Feasibility of Newly Developed Endoscopic Ultrasound with Zone Sonography Technology for Diagnosis of Pancreatic Diseases

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Background/Aims: To confirm the feasibility of using newly developed endoscopic ultrasound (EUS) with Zone sonography™ technology (ZST; Fujifilm Corp.).

Methods: Seventy-five patients with pancreatic disorders were enrolled: 45 with intraductal papillary mucinous neoplasm; 15 with ductal carcinoma; five with neuroendocrine tumors; three with serous cystic neoplasms; and seven with simple cysts. The endoscopes used were EG-530UR2 and EG-530UT2 (Fujifilm Corp.). Two items were evaluated: visualization depth among four frequencies and image quality after automatic adjustment of sound speed (AASS), assessed using a 5-scale Likert scale by two endosonographers blinded to disease status. Because sound speed could be manually controlled, besides AASS, image quality at sound speeds of 1,440 and 1,600 m/sec were also assessed.

Results: In all cases, sufficient images were obtained in the range of 3 cm from the EUS probe. Judgments of image quality before AASS were 3.49±0.50, 3.65±0.48, respectively. After AASS, A and B scored 4.36±0.48 and 4.40±0.49 (p<0.0001). There were significant differences in the data before and after AASS and plus 60 m/sec, but no significant difference between the datasets were seen after AASS and at sound speeds manually set for minus 100 m/sec.

Conclusions: EUS with ZST was shown to be feasible in this preliminary experiment. Further evaluation of this novel technology is necessary and awaited.

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Key Words: Endosonography; Zone sonography technology; Enhanced attenuation; Automatic adjustment of sound speed

INTRODUCTION

Endoscopic ultrasound-guided fine needle aspiration (EUS-FNA) is now thought to be the useful and reliable diagnostic modality for the pancreatic diseases.1-3 Regardless of these trends, there may be inevitable possibilities of dissemination or track seeding,4 though it is faint.

The development and sophistication of EUS images themselves should be the first step to the better understandings of pancreaticobiliary diseases.5,6 In the early 2000s, the main stream of EUS changed from a mechanical scanning method to electronic radial or linear scanning methods.7-9 Subsequently, useful applications in transabdominal ultrasonography came within reach of EUS, i.e., contrast-enhanced EUS and EUS-elastography.

And now, an entirely-new concept of ultrasonography named Zone Sonography™ technology (ZST; Fujifilm Corp., Tokyo, Japan) has come within reach of EUS. ZST is a novel ultrasound technology which transmits a broad ultrasound beam (contrary to the conventional method) to rapidly collect extensive echo data immediately by using large zones and it realizes the high-quality ultrasound images of deeper part of body irrespective of observation frequency used because it can put together the accumulated data in the memory. Moreover, this technology estimates the optimal sound speed which has been usually fixed as 1,540 m/sec and provides clear images for independent patients. We investigated the feasibility and usefulness of EUS with ZST in the diagnosis of pancreatic diseases.
MATERIALS AND METHODS

1. Ethics

The study design was retrospective. The study protocol was approved by the Institutional Review Board according to the Declaration of Helsinki. Written informed consent was obtained from each patient.

2. Zone sonography™ technology (ZST)

ZST is an entirely new approach to ultrasound image acquisition and processing. Conventional systems acquire acoustic data line-by-line and focus it with a beamformer using only a small fraction of the actual information contained in the echo data set. ZST has the ability to utilize all of the information contained in the returning echo data set acquired in each large zone and as such can cover the field of view in much fewer transmit/receive cycles. The original raw echo information is retrospectively reprocessed multiple times in the Channel Domain Processor to form optimal images (Fig. 1). EUS system with ZST provides the two major advantages, i.e., enhanced attenuation and sound speed correction.

1) Enhanced attenuation

The principle of an enhanced attenuation is explained in Fig. 2. This system can produces the images retrospectively using various frequencies and depict the images of the distant field using lower frequency with higher frequency for the near field.

2) Sound speed correction

All conventional ultrasound systems have to make an assumption regarding the speed of sound in the tissue being imaged as 1,540 m/sec. However, different types of tissue have different sound properties and even the same type of tissue may not have similar properties from patient to patient. Therefore, these built-in assumptions are often inaccurate. ZST could analyze the actual echo data in a variety of ways to optimize the accuracy of tissue representation for that specific patients—rather than relying on rigid prior assumptions. ZST estimates the several images using several sound speeds, and next, frequency analysis is performed in all images. The sound speed that produced the highest lateral resolution is adopted as an optimal sound speed (Fig. 3).

3. Patients and methods

From December 1, 2010 to February 10, 2012, 75 patients with pancreatic disorders were enrolled in this study. Seventy-five patients consisted of 45 with intraductal papillary mucinous neoplasm (IPMN), 15 with invasive ductal carcinoma, five with pancreatic neuroendocrine tumor, three with serous cystic neoplasm, and seven with pancreatic simple cyst. Forty-five IPMNs were divided into 15 IPMAs and three IPMCs (minimally invasive) by surgical treatment and remaining 27 cases have been followed up using EUS or computed tomography without any changes for more than at least 6 months. The diagnostic criteria for the follow-up IPMNs were a communication with main pancreatic duct and the existence of mucus by ERP. Fifteen invasive ductal carcinomas were diagnosed by either EUS-FNA or surgical treatment. Five cases of neuroendocrine tumors and three cases of serous cystic neoplasm were all diagnosed by surgical resection. Seven pancreatic cysts having no communication with main pancreatic duct have been followed up as the diagnosis of simple cysts at least for more than 6 months.

Endoscopes used were EG-530UR2 (electronic radial method, viewing direction, 0 degree forward; distal end diameter, 11.4 mm; Fujifilm Corp.) and EG-530UT2 (electronic convex method, viewing direction, 40 degrees forward oblique; distal end diameter, 13.9 mm; Fujifilm Corp.) (Table 1), and SU-800 as ultrasound processor equipped with ZST. This system is now commercially available in Japan.

Evaluated items were as follows: first, comparison of the

![Fig. 1. Principle of Zone Sonography™ technology (ZST). ZST is an entirely new approach to ultrasound image acquisition and processing. ZST can utilize all of the information contained in the returning echo data set acquired in each large zone and, as such, can cover the field of view in fewer transmit/receive cycles. The original raw echo information is retrospectively reprocessed multiple times in the channel domain processor to form optimal images. DSP, digital signal processor.]