Diagnosis of Diffuse Hepatocellular Diseases Using SPECT

Takao Kodama, Katsushi Watanabe, Hiroaki Hoshi, Seishi Jinnouchi, Keiko Arakawa, Sizuo Kusumoto, and Hiroshi Honda

Department of Radiology, Miyazaki Medical College, Miyazaki, Japan

In the scintigraphic diagnosis of diffuse hepatocellular diseases, increased splenic uptake of colloids and splenomegaly are helpful signs. To quantify these patterns, the volume and activity of liver and spleen were measured by using single photon emission computed tomography (SPECT). The spleen-to-liver (S/L) ratios in volume and activity that were calculated from SPECT images were estimated in normal individuals and in patients with diffuse hepatocellular diseases. The maximum normal limits of S/L ratios of volume, activity, and activity/volume were predicted as 0.19, 0.087, and 0.72 (mean ± 2 s.d.). Twenty-two of twenty-three patients (96%) with liver cirrhosis had at least two elevated S/L ratios, and three elevated S/L ratios could clearly differentiate the patient with liver cirrhosis from normal individuals. On the other hand, only six patients (32%) with chronic hepatitis had elevation of any S/L ratio. Abnormal S/L ratios of activity/volume in the range from 0.72 to 1.05 were not obvious on planar or SPECT images.

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Single photon emission computed tomography (SPECT) in liver scintigraphy is used chiefly for detecting space-occupying lesions (*1,2*). Liver scintigraphy with radioactive colloids, on the other hand, is widely used for evaluating hepatic configuration and function as well. Many studies have reported the significance of liver scintigraphy in the diagnosis of diffuse hepatocellular diseases such as cirrhosis, fatty metamorphoses, and hepatitis (*3–7*). Decrease of hepatic uptake and increase of splenic uptake in these diseases have been noted (*8–10*), which seem to reflect the impairment of hepatic function.

An attempt was made to quantify the change of distribution of radiocolloid on the basis of the volume and activity of the liver and spleen, that were measured using SPECT liver scintigraphy. The purpose of this study is to evaluate the diagnostic significance of this method in diffuse hepatocellular disease.

MATERIALS AND METHODS

SPECT of the liver and spleen was carried out in 22 normal individuals and 46 patients with diffuse hepatocellular disease (liver cirrhosis, 23; chronic hepatitis, 19; fatty metamorphosis, 3; others, 1). All 46 patients had liver biopsy performed. Normal subjects did not have liver biopsy performed. They had no clinical, biochemic, or scintigraphic evidence of liver disease, and most were referred for metastatic evaluation.

Each subject was given 6 mCi (222 MBq) of technetium-99m phytate ~20 min before imaging began. A scintillation camera with large field-of-view* and low-energy, general purpose collimator was used for the study. Data for SPECT were collected and analyzed on a Gamma 11 System (DEC). During data collection, a gamma camera was rotated through 360° with 5.6° increment (64 projections). The data collection time for each projection was 10 sec.

To calculate the volume and activity of liver and spleen, transaxial views were reconstructed with pixel size of 0.6 × 0.6 cm. For image display, background activity was cut off by setting the 35% threshold of the maximum activity area in the liver image that had been confirmed to be the most suitable value for calculating the volume in the previous experimental study using phantoms (*11*). The volume of the liver and spleen was derived by the summation of the volumes of each slice, that were calculated from the number of the voxels (0.6 × 0.6 × 0.6 cm) in a region of interest (ROI) outlining the organ image on each tomographic slice.

The total activity of liver and spleen was obtained by

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For reprints contact: Takao Kodama, MD, Dept. of Radiology, Miyazaki Medical College, Miyazaki 889-16, Japan.

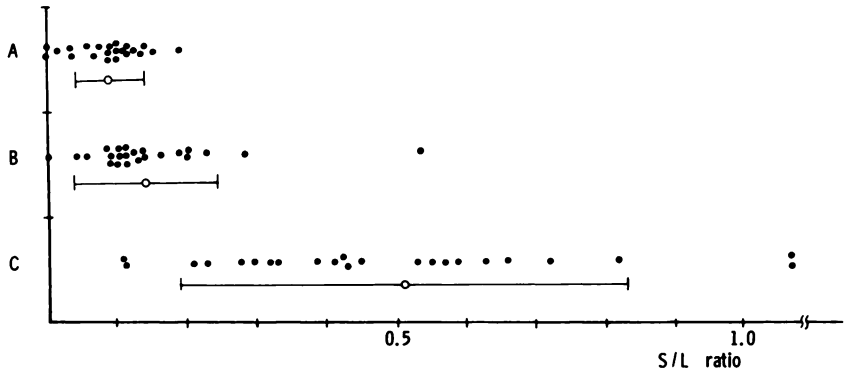

FIGURE 1
Distribution of S/L ratios of volume. A: Normal liver. B: Diffuse hepatic disease other than cirrhosis. C: Liver cirrhosis

summing the total counts in the ROI of each slice. The activity per unit volume of the organ (activity/volume) was obtained by dividing the total activity by the volume.

In addition to S/L ratios, planar and SPECT images were interpreted with respect to other characteristics: (a) hepatomegaly, (b) splenomegaly, (c) bone-marrow colloid uptake, (d) nonhomogeneous colloid distribution, and (e) increased splenic uptake (quantitative evaluation).

RESULTS

S/L ratios of volume in normal individuals and patients with diffuse hepatocellular disease are shown in Fig. 1. The mean S/L ratio in normal individuals was 0.089 with an s.d. of 0.049. In the patients with liver cirrhosis, S/L ratios of volume (0.51 ± 0.32) were significantly high compared with those in normal individuals ($p < 0.001$) and patients with other diffuse hepatocellular disease ($p < 0.001$). This difference seemed to be due to decreased hepatic volume and increased splenic volume in patients with cirrhosis. S/L ratios of volumes in the patient with hepatocellular disease other than cirrhoses were not clearly distinguished from those in normal individuals.

S/L ratios of activity and activity/volume of the organ are showed in Figs. 2 and 3. In normal individuals, the mean S/L ratio of activity was 0.037 ± 0.025, and that of activity/volume was 0.37 ± 0.18. In the patients with liver cirrhosis, S/L ratios of activity (0.63 ± 0.44) and activity/volume (1.24 ± 0.52) were significantly high compared with those in normal individuals ($p < 0.001$) and in patients with other hepatocellular disease ($p < 0.001$). In the patients with diffuse liver disease other than cirrhosis, S/L ratios of activity and activity/volume were not so clearly distinguished from those in normal individuals.

The maximum normal limits of S/L ratio of volume, activity, and activity/volume were predicted as 0.19, 0.087, and 0.72 (mean ± 2 s.d.). In normal individuals, no cases had any elevated S/L ratio. In Table 1, the ability of differential diagnosis based on the three S/L ratios in diffuse hepatic disease are listed.

The elevated S/L ratio of volume was observed in 59% (27/46) in the patients with diffuse hepatic disease (cirrhosis, 91%; chronic hepatitis, 32%; others, 0%).

Twenty-nine patients (63%) with diffuse hepatic disease had elevated S/L ratio of activity, which consisted of 96% cirrhosis, 26% chronic hepatitis and 66% fatty metamorphosis. The S/L ratio of activity/volume was elevated in 57% (26/46) of those patients, which consisted of 87% cirrhosis, 21% chronic hepatitis and 66% fatty metamorphosis.

In the patients with liver cirrhosis, 22 (96%) had elevation of any two S/L ratios, and 19 (83%) had three elevated S/L ratios. Six patients (32%) with chronic hepatitis were found to have elevation of any S/L ratio, and only four patients (21%) had elevation of all three S/L ratios. Elevated S/L ratios of activity and activity/

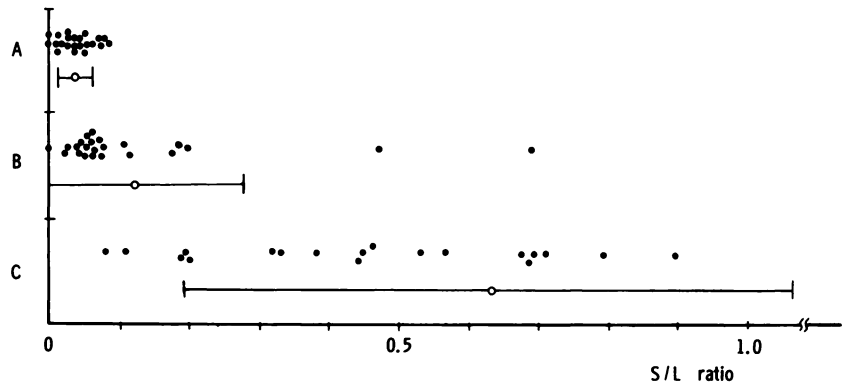

FIGURE 2
Distribution of S/L ratios of activity. A: Normal liver. B: Diffuse hepatic disease other than cirrhosis. C: Liver cirrhosis

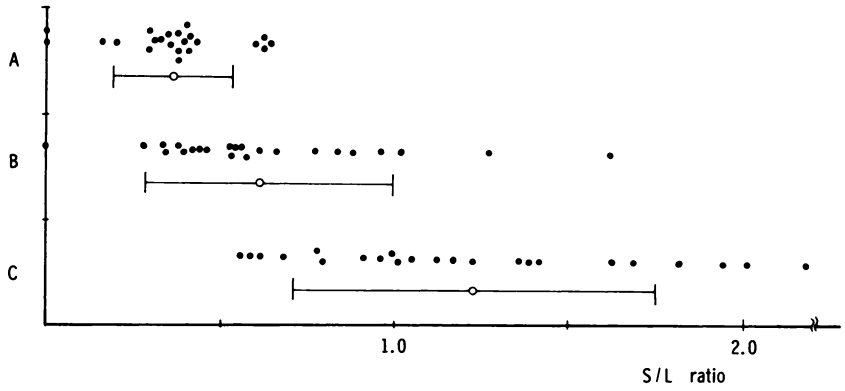

FIGURE 3
Distribution of S/L ratios of activity/volume. A: Normal liver. B: Diffuse hepatic disease other than cirrhosis. C: Liver cirrhosis. ⊢○⊣ = Mean ± s.d.

volume were recognized in two patients with fatty metamorphosis.

The evaluation of planar and SPECT images in the patients with diffuse hepatocellular disease are shown in Table 2. Nonhomogeneous colloid distribution was the most sensitive image findings. In liver cirrhosis, our three S/L ratios had similar sensitivities. In nine patients, relative splenic uptakes were not visually increased, but S/L ratios of activity/volume were elevated (in the range from 0.72 to 1.05).

DISCUSSION

In patients with diffuse hepatocellular disease, splenomegaly and increased splenic uptake of colloids in liver scintigraphy has been noted. In 1979, Kan et al. (*12*) reported the method for measurement of liver volume by using SPECT. Using the same method, volume, activity, and activity/volume of the liver and spleen were measured. We attempted to quantify the increased splenic uptake of colloids in diffuse hepatocellular disease.

Eddleston et al. (*13*) compared peak spleen activity with peak liver activity, and determined the normal range from 0 to 35%. They measured the activity of the spleen from the peak activity and the length of the spleen, and found a close relationship between the activity and esophageal varices. Gourgoutis et al. (*14*), measured S/L ratio of peak activity and found the correlation between S/L ratio and wedged hepatic venous pressure. Wasnich et al. (*15*) attempted a simple computer quantitation that compared activity in the spleen to those in the right lobe of liver, and determined the normal range of 0.37 to 1.17. S/L ratios using our method seemed to be determined more correctly.

In our study, the maximum normal limits of S/L ratios of volume, activity and activity/volume were 0.19, 0.087, and 0.72. There were some problems, however, in establishing the normal ranges because the number of normal individuals was small.

In the patients with liver cirrhosis, 22 patients (96%) had at least two S/L ratios elevated and 19 patients (83%) had at least three S/L ratios elevated. The patients with liver cirrhosis were clearly distinguished from normal individuals by these three S/L ratios. Some previous reports suggested the correlation between increased splenic uptake and degree of portal hypertension (*13,14,16*). The detailed mechanism of increased splenic uptake remains unclear. As a reduction in the number of Kupffer cells or in their phagocytic activity is considered unlikely (*17*), the increased splenic uptake may be attributed to intrahepatic portasystemic shunt (*3,18*).

In the patients with chronic hepatitis, the sensitivity of three S/L ratios was not so high (32%). Wasnich et al. (*13*) found elevated S/L ratios of activity in 43% patients with chronic hepatitis, and Geslien et al. (*4*) reported that an abnormal S/L ratio was found in 22% of patients with chronic hepatitis.

Wasnich et al. (*13*) suggested that the determination of S/L ratio improves the sensitivity of liver scintigra-

TABLE 1
Sensitivity of Three S/L Ratios in Diffuse Hepatocellular Diseases

Item	No. of cases	Elevated S/L ratio			Elevation of any S/L ratio	Elevation of any two S/L ratios	Elevation of all three S/L ratios
		Volume	Activity	Activity/volume			
Liver cirrhosis	23	21 (91%)	22 (96%)	20 (87%)	22 (96%)	22 (96%)	19 (83%)
Chronic hepatitis	19	6 (32%)	5(26%)	4 (21%)	6 (32%)	5 (26%)	4 (21%)
Fatty metamorphosis	3	0	2	2	2	2	0
Other	1	0	0	0	0	0	0
Total	46	27 (59%)	29 (63%)	26 (57%)	30 (65%)	29 (63%)	23 (50%)

TABLE 2
Evaluation of Planar and SPECT Images in Diffuse Hepatocellular Disease

Item	No. of cases	Hepatomegaly	Splenomegaly	Bone-marrow colloid uptake	Nonhomogenous distribution	Increased splenic uptake
Liver cirrhosis	23	4 (22%)	19 (83%)	14 (61%)	22 (96%)	15 (65%)
Chronic hepatitis	19	6 (32%)	7 (37%)	2 (11%)	10 (53%)	2 (11%)
Fatty metamorphosis	3	1	0	0	2	0
Other	1	0	0	0	0	0
Total	46	11 (24%)	25 (54%)	16 (35%)	34 (74%)	17 (37%)

phy for diffuse hepatocellular disease. In our study, three abnormal S/L ratios seemed to be very sensitive in liver cirrhosis and abnormal S/L ratios of activity/volume in the range from 0.72 to 1.05 were not visually obvious in planar and SPECT images. Therefore, the use of SPECT S/L ratios may improve the overall sensitivity of liver scintigraphy in the diagnosis of diffuse hepatic disease by liver scintigraphy.

FOOTNOTE

*General Electric, Milwaukee, WI (MaxiCamera 400T).

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