Ultrasound in Med. & Biol., Vol. 40, No. 9, pp. 2058–2063, 2014

0301-5629/$ - see front matter

http://dx.doi.org/10.1016/j.ultrasmedbio.2014.03.017

● *Original Contribution*

ESOPHAGEAL VARIX PREDICTIVE PERFORMANCE OF LOWER ESOPHAGEAL DOPPLER SIGNALS DURING THE SWALLOWING PROCESS

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(*Received* 26 *November* 2013; *revised* 9 *March* 2014; *in final form* 12 *March* 2014)

Abstract—The objective of this study was to assess whether the swallowing action can improve the display of lower esophageal Doppler signals (LEDS) during transabdominal ultrasound (TUS). Eighty-four patients with cirrhosis underwent both TUS and endoscopic examination for esophageal varices (EVs). LEDS were assessed under the esophageal resting state and during the swallowing process. Univariate analysis indicated that spleen diameter, spleen vein diameter, portal vein diameter, LEDS and left gastric vein hepatofugal flow were significantly associated with the presence of EVs. No LEDS were detected in patients without EVs at rest or during swallowing. Of the 69 patients with EVs, LEDS could be detected in 21 cases (30.4%) in the esophageal resting state and in 58 cases (84.1%) during the swallowing process. Compared with the esophageal resting state, the swallowing action can significantly improve display of LEDS during TUS (p = 0.000), which may be beneficial for TUS detection of EVs. (E-mail: Zcxay@163.com) © **2014 World Federation for Ultrasound in Medicine & Biology.**

Key Words: **Esophageal varices, Doppler ultrasound, Cirrhosis.**

INTRODUCTION

Esophageal varices (EVs) are the most important porto-systemic collaterals, because their rupture results in esophageal varix bleeding, which is the most common lethal complication of cirrhosis. EVs are present in approximately 50% of patients with cirrhosis, and the incidence of EVs is increasing by approximately 5% to 8% per year (Groszmann et al. 2005; Merli et al. 2003; Murachima et al. 2001). The gold standard in the diagnosis of EVs is endoscopy. A number of practice guidelines recommend periodic endoscopic examination of patients with cirrhosis for varices (Garcia-Tsao et al. 2007; Jalan and Hayes 2000). These recommendations imply a considerable burden for endoscopy units and an increased number of unpleasant procedures for patients. To reduce the frequency of endoscopies in patients with cirrhosis, many researchers have evaluated possible non-invasive markers of EVs (Adithan et al. 2010; Chen et al. 2012; Joseph et al. 2011; Lipp et al. 2011; Sporea et al. 2011; Stefanescu et al. 2011; Tamano et al. 2004; Ying et al. 2012; Yu et al. 2011), but their clinical value remains controversial.

Transabdominal ultrasound (TUS), a non-invasive technique, provides a simple method of evaluating the abdominal esophagus (Chen et al. 1997). The diameter of medium or large EVs is greater than 5 mm, which can be easily detected by TUS in theory. However, to date, the diagnostic value of TUS in detecting EVs is still considered unsatisfactory.

The resting pressure of the lower esophageal sphincter (LES) in most individuals varies from 10 to 40 mm Hg (Mittal et al. 1988). In addition, the EV pressure is similar: 15.5 to 25.6 mm Hg (Bosch et al. 1986; Kong et al. 2009; Pontes et al. 2002). Therefore, LES pressure may cause varices to be flattened or closed in the esophageal resting state (Schiano et al. 1998). Such a mechanism may be the reason for the low rate of display of EVs during TUS. During swallowing, the LES relaxes, and LES pressure decreases significantly, even to 0 mm Hg (Fornari et al. 2009; Goyal and Chaudhury 2008; Mittal et al. 1995). One study reported that the varices initially increased in size, subsequently decreased in size and later flattened, closed and opened sequentially during swallowing, with a mean variceal cross-sectional area increase of 41% above baseline (Miller et al. 2004). TUS may be beneficial for the detection of EVs.

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In this study, we attempted to identify the ultrasonographic parameters associated with the presence of EVs and to assess whether the swallowing action can improve the TUS display of lower esophageal Doppler signals (LEDS).

METHODS

Patients

This study population consisted of 84 patients with cirrhosis (57 men and 27 women, median age = 52 y, range: 30–74 y). The patients were diagnosed on the basis of standard clinical, imaging, endoscopic examination and biochemical parameters. In addition, the patients were classified according to Child-Pugh criteria. The patients were recruited consecutively at the Gastroenterology, Infectious Diseases and General Surgery departments of our hospital between August 3, 2012 and July 31, 2013. The exclusion criteria included previous operative treatment for portal hypertension and previous endoscopic sclerosis or band ligation of EVs. The study was approved by the institutional ethics committee of our hospital and was conducted according to the principles of the Declaration of Helsinki. The nature of the study was explained to the patients, each of whom provided written informed consent before beginning of the study.

Gastroesophageal endoscopy

Gastroesophageal endoscopy was performed by X. Y. Xu in a single endoscopy unit using an Olympus GIF-XQ 260 video endoscope (Olympus, Beijing, China), and EVs were classified as present or absent according to the same criteria: EVs were classified as present when there were elevated veins above the esophageal mucosal surface irrespective of size or shape. Large varices were defined as those occupying more than one-third of the esophageal lumen.

Ultrasound

Ultrasound examination was performed using a GE Logiq 7 system (General Electric Healthcare Medical Systems, Milwaukee, WI, USA) and a 4C convex-arrayed transducer with a frequency of 3–6 MHz. All patients were given a TUS examination within one wk after gastroesophageal endoscopy. Ultrasound examinations were performed by C. X. Zhang or M. Huang, who have more than 10 y of ultrasound experience and were blinded to the endoscopy findings.

All patients fasted overnight before TUS examination. First, spleen diameter, spleen vein diameter, portal vein diameter, portal vein velocity and left gastric vein hepatofugal flow were evaluated via TUS. (i) Portal vein velocity was measured in the midportion, where the hepatic artery crosses the portal vein. The angle between the long axis of the portal vein and the Doppler beam was less than 60°. (ii) Portal vein diameter was measured in the longitudinal section, at the exact site in the portal vein midportion. (iii) Spleen diameter was the maximum length of the poles on oblique subcostal scans. (iv) Spleen vein diameter was measured in the longitudinal section at the hilum of the spleen. (v) The left gastric vein was identified as a vessel communicating with the superior aspect of the portal or splenic vein in the region of the confluence. Hepatofugal flow was defined as the blood flow away from the portal vein.

The LEDS of the patients were then evaluated. After visualization of the lower esophagus under normal B-mode scanning, color Doppler flow imaging was used to detect LEDS in the esophageal resting state (defined as LEDS—resting). Next, patients were asked to swallow a bolus of water. The LEDS were detected again immediately before the water reached the lower esophagus (defined as LEDS—swallowing). To visualize the lower esophagus clearly, all patients were examined in the supine position and right anterior oblique. A few patients were given 500 mL of water to distend the stomach. The Doppler ultrasound settings had to be optimized for slow blood flow detection. Optimization included the lowest wall filter and the highest Doppler gain possible without flash artifacts and the lowest possible pulse repetition frequency without aliasing. These technical approaches were kept constant for all examinations. Moreover, ultrasound settings remained unchanged for the same patient when LEDS were detected in the resting state or during swallowing. Spectral analysis was performed on a few patients to identify the continuous venous flow or noise signal. The platelet count/spleen bipolar diameter ratio was also calculated for all patients.

Statistical analysis

Statistical analysis was performed with SPSS 15.0 software (SPSS, Chicago, IL, USA). Comparisons between groups were performed using the χ^2 test for qualitative data and Student's *t*-test for quantitative data. A p-value < 0.05 was considered to indicate a significant difference. All variables found to be of significance by univariate analysis were included as candidate variables in a logistic regression analysis to identify independent predictors of the presence of EVs.

RESULTS

The intra-abdominal esophagus appeared longitudinally as a curving tubular structure with inner hyper-echoic and outer hypo-echoic layers. LEDS were expressed as short cordlike or continuous color signals in the esophageal wall and lumen (Fig. 1). The left gastric vein exhibits hepatopetal blood flow normally