• BRIEF REPORTS •

Multidetector CT in evaluating blood supply of hepatocellular carcinoma after transcatheter arterial chemoembolization

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Abstract

AIM: To assess the value of multidetector-row computed tomography (MDCT) in choosing retreatment methods of hepatocellular carcinoma (HCC) through evaluating the blood supply of low-density area of HCC after transcatheter arterial chemoembolization (TACE).

METHODS: Thirty-two patients with HCC after TACE treatment were examined by plain scanning and hepatic multidetector-row CT. The location of low-density area on plain scanning and the enhancement patterns on dynamic contrast-enhanced scanning were observed. At the same time, three-dimensional CT (3D CT) models of the volume rendering, curved multiplanar reformations, surface shaded display and maximum intensity projection reconstruction of the hepatic artery and portal vein were performed in 6 cases.

RESULTS: In CT plain scanning data, low density areas of 32 cases of HCC after TACE treatment were divided into three types: peripheral, one-side-located and mixed types. In contrast-enhanced CT scans, the blood supply of low-density area was classified into four types: arterial blood supply (20 cases), portal blood supply (5 cases), arterial combined with portal blood supply (5 cases) and poor blood supply (2 cases). In 6 cases, the relationship between the low-density area and branches of hepatic artery as well as portal vein was shown by 3D CT.

CONCLUSION: Hepatic MDCT is an effective method for evaluating the blood supply of low-density area and therapeutic effect of HCC after TACE treatment. Types of blood supply is helpful for the selection of retreatment.

INTRODUCTION

Hepatocellular carcinoma (HCC) is one of the most common malignant neoplasms. In China, HCC was the second cancer killer in rural areas, and ranked the third in urban areas and 110 000 patients were killed annually, accounting for 40% of the HCC deaths in the world[1]. The majority of HCC patients are treated with palliative approaches because surgery is sometimes limited by poor liver function. Transcatheter arterial chemoembolization (TACE) has been one of the most common and effective palliative therapies[2-11]. To evaluate the blood supply types of the low-density area of HCC pretreated by TACE and to explore its value in selecting appropriate retreatment, we studied MDCT and 3D CT image characteristics of 32 HCC cases pretreated with TACE.

MATERIALS AND METHODS

Patients
From January to November 2003, 32 consecutive patients with HCC who underwent TACE (28 men and 4 women, age range 15-61 years, mean age 37 years) were enrolled into this study. The diagnosis of HCC was based on the results of percutaneous needle biopsy (n=13) and operation (n=2) or test of serum alpha-fetoprotein level in combination with imaging appearance and follow-up images (n=17) according to the diagnostic criteria for HCC formulated by Chinese National Association of Anticancer Committee (1990).

TACE
TACE procedure was performed as follows: the focal segmental or sub-segmental artery was detected carefully by celiac arteriography, and variants were excluded by superior mesenteric arteriography and phrenic arteriography. When the tip of the catheter arrived at the appropriate focal artery, one or two anticancer agents were injected, followed by 8-15 mL iodized oil (Huaihai Pharmaceutical Factory, Shanghai, China) injected under fluoroscopic monitoring. Some patients were embolized with a gelatin sponge (1 mm ×1 mm ×10 mm) at the same time. TACE procedures were performed followed by MDCT within 4 to 6 wk.

MDCT
MDCT was performed with an MDCT scanner after TACE within 4 to 6 wk (Sensation16, Siemens Medical System, Germany). Multidetector row helical technique was applied to the scanning in cranial to caudal direction. Plain scanning of the liver was carried out. Then, after injection of the contrast media for hepatic arterial phase and portal venous phase image acquisition, enhanced scanning of 1.5 mm axial section was performed at 25 and 60 s, respectively. A total of 100 mL contrast medium (Ultravist 300, Schering Pharmaceutical Ltd., Guangzhou, China) was administered to each patient at a rate of 3.0 mL/s through a catheter placed in the peripheral vein of the antecubital fossa. Three dimensional CT models including the volume rendering technique, multiplanar reconstruction, shaded surface display and maximum intensity projection of the hepatic artery and portal vein were simultaneously completed in 6 cases.

Diagnostic criteria for low-density area
Diagnostic criteria for low-density area were the CT of 30 to 50 HU on non-enhanced CT.

Determination of low-density area and blood supply types

According to the location in CT plain scan, low-density area was divided into three types. The peripheral low-density area was the viable area around the portion that retained iodized oil. The one-side-located type was determined by the low-density area located in any one side of the lipiodol area .The mixed low-density area showed both peripheral and one-side-located types in which the lipiodol retention in the tumor was heterogeneous.

According to the showing time of low-density area on enhanced CT at biphasic MDCT, blood supply of low-density area was divided into four types. The arterial blood supply of low-density area could be enhanced early during contrast administration (during the hepatic arterial-dominant phase, HAP) as a hyperattenuating or a mixed attenuating area against a background of slightly enhanced liver parenchyma before the liver enhanced substantially from the portal venous delivery of contrast material. Furthermore, the area must be hypoattenuating during the portal venous-dominant phase (PVP). In the same way, the portal blood supplying low-density area could be enhanced during PVP as a hyperattenuating or a mixed attenuating area but hypoattenuating during HAP. If the low-density area was enhanced during both PVP and HAP, the type of arterial combined with portal blood supply was determined. The poor blood supply was defined as non-enhanced on biphasic MDCT.

Image analysis

MDCT of all the patients was retrospectively and blindly reviewed by two experienced radiologists. Image analysis included the presence/absence and patterns of low-density area at non-enhanced examination. After these results were recorded, the HAP and PVP images were reviewed. Lesions were categorized as hyperattenuating or hypoattenuating relative to adjacent liver parenchyma. If lesions exhibited in both hyper- and hypo-attenuating areas, they were categorized as having mixed attenuation.

RESULTS

Appearances and patterns of low-density area

Thirty-two patients with low-density area after TACE were divided into three types: sixteen patients were peripheral type; 5 were one-side location type and 11 were mixed type.

Types of blood supply

The appearances of the low-density area at each phase of imaging are shown in Table 1. According to the appearance of low-density area at biphasic MDCT, the cases of arterial blood supply, portal blood supply, arterial combined with portal blood supply and poor blood supply were 20, 5, 5, 2, respectively.

Table 1 Appearance of low-density area at biphasic MDCT

Phase of imaging	Appearance at MDCT (cases)		
	Hyperattenuating	Hypoattenuating	Mixed attenuating
HAP	17	7	8
PVP	4	2 2	6

HAP: hepatic arterial-dominant phase; PVP: portal venous-dominant phase.

DISCUSSION

Although surgery remains the best treatment of HCC, it is unsuitable for most of the cases who would be better treated with interventional therapy. However, as the blood supply of HCC includes regular, variant, extrahepatic and collateral arterial blood supply, the portal vein is involved in some patients[12,13]. Furthermore, the development of compensatory circulation after the occlusion of hepatic artery and the changes of the portal venous blood supply to tumor after TACE, will both result in incomplete tumor necrosis or recurrence[14-18].

MDCT is a breakthrough in medical imaging examination technology. Equipped with a multidetector array, MDCT can perform multislice data acquisition simultaneously, which greatly reduces the time of volume scanning. Image quality is improved due to increased image resolution and clarity. MDCT could therefore provide a technique of thin-slice and dynamic enhancement scanning of liver at hepatic arterial phase and portal venous phase. In addition, multiplanar reformations, 3D renderings, and high-quality CT angiographic displays have opened a new vista in clinical applications. Its performance has been improved in several problem-solving tasks and become extremely valuable in image interpretation[19,20].

The portion of tumor that retains iodized oil is necrotic. Pathologic specimens and the necrosis rate measured from CT image showed a good correlation between the portion of tumor that retained iodized oil and the portion of tumor necrotized. Lipiodol-negative but hypodense areas examined by X-ray proved to be necrotic or fibrotic with or without viable tumor islands. HCC with heterogeneous lipiodol uptake tended to recur at the site adjacent to the original tumors more frequently than HCC with homogeneous lipiodol uptake[21-23]. HCC images that revealed a dense retention of lipiodol within the whole tumor or revealed no enhancement on contrast enhanced CT had a significantly higher necrotic rate. A lipiodol-negative but hypodense area with enhancement on dynamic MDCT was low-density area[24-26]. According to the location, we divided it into three types: peripheral, one-side-located and mixed type. According to the time of enhancement of low-density area at biphasic MDCT, blood supply in low-density area was divided into four types: arterial blood supply, portal blood supply, arterial combined with portal blood supply and poor blood supply. The portal venous blood supply was mainly of tumor periphery distribution. After treatment of TACE, the portal venous blood supply to tumor periphery increased significantly, and some did have signs of enriched blood supply around the tumor[17].

Evaluating the blood supply of low-density area with HCC after TACE has clinical significance in choosing the method and route of retreatment. When MDCT pictures revealed the patient of arterial blood supply type, repeated treatment with TACE was suggested. If it is necessary, subsegmental TACE should be performed because of its superior capability of achieving complete lipiodol accumulation. TACE showed a strong antitumor effect because of the overflow of excess iodized oil into the portal veins[3]. Therefore, when the low-density area had two blood supply routes of arterial and portal veins, repeated treatment with TACE was also suggested. As portal venous blood supply to the tumor was affected by TACE treatment in portal blood supply group, interventional therapy via portal vein should be reasonable. Percutaneous ethanol injection and other non-vascular interventional therapy could be considered when the low-density area revealed poor blood supply[27,28].

In short, MDCT plays important roles in evaluating the efficacy of chemoembolization. It is a practical, effective, and safe method for assessing the therapeutic effect of TACE. Evaluation of the blood supply of low-density area in MDCT is of practical significance for making retreatment plans.

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