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Blood flow parameters in the short gastric vein and splenic vein on Doppler ultrasound reflect gastric variceal bleeding

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ABSTRACT

Purpose: Hemodynamic features associated with the bleeding from gastric fundal varices (FV) have not been fully examined. The purpose of this study was to elucidate hemodynamics in the short gastric vein (SGV) which is a major inflow route for FV and flow direction of the splenic vein (SV) in relation to bleeding FV.

Materials and Methods: The subject of this retrospective study was 54 cirrhotic patients who had medium- or large-sized FV (20 bleeders, 34 non-bleeders) on endoscopy with SGV on both angiogram and sonogram. Diameter, flow velocity, flow volume of SGV and flow direction in the SV were evaluated by Doppler ultrasound.

Results: Diameter, flow velocity and flow volume of SGV were significantly greater in bleeders (9.6 ± 3.1 mm, 11.4 ± 5.2 cm/s, 499 ± 250.1 ml/min) than non-bleeders (6.5 ± 2.2 mm, $p = 0.0141$; 7.9 ± 3.3 cm/s, $p = 0.022$; 205 ± 129.1 ml/min, $p = 0.0031$). SV showed forward flow in 37 (68.5%), to and fro in 3 (5.6%) and reversed flow in 14 patients (25.9%). The frequency of FV bleeding was significantly higher in case with reversed or "to and fro" SV flow (11/17) than forward SV flow (9/37, $p = 0.0043$). The cumulative bleeding rate at 3 and 5 years was significantly higher in patients without forward SV flow (38.8% at 3 years, 59.2% at 5 years) than in patients with forward SV flow (18.7% at 3 years, 32.2% at 5 years, $p = 0.0199$).

Conclusion: Advanced SGV blood flow and reversed SV flow direction may be a hemodynamic features closely related to the FV bleeding.

1. Introduction

Gastric fundal varices (FV) are well known as a considerable hemodynamic feature in patients with portal hypertension [1–3]. Although the incidence is less than that of esophageal varices (EV), they provide a large hemorrhage volume, resulting in a serious condition in case of bleeding [4–6]. Management of bleeding FV is actually important issue for the clinicians.

Hepatic functional reserve, size of varices, and red spots on varices by endoscopic examination were reported as significant factors for FV bleeding [5,7]. However, as these parameters are not quantitatively well defined, they are not always satisfactory in clinical practice. Although portal venous pressure (PVP) also accounts for the FV bleeding, measurement of PVP still requires an invasive procedure and patients without high PVP sometimes present developed FV or FV bleeding [8,9]. Pathophysiological difference in the FV between bleeders and non-bleeders has not been fully resolved.

Portal hypertension frequently results in the development of collateral vessels and a change in blood flow direction. Left gastric vein (LGV) supplies blood flow for EV, and its hemodynamics reflect the grade and bleeding of EV [10–12]. Similarly, gastric veins such as LGV, short gastric vein (SGV) and posterior gastric vein (PGV) are known as inflow routes for FV, and hemodynamics of these vessels might be closely related to the pathophysiology of FV [13,14]. Additionally, it is reported that reversed flow of splenic vein (SV) was frequent in patients with advanced FV accompanied by chronic portal systemic encephalopathy [13]. Blood flow in the SV might also reflect the potential development of FV.

Pulsed and color Doppler ultrasound (US) has the advantage of allowing real-time observation of the portal hemodynamics in patients with portal hypertension, repeatedly and non-invasively, compared with other imaging modalities [15–18]. With the use of

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these US techniques, we focused on the hemodynamics of the SGV and flow direction in the SV in FV patients. The purpose of our study was to elucidate the hemodynamic features of the SGV and SV on Doppler sonograms in relation to the bleeding FV.

2. Patients and methods

2.1. Patients

There were 149 consecutive patients who had medium- or large-sized FV on endoscopic examination in our department between April 1994 and December 2003. Among them, this retrospective study enrolled subjects according to the following criteria; (i) subjects received angiographic examination, that is arterial portography for the treatment of HCC or percutaneous transhepatic portography (PTP) for the portal hemodynamic evaluation, 72/149, (ii) subjects who had SGV as inflow route for FV on the angiogram, 62/72, (iii) subjects underwent Doppler US examination for the portal hemodynamic evaluation prior to treatments for FV, 59/62, (iv) subjects who had SGV on Doppler US, 54/59. Therefore, the subjects were 54 patients who consisted of 34 males and 20 females, aged 37–79 years (63.8 ± 8.2). All subjects were diagnosed as cirrhosis on the basis of imaging findings with clinical symptoms and biochemistry findings. The cause of cirrhosis was viral in 40 patients (hepatitis C virus 33, hepatitis B virus 7), alcohol abuse in 7, cryptogenic in 5 and primary biliary cirrhosis in 2. The severity of liver dysfunction as classified by the Child-Pugh scoring system was A in 18, B in 19, and C in 17. Forty-two patients had hepatocellular carcinomas (HCCs), which were controlled by non-surgical treatment. None had thrombosis or tumor thrombosis in the portal vein on both the sonogram and angiogram. The beginning of follow-up period was the time of initial Doppler US examination, and the end of that was bleeding from FV, death, changing hospital or denial to hospital visit, or the time of the latest Doppler US observation. The duration of clinical observation of FV was 18–4380 (1159 ± 1088) days in this study. The informed written consent was obtained from all patients, and the research was carried out in accordance with the Helsinki Declaration. The ethics committee in our hospital deemed this retrospective study as an appropriate design for the publication.

2.2. 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 [19]: F1 (straight), F2 (winding), and F3 (nodule-beaded), corresponding to the grades of small, medium and large, respectively. The grades of FV were F2 in 32, and F3 in 22; 12 of the FV patients were accompanied by EV (F1 in 5 and F2 in 7). Twenty FV patients were bleeders: 12 confirmed by emergency endoscopy and 6 of them received endoscopic sclerotherapy after the Doppler US examination, and 8 by clinical symptoms of hematemesis or melena. The latter patients underwent endoscopic examination within 10 days after appearance of symptoms, and other causes for gastrointestinal bleeding were not found except for FV. The other thirty-four FV patients were non-bleeders with no history of hematemesis or melena. Endoscopic examination was performed by HI, TI and TT.

2.3. US examination

The US system used in our study was SSA-260A, 270A and 390A (Toshiba, Tokyo, Japan) with a 3.75-MHz convex probe. The imaging modes were fundamental grey-scale imaging, pulsed and color Doppler US. The fundamental grey-scale imaging was used for the measurement of maximum diameter of the vessels, and Doppler US

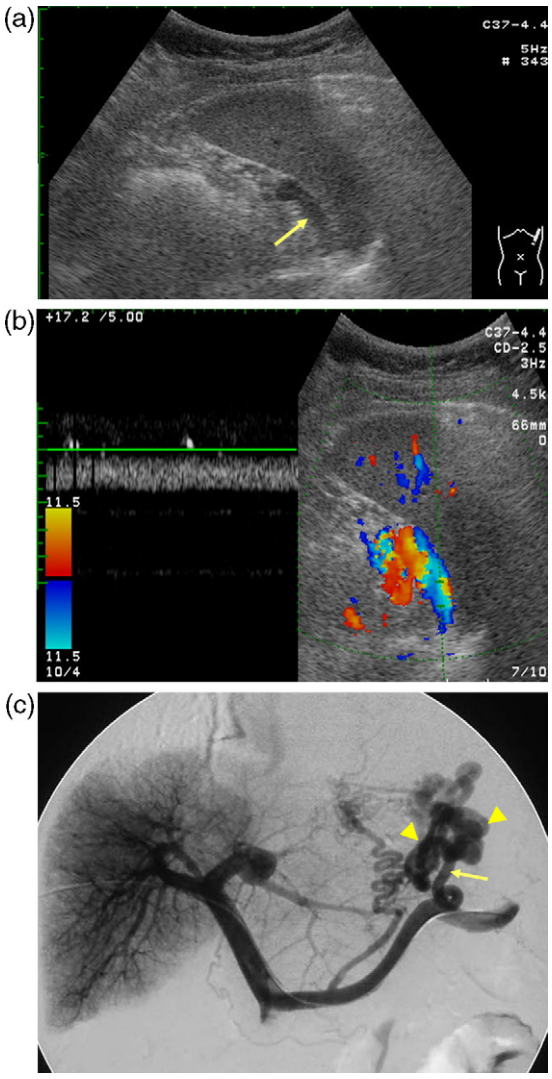

Fig. 1. 59-year-old female, cirrhotic patient with FV. (a) B-mode US by left intercostal scan. The short gastric vein (SGV, arrow) was demonstrated beside the spleen by left intercostal scan. (b) Pulsed and color Doppler US by left intercostal scan. Flow direction of SGV was hepatofugal. (c) Portogram. SGV (arrow) was observed running toward the FV (arrow heads). FV, gastric fundal varices.

was used for the demonstration of the flow direction, and measurement of mean flow velocity (cm/s) and mean flow volume (ml/min) calculated by multiplying mean flow velocity by cross-section of the vessel by 60 (s) automatically, with sampling width corresponding to the diameter of the vessel. Care was taken to ensure that the angle between the US beam and the vessel was less than 60° in this study. Color Doppler US was done with an optimal level of gain and at 60–65 dB of dynamic range, and these settings were used in all examinations. US examination was performed in a supine position in an intermediate or inspiratory phase of respiration with a fasting state of over 6 h except for the emergency setting in bleeders. The observation for SGV was performed under left intercostal scan or subcostal scan, and SGV was defined as collateral vessels originating from the splenic hilum, running along the splenic surface in a hepatofugal flow direction (Fig. 1a, b) [18,20]. The SV was observed under the transverse scan in the middle part of the upper abdomen.

The US examination was performed by two operators who had more than 5-year career for Doppler US examination at the observation of the initial case, SM for 36 patients and HM for 32 patients. Therefore, 14 patients received US examination by two operators independently, and inter-observer variability of measurement data