique was applied to the characterization of small HCC tumors which were obscure by superselective or infusion hepatic arteriography. The findings established the superiority of CTA over conventional arteriography for the detection and delineation of HCC.

## MATERIALS AND METHODS

Celiac and superior mesenteric arteriography was performed in 126 patients with liver diseases in the 22 month period from December 1980 to September 1982. CTA was performed in 61 (48 %) of the patients, 30 with HCC, 4 with metastatic liver cancer, 4 with hepatic cavernous hemangioma, 17 with liver cirrhosis, 2 with chronic hepatitis, 2 with idiopathic portal hypertension, 2 with obstructive jaundice, and one with a normal liver. After conventional celiac, superior mesenteric and hepatic arteriography, the catheter was further inserted into the common or proper hepatic artery. The patient was prepared for CT scan (TCT-60A model, Toshiba Electric Co., Tokyo). Plain CT scanning was performed first at the suspected level of the tumor. CT scanning was again performed at the same level immediately, 30 seconds and 1 min after injection of 5 to 10 ml of contrast medium (Isopaque 280, Torii Pharm. Co., Tokyo) into the common or proper hepatic artery. CTA was employed for two purposes ; to discover metastatic lesions in HCC patients who had been initially diagnosed by arteriography, and to obtain an image of the entire liver at 1 or 2 cm intervals in the case of nondefinitive arteriograms. Detection of tumor masses employing conventional arteriography and CTA was compared in the 30 HCC patients.

## RESULTS

*Comparison of the detection rate and resolution of the boundaries of HCC masses.* HCC was visualized in 28 out of 30 patients by conventional arteriography (Table 1). By CTA, HCC lesions were clearly visualized in 27 of the 28 patients, with one case going undetected, possibly because the catheter was not properly placed in the hepatic artery. HCC was not visualized clearly in 2 patients by conventional arteriography, though HCC in one of them was subsequently clarified by CTA. The boundaries of HCC were delineated in half the patients by conventional arteriography, whereas they were clear in 26 of the patients with CTA including those patients in which the boundaries were seen by conventional arteriography.

*Minute HCC tumors detected by CTA.* In 6 patients who had HCC lesions smaller

TABLE 1. COMPARISON OF THE DETECTION RATE AND RESOLUTION OF THE BOUNDARIES OF HCC MASSES

	Conventional arteriography		CTA	
Existence of HCC	Clear	28	Clear	27
	Obscure	2	Obscure	1 <sup>a</sup>
Boundary of HCC	Clear	15	Clear	15
			Obscure	0
	Obscure	15	Clear	11
			Obscure	4

<sup>a</sup>It is believed that the catheter tip did not reach the hepatic arteries, and remained in the celiac trunk. <sup>b</sup>p<0.001.

TABLE 2. MINUTE HCC TUMORS DETECTED BY CTA

Patients	Conventional arteriography		HCC detected by CTA	
	Right lobe	Left lobe	Right lobe	Left lobe
1	5 cm	UD	5 cm	1 cm*
2	2 cm	0.8 cm	2 cm	0.8 cm 1 cm*
3	1 cm	UD	1 cm	0.5 cm*
4	5 cm	UD	5 cm	1 cm*
5	UD	7 cm	0.8 cm*	7 cm
6	UD	UD	1 cm*	1 cm*

UD ; undetected. \*represents newly discovered lesions.

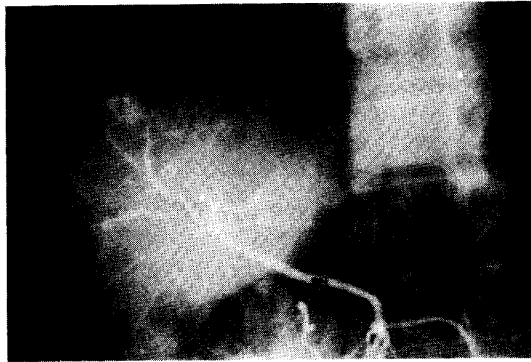


Fig. 1A. Superselative arteriography of the right hepatic artery branching from the superior mesenteric artery. Round tumor stain (arrow heads) 2 cm in diameter with an irregular border is observed in the upper portion of the right lobe. (57-year-old male HCC patient.) RH right hepatic artery.

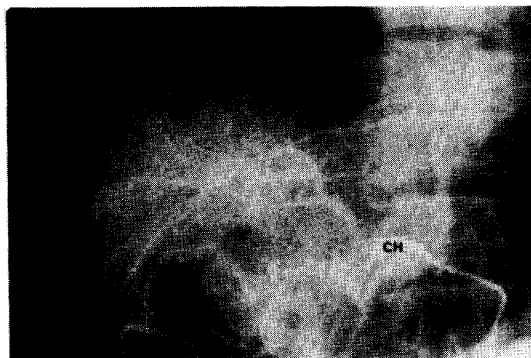


Fig. 1B. Superselative arteriography of the common hepatic artery branching from the celiac artery. The right hepatic artery was ligated during the operation. Irregular arterial channels are present in the upper part of the right lobe where HCC had been resected (long arrow). A small stain, 0.8 cm in diameter, suggestive of HCC recurrence is observed in the left median lobe (short arrow). (Same patient as Fig. 1A. eight months postoperative.) CH common hepatic artery.

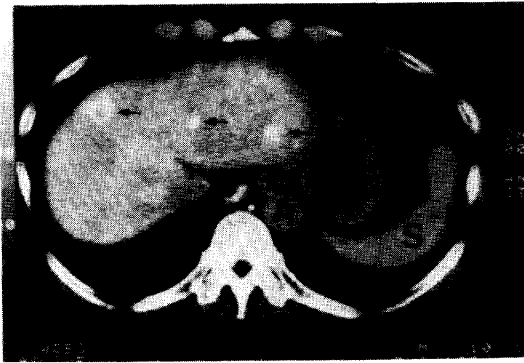


Fig. 1C. CTA imaging of the patient shown in Fig. 1B. Another small, 1 cm stain is observed in the left lateral lobe as well as the previously detected stains in the left median and anterior right lobes (arrows). A aorta, S spleen.

than 1 cm in diameter the masses were detected only by CTA (Table 2). The lesions were situated in the left lobe in 5 patients, and in the right lobe in 2 patients. The following two cases illustrate the usefulness of CTA.

In the first patient, a 57-year-old male (patient No. 2, Table 2) with liver cirrhosis, HCC was found in the right lobe by conventional arteriography in October 1981 (Fig. 1A). Resection (enucleation) of the mass was performed in November 1981. Histological analysis revealed a well differentiated hepatocellular carcinoma. Arteriography was performed in June 1982 to investigate the cause of elevated serum alphafetoprotein (700 ng/ml). A 0.8 cm mass was discovered in the left median lobe, suggestive of recurrent HCC (Fig. 1B). CTA revealed

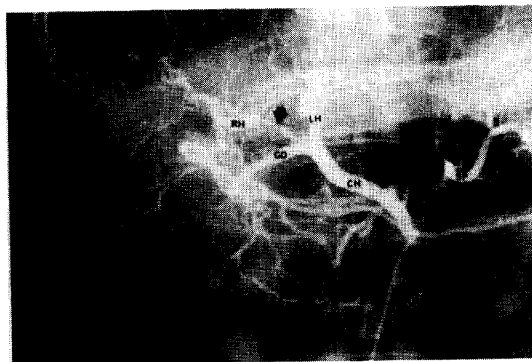


Fig. 2A. Selective common hepatic arteriography. Slight irregularities of the right hepatic arteries are observed in the lateral right portion (arrow heads). This pattern suggests recurrence of HCC, but definitive diagnosis is not possible. The arrow indicates narrowing of the right hepatic artery ligated during a previous HCC resection (47-year-old male). CH common hepatic artery; RH right hepatic artery; LH left hepatic artery; GD gastroduodenal artery, and SP splenic artery.

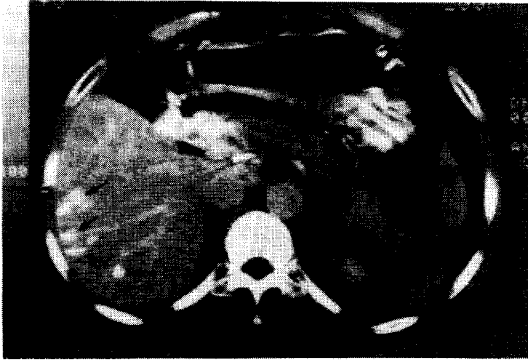


Fig. 2B. CTA imaging of the patient shown in Fig. 2A. Several small tumor stains approximately 1 cm in diameter, suggestive of HCC recurrence are observed in the posterior right lobe (arrows). These stains are consistent with the irregularities of right hepatic arteries seen in Fig. 2A.



Fig. 2C. A lower section seen by CTA (patient Fig. 2A). A small stain, 1 cm in diameter, is observed in the caudate lobe (arrow).

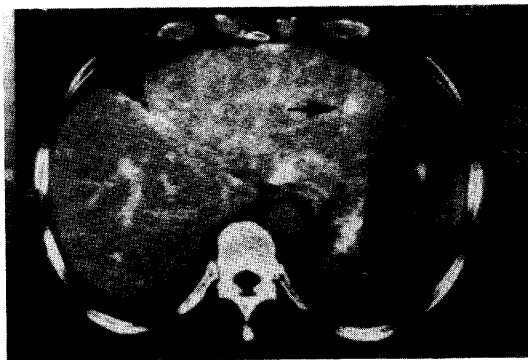


Fig. 2D. A cephalad section seen by CTA (patient Fig. 2A). A small stain, 1 cm in diameter, is observed in the left lateral lobe (arrow).

another small stain 1 cm in diameter in the left lateral lobe as well as the previously established tumor stains in the left median and anterior right lobes (Fig. 1C).

The second patient, a 47-year-old male (patient No. 6, Table 2), had an HCC tumor resected. Re-examination of superselective common hepatic arteriograms 8 months after the operation revealed slight irregularities in the right hepatic arteries of the lateral right lobe, but HCC recurrence was not defined (Fig. 2A). CTA performed at the same time demonstrated several hypervascular areas about 1 cm in diameter, suggestive of recurrence in the posterior right lobe (Fig. 2B). Furthermore, other lesions were visualized in the left median (Fig. 2C) and left lateral lobes (Fig. 2D). These 2 lesions had not been detected or suggested by conventional arteriography.

#### DISCUSSION

Detection of large HCC tumors is easily accomplished, but this is not the case, unfortunately, with small, silent tumors. The minimum detectable tumor size is reported to be 2-3 cm by radioisotopic scintigraphy (7, 8), 2 cm by US (9), 2 cm by CT (10, 11), and 1 cm by arteriography (12). HCC tumors of 2-3 cm in diameter are easily detected by superselective hepatic arteriography or infusion hepatic arteriography (13). However, HCC occasionally recurs after surgical resection of the seemingly solitary tumor nodule. The reasons that have been proposed to explain the high recurrence rate are incomplete resection, tumor cell dissemination during surgical manipulation and micrometastasis. In the present study, CTA revealed tumor masses as small as 0.5 cm in diameter, a size which is undetectable even by the most accurate infusion hepatic arteriography.

Conventional celiac or hepatic arteriography selectively visualize the right lobe, thus making small, left-situated HCC more difficult to detect. In fact, small HCC tumors are occasionally not visualized in the left lobe by conventional arteriography in spite of contrary evidence obtained by CT or US. CTA was found to detect small masses even in the left lobe. In the present study, 5 HCC lesions not visualized by arteriography were discovered by CTA in the left lobe (Table 2). Therefore, CTA is considered essential in the diagnosis of HCC located in the left lobe or in the hilar region.

Contrast enhanced CT (14) is necessary for the detection of HCC, as even large tumors occasionally have been overlooked because of isodensity with surrounding tissue (14, 15). Contrast enhancement by intravenous drip infusion of contrast medium is technically easy, but often fails to reveal small tumors because of negative enhancement. CT scanning after an intravenous bolus injection of medium (16, 17) reveals small HCC tumors; however whole liver scanning is prohibited by the large amounts (50-100 ml) of contrast medium necessary for each scan. CTA excels in the detection of small HCC tumors, revealing the masses with positive enhancement. Each cross section of the liver may be examined since a minimum of contrast medium (5-10 ml) is needed for each scan.



However, the catheter must be inserted into the common or proper hepatic artery in CTA to prevent spillage of the contrast medium into the splenic or left gastric arteries. This problem illustrated by the failure to detect a tumor by CTA subsequent to its demonstration by conventional arteriography (Table 1). Other known HCC lesions were clearly observed by CTA.

CTA is easily performed after routine selective hepatic arteriography. CTA is not necessary in cases presenting large non-resectable HCC ; in such situations the tumor is readily apparent by less invasive techniques. CTA is considered essential in cases of small, operable HCC tumors in order to establish the presence of small metastases.

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