Randomized Controlled Trial Comparing the Usefulness of Endoscopic Ultrasound Processor

Hiroki Koda,* Kazuya Matsumoto,* Yohei Takeda,* Takumi Onoyama,* Soichiro Kawata,* Hiroki Kurumi,* Taro Yamashita,* Hisashi Noma† and Hajime Isomoto*

**Department of Gastroenterology, Tottori University Hospital, Yonago 683-8504, Japan and †Department of Data Science, The Institute of Statistical Mathematics, Tachikawa 190-8562, Japan*

ABSTRACT

Background Although endoscopic ultrasonography (EUS) is a useful tool for diagnosing pancreatobiliary diseases, not many facilities perform this technique as it is difficult to master. Currently, two new EUS systems exist: EU-ME2/GF-UCT260, manufactured by Olympus, and SU-1/EG-580UT, manufactured by Fujifilm. Some reports have compared new EUS models to older versions, but the operability and image quality of these two latest systems have not been compared. Our study aimed to compare the usefulness of these two types of EUS.

Methods Forty consecutive patients were recruited and randomized in a two-arm clinical trial; Arm 1: EU-ME2/GF-UCT260 was used only for observation and SU-1/EG-580UT for EUS-fine needle aspiration (FNA); Arm 2: SU-1/EG-580UT was used only for observation and EU-ME2/GF-UCT260 for EUS-FNA. Using a crossover design, we evaluated image findings, ease of scope insertion, and visibility of the gastrointestinal (GI) tract. Each procedure was scored using a 5-point scale (Clinical Trial ID: UMIN000031373).

Results SU-1/EG-580UT was significantly better in terms of lesion-delineating capacity: lesion border ($P < 0.001$), internal echo ($P < 0.001$). Significantly easier scope insertion was observed with SU-1/EG-580UT with respect to any insertion into the piriform recess ($P = 0.018$), the pylorus ring ($P < 0.001$), and the superior duodenal angle ($P < 0.001$). Visibility during gastrointestinal observation was also significantly better with the SU-1/EG-580UT ($P < 0.001$) than with the EU-ME2/GF-UCT260.

Conclusion SU-1/EG-580UT EUS demonstrated superior performance during ultrasonic endoscopic GI observation, operability, and ultrasonic image quality. The result of the superior ultrasound imaging quality of SU-1/EG-580UT EUS will aid in the identification of small pancreatic malignancies with unclear borders and prove useful in evaluating mural nodules of IPMN in detail. These findings could result in an increased use of EUS and improve identification and prognosis of patients with pancreatobiliary diseases.

Key words EG-580UT; endoscopic ultrasonography; EU-ME2; GF-UCT260; SU-1

While survival rates for many types of malignancies are improving, those of pancreatobiliary malignancies, especially pancreatic and biliary tract cancer, are still very low; therefore, early detection of lesions is indispensable in improving prognosis.[1]

Currently, endoscopic ultrasonography (EUS) is becoming a popular tool for the diagnosis and treatment of pancreatobiliary diseases. For pancreatic cancer, EUS is superior in spatial resolution and has a higher sensitivity than other techniques, such as abdominal ultrasonography (AUS), computed tomography (CT), and magnetic resonance imaging (MRI).[2–4] Furthermore, for pancreatic lesions smaller than 2 cm, the detection rate by multi detector-row CT (MDCT) decreases, while EUS is reported to have a high diagnostic ability of more than 90% in pancreatic lesions smaller than 2 cm.[5–9] However, facilities where this procedure is performed in Japan are limited because EUS requires specialized training to visualize and interpret lesions compared to typical endoscopy and ultrasonography. Moreover, other drawbacks include difficulty of scope insertion, which is due to forward oblique viewing of the scope and the image quality of the ultrasonography, which has not been improved since 2008. A new EUS Processor, EU-ME2/GF-UCT260, was developed by Olympus Medical System Corporation (Tokyo, Japan) in 2013, while Fujifilm Medical Corp (Tokyo, Japan) developed SU-1/EG-580UT in 2015. We would have expected that ease of insertion and image quality of the ultrasonography have improved significantly, especially in the SU-1/EG-

Corresponding author: Kazuya Matsumoto, MD, PhD
matsumotokazuya@med.tottori-u.ac.jp
Received 2018 December 17
Accepted 2019 February 1
Abbreviations: AUS, abdominal ultrasonography; CT, computed tomography; EUS, endoscopic ultrasonography; EUS-FNA, endoscopic ultrasound-guided fine needle aspiration; GI, gastrointestinal; MDCT, multi detector-row computed tomography; MRI, magnetic resonance imaging; TS, tumor size; TSCI, target sample check illuminator

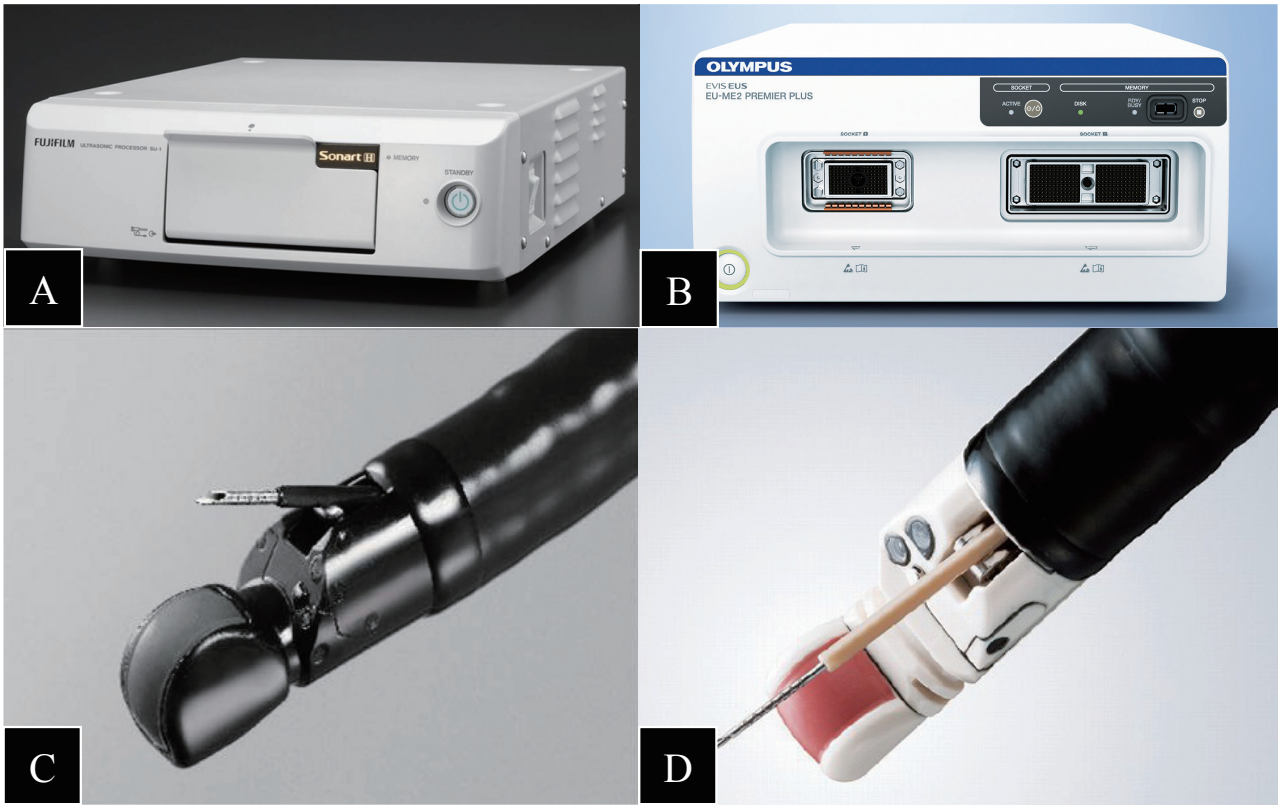

Fig. 1. SU-1/EG-580UT and EU-ME2/GF-UCT260. **A**: SU-1, **B**: EU-ME2, **C**: EG-580UT, **D**: GF-UCT260.

580UT system.

Some reports have compared new EUS models to older versions,[10, 11] but the operability and image quality of these two latest systems have not been compared. In the present study, we compared the EU-ME2/GF-UCT260 versus the SU-1/EG-580UT system to determine their usefulness.

SUBJECTS AND METHODS

Study design

This study is a randomized controlled crossover trial conducted at a single center, Tottori University Hospital in Yonago, Japan. This study was approved by the institutional review board of our University Hospital (approval number 1609B044).

Study population

Forty consecutive patients provided informed consent to participate in the study and were prospectively enrolled from December 2016 through April 2018. Patients presented with lesions detected by AUS, CT, and MRI that would benefit from imaging using EUS and EUS-FNA. The inclusion criteria were > 20 years old and a clinical presence of suspicious lesions that needed a more detailed observation in the gastrointestinal (GI) tract, gall bladder/bile duct, pancreas, or lymph nodes, as well as a necessary histopathological diagnosis. Exclusion criteria were pregnancy, inability to provide informed consent, and patients judged inappropriate as research subjects by the research physician.

EUS/EUS-FNA procedure

All procedures took place with the patients under conscious sedation from either midazolam or dexmedetomidine and were performed by one of five endoscopists used in this study, each with more than three years' experience in performing EUS and EUS-FNA. We used two types of EUS scopes and processors (EU-ME2/GF-UCT260 and SU-1/EG-580UT) in all cases (Fig. 1). Tissue samples of the lesions were collected using EUS-FNA with a 22-G needle (EZ-shot 3 plus, Olympus corp., Tokyo, Japan or Expect™/Acquire™, Boston Scientific, Marlboro, MA, USA). After the lesion was identified, it was punctured and approximately 20 back-and-forth movements were performed with the FNA needle on the target using 20 ml of suction. Whether tissue sampling could be performed was determined visually by the endoscopist and using the Target Sample check illuminator (TSCI), which we developed and previously reported on its utility.[12] If sample collection was

not successful the first time, an additional puncture was performed.

Study protocol and outcome measures

Patients were randomly divided into two groups. In one group, EUS was performed with EU-ME2/GF-UCT260 on either an in- or outpatient basis, while EUS-FNA was performed with SU-1/EG-580UT in an inpatient setting only; in the other group, these procedures were reversed (Fig. 2). These two procedures were evaluated for several parameters. The primary aim was to determine which modality is superior by comparing the drawability of the lesion using EUS (border, internal echo, septal wall). The secondary aim included comparison of endoscope insertion (piriform recess, pylorus ring, superior duodenal angle) and visibility in the GI tract. Each item was subjectively evaluated on a 5-point scale (1: poor, 2: bad, 3: moderate, 4: good, 5: excellent), and any adverse event related to this study was reported (Figs. 3 and 4). With regard to EUS-FNA, we did not include the procedures related to EUS-FNA and tissue collection results in the study items because this study aimed to compare the performance only of EUS equipment (scope and processor).

Statistical analysis and sample size

The statistical analysis was performed using SPSS ver. 25 (IBM, Armonk, NY). Results for normally distributed continuous variables are expressed using mean ± standard deviation. The stratified categories in each clinical parameter were evaluated by a paired *t*-test or a Mann-Whitney *U* test (in case of less than twenty in the category). Paired Wilcoxon signed rank test was used

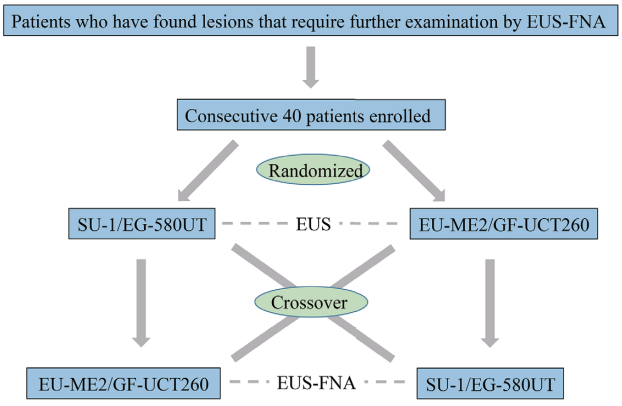

Fig. 2. Study flow chart. Forty patients, consecutively enrolled, who required further examination by EUS-FNA were randomized into the two-arm study (SU-1/EG-580UT group and GF-UCT260 group).
EUS-FNA, endoscopic ultrasound-guided fine needle aspiration.

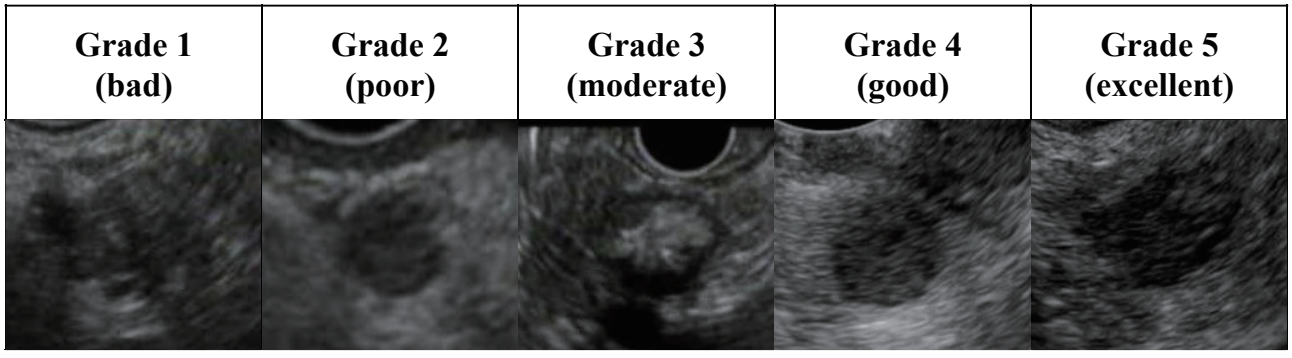

Fig. 3. Representative EUS imaging ~Border~. Representative images from each EUS system depicting the border of lesions. As the grade increases, the lesion border becomes clearer.
EUS, endoscopic ultrasonography.

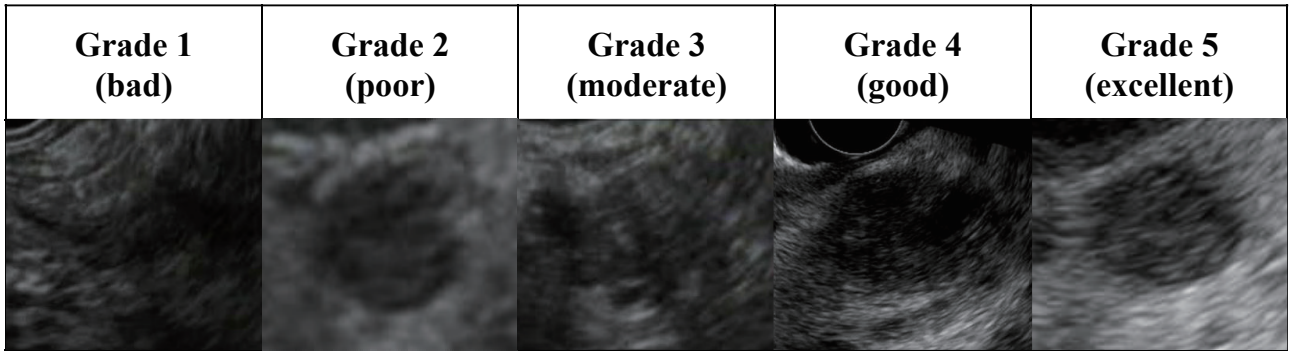

Fig. 4. Representative EUS imaging ~Internal echo~. Representative images from each EUS system depicting the internal echo of lesions. As the grade increases, the internal structure of the lesion becomes clearer.
EUS, endoscopic ultrasonography.

for variables not normally distributed and McNemar test was used to compare the association between categorical variables and outcomes. P value < 0.05 was considered significant. The results in this study are reported in accordance with the CONSORT statement.

A power analysis (detection power of 80%) revealed that samples of 38 cases (19 in each group) were required to confirm the main outcome that 20% of all cases scored as 3 to 4 using EU-ME2/GF-UCT260 (or SU-1/EG-580UT) improved to scores of 4 or 5 using SU-1/EG-580UT (or EU-ME2/GF-UCT260) and that 24 cases (12 cases in each group) were necessary to confirm the secondary outcome that 30% of all cases scored as 3 or 4 with EU-ME2/GF-UCT260 (or SU-1/EG-580UT) concerning endoscope insertion/visibility improved to scores of 4 or 5 by using SU-1/EG-580UT (or EU-ME2/GF-UCT260). To ensure we did not fall short on required samples, we set the maximum number of cases and the target number of cases to 40 in this study.

RESULTS

The median age of the subjects was 71.5 years (range: 38–85), and the ratio of males to females was 19:21. Pancreatic cancer was the most common primary lesion observed (20 subjects, 50%), followed by pancreatic neuroendocrine tumor (3 subjects, 7.5%), GI stromal tumor (2 subjects, 5%), malignant lymphoma (2 subjects, 5%), and other lesions (benign/malignant; 9 subjects (22.5%)/4 subjects (10%)). Seventy percent of the total observed lesions were located in the pancreas, with the pancreatic head/body/tail involved in 12 cases (30%), 8 cases (20%), and 10 cases (25%), respectively. The remaining 10 cases (25%) involved other sites, including the hepatic hilar. The median lesion diameter was 23.3 mm (range: 6–88.7) (Table 1). There was no significant difference between the two groups with respect to examination time (P = 0.442). The SU-1/EG-580UT group was significantly better at delineating lesion capacity for any lesion border (P < 0.001) and at detecting an internal echo (P < 0.001). Statistical analysis was not possible with regard to the visualization ability of the septal wall because only two cases of cystic lesions were included in this study population. However, very clear septal wall images were obtained with SU-1/EG-580UT compared to those with EU-ME2/GF-UCT260 in these two cases, (Fig. 5). Ease of scope insertion was significantly better in the SU-1/EG-580UT group with respect to insertion into the piriform recess (P = 0.018), the pylorus ring (P < 0.001), and the superior duodenal angle (P < 0.001). Visibility during GI observation was also significantly better in the SU-1/EG-580UT group (P < 0.001) (Table 2). No complications were observed in either group (Table 2).

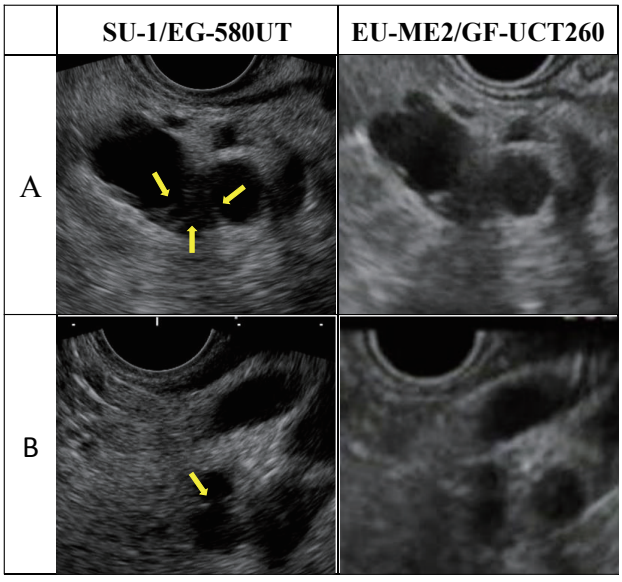

Fig. 5. Representative EUS imaging ~Septal wall~. Representative images from each EUS system depicting the septal wall of lesions. Three septal walls (A: arrows) and a septal wall (B: arrow) can be clearly recognized in the imaging by SU-1/EG-580UT, but in the imaging by EU-ME2/GF-UCT260, the septal wall cannot be discerned.
EUS, endoscopic ultrasonography.

Table 1. Patient demographics and lesion characteristics

Characteristics	n = 40
Age (years), median (range)	71.5 (38–85)
Male:Female, n	19:21
Final diagnosis	
PDAC, n (%)	20 (50)
P-NET, n (%)	3 (7.5)
GIST, n (%)	2 (5)
ML, n (%)	2 (5)
Others, n (%)	13 (32.5)
Location of lesions	
Pancreatic head/body/tail, n (%)	12 (30)/8 (20)/10 (25)
Hepatic hilar, n (%)	4 (10)
Others, n (%)	6 (15)
Diameter of lesions (mm), median (range)	23.3 (6–88.7)

GIST, gastrointestinal stromal tumor; ML, malignant lymphoma; PDAC, pancreatic adenocarcinoma; P-NET, pancreatic neuroendocrine tumor.

DISCUSSION

EUS and EUS-FNA are useful tools for the diagnosis of pancreatobiliary diseases with poor prognosis.[13] In this study, SU-1/EG-580UT was superior to EU-ME2/GF-UCT260 in all parameters examined.

Although ultrasound imaging device resolution is primarily evaluated based on lateral resolution,

Table 2. Comparison of parameters in each EUS scope/processor

		SU-1/EG-580UT	EU-ME2/GF-UCT260	*P*-value
Procedure duration (second), mean (S.D.)		1195 (± 392)	1130 (± 443)	0.442 *
		Grade 1/2/3/4/5, *n* (%)		
Drawability of lesions	Border	0 (0)/1 (2.5)/7 (17.5)/21 (52.5)/11 (27.5)	1 (2.5)/5 (12.5)/23 (57.5)/7 (17.5)/4 (10)	< 0.001†
	Internal echo	0 (0)/1 (2.5)/7 (17.5)/18 (45)/14 (35)	1 (2.5)/6 (15)/17 (42.5)/12 (30)/4 (10)	< 0.001†
Ease of scope insertion	Piriform recess	1 (2.5)/5 (12.5)/15 (37.5)/16 (40)/4 (10)	3 (7.5)/9 (22.5)/16 (40)/9 (22.5)/3 (7.5)	0.025†
	Pylorus ring	3 (7.5)/1 (2.5)/4 (10)/19 (47.5)/13 (32.5)	2 (5)/8 (20)/15 (37.5)/14 (35)/1 (2.5)	< 0.001†
	SDA	0 (0)/1 (2.6)/10 (26)/19 (50)/8 (21)	2 (5.3)/5 (13.2)/19 (50)/8 (21.1)/4 (10.5)	0.001†
Visibility in GI tract		0 (0)/0 (0)/11 (17.5)/21 (52.5)/8 (20)	1 (2.5)/13 (32.5)/20 (50)/6 (15)/0 (0)	< 0.001†
Complications		None	None	–

*paired *t* test †paired Wilcoxon singed rank test EUS, endoscopic ultrasonography; GI, gastrointestinal; SDA, superior duodenum angle.

Table 3. Specifications about SU-1/EG-580UT and EU-ME2/GF-UCT260

		SU-1/EG-580UR	EU-ME2/GF-UCT260
Endoscopic Functions	Field of view (°)	140	100
	Direction of view (°)	Forward oblique viewing 40	Forward oblique viewing 55
	Distal end hard portion diameter (mm)	40	45
	Distal end outer diameter (mm)	13.9	14.6
	Insertion tube outer diameter (mm)	12.4	12.6
	Angulation range (up/down/right/left) (°)	150/150/120/120	130/90/90/90
	Channel inner diameter (mm)	3.8	3.7
Ultrasound Functions	Frequency (MHz)	5/7.5/10/12	5/6/7.5/10/12
	Scanning range (°)	150	180
	Scanning Method	Electronic curved linear array	Electronic curved linear array

horizontal distance accuracy, and distance resolution, detailed data and mechanisms of EUS equipment as it relates to ultrasound imaging are considered proprietary and are not disclosed by the manufacturers. Therefore, understanding the improvement of ultrasound imaging quality from the detailed mechanism of EUS devices is difficult, but the 5-year period from the release of the EU-ME2/GF-UCT260 until the release of the SU-1/EG-580UT appears to be a sufficient period to improve the ultrasound imaging quality.

For scope insertion and visibility during direct observation, the visual field direction is more shallow with the SU-1/EG-580UT at 40° than with the EU-ME2/GF-UCT260 at 55°, and field of view is wider with the SU-1/EG-580UT at 140° than with the EU-ME2/GF-UCT260 at 100°, which, we believe, enabled GI tract observation under the visual field near the forward-viewing endoscope, explaining the favorable results of SU-1/EG-580UT (Table 3). While not considered in this study, one disadvantage of SU-1/EG-580UT is that the scope can easily become erroneously positioned in the stomach during examinations of the descending portion of the duodenum. This may be due to the fact that the hard, distal end of the scope is shorter on SU-1/EG-580UT than on EU-ME2/GF-UCT260. However, because this portion is short, the viewing direction becomes shallower and ease of insertion improves, by allowing for a better balance of the two portions.

According to the results of this study, all the problems associated with conventional EUS, like GI tract scope insertion and challenging ultrasound images interpretations for a diagnosis, can be overcome by using SU-1/EG-580UT. Moreover, by using SU-1/EG-580UT, we expect that EUS would become a more popular technique in the diagnosis of pancreatobiliary diseases. In fact, the current EUS proficiency level of new residents at our hospital is increasing at a quicker pace than prior to the introduction of SU-1/EG-580UT (unpublished data). This study has limitations worth noting. The scoring evaluations were subjective and evaluation criteria were not strictly defined. Further, this was a single-center study with a small sample size. In the future, an objective evaluation of these two systems in a large multicenter study would be useful in validating these findings.

SU-1/EG-580UT demonstrated superior performance compared to EU-ME2/GF-UCT260 during

ultrasonic endoscopic GI observation, operability, and ultrasonic image quality. We believe that the result of the superior ultrasound imaging quality of SU-1/EG-580UT EUS will aid in the identification of small pancreatic malignancies with unclear borders and prove useful in evaluating mural nodules of intraductal papillary mucinous neoplasm in detail. We hope these findings will result in an increased use of EUS and an improvement in the identification and prognosis of patients with pancreatobiliary diseases.

The authors declare no conflict of interest.

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