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Sonographic and clinical features of collateral vessels at the splenic hilum in cirrhosis

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AIM: To examine the sonographic features of shunt vessels derived from the splenic vein at splenic hilum (SS), and explore the relationship between the SS pattern and clinical presentations.

MATERIALS AND METHODS: This prospective study in cirrhotic patients consisted of study I ($n = 15$), which compared the anatomical features of SS at ultrasonography versus angiography, and study II ($n = 233$), which examined the incidence/haemodynamics of SS and SS-related presentations.

RESULTS: Study I showed that SS1 (running toward the upper pole of the spleen) corresponded to short gastric veins, and SS2 (running toward the lower pole of the spleen) corresponded to splenorenal/retroperitoneal shunts. In study II, SS were detected in 47.6% of patients (111/233), SS1 in 77.5% (86/111), SS2 in 17.1% (19/111), and SS3 (both SS1 and SS2) in 5.4% (6/111). The incidence of gastric cardia varices was significantly higher in patients with SS2 (6/19) than in those with SS1 (8/86, $p = 0.0097$), whereas the incidence of gastric fundal varices was significantly higher in patients with SS1 (44/86) than in those with SS2 (1/19, $p = 0.00025$) or SS3 (0/6, $p = 0.015$). There was no difference in the incidence of oesophageal varices among the three SS groups. The Child–Pugh score and grade of ascites was significantly worse in patients with SS3 than in those with SS1 ($p < 0.0001$, $p = 0.0009$). Hepatic encephalopathy grade was significantly worse in patients with SS2 ($p = 0.0047$) or SS3 ($p < 0.0001$) compared to SS1.

CONCLUSION: The SS pattern facilitates estimation of the possible manifestations, indicating the direction of clinical management of cirrhosis patients. Potential poor liver function is noted in patients with SS3.

Introduction

Portal hypertension is characterized by both increased portal inflow and increased outflow resistance.[1] Consequently, increased portal blood pressure may promote the development of collateral vessels, which contribute to the diversion of blood away from the liver. In fact, previous studies have shown the relationship between portal blood pressure and haemodynamic abnormalities, with 10 mmHg being the minimum threshold level of the hepatic venous pressure gradient (HVPG) associated with the development of oesophageal varices.[2,3] There are various types of shunt vessels, and their development patterns and location may be related to the clinical presentation of portal hypertension; for example, left gastric vein collaterals are associated

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with oesophageal varices, and posterior/short gastric vein collaterals are associated with gastric varices.[4,5]

Ultrasonography (US) is a simple, non-invasive imaging method with improved spatial resolution made possible by the recent development of digital technology.[6] Doppler US with pulsed and/or colour modes can be used to evaluate real-time portal haemodynamics.[7] It is known that various collateral vessels develop at the splenic hilum, short gastric veins, splenorenal shunt, and retroperitoneal shunt,[8] and US may be the preferred tool used to image these vessels because the spleen acts as an effective acoustic window. A previous study reported a close relationship between the development of short gastric vein and gastric fundal varices.[9] However, in general, the relationships between the patterns of shunt vessels derived from the splenic vein at the splenic hilum (splenic shunt, SS) and clinical features, including portal haemodynamics, have not been described comprehensively. In addition, the sonographic features of these shunt vessels in relation to their angiographic appearance have not been well examined.

The aims of the present study were to determine the sonographic features of SS, compared to angiographic findings, and to elucidate the effect of SS on portal haemodynamics and clinical presentation.

Materials and methods

Study design

This prospective study comprised two parts, studies I and II, and was approval by the ethics committee of Chiba University Hospital. Informed written consent was obtained from all participants. Study I was performed from April 2007 through March 2009 to compare the imaging features of SS revealed by sonography versus angiography. The inclusion criteria specified cirrhotic patients with portal hypertension who underwent both US and percutaneous transhepatic portography (PTP). The indication for PTP was the need for evaluation of portal haemodynamics in patients with gastro-oesophageal varices or hepatic encephalopathy due to portosystemic shunt. However, patients with the following conditions were excluded from the study I: (1) ascites, portal vein thrombosis, or hepatocellular carcinoma; (2) previous allergic reaction to iodinated contrast media; (3) severe impaired coagulation (platelet count $<$50,000/μl or prothrombin time $<$40%); (4) impaired renal function (serum creatinine level $>$1.2 mg/dl); (5) severe cardiac insufficiency; (6) pregnancy; or (7) age younger than 18 years, or older than 80 years.

Study II was performed from April 2009 through May 2012 to examine the incidence, haemodynamics, and clinical features of SS in cirrhotic patients. The inclusion criterion specified cirrhotic patients with portal hypertension who underwent both Doppler US and endoscopy within a 1 month interval between these two examinations. The diagnosis of cirrhosis in both study I and study II was based on both imaging and biochemical findings. The grade of hepatic encephalopathy was assessed using the West Haven criteria,[10] and grade II or more was determined as overt hepatic encephalopathy.

US

US was performed using SSA-770A or 790A (Toshiba, Tokyo, Japan) with a 3.75 MHz convex probe. All examinations were performed with patients in the supine position after fasting for 4 h or more.

Among various shunt vessels that could be observed in cirrhosis patients (Fig 1), SS was documented using a left intercostal or subcostal scan, and shunt vessel patterns were defined as follows: SS1 encompassed vessels running toward the upper pole of the spleen, and SS2 encompassed vessels running toward the lower pole, both along the spleen. A pattern showing both SS1 and SS2 was defined as SS3. Blood flow was measured with the sampling width corresponding to the diameter of the vessel and at an angle of $<60^{\circ}$ between the US beam and the vessel.[11] The data used for analysis were the average values, calculated using measurements taken two times or more. Spleen size (mm^2) was determined by multiplying the distance from the splenic hilum to the caudal polar angle measured by two intersecting lines. The upper limit of the normal subject used in the study was 2000 mm^2, according to the literature.[12] The grade of ascites was determined according to the clinical and US findings: mild (+) for ascites only detectable by US examination and moderate (++) to severe (+++) for ascites causing abdominal distension. All of the US examinations were performed by H.M. or M.T., who each had $>$8 years of experience.

Endoscopy

In study II, endoscopy of the upper gastrointestinal tract was performed using the GIF Q240 or Q260 (Olympus). The classification of the General Rules for Recording Endoscopic Findings set by the Japan Research Society for Portal Hypertension was followed for grading endoscopic findings of oesophageal varices: F1 (small), F2 (medium), and F3 (large).[13] All endoscopic procedures were performed by H.M., T.K, or M.T.

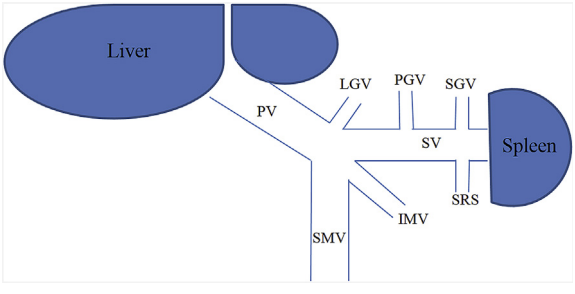

Figure 1 Diagram of the common patterns of shunt vessels. The image shows the representative appearance of five shunt vessels, LGV, PGV, SGV, SRS, and IMV. PV, portal vein; SV, splenic vein; SMV, superior mesenteric vein; LGV, left gastric vein; SGV, short gastric vein; PGV, posterior gastric vein; SRS, splenorenal shunt; IMV, inferior mesenteric vein.