Forward-viewing versus oblique-viewing echoendoscopes in the diagnosis of upper gastrointestinal subepithelial lesions with EUS-guided fine needle aspiration: a prospective, randomized, crossover study

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Abstract

Background: The role of the forward-viewing echoendoscope compared with the oblique-viewing echoendoscope for endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) of upper gastrointestinal subepithelial lesions has not been defined.

Objective: To compare the diagnostic yield and clinical efficacy of EUS-FNA using the two echoendoscopes in the same upper gastrointestinal subepithelial lesion.

Design: Prospective, randomized, crossover study.

Setting: Tertiary medical center.

Patients: Forty-one patients with an upper gastrointestinal subepithelial lesion.

Interventions: All patients first underwent EUS-FNA with a 19-gauge needle using both echoendoscopes based on random selection. When required, 22- or 25-gauge needles were used additionally.

Main outcome measurements: Comparison of diagnostic yield, tissue sample area, puncture success rates, procedure time, and adverse events.

Results: Forty-one patients (median lesion size 22 mm; range 15-63 mm) were enrolled. Rates of histological diagnosis were 80.5% (33/41) and 73.2% (30/41) \( (P = 0.453) \) using forward and oblique-viewing echoendoscopes, respectively. Median tissue sample area in gastrointestinal stromal tumors \( (n=22) \) obtained with the forward-viewing echoendoscope was larger than with the oblique-viewing echoendoscope \( (2.46 \text{ mm}^2 \text{ vs. } 1.00 \text{ mm}^2; \ P = 0.046) \). Puncture success rates were 39/41 (95.1%) and 35/41 (85.4%), \( (P = 0.289) \) with forward and oblique-viewing echoendoscopes, respectively. Median procedure time was 21 min with the forward-viewing echoendoscope and 27 min with the oblique-viewing echoendoscope \( (P = 0.009) \). An infectious adverse event occurred in a patient and was treated with antibiotics.

Limitations: Small sample size.

Conclusions: Diagnostic yield did not differ between the two echoendoscopes. However, tissue sample area and procedure time was superior with the forward-viewing echoendoscope.
Main text
Most subepithelial lesions harbor a very low risk of progression. However, gastrointestinal stromal tumors (GISTs) have malignant potential, and surgical resection is recommended [1-5]. Endoscopic ultrasonography (EUS) is considered the first choice for evaluating subepithelial lesions and is used to differentiate GISTs from other subepithelial lesions [6-8]. However, a definitive diagnosis based on imaging alone is insufficient and tissue sampling is necessary [9-11]. Endoscopic ultrasound-guided fine-needle aspiration (EUS-FNA) has become an accurate method for obtaining tissue samples from upper gastrointestinal subepithelial lesions. In several retrospective studies, the diagnostic yield of EUS-FNA in upper gastrointestinal subepithelial lesions ranged from 43 to 91% [10,12-16]. At present, the oblique-viewing echoendoscope is the standard instrument for EUS-FNA. Recently, a new forward-viewing echoendoscope was developed to overcome the major disadvantages of the former instrument: lack of a forward endoscopic view and difficulty in fixing the target. The advantages of the forward-viewing echoendoscope for the treatment of pancreatobiliary disease were noted in several reports [17-25]. A few reports described the diagnostic accuracy of forward-viewing echoendoscopes compared with oblique-viewing echoendoscopes [20,23,26]. More recently, Larghi et al. reported extraordinary results using the forward-viewing echoendoscope for subepithelial lesions [27]. To date, a comparative study of forward-viewing and oblique-viewing echoendoscopes has not been reported. We therefore hypothesized that the forward-viewing echoendoscope would increase the diagnostic yield and facilitate EUS-FNA.

The aim of this study was to compare the diagnostic yield and clinical efficacy of EUS-FNA between the newly developed forward-viewing echoendoscopes and conventional oblique-viewing echoendoscopes for the same upper gastrointestinal subepithelial lesions.

Patients and Methods
This study was a prospective, randomized, crossover trial, and was conducted at the Nagoya University Hospital in Japan. Between January 2013 and May 2014, all 78 patients with upper gastrointestinal subepithelial lesions were examined with a radial scanner (GF-UM2000; Olympus Medical Systems Corp., Tokyo, Japan) before EUS-FNA.
The inclusion criterion for the study was the presence of an upper gastrointestinal subepithelial lesion. Exclusion criteria were as follows: age >80 y; tumor size <1.5 cm; diagnosis of lipoma, cyst, or ectopic pancreas by EUS; hemodynamic instability or
severe coagulopathy (international normalized ratio: INR >1.5 or platelet count <60000/ml), and lack of patient’s consent. This study was approved by the institutional review board of the Nagoya University (IRB No. 2012-0257), and written informed consent was obtained from all patients.

**Equipment**

*Echoendoscope*

All EUS procedures were performed by experienced endosonographers (I.M., R.M., K.F.) who had performed EUS for more than 200 upper gastrointestinal lesions using the newly developed forward-viewing echoendoscope (GIF-Y0007-UCT or TGF-UC260J; Olympus) and oblique-viewing echoendoscope (GF-UCT240AL-5; Olympus) (Table 1). These echoendoscopes were used with an ultrasound processor with color Doppler function (EU-ME1; Olympus). All patients underwent EUS-FNA with both echoendoscopes. The echoendoscopic order was selected randomly using computer-generated numbers.

*Forward-viewing echoendoscope*

The prototype forward-viewing echoendoscope (GIF-Y0007-UCT; Olympus) was used in 33 patients between January 2013 and January 2014, and the commercially available forward-viewing echoendoscope (TGF-UC260J; Olympus) was used in 8 patients between February and May 2014. Specifications for these echoendoscopes did not differ significantly (Table 1). The forward-viewing echoendoscopes were used with the attachment of a transparent hood (D-201-16403; Olympus) to the tip for fixing the lesion (Fig. 1). This echoendoscope provides a forward endoscopic view, allows device deployment along the axis of the scope, and has a larger tip angulation compared with the oblique-viewing echoendoscope. However, it has no elevator function for the accessory channel and has a narrower ultrasound scanning range.

*FNA needle*

The puncture was carried out using disposable 19-, 22- and 25-gauge puncture needles (EZ Shot2: NA-220H-8019, NA-220H-8022, NA-220H-8025; Olympus). EUS-FNA was basically performed using a 19-gauge needle. If the puncture was not successful within 3 tries, or the lesions were highly vascularized, a 22- or 25-gauge needle was used. The choice of needle size was left to the discretion of the endosonographers. If the needle had broken, including bending, or there was loss of handle maneuverability, a new needle of the same size was used.

**EUS-FNA procedure**

All patients were placed in the left lateral position under conscious or deep sedation
with intravenous anesthesia using midazolam and pentazocine. Once the originating layer and echo characteristics of the lesion were observed and color flow mapping was applied to avoid puncturing vessels, the needle was advanced into the lesion under EUS visualization. After the mass was punctured, the stylet was completely removed. The needle was positioned at different areas within the mass and 15 uniform to-and-fro needle movements were made with 20-ml syringe suction applied during each puncture session. The puncture needle was removed and the aspirated tissue samples were ejected into saline solution. The aspiration procedure was repeated until whitish tissue was obtained macroscopically, with a maximum of 3 passes in each echoendoscopy. If macroscopic examination determined that a sufficient specimen was present, the echoendoscope was changed and EUS-FNA was performed using the other echoendoscope. On-site pathologists were not present to determine the adequacy of specimens.

**Histological assessment**
Pathological results from EUS-FNA were categorized as diagnostic or non-diagnostic. The collected specimens were immediately placed in formalin and embedded in paraffin for histological examination. The pathological diagnosis was made on the basis of hematoxylin-eosin staining and immunopathological stains by expert pathologists (A.N., Y.S.) blinded to the echoendoscopes and needle size used. Cases with insufficient material for immunopathological diagnosis were included in the non-diagnostic group.

**Outcome measures**

*Primary endpoint: diagnostic yield*
The primary endpoint was comparison of diagnostic yield from EUS-FNA with the forward-viewing echoendoscope and oblique-viewing echoendoscope. If the yield was sufficient for a pathological diagnosis, the patient was classified as a diagnostic case while if the yield was insufficient the patient was classified as a non-diagnostic case. In some cases, puncture was unsuccessful.

*Secondary endpoints: clinical efficacy*

**Diagnostic accuracy**
Diagnostic accuracy was calculated after the EUS-FNA results were confirmed by additional available modalities, including surgical pathology, additional EUS-FNA, and biopsy with a thin endoscope. Technical failures and insufficient samples for histological evaluation were considered false negatives even if the final diagnosis was benign.

**Tissue sample area**
In GIST cases (n=22), the maximum total area of the specimen obtained with each echoendoscope was measured and compared under a photomicroscope using imaging software (cellSens; Olympus). Data were expressed as a median of lower quartile (LQ) and upper quartile (UQ) values (Fig. 2).

**Technical efficacy**

Total puncture success rates and success rate with 19-gauge needles were evaluated. Furthermore, the number of passes and procedure times were calculated. Procedure time was defined as the time from oral insertion of the endoscope to retrieval of the endoscope.

**Adverse events**

Adverse events were defined as any deviation from the clinical course after EUS-FNA as observed by endosonographers. All patients were contacted within 1 month of the procedure to assess if there were any late adverse events.

**Statistical analysis**

Continuous variables such as patients’ age and tumor size were reported as median and range. Comparisons of proportions such as diagnostic yield, diagnostic accuracy, and technical success were expressed as frequencies and proportions and were tested using the McNemar’s test. Furthermore diagnostic yield in relation to endoscopic order was tested using the Fisher’s exact test. Tissue sample area, number of passes, and procedure time were reported as median and interquartile range and tested with the Wilcoxon signed-rank test. P value <.05 was considered statistically significant. Based on an anticipated diagnostic yield by EUS-FNA of 90% for forward-viewing echoendoscopes and 70% for oblique-viewing echoendoscopes, we calculated that 40 patients would be needed to detect significant differences (P < .05) with 80% power. SPSS software version Statistics20 (SPSS Inc., Chicago, IL, USA) was used for statistical analysis.

**Results**

During this study period, 78 patients with upper gastrointestinal subepithelial lesions were identified as potentially eligible for participation. Thirty-seven patients were excluded for the following reasons: age >80 y (n=3), lesion <1.5 cm (n=20), cyst (n=4) and ectopic pancreas (n=6) diagnosed by EUS, and lack of patient consent (n=4). Thus, 41 patients were enrolled in this study and underwent EUS-FNA with both echoendoscopes. Based on random selection, 21 patients underwent the procedure first with the forward-viewing echoendoscope (Fig. 3). There were 21 males and 20 females, and the median age was 64 y (range 25-80 y). Tumor locations were esophagus, 7 cases; stomach, 32 cases; and duodenum, 2 cases. The median tumor size was 22 mm (range
The layers of origin were the submucosa, 2 cases; muscularis propria, 38 cases; and undetermined, 1 case (Table 2). All of the tumors were endoscopically apparent within the lumen of the gastrointestinal tract.

The overall rates of histological diagnosis using the forward-viewing and oblique-viewing echoendoscopes were 80.5% (33/41) and 73.2% (30/41), respectively, a difference that was not significant (Table 3). Furthermore, in relation to endoscopic order, the diagnostic yield using the forward-viewing echoendoscope firstly and secondly were 81.0% (17/21) and 80.0% (16/20) ($P = 1.000$), respectively, and the diagnostic yield using oblique-viewing echoendoscope firstly and secondly were 85.0% (17/20) and 61.9% (13/21) ($P = 0.273$), respectively. The combined results of forward-viewing and oblique-viewing echoendoscopes established the diagnosis in 35 of 41 (85.4%) lesions. The histologic results of EUS-FNA with both echoendoscopes were GIST (n = 22), leiomyoma (n = 9), carcinoma (n = 1), malignant lymphoma (n = 1), ectopic pancreas (n = 2), and non-diagnostic (n = 6) including spindle cell tumor (n = 2). Details of the 4 indeterminate cases are provided below.

In one patient, a 16 mm leiomyoma was located in the cardia and the lesser curvature and was diagnosed by repeat EUS-FNA. The second lesion was highly vascularized and located in the second portion of the duodenum. The bite-on-bite forceps technique allowed the diagnosis of a GIST. The third lesion was 15 mm and located in the forix and greater curvature, and was resected laparoscopically with the final diagnosis of a GIST. The fourth case had an esophageal stricture due to a tumor. Puncture could be performed with the forward-viewing echoendoscope, but the materials obtained were insufficient. Bite-on-bite forceps technique using a thin endoscope allowed the diagnosis of a tubular adenocarcinoma.

At the time of the current follow-up, a definitive diagnosis was established in 22 of the 41 cases: surgical pathology in 20 GIST cases, additional EUS-FNA in 1 leiomyoma case and biopsy with a thin endoscope in 1 carcinoma case. Among the 19 remaining cases for whom there was not a definitive diagnosis, one GIST case underwent tyrosine-kinase inhibitor treatment and a metastasis of breast cancer was treated by chemotherapy and esophageal mucosa-associated lymphoid tissue was treated by radiation therapy. Tumors in the other 16 cases, including 3 GIST cases, did not show changes in size during a median follow-up of 11 months (range 3-18 months). In 17 of the 22 patients in which an EUS-FNA diagnosis with the forward-viewing endoscope was made a definitive diagnosis was confirmed while in the 16 cases that were diagnosed using the oblique-viewing echoendoscope, a definitive diagnosis was confirmed. The diagnostic accuracy of the forward-viewing echoendoscope was not
significantly different from that of the oblique-viewing echoendoscope (Table 3).
The total median tissue sample area in the GIST cases (n=22) obtained with the forward-viewing echoendoscope was significantly larger than that obtained with the oblique-viewing echoendoscope, 2.46 mm² and 1.00 mm² (P = 0.046), respectively (Fig. 4). Furthermore, total puncture success rates were 39/41 (95.1%) and 35/41 (85.4%) (P = 0.289), and the 19-gauge needle puncture success rates were 29/41 (70.7%) and 24/41 (58.5%) (P = 0.180) using the forward-viewing and oblique-viewing echoendoscopes, respectively. Significant differences were not found (Table 3). In all cases of total puncture failure, puncture was successful using the alternative echoendoscope.

With regard to puncture failure, puncture could not be performed by the forward-viewing echoendoscope in 2 patients, one with a 16 mm lesion in the cardia and lesser curvature and the other with a hypervascular tumor in the duodenum. With the oblique-viewing echoendoscope the tumor could not be visualized in 3 patients, 2 with esophageal stricture due to a tumor and scarring from endoscopic submucosal dissection and 1 with a cervical esophageal lesion. In another 3 cases the tumors were <20 mm and were visualized on the puncture route before the needle was passed into the accessory channel; however, puncture was impossible due to the strong resistance encountered when the needle was advanced with the oblique-viewing echoendoscope.

Median number of passes was 2 (P = 0.212) with both the forward viewing echoendoscope and the oblique-viewing echoendoscope. The median procedure times were 21 min with the forward-viewing echoendoscope and 27 min with the oblique-viewing echoendoscope (P = 0.009) and the median procedure times in cases in which puncture was successful with a 19-gauge needle (n=22) were 17 min with the forward-viewing echoendoscope and 25 min with the oblique-viewing echoendoscope (P = 0.004) (Table 3). An infectious adverse event occurred in a patient with an esophageal leiomyoma who developed a fever 2 days after EUS-FNA. Computer tomography showed a possible abscess in the tumor. This case was treated successfully with broad spectrum antibiotics.

Discussion
This is the first prospective, randomized, crossover trial comparing the forward-viewing echoendoscope and oblique-viewing echoendoscope for EUS-FNA of upper gastrointestinal subepithelial lesions. Differences in diagnostic yields were not found between the two echoendoscopes. However, the tissue sample area in GIST cases was larger and the procedure time was shorter with the forward-viewing echoendoscope than with the oblique-viewing echoendoscope with statistical significance.
Subepithelial lesions comprise a diverse group of histologic diagnoses, including benign or potentially malignant lesions [3,4]. EUS is considered the first choice for evaluation of subepithelial lesions in the upper gastrointestinal tract [6,7,8]. Therefore, definitive histology is important to guide further management [9-11]. Furthermore, certain neoplasms such as lymphomas and gastrointestinal stromal tumors are usually difficult to assess by evaluation of cytologic material and often require histologic confirmation for a definitive diagnosis [28]. Because a biopsy examination by conventional forceps is not helpful in most cases, jumbo biopsy forceps and bite-on-bite forceps techniques have been reported. However, the diagnostic yields were low and most lesions were located in the submucosa, with significant bleeding occurring that required endoscopic hemostasis [29-32]. On the other hand, some techniques using endoscopic mucosal resection and endoscopic submucosal dissection are thought to be useful for obtaining a histological diagnosis even with small lesions. However, it might be more difficult to obtain tissue from a lesion located in extraluminal regions [29,33-35]. Recently, new endoscopic resection techniques, including laparoscopic endoscopic cooperative surgery [36], endoscopic full-thickness resection, and endoscopic submucosal tunnel dissection were developed. These techniques are safe and effective for small GISTs [37-40].

EUS-FNA is an accurate method for obtaining histopathological specimens, including those for immunopathological diagnosis, from upper gastrointestinal subepithelial lesions [9,10,12]. Gastric lesions <2 cm appear to have a low risk of malignant behavior and may be considered for EUS surveillance without resection [1,2,5]. However, rapid growth of such tumors was also reported and accurate prediction remains difficult [41]. Management strategies, including tissue sampling of subepithelial lesions <2 cm, may need to be revised [27]. Therefore, tumors <20 mm (n=15) were included in our study.

In several retrospective studies, the diagnostic yield of EUS-FNA with the use of a 22-gauge needle ranged from 43 to 91% [10,12-16]. To increase the yield of histological specimens, the Tru-cut needle (Quick-Core; Wilson-Cook Medical Inc., Winston-Salem, NC, USA) was developed. Moderate diagnostic yields of 63-90% were found by several studies [42-47]. The Tru-cut needle might be suitable to puncture larger lesions because the needle tray is designed to advance at least 20 mm into the lesion. Recently, a forward-viewing echoendoscope was developed to facilitate the EUS-FNA procedure. Several studies have reported the advantages of the forward-viewing echoendoscope for the diagnosis and treatment of pancreaticobiliary disease and celiac plexus neurolysis [17-26]. The advantage of the forward-viewing echoendoscope is that the target is
punctured in a straight line with the endoscope and the puncture site can be readily visible, especially in the pancreatic head from the bulb and the pancreatic uncinate and ampulla from the second portion of the duodenum [17-27]. Also, our results showed that the use of the forward-viewing echoendoscope facilitated the puncture of lesions associated with strictures by lesions and of lesions that were located at the fornix, which are sites difficult to access with the oblique-viewing echoendoscope. In addition, attaching a transparent hood to the tip was shown to expand the capabilities of the endoscope by fixing the target, especially small gastrointestinal subepithelial lesions [48]. In our study, the transparent hood was used in almost all cases except for the esophageal stricture due to scarring, and good fixation between the target and endoscope was obtained. On the other hand, the distal end of the outer diameter of the forward-viewing echoendoscope was larger than that in the oblique-viewing echoendoscope. However, the forward endoscopic view allowed a safe esophageal insertion and ease in detection of the lesion.

A large-caliber needle may help overcome the limitation of a 22-gauge needle by acquiring a larger tissue sample. On the other hand, the increased diameter of the needle made penetration of subepithelial lesions more difficult [49]. To resolve this problem, from the recent study by Larghi et al., it was suggested that the forward-viewing echoendoscope and 19-gauge needle was a good combination [27]. Histological assessment, including immunostaining, could be completed in 93.4% (113/121) of the patients. Twenty-seven lesions (22.3%) had a mean diameter of 14 mm (range 7-19). A definitive diagnosis could be made in 22 of these patients (81.5%). In our study, the overall rates of histological diagnosis were 80.5%, 73.2%, and 85.4% of all lesions using the forward-viewing, oblique-viewing, and both echoendoscopes, respectively. If cytological assessments were made and on-site pathologists were available, the overall diagnostic yield might have been higher.

Small tumor size was thought to be one of the factors related to a nondiagnostic result of EUS-FNA [13, 15, 27]. The design of the forward-viewing echoendoscope with the frontal exit of the needle and a transparent hood allowed for fixing the target, especially small and mobile lesions [27,48]. There was no resistance when a mass was punctured, which enabled back-and-forth movement of the needle within the mass easily with the forward-viewing echoendoscope. However, significant differences in puncture success rates were not found between forward-viewing and oblique-viewing echoendoscopes in our study. Our study clarified that in GIST cases larger samples were obtained with the forward-viewing echoendoscope than with the oblique-viewing echoendoscope and the procedure time was shorter. A larger tissue sample area would be theoretically useful to
increase diagnostic yield including that for immunopathological diagnosis. However, significant differences in diagnostic yields were not found between forward-viewing and oblique-viewing echoendoscopes. Furthermore, detecting the target with a forward endoscopic view might be easier than with an oblique endoscopic view.

On the other hand, because of lack of an elevator function, it is difficult in some cases to penetrate different areas in a tumor, the so-called fanning technique, with a forward-viewing echoendoscope compared to the oblique-viewing echoendoscope. As a result, some of specimens might include unsuitable materials, like a blood clot [50].

In this study, on-site pathologists were not present during the procedure to verify the adequacy of specimens as in the study of Larghi et al. There were methodological differences between our study and theirs: the type of FNA needle, number of to-and-fro needle movements, pressure of syringe suction, and use or non-use of a transparent hood [27]. Nevertheless, the tumors in our study were relatively small and diagnostic yields were modest although useful. For adequate tissue acquisition, the combination of a forward-viewing echoendoscope and a 19-gauge needle would be reasonable.

The main risks related to the use of a 19-gauge needle are hemorrhage and infectious adverse events. Actually, we experienced only self-limited hemorrhages. In our study, one patient had fever and was treated with broad spectrum antibiotics. Similarly, severe septic adverse events were reported using the Tru-cut needle with a 19-gauge needle [43,45,49]. Peri-interventional antibiotics might be recommended.

There are a few limitations to this study. One is the small sample size, and the lack of a definitive diagnosis to confirm the findings of EUS-FNA in a major portion of cases.

In conclusion, differences in diagnostic yields were not confirmed between forward-viewing and oblique-viewing echoendoscopes. However, this study clearly demonstrated that the tissue sample area and procedure time of EUS-FNA with the forward-viewing echoendoscope were better than those with the oblique-viewing echoendoscope in upper gastrointestinal subepithelial lesions.
Fig. 1 Forward-viewing echoendoscope with a transparent hood and 19-gauge needle.

Fig. 2 Example of gastrointestinal stromal tumor. Area of specimen measured under a photomicroscope using imaging software. (hematoxylin and eosin, mag. ×40)

Fig. 3 Flow chart of the prospective, randomized, crossover study design.
Fig. 4  Representative case of a gastrointestinal stromal tumor. A, Endoscopy showing subepithelial lesion in the lower body of stomach. B, Endoscopic ultrasound image with radial scanner. The hypoechoic tumor was 17 mm and had a heterogeneous echo pattern, irregular border, and was localized in the muscularis propria. C, Puncture of the tumor under direct endosonographic visualization with a 19-gauge needle using the forward-viewing echoendoscope. D, Puncture of the tumor with 22-gauge needle using the oblique-viewing echoendoscope. E, Abundant tissue fragments were obtained using
the forward-viewing echoendoscope (hematoxylin and eosin, mag. ×40). F. Small tissue fragments were obtained using the oblique-viewing echoendoscope (hematoxylin and eosin, mag. ×40).

Table 1. Specifications of the forward-viewing echoendoscope and oblique-viewing echoendoscope

<table>
<thead>
<tr>
<th>Endoscope details</th>
<th>Forward-viewing echoendoscope</th>
<th>Oblique-viewing echoendoscope</th>
</tr>
</thead>
<tbody>
<tr>
<td>GIF-Y0007-UCT</td>
<td>TGF-UC260J</td>
<td>GF-UCT240AL-5</td>
</tr>
<tr>
<td>Distal end outer diameter (mm)</td>
<td>14.2 (16.7*)</td>
<td>14.6 (16.7*)</td>
</tr>
<tr>
<td>Insertion tube outer diameter (mm)</td>
<td>11.8</td>
<td>12.6</td>
</tr>
<tr>
<td>Channel inner diameter (mm)</td>
<td>3.7</td>
<td>3.7</td>
</tr>
<tr>
<td>Elevator</td>
<td>Not available</td>
<td>Not available</td>
</tr>
<tr>
<td>Angulation range (degree)</td>
<td>180/100</td>
<td>180/90</td>
</tr>
<tr>
<td>Right/Left</td>
<td>100/100</td>
<td>90/90</td>
</tr>
<tr>
<td>Possible US frequencies (MHz)</td>
<td>5, 6, 7.5, 10, 12</td>
<td>5, 6, 7.5, 10, 12</td>
</tr>
<tr>
<td>Scanning range (degree)</td>
<td>90</td>
<td>90</td>
</tr>
</tbody>
</table>

*size of transparent hood (D-201-16403)

Table 2. Patients’ characteristics and indications for the performance of EUS-FNA

<table>
<thead>
<tr>
<th>Patients’ characteristics</th>
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<tbody>
<tr>
<td>N (male/female)</td>
<td>41 (21/20)</td>
</tr>
<tr>
<td>Age, median (range), y</td>
<td>64 (25-80)</td>
</tr>
<tr>
<td>Tumor location</td>
<td></td>
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<tr>
<td>Esophagus, no.</td>
<td>7</td>
</tr>
<tr>
<td>Stomach, no.</td>
<td></td>
</tr>
<tr>
<td>Upper/middle/lower</td>
<td>32</td>
</tr>
<tr>
<td>AW/PW/LC/GC</td>
<td>24/7/1</td>
</tr>
<tr>
<td>Duodenum, no.</td>
<td>5/6/10/11</td>
</tr>
<tr>
<td>Tumor size on EUS, median (range), mm</td>
<td>22 (15-63)</td>
</tr>
</tbody>
</table>
Wall layer of origin on EUS

| Submucosa/Muscularis propria/Undetermined | 2/38/1 |

**Abbreviations:** LC, lesser curvature; PW, posterior wall; GC, greater curvature; AW, anterior wall

Table 3. Outcome of EUS-FNA

<table>
<thead>
<tr>
<th></th>
<th>Forward-viewing echoendoscope</th>
<th>Oblique-viewing echoendoscope</th>
<th>P value</th>
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</thead>
<tbody>
<tr>
<td>Diagnostic yield, no. (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>33/41 (80.5%)</td>
<td>30/41 (73.2%)</td>
<td>0.453</td>
</tr>
<tr>
<td>Tumor &lt;20 mm</td>
<td>12/15 (80.0%)</td>
<td>11/15 (73.3%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Diagnostic accuracy, no. (%)</td>
<td>17/22 (77.2%)</td>
<td>16/22 (72.7%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Tissue sample area*, median, (IQR), mm²</td>
<td>2.46 (0.908-8.095)</td>
<td>1.00 (0.477-4.764)</td>
<td>0.046</td>
</tr>
<tr>
<td>Puncture success, no. (%)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>39/41 (95.1%)</td>
<td>35/41 (85.4%)</td>
<td>0.289</td>
</tr>
<tr>
<td>Tumor ≥20 mm</td>
<td>25/26 (96.2%)</td>
<td>23/26 (88.5%)</td>
<td>0.625</td>
</tr>
<tr>
<td>Tumor &lt;20 mm</td>
<td>14/15 (93.3%)</td>
<td>12/15 (80.0%)</td>
<td>0.625</td>
</tr>
<tr>
<td>19 gauge</td>
<td>29/41 (70.7%)</td>
<td>24/41 (58.5%)</td>
<td>0.180</td>
</tr>
<tr>
<td>Tumor ≥20 mm</td>
<td>20/26 (76.9%)</td>
<td>19/26 (73.1%)</td>
<td>1.000</td>
</tr>
<tr>
<td>Tumor &lt;20 mm</td>
<td>9/15 (60.0%)</td>
<td>5/15 (33.3%)</td>
<td>0.219</td>
</tr>
<tr>
<td>Number passes, median, (IQR)</td>
<td>2 (2-3)</td>
<td>2 (1-3)</td>
<td>0.212</td>
</tr>
<tr>
<td>Procedure time, median, (IQR), min</td>
<td>21 (15-30)</td>
<td>27 (17-35)</td>
<td>0.009</td>
</tr>
<tr>
<td>Procedure time, 19 gauge puncture success cases, median, (IQR), min</td>
<td>17 (13-31)</td>
<td>25 (16-33)</td>
<td>0.004</td>
</tr>
</tbody>
</table>

*Tissue sample area was measured in GIST cases.

**DISCLOSURE**

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