# Pitfalls in interventional EUS procedures and coping strategies for endoscopy assistants (with video)

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## ABSTRACT

In recent years, the application of EUS in the diagnosis and treatment has become increasingly popular due to the rapid technological advancements in this field. With the application of new technologies, EUS assistants encounter various problems or "pitfalls" during clinical operations, which may pose challenges to the successful completion of relevant procedures. For example, a needle tip may not be visualized by ultrasonography during EUS-FNA; a stiff fine needle may not be introduced through the working channel of the endoscope in the duodenum, and withdrawal of a guidewire in a needle may be associated with tearing and peeling of the guidewire in EUS-guided biliary drainage. In view of these commonly encountered problems, this article summarizes the countermeasures that EUS assistants can take for EUS-FNA and EUS-guided drainage to improve the efficiency of the procedures and reduce the occurrence of adverse events.

**Key words:** adverse event, complication, endoscopic assistant, interventional EUS

## INTRODUCTION

Recently, EUS has developed rapidly and is widely used in the clinical diagnosis and treatment.[1,2] In clinical practice, especially when interventional diagnosis and treatment of the hepatobiliary and pancreatic systems of the digestive tract are required under EUS guidance, improper operation may directly lead to failure of diagnosis and treatment. To avoid adverse events in the diagnosis and treatment process, the operator needs to be cautious and precise, and cooperation with the assistant is extremely critical. This article focuses on the difficulties faced by endoscopic assistants while performing EUS interventions and the response measures needed to avoid complications.

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## PITFALLS AND COUNTERMEASURES IN EUS-FNA

### *Outer sheath of the puncture needle not passing through the echoendoscope-working channel*

Although it is easier to perform transgastric puncture for pancreatic lesions, EUS-FNA through the duodenum is currently recommended.[3-5] Because the duodenum is within the scope of pancreaticoduodenectomy, surgical resection is possible even if puncture-tract seeding occurs after duodenal puncture. During duodenal EUS-FNA, the head of the pancreas is punctured through the duodenum. Since a puncture needle negotiates many bends from the oral cavity to the duodenum, the outer sheath of the puncture needle sometimes cannot pass through the working channel of the echoendoscope. In such situations, the assistant often tries to withdraw the needle repeatedly, which causes the outer sheath of the puncture needle to damage the working channel. Therefore, after an EUS-FNA procedure, the assistant should carefully check for any possible damage to the echoendoscope.

If the puncture needle cannot reach the duodenum, the echoendocope should be withdrawn to the antrum. Further, to avoid damage to the pylorus, the outer sheath of the needle should not be pushed out to a high length from the working channel.

A needle with a flexible nitinol needle and coiled sheath, such as the COOK ECHO 3-22 (Cook Medical, Bloomington, IN, USA), Boston scientific 19G flexible nitinol needle (Boston Scientific; Marlborough, MA, USA), or other fine needles, may be helpful for the transduodenal puncture of the pancreas;[6,7] A 19G needle is sometimes used to obtain a large tissue sample for histological evaluation.[8,9] However, in the transduodenal puncture approach, the needles made of a nickel–titanium alloy, such as the Boston scientific 19G flexible nitinol needle, should be recommended.

### *Disappearance of the needle tip during the EUS-FNA procedure*

Under normal circumstances, ultrasound images should display both lesions and needle tips throughout the EUS-FNA procedure. However, the puncture needle could be bent by the curved endoscope shaft during the first pass. When bent needle is pushed out of the working channel, the needle tip may not be present in the ultrasound section and become invisible. In such cases, the endosonographer should slowly rotate the echoendoscope left and right to bring the needle tip into the view. After the needle tip becomes visible, the echoendoscope should be adjusted carefully to follow the needle tip while slowly inserting the needle. If the needle tip cannot be visualized despite adjusting the echoendocope, the assistant should consider replacing the nitinol needle with a harder sheath.

In certain situations, the tip of the needle is visible during the first pass but not during the second pass, possibly because the elevator bends the needle during the first pass. The assistant can assist the doctor by removing the needle, placing it on the operating table, straightening it by applying external force, and slowly reinserting it into the working channel for puncture.

## PITFALLS AND TIPS IN EUS-GUIDED DRAINAGE

### *Damage to the guidewire*

In the EUS-guided biliary drainage (EUS-BD) procedure, the carelessness of the assistant during the procedure may damage the guidewire.[10,11] After the puncture needle is inserted into the bile duct, the assistant is responsible for assistance in introducing the guidewire through the puncture needle. At this time, the assistant should consider that the guidewire can only be moved forward and cannot be withdrawn, even if the guidewire is in the wrong direction in the bile duct. Because most current needles are designed for FNA and are sharp, withdrawing the guidewire may result in its peeling, which may cause the guidewire to be stuck in the needle cavity or leave a foreign body in the bile duct.

When the guidewire is stuck in the needle, the assistant should withdraw the needle and guidewire simultaneously, and then confirm the integrity of the guidewire coating. If the outer coating is damaged, the assistant should replace the guidewire immediately. Therefore, when the guidewire travels in the opposite direction in the intrahepatic duct, the assistant should continue to push the guidewire forward until the last entered part goes in the right direction. After the guidewire is placed in the target bile duct, the needle should be exchanged over the guidewire for 6-French (Fr) cystotome (Cysto Gastro Set; Endo-flex, GmbH, Voerde, Germany). When the 6-Fr cystotome enters the target bile duct with electrocautery, the assistant could help to withdraw and check the

guidewire integrity. If the integrity is compromised, the guidewire should be replaced by a new one. Next, the cystotome and guidewire are advanced and retreated in conjunction with each other until the guidewire finally passes through the stricture of the bile duct.

When the pancreatic fluid collection drainage procedure is performed, a 19G needle is punctured into the cystic cavity first, and then, a guidewire is introduced through the needle.[12,13] The guidewire may form a large angle with the tip of the needle. In such situations, if the assistant forcibly pushes the guidewire, the outer coating of the guidewire may be peeled as well.

Therefore, the guidewire encounters resistance owing to the needle, and the assistant should not manipulate the guidewire with force. The endosonographer should pull the needle back to adjust the direction and angle of the needle. The guidewire should then be pushed forward after straightening so that it can pass through the needle smoothly.

### *Failed fistula creation*

The efficiency of cystotome depends on its diameter and the electrocautery power. It may be difficult to create a fistula with the cystotome if the electrocautery power is not sufficiently high or if cautery programs designed for polypectomy are selected. Therefore, in some common cautery equipment, taking ERBEVIO 300S (ERBE, Tuebingen, Germany) as an example, "endo-cut-I" or "pure-cut" programs should be selected. Moreover, 6-Fr cystotome is much more effective than the 10-Fr. If the incision process is difficult with a 10-Fr cystotome, a 6-Fr knife is a good option to improve the cutting performance.

### *Air leakage associated with the working channel valve*

During the drainage procedure, it is important to consider the details. If the assistant forgets to install the working channel valve on the echoendoscope with the 3.8-mm working channel, the gastric cavity cannot be filled, and subsequent procedures will become extremely difficult.[14] The assistant should develop a good operating habit. When the endosonographer removes the valve from the working channel port before using the needle, the assistant should immediately take the removed valve and place it on the cystotome or dilation balloon to be used in the next step of this procedure. Further, when the cystotome or dilator is inserted into the working channel, the valve will land on the port naturally.

### *Problems related to the drainage of stents*

#### Drainage with a single guidewire

Multiple plastic-stent placement is widely accepted in the EUS-guided pancreatic fluid collection (PFC) drainage, especially for PFC with solid necrosis or viscous cystic fluid.[15,16] If the multiple stents are placed by repeatedly intubating a single guidewire in the fistula tract and then introducing several stents along the single guidewire, when the second stent is introduced, the first indwelling stent may be inadvertently migrated into the cystic cavity. To avoid this issue, it is best to use a balloon catheter with a diameter of at least 10 mm to completely dilate the fistula before placing the first plastic stent to ensure that the diameter of fistula is sufficient to accommodate several 10-Fr stents.

#### Stent drainage with double guidewires

Some endosonographers would prefer to use the double or multiple guidewire method for multi-stent or double-stent implantation. During drainage, two guidewires are placed directly in the fistula and then in the plastic stent along the guidewire separately. Since the working channel of current linear array echoendoscope is only 3.8 mm, it is not feasible to pass both 10-Fr (3.4-mm) stents and a 0.035-inch (0.88-mm) guidewire side-by-side. If the double guidewires are introduced first, the 10-Fr stent cannot pass and may get stuck in the working channel. Therefore, in addition to complete balloon dilatation of the fistula before multiple-guidewire placement, a 7-Fr stent should be placed along a guidewire first, and then, the guidewire is withdrawn. The process is repeated again. The 10-Fr stent cannot be placed until only the last guidewire is left.

#### Migration of the metal stent

Fully covered self-expanded metal stents (FCSEMS) are widely applied in EUS-BD, and EUS-guided drainage of wall-off pancreatic necrosis. However, migration of FCSEMS is a burden for endosonographers. Although lumen-apposing metal stent has anti-migrating ability, it is not always available or applicable. Especially for the hepaticogastrostomy, migration is common and causes severe bile leakage. The migration after PFC drainage is also troublesome. When the stent falls into the cystic cavity completely, it is difficult to retrieve the stent. To prevent the migration of the FCSEMS, a plastic stent can be used to anchor the metal stent longitudinally, or a thin double-pigtail plastic stent can be bolted to cross-through the proximal part of the stent.[17] A simpler method is to place several hemoclips on the

wire mesh at the proximal part of the stent to form flaps to prevent stent migration [Figure 1].

### *Selection of the puncture site of hepaticogastrostomy*

Selecting the puncture site is the first step in hepaticogastrostomy. There are two common segment-puncture sites: segment III bile duct (B3) and segment II bile duct (B2).[18] Some studies recommend B3 as the preferred puncture point site over B2 for transgastric stenting.[19] Because B2-approach puncture is performed in the proximal part of the stomach, esophageal gastric junction, or distal part of the esophagus. Although B2 is more feasible than B3 for the rendezvous technique and antegrade approach because the direction of the guidewire in B2 is relatively straight to the hepatic hilum. During the B2-approach procedure, the transducer is usually in the cardia position and endoscope shaft is relatively stable as the working platform. However, sometimes, the biliary drainage is performed in the esophagus and is hepaticoesophagostromy.[20] In consideration of the possibility of complications of the mediastinum or thoracic cavity, the B3 approach is more recommended.

However, when the B2 is selected for puncture and hepaticoesophagostromy is performed, the orifice of the stent in the esophagus may be facing the mouth side [Figure 2]. In this case, when the patient ingests food or water, these can enter into the stent and intrahepatic duct. To avoid this, the operator could attempt to use a gastroscope with a transparent hood to push the proximal part of the stent in the esophagus into the stomach [Video 1]. If the proximal end of stent cannot be inserted into the stomach with the endoscope, foreign body forceps can be used. Note that the assistant should avoid using a rat-toothed foreign object forceps, which may be entangled by the stent wire and cause the stent to be pulled out.

Stent migration in the esophagus to the chest cavity can lead to more serious consequences than that in the stomach. Therefore, it is important to prevent the stent from migration. As mentioned earlier, it may be helpful to clip a few hemoclips on the FCSEMS.

When B3 is selected to puncture, due to the poor stability of the echoendoscope in the large gastric cavity, the reaction force of the puncture will cause the echoendoscope to move away from the puncture site and slide toward the gastric greater curvature. Due to the distance between the orifice of the working channel and the puncture site, the guidewire may fall into the gastric cavity and coil, if the assistant pushes the guidewire excessively. To avoid this, the assistant should be careful and ensure that an even force is applied when the guidewire is exchanged.

## CONCLUSIONS

With the advancements in EUS diagnosis and treatment, the technical skills of an EUS assistant have become more important to ensure that a procedure is performed in a smooth and efficacious manner. Further, some of the devices currently used in EUS therapy are borrowed under off-label conditions. For example, puncture needles are derived from EUS-FNA,


**Figure 1.** Installation of a clip on the wire network near the end of the stent for preventing stent migration

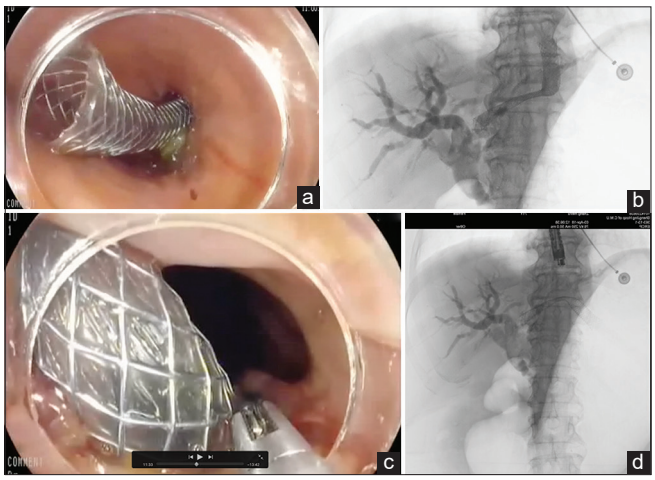


**Figure 2.** After the segment II bile duct was stented, the proximal part of the stent was placed into the esophagus, and the stent orifice was facing upward ((a) endoscopic image; (b) fluoroscopic image). Then the proximal part of the stent in the esophagus was pushed into the stomach with a gastroscope ((c) endoscopic image; (d) fluoroscopic image)

and guidewires are derived from ERCP. Mismatch or incompatibility between these devices increases the reliance on the skills of the operating assistants. Assistants need to completely understand the patient's condition and procedural details before an operation, grasp all relevant techniques, pay attention to details, accumulate experience, and develop the skills required to respond to all kinds of emergencies in a timely and independent manner, to avoid procedure failure. We also look forward to the development of more specialized devices in future to make EUS interventional drainage more convenient, efficient, and safe.

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### *Conflicts of interest*

Siyu Sun is the Editor-in-Chief of the journal *Endoscopic Ultrasound*. The article was subject to the journal's standard procedures, with peer review handled independently of this editor and their research groups.

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