

# Study of the Capability of Multislice CT to Diagnose Arterioportal Shunt in Hepatocellular Carcinoma

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**OBJECTIVE** This study was designed to evaluate the capability of multislice CT (MSCT) for the diagnosis of arterioportal shunt (APS) associated with hepatocellular carcinoma (HCC).

**METHODS** A total of 282 patients with HCC were examined by both enhanced thin slice MSCT scanning and digital subtraction angiography (DSA) in the early hepatic-arterial phase, late hepatic-arterial phase and portal-venous phase. The criteria for diagnosis of APS were: (1) Earlier enhancement or stronger opacification of the main portal trunk and/or the first order branches compared with that of the superior mesenteric vein or splenic vein; (2) Earlier enhancement or stronger opacification of the second order and smaller portal venous branches compared with that of the main portal trunk. The presence and degree of APS demonstrated with MSCT and DSA were analyzed by a double-blind method.

**RESULTS** In 282 HCC patients, 56 were complicated with APS. MSCT demonstrated central APS in 48 patients of which 41 had a severe, and 7 a moderate shunt. One revealed no APS by DSA due to a giant HCC focus. Among the 7 patients with mild peripheral APS, 2 lesions were not detected by DSA due to faint shunt, and one lesion in the patient with a mixed APS was detected by both MSCT and DSA.

**CONCLUSION** MSCT is a simple, effective and noninvasive new technique for the diagnosis of APS associated with HCC.

**KEYWORDS:** hepatocellular carcinoma, arterioportal shunt, angiography, tomography, X-ray computed.

**H**epatocellular carcinoma (HCC) easily invades the portal vein and then forms a hepatic arterioportal shunt (APS). An APS can cause portal hypertension and lead to splenomegaly, ascitic fluid, diarrhea and hemorrhage of the digestive tract and accelerate the dissemination and metastasis of the HCC. Transcatheter embolic therapy for APS can relieve the portal hypertension and improve its prognosis. Therefore, the diagnosis of APS is important for effective treatment of HCC. The gold standard for the diagnosis of HCC complicated with APS is hepatic transcatheter arteriography, including digital subtraction angiography (DSA), which is performed by intubation through the femoral artery, thus causing pain for the patients and also possible complications. We used multislice CT (MSCT) which has the advantages of quickness, convenience and noninvasion.<sup>[1]</sup> We compared that technique with DSA to evaluate the

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capability of MSCT for the diagnosis of APS associated with HCC.

## MATERIALS AND METHODS

### Materials

A total of 282 HCC patients were examined by MSCT and DSA, including 247 males and 35 females. Age of the patients ranged from 26 to 76 (mean of 48.8 years). Twenty-six cases were verified by biopsy and pathological examination. Diagnoses of 256 cases were conducted by characteristic radiologic appearance and the serum AFP level, all of which corresponded with UICC diagnostic criteria for HCC.

### Methods

A LightSpeed QX/i MSCT scanner (GE Co.) was utilized in our studies. Following plain scanning, the enhanced thin-slice MSCT scanning was performed in the early hepatic-arterial phase, late hepatic-arterial phase and portal-venous phase, with 2.5 mm slice thickness, delayed time 10~15 s, 20~25 s and 60~65 s, respectively. Contrast medium (ultravist 300 mg I/ml or Iopamiro, 300 mg I/ml), in a total dose of 80~100 ml was injected quickly via the antecubital vein at the rate of 3.0~3.5 ml/s. The scanning data of the early hepatic-arterial phase were retrospectively reconstructed by a 1.25 mm thickness and 0.3 mm gap, then the data were transmitted to an AW work-station through PACS and its post-processing was conducted for maximum intensity projection (MIP) and volume rendering (VR).

The DSA examination was performed by a DSA system (TOSHIBA Co.) and the Seldinger technique was executed to conduct the catheterization of the celiac artery or the selective hepatic artery. In a total of 30 ml, Ultravist, 300 mg I/ml or Iopamiro, 300 mg I/ml, was injected at the rate of 6.0 ml/s, and the hepatic-arterial, portal-venous and parenchymal phase films in the anterior-posterior position were taken. The time difference between the MSCT and DSA examinations was less than 2 weeks.

### The criteria for diagnosis of APS<sup>[2]</sup>

(1) Earlier enhancement or stronger opacification of the main portal trunk and/or the first order branches compared with that of the superior mesenteric vein or splenic vein; (2) Earlier enhancement or stronger opacification of the second order and smaller portal venous branches compared with that of the main portal trunk. The analysis of features included the presence of APS, position, type, degree and the presence of a cancer embolus. The results of APS revealed by MSCT and DSA were analysed and compared by a double-blind method which was conducted by 2 visiting doctors or staff radiologists who belonged to our digestive and interventional division.

### Types of APS<sup>[3]</sup>

(1) Central type: APS occurred in the porta hepatis and had development of the main portal trunk and (or) the first order branches in early hepatic-arterial phase. (2) Peripheral type: APS existed in the distal part of the hepatic lobes and had development of the second order of branches and smaller portal venous branches in the late hepatic-arterial phase, MSCT scanning of which exhibited transient patchy or wedge-shaped enhancement around the HCC foci. (3) Mixed type: It presented with the compound appearance of central and peripheral type.

### Classification of degrees of APS

(1) Severe: non-enhancement or early enhancement of HCC and APS developed in the main portal trunk and (or) the first order branches in the early hepatic-arterial phase. (2) Moderate: middle or late phase enhancement of HCC at the late hepatic-arterial phase, and APS had development of the main portal trunk and (or) the first order branches in the late hepatic arterial phase. (3) Mild: There were developments of the second order and smaller portal venous branches in the late hepatic-arterial phase and transient patchy or wedge-shaped enhancement around the HCC foci in MSCT scanning.

## RESULTS

Of the 282 cases of HCC, 56 were complicated with

APS. Among the 56 cases, DSA revealed a central APS in 47 cases, with 41 of the severe type and 6 moderate type. MSCT, MIP and VR detected APS in all of these cases. (Fig.1~3). There was another case of central APS in which use of DSA revealed no moderate APS in the back of the lesion due to the giant HCC focus, while its presence was clearly shown by MSCT. Five cases of mild peripheral APS were revealed by MSCT, but were not detected by DSA due to a faint shunt (Fig.4,5). One case of moderately mixed APS was detected by both DSA and MSCT (Table 1).

**Table 1. Presentation of APS by DSA and MSCT**

Methods	Shunt type			Shunt degree			Total (Case)
	Central	Peripheral	Mixed	Severe	Moderate	Mild	
DSA	47	5	1	41	7	5	53
MSCT	48	7	1	41	8	7	56

In this study, 32 cases of central APS had a portal cancer embolus, which included 18 cases in the main portal trunk and the first order branches, 11 cases in the first order branches of the right portal vein and 3 cases in the first order branches of the left portal vein.

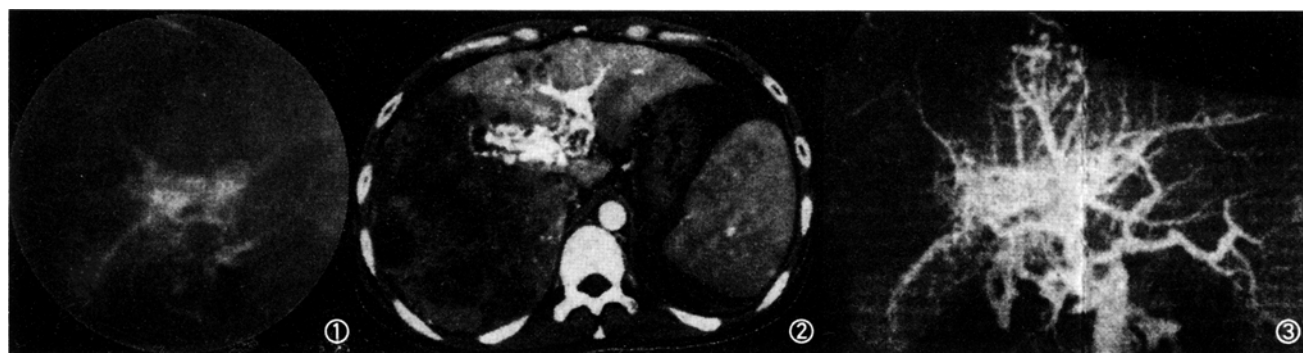
## DISCUSSION

Hepatic arteriography via a catheter (including DSA)

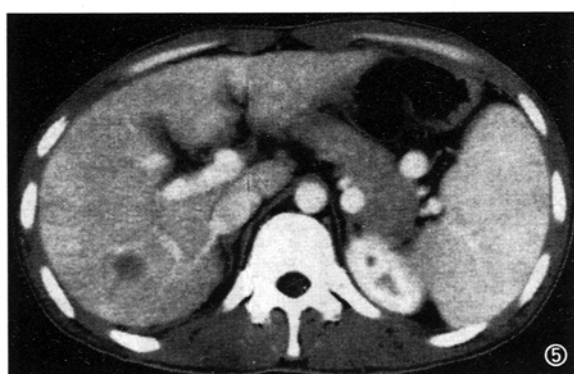
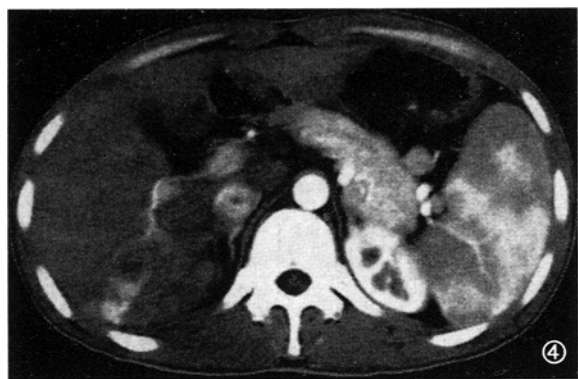
has been the paramount means for the diagnosis of HCC complicated with APS so it can demonstrate the site and degree of APS. However, it has some disadvantages as follows: (1) it requires intubation through the femoral artery, so it is an invasive examination and patients have some pain along with possible complications; (2) the examination might not be successful because the hepatic artery has many anatomic variations; (3) HCC located in the left external lobe would be missed due to the lesser development of the hepatic artery. Therefore, a good many patients with APS who cannot undergo hepatic arteriography via a catheter have a missed diagnosis and fail to receive proper therapy.

Itai et al.<sup>[4]</sup> made a comparative study using conventional CT and hepatic arteriography. They demonstrated that CT could detect 82% of the central APS diagnosed by catheterization and hepatic arteriography and 32% of peripheral APS which was shown as a transient wedge-shaped enhancement in the periphery of the HCC lesions. Chen et al.<sup>[2]</sup> reported on the capability of single-slice spiral CT for the diagnosis of APS, indicating that 2-phase enhanced scanning could thoroughly show the presence of central APS and the degree of shunt.

MSCT has a multidetector and therefore can collect data and produce multislice images at the same time, so that it enhances the scanning rate, improves the resolving power and quality of the images and keeps



**Fig. 1~3** Giant nodular HCC complicated with severe central APS. Early enhancement, dense development and cancer embolus in main portal trunk and the left and right first order portal venous branches in early hepatic-arterial phase revealed in DSA (Fig.1), MSCT (Fig.2) and MIP (Fig.3) respectively.



**Fig. 4,5** Nodular HCC concurrent with mild peripheral APS. MSCT revealed transient patchy enhancement around the HCC focus in late hepatic-arterial phase (Fig.4), and the image turned into isodensity in portal-venous phase.

the reconstruction of the isotropic image. MSCT scanning in the early hepatic-arterial phase, late hepatic-arterial phase and portal-venous phase can be completed with 1 injection of the contrast agent, so this reflects the hemodynamic change fully and can reconstruct MIP and VR and can produce results similar to CT angiography, and thus afford a convenient and non-traumatic examination for HCC apart from the complication with APS. In this study, MSCT demonstrated that not only 53 cases of APS revealed by DSA including 47 cases of moderate-severe central APS, 5 cases of mild peripheral APS and one case of moderate mixed APS, but also one case of moderate central APS in the back of a lesion which had a giant HCC focus and could not

be revealed by DSA. Furthermore 2 cases of mild peripheral APS which had a faint fistula were detected by MSCT but could not be revealed by DSA.

The present study demonstrated that by using MSCT it was not difficult to diagnose moderate-severe central APS associated with HCC by 3-phase enhanced thin-slice scanning, while the mild peripheral APS needed to be differentiated from the physiological [5] and pathological factors [6-9] which may lead to perfusion disorders of the liver parenchyma: (1) physiological factors: such as the variability of origin of the segmental or subsegmental hepatic artery, aberrant location of the cystic vein or gastric vein. All these factors may cause the increasing density of the local liver parenchyma in the hepatic arterial phase and have no effect in the portal venous phase. (2) pathological factors: a) cavernous hemangioma: It presented as a peripheral nodular enhancement which extended to the center and filled the lesion; its APS revealed a wedge-shaped, triangular and patchy well-distributed enhancement existing around the tumor in the hepatic arterial phase, isodensity or more in the portal venous phase with or without portal venous early development which often occurred especially in a quickly enhanced tumor. b) adenoma: often occurred in women of childbearing age and had a relationship with the use of oral contraceptives. MSCT revealed quick well-distributed enhancement and the following isodensity in the hepatic-arterial phase. c) focal nodular hyperplasia: was observed more in young females. MSCT revealed a well-distributed enhancement in most parts of the foci, and a widened and distorted supplying artery in the periphery or center and wheel-shaped scar tissue that presented with delayed enhancement in the center in some cases. d) hepatic cirrhosis: this kind of regional perfusional disorder appeared as the presence or absence of linear branches and intermediate to high density. e) the thrombosis of the portal vein: the perfusion disorder sites of which was consistent with the distribution of an involved portal vein. f) the metastatic tumor of the liver with enriched blood supply, hepatic infection, Budd-Chiari syndrome, postoperation of TIPPS, acute cystitis and pancreatitis. These disorders caused

aberrant perfusion and had corresponding MSCT showings. Thereby these disorders could be distinguished from mild peripheral APS of HCC by using clinical data.

The formation of APS caused certain difficulties and problems for the treatment of HCC such as chemotherapeutic agent by passing the tumor and embolic agent via the fistula leading to an ectopic embolism; however the embolic therapy was safe, effective and essential for increasing the survival period and improving the quality of life if the patients had a favorable liver function and general status. The rational therapeutic scheme was drafted on the premise of a careful understanding of the site and degree of APS, and the presence or absence of a cancer embolus and collateral circulation. In our study, under the direction of MSCT imaging, 49 patients received superselective hepatic intubation using a 4.0 F or 3.0 F catheter, and the complete embolism of APS was obtained by using the combined embolism of absolute alcohol and a spring coil. Therefore we controlled the development of hemorrhage of the upper digestive tract, ascites and obstinate diarrhea etc. in a timely manner and did not find a recurrence of APS by MSCT with follow-up.

In conclusion, the enhanced thin slice MSCT scanning in 3 phases can be used to diagnose APS not only for these revealed by DSA but also for these not revealed by DSA due to a giant HCC focus or a faint shunt. Furthermore employing MSCT can improve the safety and efficiency of embolic treatment. Therefore

our findings suggest that MSCT is a simple, effective and noninvasive innovative technique for the diagnosis of APS associated with HCC.

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