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Dynamic CT of hepatic cirrhosis

Cirrhosis is characterisedby the presence of extensive fibrosis and innumerable regenerative nodules replacing the normal liver parenchyma. These features represent the final common pathway of chronic liver injury of many causes. The process is initiated by parenchymal necrosis, followed by connective tissue deposition, nodular hepatocytes regeneration, and distortion of the lobular and vascular hepatic architecture (1)

Patients with cirrhosis are at increased risk of the development of hepatocellular carcinoma. The cirrhotic liver, however, is more difficult to evaluate for a tumour than the normal liver. The presence of fibrosis, regenerating nodules, and parenchymal necrosis in the cirrhotic liver produce a heterogeneous parenchyma that makes detection of focal lesion more difficult(1, 2, 3, 4, 5, 6, 10).

Protocols for contrast enhanced hepatic CT have evolved along with advances in CT technology. With conventional scanning techniques, most current CT scanners can image the entire liver in 2-3 minutes. With continuous – acquisition helical CT technology, it is possible to scan the entire liver in 20-30 seconds. As a result, dynamic sequential scanning can be performed after contrast material injection during the hepatic arterial and portal venous phases of enhancement. Further research is needed to optimise the imaging protocols and clarify the role of arterial phase and portal venous phase in patients with cirrhosis (6, 7, 8, 9).

The purpose of this article is to present our study of the patterns of the time-density curves of the liver and the spleen in portal hypertension and liver cirrhosis, and evaluation of the liver structures with clinical and morphological pictures.

MATERIAL AND METHODS

Sequential computed tomography of the liver was performed in 23 patients (8 women and 15 men aged from 39 to 77 – mean 57) with histopathologic findings of hepatic cirrhosis. Dynamic enhancement in the liver was analysed during the nonequilibrium phase (30–150 s) and delayed equilibrium phase (2.5–7 min).

All CT scanning was performed with a Somatom DRH scanner (Siemens) by using a 2-second scanning time and a 6-second interscanning delay. Continuous 8 mm sections were obtained, beginning at the diaphragm. Scanning began 30-40 seconds after the start of administration of the intravenous contrast material bolus. Each patient received a different dose of contrast medium up to 125 ml of 60% uropolina.

Attenuation values of the liver and aorta were measured from a single precontrast scan obtained at the level of the main portal vein, by using a circular region of interest (ROI-2cm^2) cursor.Attenuation values of the liver and aorta were then obtained from scans obtained at 30, 39, 48, 57, 66, 75, 84, 93, 102, 111, 140, 170, 200 second after the start of the contrast medium bolus.

In the liver, ROIs were measured in three separate areas including both left and right lobes, and the results were average. Vessels were carefully excluded from the ROI measurements.

RESULTS

In our investigated group the peak CE (contrast enhancement) of both the liver and the spleen occurred significantly later, and average peak of CE of both the liver and the spleen was lower than in the control group .

Time-density curve of the spleen and the liver of all patients were devoid of a fast disposition phase. Time-density curve of the liver and the spleen were considerably flattened and the splenic curve resembled the liver curve by pattern. Only three splenic time-density curves appeared normal. All time-density curves of the liver cirrhosis were flattened of peak and were slow washout phase (Fig. 1). Moreover, time to peak to portal vein curves were longer and flattened.

Several other more non-specific signs of liver cirrhosis such as ascites (6), nodular liver surface (3), splenomegaly (7), enlarged left lobe of the liver (3), presence of neoplastic focus liver (3), presence of hepatic cyst (2), reduction of hepatic vascular markings (11) were present (Table 1).

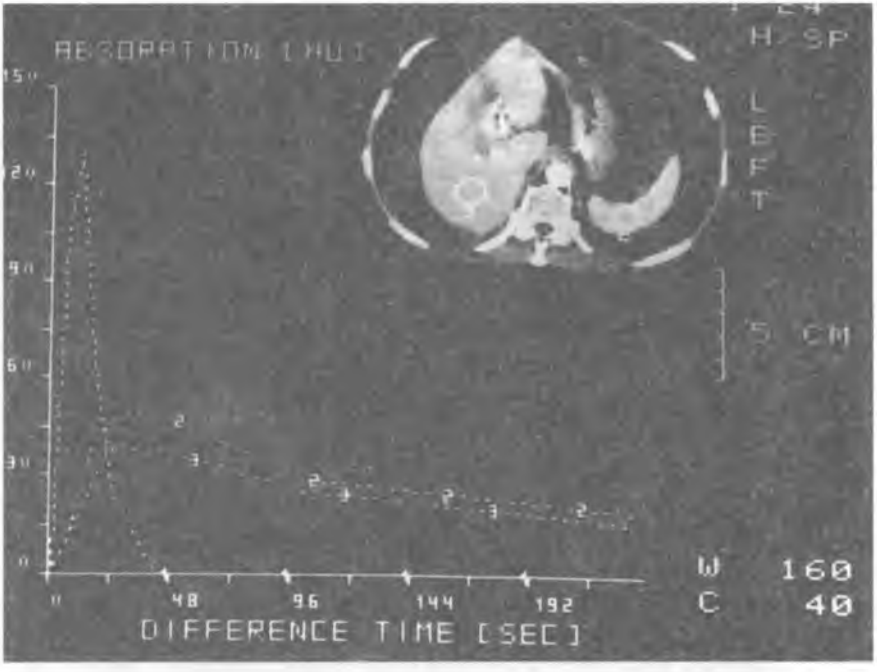

Fig. 1. Time-density curves of liver cirrhosis (3) and the spleen (2). Both curves are considerably flattened and the washout phase is slow

Table 1. CT picture of hepatic and spleen structures in patients with cirrhosis

Type of pathologic changes	Cirrhosis n = 23
Hepatomegaly	12 (52%)
Mean density of hepatic parenchyma	52 HU
Splenomegaly	19 (82%)
Reduction of hepatic vascular picture	19 (82%)
Nodular structure of liver	17 (74%)
Presence of hepatic cysts	2 (8%)
Ascites	5
Presence of neoplastic focus in liver	3 (13%)

DISCUSSION

The role of radiology in the evaluation of cirrhosis is primarily to characterise the morphologic manifestations of the disease, evaluate the hepatic and extrahepatic vasculature, assess the effects of portal hypertension, and detect hepatocellular cancer (1, 2).

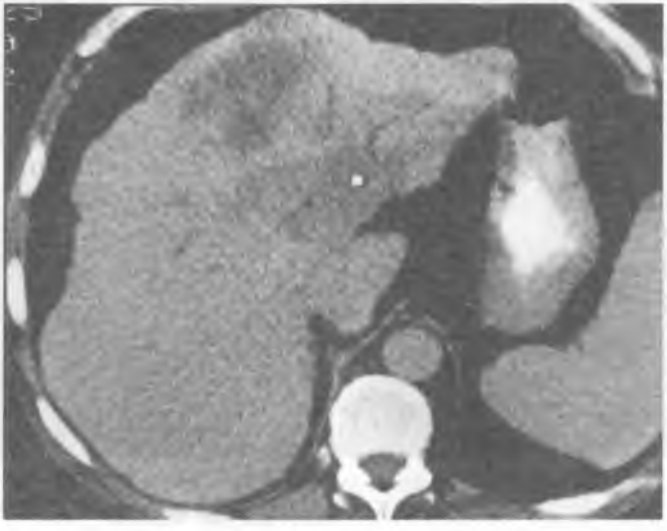

Fig. 2. Dynamic CT shows a large low attenuation hepatoma in liver cirrhosis

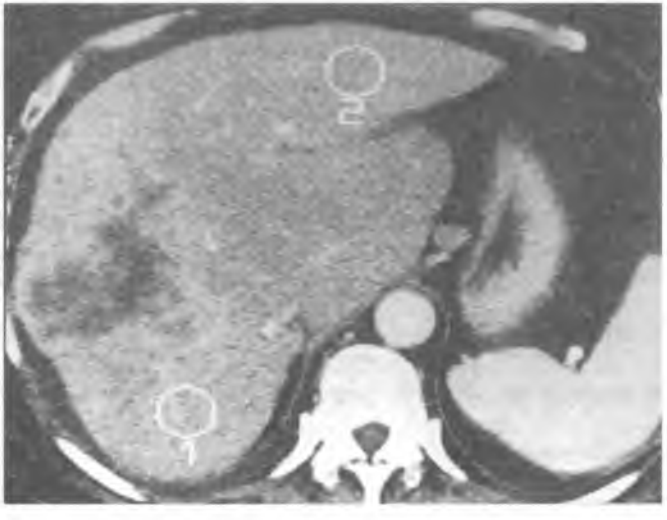

Fig. 3. Dynamic CT scan of the patient with cirrhosis and peripheral enhancing foci of tumour (hepatoma). Enlargement of the caudate lobe

The findings in computed tomography (CT) in cirrhosis are variable. In its early stages, the liver may appear normal. With progression of the disease, nodularity of the liver surface and generalised heterogeneity of the hepatic parenchyma are typically seen. Its advanced phase is characterised by the lobe and segment atrophy and high nodular irregularity of the surface and the whole liver contour, depending on the presence of the regenerative nodules, which was observed in 39% of the cases. In general, the density of the hepatic parenchyma is normal (12) – in our material – about 59 u.H. In 52% of the patients the hepatic diagnosis was made manifesting the normal parenchyma density, uneven nodular surface, enlargement of the left lobe and of the whole organ, splenomegaly (Fig. 4). The hepatic parenchyma in advanced disease often enhances heterogeneously after contrast material administration. Findings associated with portal hypertension, including ascites, splenomegaly and enlargement of the splenic and portal veins, are readily detected with CT. In patients with cirrhosis, decreased portal perfusion and increased hepatic arterial perfusion have been observed. Imaging contributes to the diagnosis and management of cirrhosis in several ways.

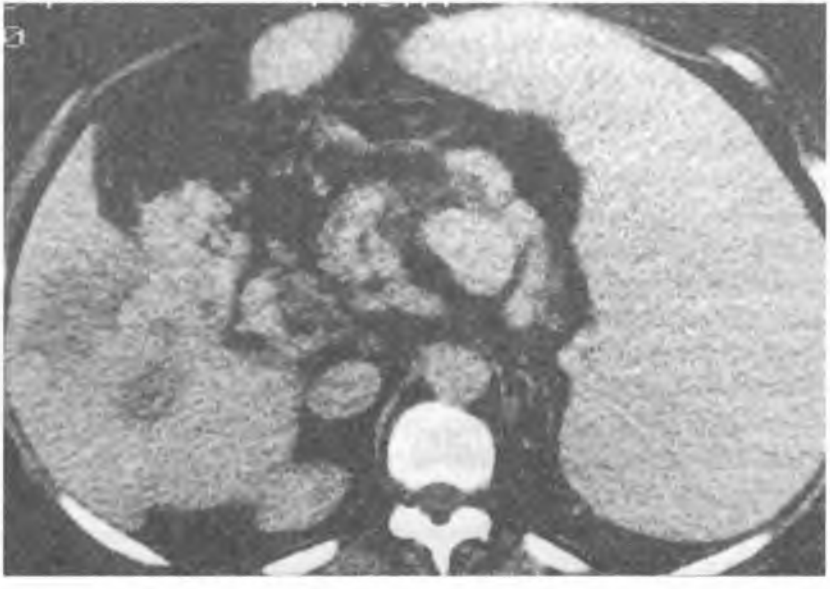

Fig. 4. Dynamic CT scan shows mildly heterogeneous enhancement in right hepatic lobe (hepatoma). Splenomegaly

Dynamic CT scanning is commonly used to diagnose the focal liver lesion, but the diagnosis in diffuse parenchymal liver diseases has gained little attention. Few authors have described the time-density curves of the normal liver after intravenous bolus injection of contrast medium, and compared them to the curves of liver cirrhosis. Sugano et al. (9) estimated pharmacokinetics of contrast media in the liver in healthy controls, in

patients with chronic viral hepatitis, posthepatitis liver cirrhosis and alcoholic liver cirrhosis. The time of peak enhancement (the time interval between peak of aortic and the liver enhancement) was significantly different between each group. Alcoholic liver cirrhosis was the most prolonged , followed by posthepatic liver cirrhosis, chronic viral hepatitis, and finally controls. The decay time (the time from peak enhancement of the liver to the curve's centre of gravity) was also significantly different: alcoholic liver fibrosis was the longest, followed by posthepatic liver cirrhosis, chronic viral hepatitis, and then the controls.

The comparison of the values of the different curves of the liver, the spleen, and portal vein show significantly lower and delayed peaks in patients with cirrhosis than in normal people according to Kurtz et al. (5)

In the study of Partanen (7) time-density curves of the liver and spleen from dynamic CT scans, performed in 10 patients with liver cirrhosis and 15 patients with fatty liver, were compared with 41 normal cases. In liver cirrhosis the peak contrast enhancement of both the liver and spleen was lower and delayed, and washout phases were slower. Our results were similar. Peak contrast enhancement of both the liver and spleen occurred significantly later, and the average peak of the contrast enhancement of both liver and spleen was lower than in the normal group. Moreover, time to peak to portal vein curves were longer and flattened. The mean time-density curve of the liver in all patients with cirrhosis was devoid of a fast deposition phase. According to the results of the present study, patterns of the time-density curves may contain diagnostic information despite the wide variations in individual hepatic and splenic contrast enhancement values. Dynamic CT can be helpful if liver cirrhosis is suspected clinically, but the liver biopsy is contraindicated because of coagulopathy. Our results indicate that the patterns of the time-density curves of the liver and spleen, may contain diagnostic information useful for prophylactic monitoring of neoplastic lesions, which develop in hepatic cirrhosis (Figs 2, 3, 4).

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SUMMARY

The aim of this research was the estimation of the dynamic sequential CT scanning(d-CT) method of the cirrhotic liver. The examined group consisted of 23 patients (8 women and 15 men, average age – 57) histopathologically diagnosed as the cirrhotic liver. Dynamic CT scanning was performed 30-40 seconds after contrast material injection administered with an automatic syringe in the amount of 125 ml at flow time 2-3 ml/s. After the administration of contrast material the measurements of the hepatic parenchyma density were taken both in the left and right lobes. Time-density curves of the liver, spleen and portal vein were drawn for each patient. The curves of the liver and spleen of cirrhotic liver patients were not different from the curves obtained due to examining people with no medical problems. The time of peak enhancement of the liver and spleen of cirrhotic liver patients was delayed compared with control group. Time-density curves of the liver and spleen were considerably flattened of peak and were slow and longer in washout phase. Moreover, the time of peak enhancement of the portal vein curves was longer and the curves were flattened. Three cirrhotic liver patients had focal neoplastic lesion. The patterns of the time-density curves of the liver in dynamic CT scanning may contain diagnostic information useful for prophylactic monitoring of the neoplastic lesion, which develops in hepatic cirrhosis.

Dynamiczna tomografia komputerowa w marskości wątroby

Celem pracy była ocena wartości metody dynamicznej tomografii komputerowej (d-TK) w marskości wątroby. Grupę badaną stanowiło 23 pacjentów (8 kobiet i 15 mężczyzn, średni wiek 57 lat) z histopatologicznym rozpoznaniem marskości wątroby, u których wykonano d-TK wątroby. Środek cieniujący podawano strzykawką automatyczną w ilości 125 ml z czasem przepływu 2-3 ml/s i czasem opóźnienia skaningu 30-40s. Pomiary gęstości miąższu wątroby po podaniu środka cieniującego wykonywano w lewym oraz prawym płacie wątroby. Dla każdego pacjenta została wykreślona krzywa koncentracji środka cieniującego wątroby, śledziony i żyły wrotnej. U pacjentów z marskością wątroby krzywe koncentracji środka cieniującego wątroby i śledziony nie różniły się od wykonanych u osób zdrowych co do charakteru krzywej. W marskości wątroby w badaniu d-TK szczyt kontrastowego wzmocnienia w wątrobie i śledzionie następował później niż w grupie kontrolnej. Szczyt krzywej śledziony i wątroby był wyraźnie spłaszczony, a faza opadania środka cieniującego wolniejsza i wydłużona. Podobnie czas do szczytu krzywej kontrastowego wzmocnienia w żyle wrotnej był wydłużony i płaski. U 3 pacjentów z marskością wątroby stwierdzono obecność ogniska nowotworowego w wątrobie. D-TK poprzez wykreślone krzywe koncentracji środka cieniującego w wątrobie może stanowić ważny czynnik diagnostyczno-prognostyczny, ukierunkowany na profilaktykę raka wątrobowo-komórkowego współistniejącego w marskiej wątrobie.