A preferable modality for the differentiation of peripancreatic fluid collections: Endoscopic ultrasound

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ABSTRACT

Background and Objectives: Peripancreatic fluid collections (PFCs), including walled-off necrosis (WON) and pancreatic pseudocysts (PPCs), are categorized by imaging modalities, including EUS, computed tomography (CT), and magnetic resonance imaging. Our study aimed to evaluate the effectiveness of EUS in differentiating PFCs compared with that of other modalities. **Subjects and Methods:** Data were collected retrospectively from 99 patients at fourteen centers who were recruited to undergo lumen-apposing metal stent placement to treat PFCs. **Results:** PFCs were detected by CT and EUS in 51 WON and 48 PPC patients. The accuracy in differentiating PFCs by EUS was much higher than that of CT (90.9% *vs.* 50.5%, *P* < 0.001). The accuracy in identifying WON on EUS was much higher than that on CT (82.4% *vs.* 13.7%, *P* < 0.001), while the accuracy in identifying PPC was comparable in these two modalities (89.6% *vs.* 100%, *P* > 0.05). WON patients required more times of debridement than PPC patients (*P* < 0.001). **Conclusion:** EUS can categorize symptomatic PFCs with higher accuracy than CT and is a preferred imaging modality to detect solid necrotic debris.

Key words: accuracy, computed tomography, EUS, solid necrotic debris

INTRODUCTION

The increasing incidence rates combined with the diminished mortality of acute pancreatitis have led to its increased prevalence and hospitalization in the population over the last few decades.[1] As a potentially life-threatening disease, acute pancreatitis is usually associated with systematic and local complications. According to the 2012 Atlanta classification of acute pancreatitis, peripancreatic fluid collections (PFCs),

including pancreatic pseudocysts (PPCs) and walled-off necrosis (WON), are well-recognized local complications that frequently occur more than 4 weeks after the onset of pancreatitis.[2] A PPC is defined as an encapsulated collection containing no solid material, whereas WON is defined as an encapsulated collection of liquid content with varying amounts of nonliquefied necrotic debris.[3]

It is important to differentiate between PPCs and WON, as this has implications for management.[4] Compared with PPCs, more aggressive therapeutic interventions should be conducted in WON due to its morphological features.[5] Specific methods have been applied to address collections according to the different amounts of debris and fluid, such as surgical or endoscopic necrosectomy with the placement of lumen-apposing metal stents (LAMSs) or plastic stents, whereas a PPC can be treated with drainage alone.[6]

Although the presence of severe complications, including organ failure and sepsis, may indicate WON instead of a PPC, severe complications alone are impractical or unreliable.[7] In addition, the clinical symptoms of PFCs vary from person to person because of the different sizes and locations of the lesions. Appropriately, half of the patients may be asymptomatic and rarely require further interventions.[8] Thus, differentiating PPC formation from WON may be difficult based on clinical grounds.[9]

The widespread availability of cross-sectional imaging modalities, such as computed tomography (CT) and magnetic resonance imaging (MRI), has been recommended to be the most effective examination in the perioperative procedure.[10] Currently, CT has become the most commonly obtained test for detection and plays a pivotal role in evaluating the extent and evolution of PFCs.[11] However, the accuracy of cross-sectional imaging modalities in differentiating PPC from WON is not sufficiently high to provide a reliable outcome.[12]

EUS is an inexpensive and complementary modality and has generally emerged to evaluate the morphological features of PFCs.[13] It is mainly used to localize the blood vessels surrounding the cyst and is essential to confirm the optimal puncture site during EUS-guided drainage.[14] It has also been reported to be an accurate investigation for evaluating solid contents.[15] However, the true accuracy in categorizing PFCs is rarely reported. We performed a study to evaluate and compare the diagnostic performance of EUS and CT in patients with symptomatic PFCs.

SUBJECTS AND METHODS

Study participants
This retrospective study comprised ninety-nine patients whose data were collected from fourteen centers. From August 2018 to January 2021, the data of our study were obtained from a prospective study registered at Clinical Trials Government in January 2017 (Identifier: NCT03027895). All the enrolled patients had already been diagnosed with documented PFCs on CT and/or MRI and showed clinical symptoms. Fourteen centers used the same criteria to enlist the participants. The inclusion criteria were as follows: (1) An age range from 18 to 75 years; (2) Cross-sectional imaging suggesting PFCs before registration; and (3) A diameter of PFC equal to or >6 cm. The exclusion criteria were as follows: (1) Intolerance to or uncooperative history of gastrointestinal endoscopy; (2) a cyst located next to great vessels or aneurysms; (3) coagulation inability or bleeding tendency; and (4) pregnancy or readiness to conceive. Informed written consent was obtained from every patient before the procedure.

Study design
All the participants had carefully undergone secondary cross-sectional imaging to ensure the correct diagnosis of PFCs. The results of cross-sectional imaging, CT or MRI originated only from the last perioperative imaging examinations of self-centers. Linear EUS (GF-UCT260, Olympus, Japan) was performed with the patient in the left lateral decubitus position under conscious sedation with intravenous midazolam. All EUS procedures were performed by experienced endosonographers. On EUS, the detailed morphology, particularly the presence of solid necrotic debris, was obtained and recorded [Figure 1]. The echogenic material was suggestive of nonliquefied contents. Two endosonographers diagnosed WON or PPC according to EUS observations. The participants had undergone LAMS placement by experienced endoscopists, and morphological features of the PFCs were captured by the inserted endoscope [Figures 2 and 3]. The gold standard diagnostic criterion for PFCs was based on the direct observation of the presence of necrotic debris.

Statistical analysis
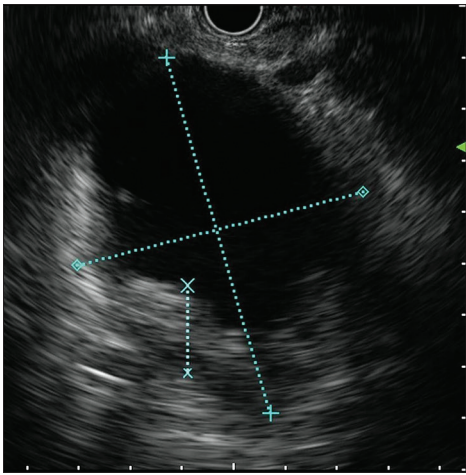Categorical variables were presented as numbers and percentages, and continuous variables were presented

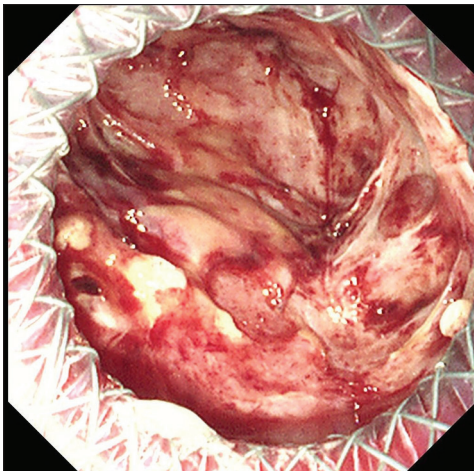**Figure 1.** Typical EUS image of walled-off necrosis with solid contents

Figure 2. Morphological features of pancreatic pseudocysts under direct endoscopic observation
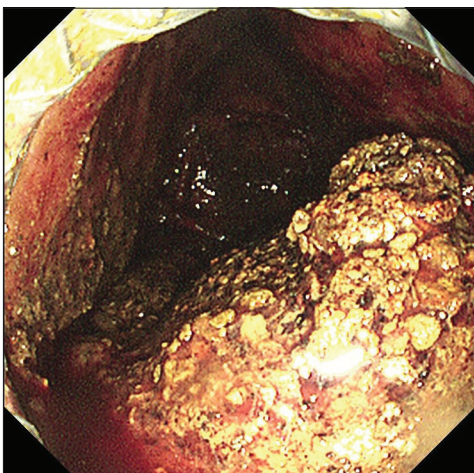

Figure 3. Morphological features of walled-off necrosis under direct endoscopic observation

as means ± standard error. The distribution of categorical variables was summarized using frequencies and percentages. Fisher's exact test or the Chi-squared test was performed to evaluate associations between categorical variables, and $P < 0.05$ was considered statistically significant. The Spearman rank correlation coefficient was used to evaluate the correlation between the diagnosis of WON and the finding of solid necrotic debris. Continuous variables were compared using Student's *t*-test. All the analyses were performed using SPSS Statistics software (version 25.0; IBM Corporation, Armonk, NY, USA).

RESULTS

Basic characteristics of the patients

Ninety-nine patients with perioperative imaging indications for PFCs were included in our study, with a mean age of 45.12 ± 11.46 years (range from 20 to 69). Of these, 71 were male with a mean age of 45.10 ± 11.76 years, and 28 were female with a mean age of 45.18 ± 10.88 years. On direct visualization by endoscopy, 51 patients were finally categorized as having WON, while 48 patients with liquid contents alone were identified as having PPCs [Table 1].

All the patients had undergone CT during the perioperative period at each center. The CT images of 85 patients (85.9%) indicated PPCs, and eight patients (8.1%) were identified as exhibiting WON. The remaining six patients (6.1%) were categorized as having other pancreatic or peripancreatic diseases, such as severe acute pancreatitis and cystadenoma (comprehensive evidence suggested PFCs). Only six patients had received MRI. The collections were classified as PPCs in two patients (33.3%) and WON in four patients (66.7%). Based on the visual estimation by the two experienced endosonographers, all the collections were categorized. Among them, 57 (57.6%) collections were recognized as PPCs, whereas 42 (42.4%) collections were recognized as WON. Of the latter, 39 (92.9%) cases were considered to have perceptible necrotic debris.

The comparison between EUS and other imaging modalities

Based on the endoscopic diagnostic data, the CT scans of seven patients were correctly identified as WON with an extremely low accuracy of 13.7%, while the CT scans of 43 patients were accurately categorized as PPCs with an accuracy of 89.6% [Table 2]. According to the MRI outcomes, 4 collections (66.7%) were identified with the correct classification. The agreement in identifying PFCs was higher on EUS

Table 1. Patient characteristics and the results of imaging modalities (*n*=99)

Characteristics	Value
Median age	45.12±11.46 (20-69)
Sex, male/female	71/28
CT modality (*n*=99)	
PPC	85
WON	8
Others	6
MRI modality (*n*=6)	
PPC	2
WON	4
Others	0
EUS (*n*=99)	
PPC	57
WON	42
Others	0

CT: Computed tomography; PPC: Pancreatic pseudocyst; WON: Walled-off necrosis

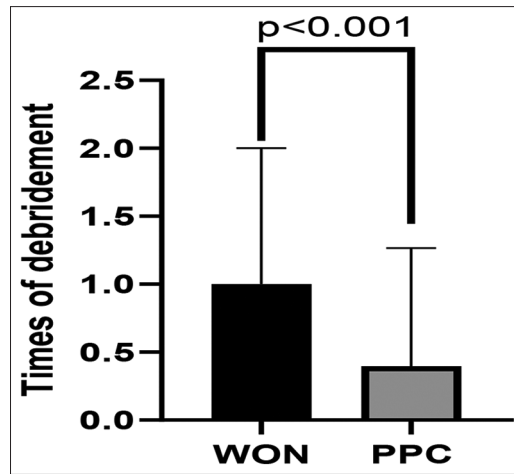## Table 2. Comparison of the diagnostic accuracy of computed tomography and EUS for peripancreatic fluid collections

	Accuracy of CT (%)	Accuracy of EUS (%)	*P*
PFCs (*n*=99)	50.5	90.9	<0.001
WON (*n*=51)	13.7	82.4	<0.001
PPC (*n*=48)	89.6	100	>0.05

CT: Computed tomography; PFCs: Peripancreatic fluid collections; WON: Walled-off necrosis

Graph 1. Comparison of the debridement times between walled-off necrosis and pancreatic pseudocyst

Endoscopy.[17] In this retrospective study of 99 patients from 14 centers, we compared the accuracy of CT and EUS in differentiating WON from PPCs in patients with PFCs assessed by endoscope visualization.

In our study, the accuracies of the two modalities in identifying PPC were similar. CT plays a critical role in evaluating the efficacy and timely detection of complications. Collections organized within a radiologically perceptible wall are termed PPCs in the delayed phase (>4 weeks) of initial acute pancreatitis. However, a small subset of WON comprising essential minimal solid debris may show similar imaging performance to other cystic lesions of the pancreas, such as cystadenoma, frequently resulting in misdiagnoses.[18,19] In our WON patients, the accuracy of CT images was extremely poor, likely because of challenges in detecting solid necrotic debris. Although only six patients had undergone MRI, it showed a better differentiation ability than CT, as reported in the current study.[20]

Characterized by high sensitivity to density change, EUS was shown to be the most accurate imaging modality to identify pancreatic or peripancreatic collections,[21] as demonstrated in our study. Simultaneously, solid debris detection was efficient in differentiating WON from PPCs on EUS. Recommended to be performed before the endoscopic cystogastrostomy procedure, EUS has been generally used to measure the size and localize the surrounding vessels; the latter aspect is indispensable to confirm the optimal puncture site and prevent intraoperative bleeding.[22] In addition, EUS is an available and inexpensive imaging modality that can accurately estimate the presence of solid necrotic debris,

than on CT (90.9% *vs.* 50.5%, *P* < 0.001). Of the 51 WON patients, EUS was able to identify 42 patients compared to seven patients on CT (82.4% *vs.* 13.7%, *P* < 0.001), whereas all 48 patients with PPC were well characterized with high accuracy by EUS and CT (100% *vs.* 89.6%, *P* > 0.05). On EUS, solid necrotic debris was detected correctly in 39 patients with WON and 49 patients with PPCs (total accuracy: 88.9%). The classification of PFC patients and solid necrotic debris detected by EUS was statistically correlated (*P* < 0.001). The times of debridement were higher in the WON patients than in the PPC patients [Graph 1].

DISCUSSION

Accurate differentiation of PFCs is significant so that an optimal treatment plan can be arranged to limit complications, minimize the duration of disability, and decrease the PFC recurrence rates.[16] PPCs characterized by essentially liquid contents may be treated with drainage alone, whereas WON containing a mixture of fluid and necrotic debris may require drainage along with endoscopic or percutaneous necrosectomy according to the guidelines of the European Society of Gastrointestinal

which may have implications for drainage.[23] In our study, the debridement times in WON were higher than those in PPCs, which confirmed this fact.

Our study is not meant to recommend EUS as an alternative to CT to differentiate PFCs because EUS is a relatively invasive approach and may induce discomfort during the procedure. The present findings confirm the using EUS to assess PFCs when transluminal endoscopic drainage or a percutaneous approach is arranged. An accurate estimate of the percentage of necrotic debris may affect drainage efficiency.[24] Therefore, physicians can contemplate a package of treatment plans.

The advantages of this study are as follows: the eventual diagnostic results were much more reliable because they originated from direct endoscopic visualization. The main disadvantage of this study is that the outcomes of the CT modalities were all obtained from clinical documents at 14 centers, which may not have been scrutinized by experienced radiologists, whereas EUS was performed by experienced endosonographers. The diagnostic criteria of CT might vary from one unit to another. However, the current findings reflect the real diagnostic ability of CT in the clinic. Furthermore, few patients have undergone MRI, and the diagnostic documents were not comparable.

CONCLUSION

EUS can categorize symptomatic PFCs with higher accuracy than CT and is superior for detecting solid necrotic debris and collaterals of PFCs. Thus, EUS may be helpful in determining the drainage methods and times of debridement.

Conflicts of interest
Enqiang Linghu is an Associate Editor of the journal. The article was subject to the journal's standard procedures, with peer review handled independently of this editor and his research groups.

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