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● *Original Contribution*

EVALUATION OF TRANSABDOMINAL ULTRASOUND WITH ORAL CELLULOSE-BASED CONTRAST AGENT IN THE DETECTION AND SURVEILLANCE OF GASTRIC ULCER

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Abstract—The aim of this study was to assess the role of transabdominal ultrasound with cellulose-based oral contrast agent (TUS-OCCA) in the detection and surveillance of gastric ulcer. The study was approved by the institutional review board at Shengjing Hospital of China Medical University. A total of 124 consecutive patients with benign gastric ulcer diagnosed by gastroscopy and biopsy were enrolled. Serial TUS-OCCA (approximately 1 exam every 2 wk) was performed to monitor the effects of treatment, and additional interventions were planned according to the results. TUS-OCCA detected gastric ulcer in 76% of patients (94 of 124). The detection rates for lesions of ≤5 mm, lesions of 5–10 mm, lesions of 10–15 mm and lesions >15 mm were 32% (10 of 31), 77% (27 of 35), 96% (25 of 26) and 100% (32 of 32), respectively. The detection rates for lesions located in the antrum, angle and body were 70%, 84% and 85%, respectively. Among 30 undetected lesions, which ranged 2–13 mm in size, 11 were at the antrum, 9 at the angle, 3 in the body, 6 at the cardia and 1 at the fundus. During the follow-up period, patients underwent a mean of 3.8 TUS-OCCA examinations (range 2–7), and ulcers were healed after 8 wk (range 2–12 wk) of standard therapy in 76 patients. Eighteen patients who did not show improvement after standard therapy underwent repeat gastroscopy with biopsy. Repeat biopsy was positive for gastric cancer in 4 of these: 2 of the remaining 14 were diagnosed with gastric cancer at gastrectomy, and 12 were diagnosed with chronic benign ulcer. These results indicate that serial TUS-OCCA can be used for close monitoring during routine treatment of gastric ulcers that are detectable by TUS-OCCA and that monitoring by TUS-OCCA can guide additional interventions. A non-invasive follow-up program based on TUS-OCCA can also help to detect gastric cancers that have been misdiagnosed as benign ulcers at the initial endoscopic biopsy. (E-mail: liuzj1@sj-hospital.org) **© 2017 The Authors. Published by Elsevier Inc. on behalf of World Federation for Ultrasound in Medicine & Biology. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/licenses/by-nc-nd/4.0/).**

Key Words: **Transabdominal ultrasound, Cellulose-based echoic ultrasound contrast agent, Gastric ulcer, Detection rate, Surveillance.**

INTRODUCTION

The use of gastroscopy for opportunistic screening of gastric cancers is widely accepted, while the use of this procedure for mass screening of gastric cancers remains questionable, even in developed countries such as Japan (Leung et al. 2008). Various imaging modalities are used to detect gastric lesions, including endoscopy, barium studies, computed tomography, magnetic resonance imaging and ultrasound (Altonbary et al. 2015; Liu and Adler 2014; Liu et al. 2014a, 2014b; Machicado et al. 2014; Rana et al. 2015; Salah and Faigel, 2014). Among these, the double-contrast barium meal continues to be the most common mass screening tool for gastric cancers in Japan and Korea (Lee et al. 2011; Leung et al. 2008; Nakajima 2012).

Considering the remarkable advances in ultrasound technology, transabdominal ultrasound after oral administration of an echoic, cellulose-based, gastric ultrasound contrast agent (TUS-OCCA) has recently been suggested as a valuable initial screening tool for gastric lesions in selected patients (Li et al. 2012; Liu et al. 2014a,

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2014b, 2015a, 2015b; Shen et al. 2014; Shi et al. 2012; Wei et al. 2013). However, the value of TUS-OCCA in the detection and surveillance of gastric ulcer remains unclear. The purpose of this study was to assess the role of TUS-OCCA in the detection and surveillance of gastric ulcer.

Patients and methods

Patients. Consecutive patients with gastric ulcer confirmed by gastroscopy with an initial biopsy result of benign were enrolled in this study July 1, 2012–April 1, 2016. The study was approved by the ethics committee at Shengjing Hospital of China Medical University and informed consents were obtained from all patients. Patients were classified into two groups for subgroup analysis according to body habitus, group S (suitable body habitus) and group U (unsuitable body habitus). Body habitus was considered suitable for TUS-OCCA when both the cardia and the pylorus were clearly visualized by conventional transabdominal ultrasound (TUS) and was considered unsuitable for when either cardia or pylorus could not be clearly visualized. TUS examinations were performed by the same sonologist before administration of oral contrast agent. Each patient's body mass index (BMI) and the depth of the location of the cardia were also recorded.

TUS-OCCA protocol. TUS-OCCA examinations were performed by an experienced sonologist who was blinded to the site and size of the gastric ulcer. Features including lesion size, site and echo pattern were recorded during each examination. TUS-OCCA findings were compared with those of endoscopy and pathologic diagnosis as the gold standard. The endoscopy reports described the location (antrum/angle/body/fundus/cardia) of the ulcers and the size of the ulcers, which was estimated by the doctor who performed the endoscopy based on his experience and/or by comparison to a set of open biopsy forceps measuring 4.5 mm. Sonographic examinations were performed with a Toshiba Aplio 400 (Toshiba Medical Systems Corporation, Tochigi, Japan), Hitachi Eub-8500 Ultrasound System (Hitachi, Ltd., Tokyo, Japan), or Philips iU22 Ultrasound System (Philips Healthcare, Bothell, WA, USA) with a 2-MHz–5-MHz convex array probe.

Generally, at approximately 7 d after the initial biopsy, if the pathology result indicated a benign ulcer, immediate follow-up by serial TUS-OCCA examination (1 examination every 2 wk) was recommended, although in fact, the TUS-OCCA examinations were performed on the basis of each patient's adherence and availability. The goals of the serial TUS-OCCA examinations were to monitor response to routine treatment and, on the basis of these results, to determine whether additional clinical interventions should be provided.

Cellulose-based oral contrast agent. The commercially available oral contrast agent (50 g per package) (Best; East Asia Medical Products Co, Ltd, Huzhou, China) was reconstituted in 500 mL of boiling water to form a homogeneous thin paste. The paste was cooled to a suitable temperature and was then administered orally to facilitate distension of the stomach. This cellulose-based oral contrast agent was slightly sweet, with a pleasant taste that was generally acceptable to the patient. The acoustic velocity and specific acoustic impedance of the contrast agent were similar to those of liver tissue, and the contrast-filled stomach had a homogeneous appearance with a mid-high level echogenicity. No antispasmodics were used. Each patient was encouraged to drink the entire 500 mL of contrast solution; in the few cases where this was not tolerable to the patient, a smaller amount was acceptable.

Scanning procedure. The entire stomach was scanned in the following 5 steps (Liu et al. 2014a, 2014b, 2015a, 2015b) (Fig. 1):

1. Performed by moving the probe from the xiphoid process to the left costal arch with the patient in a supine position. This was mainly for scanning the cardia.
2. Performed by placing the probe at the left 10th intercostal space. This was mainly for scanning the gastric fundus.
3. Performed by moving the probe from the left costal arch along the outline of the stomach with the patient in the right decubitus position. This was for scanning the gastric fundus, body and antrum in transverse section.
4. Performed by rotating the probe along the left costal arch, using the caudal end of the probe as an axis,

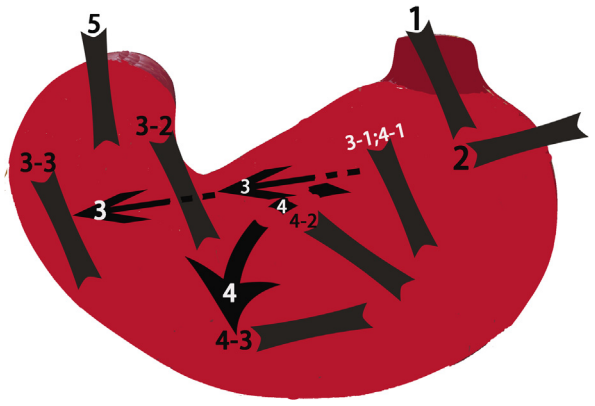

Fig. 1. The entire stomach was scanned in 5 steps. Step 1: Scan the cardia. Step 2: Scan the gastric fundus. Step 3: Scan the gastric fundus, body and antrum in serial transverse section. Step 4: Scan the fundus, body and antrum in serial coronal section. Step 5: Scan the antrum and pylorus. Steps 3 and 4 were the key steps, respectively obtaining serial transverse and coronal sections of the whole stomach, including the gastric fundus, body, angle and antrum.