Hemodynamic Features of Gastrorenal Shunt:

A Doppler Study in Cirrhotic Patients with Gastric Fundal Varices[1]

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Rationale and Objectives. Little is known about the hemodynamics of gastrorenal shunt (GRS), a major drainage route of gastric fundal varices (FV), in patients with FV. The aim of this study was to clarify the hemodynamic features of GRS on Doppler sonography in relation to the grading and bleeding of FV.

Materials and Methods. The study subjects consisted of 69 cirrhotic patients with FV. Diameter, flow velocity (FVe), and flow volume (FVo) of GRS were measured by Doppler ultrasound (US). The detection rate was compared to contrast-enhanced computed tomography (CECT), and percutaneous transhepatic portography (PTP) was used in six patients without GRS on CECT.

Results. The use of CECT detected GRS in 60 of 69 patients, and US, 58 of 69 patients. A false-negative result for detecting GRS on both CECT and US was found in one patient after PTP. The diameter, FVe, and FVo of GRS increased according to the endoscopic grade of FV: F1 (7.2 ± 1.3 mm, 9.8 ± 1.1 cm/s, 358.3 ± 123.4 ml/min), F2 (9.9 ± 3.3 mm, 12.8 ± 5.1 cm/s, 701.7 ± 411.3 ml/min), and F3 (11.8 ± 2.4 mm, 17.9 ± 8.3 cm/s, 1706.6 ± 989.5 ml/min). A significant difference was seen between F1 and F3 (diameter, $P = .0022$; FVe, $P = .0133$; FVo, $P = .0007$) and between F2 and F3 (FVe, $P = .0112$; FVo, $P < .0001$). FVe of GRS was significantly higher in bleeders (16.7 ± 8.1 cm/s) than in nonbleeders (12.2 ± 5.4 cm/s, $P = .017$), whereas the diameter and FVo were not significant.

Conclusion. Hemodynamics of GRS on Doppler sonograms reflected the grading and bleeding of FV. Doppler US may be valuable as a noninvasive method to evaluate the severity of FV.

Key Words. Gastric varices; portal hypertension; Doppler ultrasound; gastrorenal shunt.

Gastric fundal varices (FV) are known to be a considerable complication in patients with portal hypertension (1,2). Although the rates of bleeding for FV have been reported to be lower than those for esophageal varices (EV), rupture from FV sometimes results in serious consequences in the clinical course (3,4). Certain treatment methods using endoscopy, interventional techniques, and surgical procedures have been introduced for FV (5–19). However, a few studies have reported risk factors for FV bleeding, and hemodynamic features associated with FV bleeding have not been clarified (1,20,21).

There are a number of inflow vessels into FV: the left gastric, posterior gastric, and short gastric veins (22–26). The main outflow pathway in the majority of FV is the gastrorenal shunt (GRS), and the blood flow manner of GRS may represent the clinical condition of FV. Watanabe et al. (25), using the percutaneous transhepatic portography (PTP) technique, reported that the diameter of the GRS depended on the severity of FV. However, that study was based on a nonphysiologic condition using portal venous catheterization, and it lacked quantitative assessment. Little is known about

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the physiologic hemodynamic features of the GRS in patients with FV.

Pulsed and color Doppler ultrasound (US) allows the real-time observation of the portal hemodynamics in patients with portal hypertension, repeatedly and noninvasively, with quantitative evaluation (27–29). The recent study demonstrated the portal systemic shunt through the renal vein on sonograms (30,31). Using this technique, we designed the present study to investigate the physiology of GRS in patients with FV. The aim of this study was to clarify the hemodynamics of GRS on Doppler sonography in relation to the grading and bleeding of FV.

MATERIALS AND METHODS

Patients

There were 76 consecutive patients with FV confirmed by endoscopic examination in our hospital between December 1999 and August 2007. Among them, seven patients received endoscopic treatment before the hemodynamic evaluation using US because of active bleeding from the FV. Therefore, 69 patients with FV formed the subject group in this retrospective study. They consisted of 36 men and 33 females, aged 41 to 80 years (mean age, 61.5 ± 8.9), and their body mass index (BMI) was 22.5 ± 4.1 kg/m^2 (range, 16.8 to 30.9). All of them had liver cirrhosis diagnosed on the basis of imaging findings, histologic findings, clinical symptoms, and biochemistry findings. The cause of liver cirrhosis was viral in 44 patients (hepatitis virus C, 40; hepatitis virus B, 4), alcohol in 9, nonalcoholic steatohepatitis (NSAH) in 3, autoimmune in 1, primary biliary cirrhosis in 3, and cryptogenic in 9. The severity of liver dysfunction, as classified according to the Child-Pugh scoring system (32), was A in 30, B in 26, and C in 13 patients. Eighteen patients had hepatocellular carcinoma (HCC), which was being controlled by nonsurgical treatment, and none had thrombus or tumor thrombus in the portal vein on US and contrast-enhanced computed tomography (CECT). Informed written consent was obtained from all patients. The preliminary step for ethics committee in our hospital deemed this retrospective study as appropriate design without approval.

Endoscopy

Endoscopic findings of FV and EV were classified according to the General Rules for Recording Endoscopic Findings set by the Japan Research Society for Portal Hypertension (33)—F1 (straight), F2 (winding), and F3 (nodule-beaded), corresponding to the grades of small, medium, and large, respectively. The grades of FV were F1 in 10, F2 in 38, and F3 in 21 patients; 24 of the FV patients were accompanied by EV, F1 in 14, and F2 in 10. All patients had primary FV, and there was no secondary FV developed after the obliteration of esophageal varices. Twenty patients were bleeders—6 were confirmed by emergency endoscopy and 14 were confirmed by clinical symptoms of hematemesis or melena. The former six bleeders received endoscopic cyanoacrylate injection therapy to attain hemostasis after the US examination. The latter 14 bleeders underwent endoscopic examination within 2 weeks after their symptoms, and another cause for gastrointestinal bleeding was not found except for FV. The remaining 49 were nonbleeders with no history of hematemesis or melena.

Contrast-enhanced Computed Tomography

CECT with dynamic study was performed in all patients using either a Somatom Plus 4 (Siemens Medical Systems, Erlangen, Germany) or a Lightspeed Ultra16 (GE Medical Systems, Milwaukee, WI) with the injection of 100 ml of contrast medium at 3 ml/s from the antecubital vein via mechanical power injector. The acquisition parameters of computed tomographic examination were 140 kV, 200 mA, scan time 0.75 s/rotation, and beam pitch 1.5 for Somatom Plus 4, and 120 kV, 350 mA (CT-AEC), scan time 0.8 s/rotation, beam pitch 1.375, and collimation 0.625 mm for Lightspeed Ultra16. Scanning was performed with a 30-s delay between contrast administration and start of scanning for the hepatic artery−dominant phase, 80-s delay for the portal vein−dominant phase, and 180-s delay for the equilibrium phase. The computed tomographic image was evaluated by one of the authors (H.O.).

Ultrasound

Equipment and settings.—The US systems used in the present study were SSA-380A, 390A, and 770A (Toshiba, Tokyo, Japan), which were the high-end systems during the study period, with a 3.75-MHz convex probe. The imaging modes were gray-scale B-mode US, pulsed Doppler US, and color flow imaging. Pulsed Doppler US was used for the measurement of mean flow velocity (FVe, centimeters per second) and mean flow volume (FVo, milliliters per minute), with sampling width corresponding to the maximum diameter of the vessel and at an angle less than 60° between the US beam