REVIEW ARTICLE

Technical tips for EUS-guided embolization of varices and pseudoaneurysms

Radhika Chavan, MD, DNB,[1] Stefano Baraldo, MBBS,[2] Nishant Patel, MD,[3] Chaiti Gandhi, MD, DNB,[1] Sanjay Rajput, MD, DM[1]

Backgrounds and Aims: EUS-guided vascular intervention has expanded the horizons of diagnostic as well as therapeutic interventions for vascular pathology. EUS-guided embolization is a commonly performed technique for the treatment of gastric varices. However, there is a lack of data on the standardization of the technique. Here, we review the techniques and difficulties encountered during EUS-guided embolization of varices and pseudoaneurysms.

Methods: This article and accompanying video describe the EUS-guided embolization techniques for various vascular lesions. EUS-guided embolization was achieved by combination therapy using coils and cyanoacrylate. Complete obliteration of the lesions was documented on follow-up. The existing literature of EUS-guided embolization therapy is also reviewed.

Results: Patients with various vascular lesions, including gastric varices, ectopic duodenal varices, and splenic artery pseudoaneurysms, were successfully treated with EUS-guided coil plus cyanoacrylate injection. Patients with gastric varices underwent treatment with 2 EUS-guided techniques: (1) direct puncture of the varix and embolization and (2) feeder vessel embolization. Following embolization, the absence of Doppler flow within the varix and pseudoaneurysm was documented.

Conclusions: Techniques of EUS-guided embolization of varices and pseudoaneurysms are demonstrated. Understanding the techniques and the challenges encountered during therapy is crucial to optimize outcomes and reduce adverse events. (VideoGIE 2024;9:211-9.)

INTRODUCTION

EUS-guided vascular interventions have been rapidly progressing owing to the ability to access vascular structures and facilitate real-time interventions. EUS-guided treatment of gastric varices has become a routine practice. Compared with the conventional gastroscopic glue injection, EUS-guided embolization of gastric varices reduces the rebleeding rate, need for reintervention, volume of cyanoacrylate, and systemic glue embolization risk.[1] Embolization of the gastric varices can be carried out by directly puncturing the varices or embolizing the feeder vessels under EUS guidance.[2] EUS-guided embolization has also been used for other vascular lesions, such as pseudoaneurysms, ectopic varices, Dieulafoy lesions, duodenal ulcers, and tumor feeder vessels.[3] Despite its widespread adoption, the standardization of EUS-guided embolization techniques remains an ongoing endeavor.[4] In this comprehensive review, techniques and various approaches of EUS-guided embolization procedures of vascular lesions are discussed (Video 1, available online at www.videogie.org).

2468-4481
https://doi.org/10.1016/j.vgie.2023.12.006

Ansh Clinic, Ahmedabad, Gujarat, India (1), Barretos Cancer Hospital, Sao Paulo, Brazil (2), Arnold Palmer Hospital for Children, Orlando Health, Orlando, Florida, USA (3).

GASTRIC VARICES

Gastric variceal bleeding comprises 20% of all variceal bleeding and is associated with a high rebleeding rate.[5,6] Sarin classification is used widely to classify gastric varices, as it aids in guiding therapy.[7] The Arakawa classification can be used to guide EUS therapy, and it categorizes gastric varices into 2 types: type I (localized) gastric varices are formed by a single large vessel emerging from the supplying vein, which penetrates the gastric muscularis layer, and type II (diffuse) varices are composed of a network of vessels within the gastric wall with multiple communications between them (Fig. 1).[8]

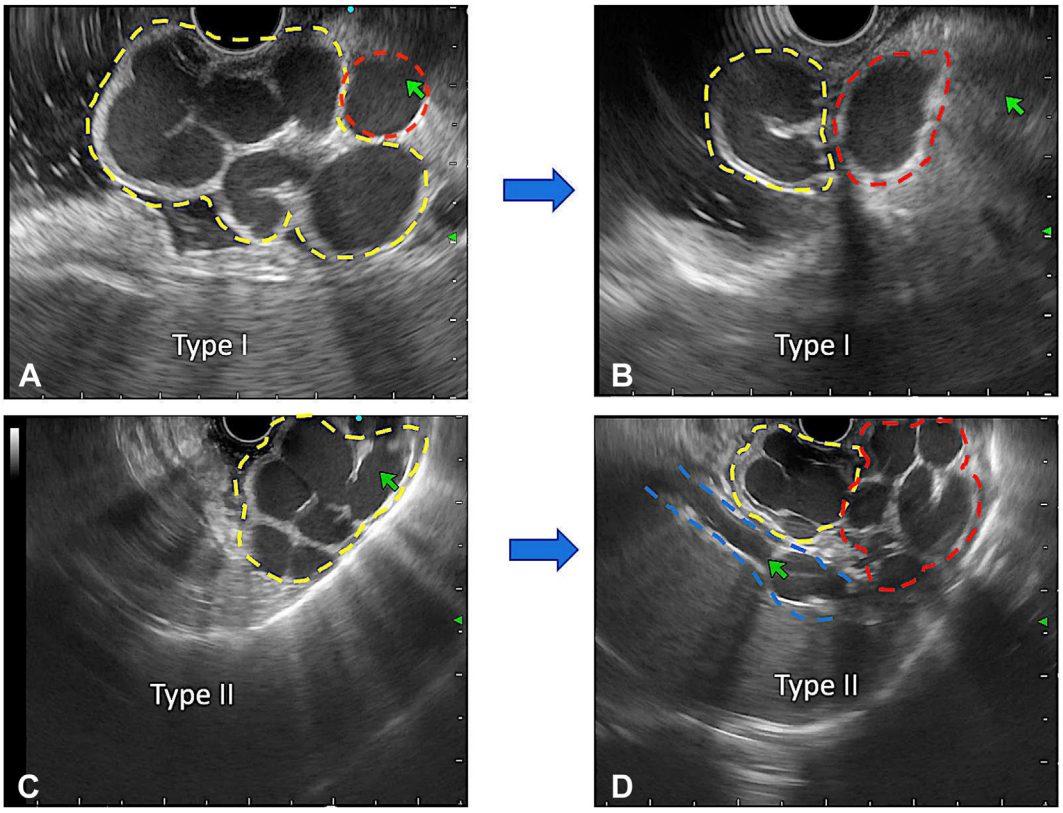

Figure 1. Arakawa classification of gastric varices. **A and B,** EUS image of type I gastric varices. **A,** Luminal part of the varix (*dotted yellow circle*) and extraluminal part (ie, single perforator [*dotted red circle*]). **B,** The perforator was confirmed further on counterclockwise rotation. **C and D,** EUS image of type II gastric varices. **C,** Luminal part of the varix (*dotted yellow circle*). **D,** Multiple extraluminal collaterals (*dotted red circle*) with lienorenal shunt (*dotted blue line*) seen on counterclockwise rotation.

The management of gastric varices is challenging because of conflicting and heterogeneous data. A European Society of Gastrointestinal Endoscopy guideline recommends gastroscopic cyanoacrylate injection for actively bleeding gastric varices and radiological interventions for refractory bleeding.[9] Several studies have demonstrated effectiveness and safety of EUS-guided embolization for actively bleeding gastric varices as well as for the secondary prophylaxis of gastric varices, compared with the conventional gastroscopic technique.[1,10-12] EUS-guided therapy also offers comparable and noninferior effects compared with the radiological intervention.[13,14]

The advantages of EUS include (1) complete visualization of the entire varix, including feeder vessels, enabling precise targeting even in the presence of a bloody field; (2) the ability to inject the coils (which is impossible with gastroscopy); and (3) simultaneous assessment of varix obliteration using Doppler flow.[2] However, literature on various EUS-guided techniques is scarce about (1) embolization of varix versus feeder vessels; (2) individual use of coils, glue, or a combination; (3) determining the size and number of coils needed; and (4) the use of other sclerosants (thrombin, gelatin sponge) or hydrocoils.

Studies have demonstrated the superiority of combination therapy over monotherapy.[10,11] Specifically, a combination of coils and glue was associated with higher technical success (98.66%), variceal obliteration (96.79%), and lower rebleeding rates (4.92%).[10,11,15] Coils act as a scaffold for the glue, reducing the volume of glue required and the systemic embolization risk.

There is no direct comparison of the 2 EUS techniques: direct variceal embolization versus feeder vessel embolization. However, EUS-guided feeder vessel embolization is reported to achieve high obliteration rate in fewer endoscopic sessions, with a minimum coil and glue use, and is associated with limited adverse events.[16,17]

This review describes both techniques of EUS-guided gastric variceal embolization.

TECHNIQUES

Preprocedural assessment of the patient's hemodynamic status is conducted. Contrast-enhanced CT of the abdomen can be considered for shunt visualization. Gastroscopy is performed to assess the concurrent esophageal varices.

TABLE 1. Instruments and accessories required for EUS-guided vascular therapy

1	Curvilinear echoendoscope
2	Nineteen- or 22-gauge FNA needle
3	Five- or 2-mL syringes filled with distilled water (5-6 syringes)
4	Coils (0.035 or 0.018 inches; straight lengths of 50-150 mm; coiled diameter of 8-20 mm; 3.2-5.6 configuration loops)*
5	Glue (n-octyl-cyanoacrylate or n-butyl-cyanoacrylate)
6	Lipiodol†

*Specification of Nester coils (COOK Medical, Bloomington, Ind, USA).
†Lipiodol can be used at the discretion of the endoscopist. Alternatively, 5% or 50% dextrose can also be used to flush the glue out of the needle.

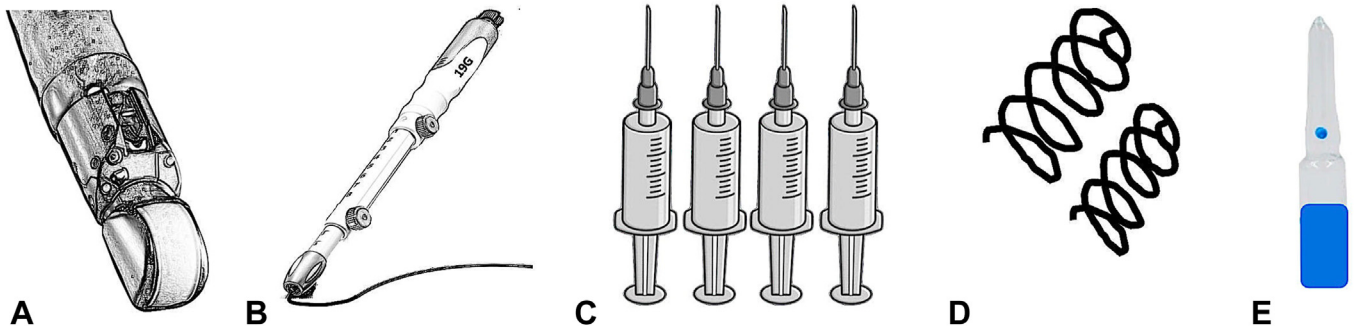

Figure 2. Instruments and accessories required for EUS-guided vascular therapy. **A,** Curvilinear echoendoscope. **B,** Nineteen-gauge FNA needle. **C,** Five to six 2- or 5-mL syringes filled with distilled water. **D,** Coils (0.035 or 0.018 inches). **E,** Glue (n-octyl-cyanoacrylate or n-butyl-cyanoacrylate).

The instruments required for EUS-guided vascular therapy are prepared (Table 1; Fig. 2).

The procedure can be performed with the patient under deep sedation or general anesthesia in the left lateral position. General anesthesia is recommended to mitigate the risk of aspiration. It is advisable to instill 100 to 200 mL of water into gastric lumen, as it helps in floating of the varix and enhances the acoustic coupling. One should take all aseptic precautions during the procedure and consider prophylactic intravenous antibiotics to reduce the risk of infection.

A curvilinear EUS scope is used for therapy. Varices typically appear as a cluster of anechoic channels located within the submucosa, exhibiting strong Doppler flow. Achieving good visualization of the gastric varix often requires extreme clockwise rotation from the gastroesophageal junction. Although minimal counterclockwise rotation from the left lobe of the liver can also provide a good view, it can be challenging to pass accessories in this position.

There are 2 methods by which the varix can be embolized under EUS guidance (Fig. 3). The first is direct puncture of the varix and embolization, in which coils and glue are injected directly into the varix under EUS guidance (Fig. 4A and B). This is a preferred method for all types of varices, including ectopic varices and those with multiple collaterals (Arakawa type II). The second method is feeder vessel embolization, in which coils and glue are injected within the feeder vessels of the varix (Fig. 4C).

Direct Puncture of the Varix Embolization

Under EUS guidance, the gastric varix is punctured with a 19-gauge FNA needle. This can be performed via a transesophageal or transgastric route (Fig. 4A and B). Transesophageal puncture is recommended to mitigate bleeding from the varix puncture, as the FNA needle traverses through the muscularis propria of the esophagus, stomach, and then into the varix (submucosal), thus providing a tamponade effect (Fig. 5).

Following the varix puncture, the needle tip is visualized, and its position can be confirmed either by injecting 1 to 1.5 mL of distilled water while visualizing hyperechoic bubbles or by aspirating the blood, with the former method being the preferred choice. The coil size should be selected based on the varix size, typically 20% to 30% larger than the varix.[16] The maximum available coil size is 20 mm; thus, multiple coils are required to obliterate larger varices. These coils come in thicknesses of 0.018 or 0.035 inches, with straight lengths of 50 to 200 mm and a coiled diameter of 8 to 20 mm (Nester; COOK Medical, Bloomington, Ind, USA). One or 2 coils can be loaded into an FNA needle and then pushed into the varices with the help of a stylet, and if the coil is less than 15 mm it can be pushed with a guidewire. A thickness of 0.035 inches is compatible with 19-gauge needles, whereas 0.018 inches is compatible with 22-gauge needles.

It is essential to keep the needle tip visible during coil deployment and avoid placing it against the varix's counter

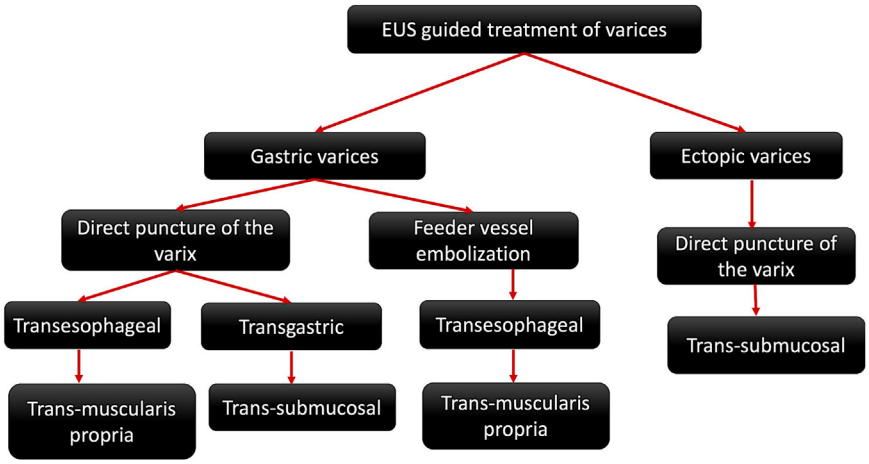

Figure 3. Methods and various routes of EUS-guided variceal embolization.

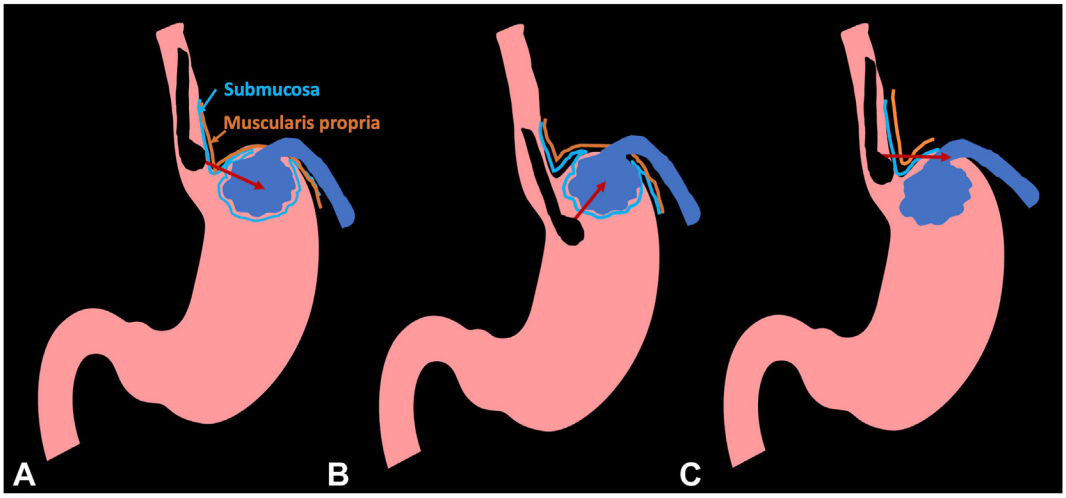

Figure 4. Various approaches of EUS-guided gastric variceal therapy. **A,** EUS-guided embolization of gastric varices via transesophageal (transmuscularis propria) approach: direct puncture of the varix and embolization technique. **B,** EUS-guided embolization of gastric varices via transgastric (trans-submucosal) approach by directly puncturing the varix. **C,** EUS-guided embolization of gastric varices by feeder vessel embolization via transesophageal (trans-muscularis propria) approach.

wall to prevent perforation or forceful coil extrusion. After each deployment, the FNA needle is flushed with 1.5 to 2 mL of distilled water to clear any blood debris that may have refluxed into the needle during stylet withdrawal. This flushing is necessary to prevent clot formation within the needle, because a blood clot can impede subsequent coil deployment and cause premature glue solidification, potentially leading to needle blockage.

After coil deployment, glue injection can be performed under EUS guidance (preferred method) or directly with a gastroscope. It is essential for everyone, including the patient, to wear protective eyeglasses. Accidental glue splatter in the eyes during the injection can lead to significant consequences.[18] Following glue injection, rapidly flush the needle with 1.5 to 2 mL distilled water. Instead of distilled water, 5% or 50% dextrose or lipiodol can also be used to flush the glue out of the needle.[18,19] The advantage of lipiodol (iodized oil) is that it opacifies the glue and delays the polymerization rate, which eventually prevents early needle blockage. Lipiodol can be mixed with glue in the proportion of 1:1 or 0.5:0.8 before injection.[18] It is also important to note that the use of normal saline with the glue should be avoided, as it can cause premature solidification of the glue within the needle.[19]

After injecting the glue, promptly withdraw the needle within the sheath, push the sheath out (3-4 cm) of the echoendoscope, and then remove the entire assembly including the scope (Supplementary Fig. 1A-C). Any delay in

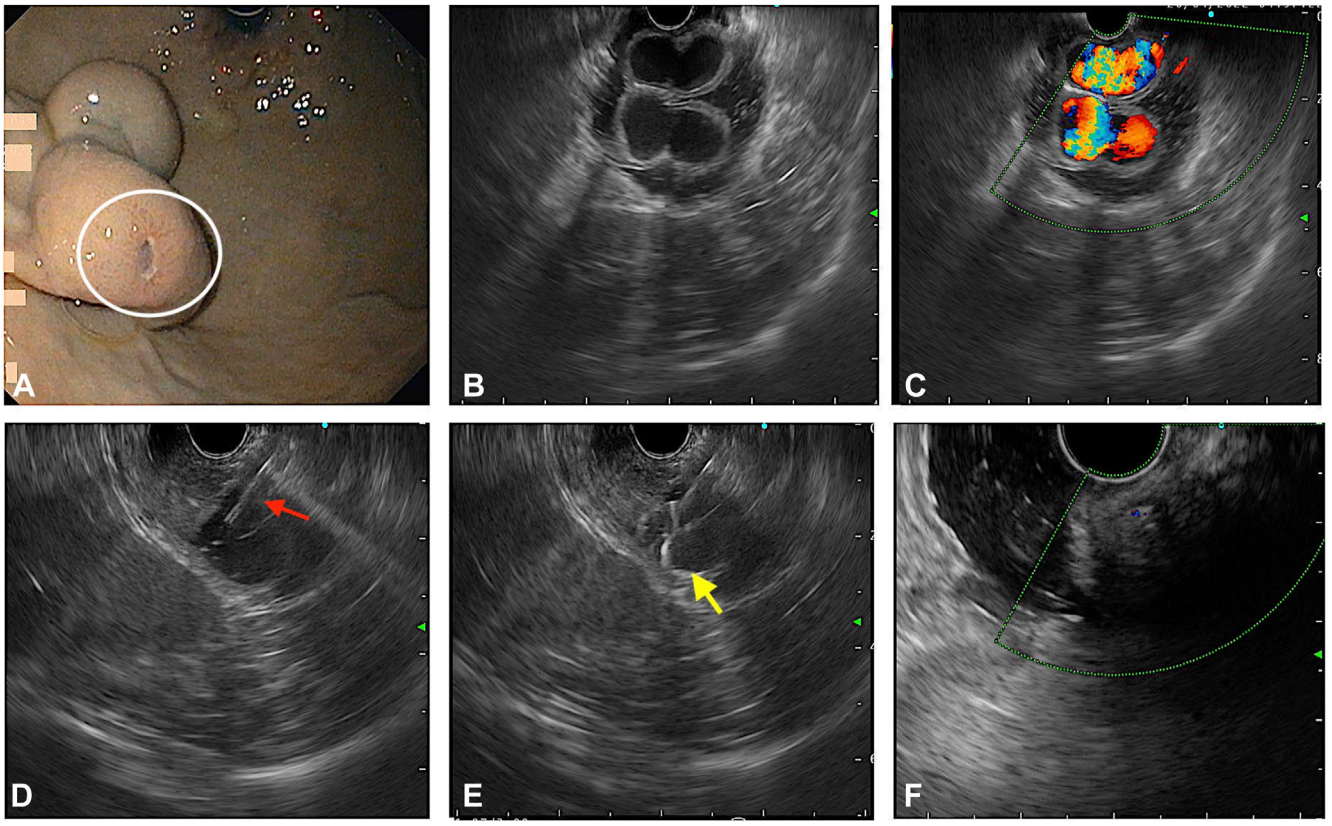

Figure 5. EUS-guided embolization of the gastric varices via transesophageal route. **A,** Endoscopic view of isolated gastric varices with stigmata of recent bleed on the varix (*white circle*). **B,** EUS image of large gastric varices. **C,** Color Doppler revealed strong Doppler flow within the varix. **D,** Varix was punctured with a 19-gauge needle (*red arrow*) under EUS guidance. **E,** Coils (hyperechoic rings, *yellow arrow*) were deployed under EUS guidance. **F,** Complete disappearance of Doppler flow within the varix seen after coil–glue injection.

withdrawing the needle within the sheath can lead to needle impaction within the varix due to glue solidification, and any forceful needle removal may lead to varix avulsion.[20]

To ensure proper instrument functionality, inspect the scope transducer for any glue residue and promptly clean it with water or acetone. Remove the FNA needle and flush the working channel of scope with 30 to 40 mL of distilled water followed by a burst of air to clear off any glue debris from the channel. Perform a similar maneuver for the FNA needle.

Reintroduce the echoendoscope and check for Doppler flow within the varix. Fluoroscopy is not mandatory during the procedure unless contrast is injected to delineate the feeder vessels and shunt. Although glue is widely available and cost effective, the risk of systemic embolization and potential scope damage from improper injection cannot be precluded. The use of absorbable gelatin sponge, as an alternative to glue, can reduce embolization risk.[21,22]

Feeder Vessel Embolization

In this method, the feeder vessel is identified and embolized under EUS guidance. It is quite challenging to identify a feeder vessel, and occasionally, multiple feeder vessels may be observed. Differentiating inflow and outflow tract on EUS can be arduous. The technique is similar, and it does not offer additional advantages over the direct EUS-guided varix embolization method (Fig. 6). However, it reduces the reintervention rate and requires fewer coils to embolize the feeder vessel. Coil or glue can be used to embolize the feeder vessel; however, coils offer a higher obliteration rate (82% vs 53%) and fewer adverse events (58% vs 9%, $P < .01$).[16]

ECTOPIC VARICES

Ectopic varices are rare, accounting for 5% of variceal bleed; however, they are associated with a high mortality rate (40%).[23,24] Ectopic varices are most commonly found in the duodenum, with the duodenal bulb more frequently affected than the descending duodenum, followed by jejunum, ileum, rectum, peritoneum, stoma, and vagina.[25,26] Management guidelines for ectopic varices are lacking, but actively bleeding varices are usually treated with endoscopic banding or sclerotherapy.[26] Rebleeding rate after endotherapy is substantial, up to 20%, and may require radiological intervention.[23]

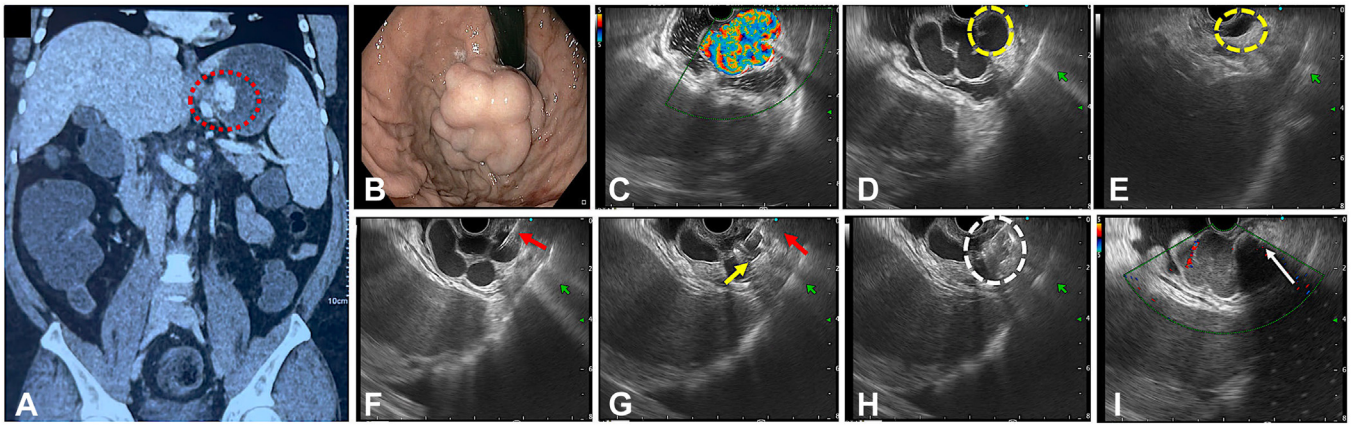

Figure 6. EUS-guided embolization of the gastric varices by embolizing feeder vessels. **A,** Coronal section of contrast-enhanced CT scan of the abdomen showed large fundal varices with perigastric collateral (*dotted red circle*). **B,** Endoscopic view of large gastric varices. **C,** EUS image showing strong Doppler flow within the large gastric varix. **D,** EUS image showing the gastric varix was formed by a single large feeder vessel (*dotted yellow circle*; Arakawa type I). **E,** Extramural part of the feeder vessel was traced (till splenic vein in majority) on counterclockwise rotation and confirmed (*dotted yellow circle*). **F,** Feeder vessel was punctured with a 19-gauge needle (*red arrow*). **G,** Coils (hyperechoic rings, *yellow arrow*) were deployed into the varix. **H,** Glue was injected. EUS image shows coil–glue cast complex (*dotted white circle*). **I,** Complete thrombosis with obliteration of gastric varix, with shadowing from the coil–glue complex seen (*white arrow*).

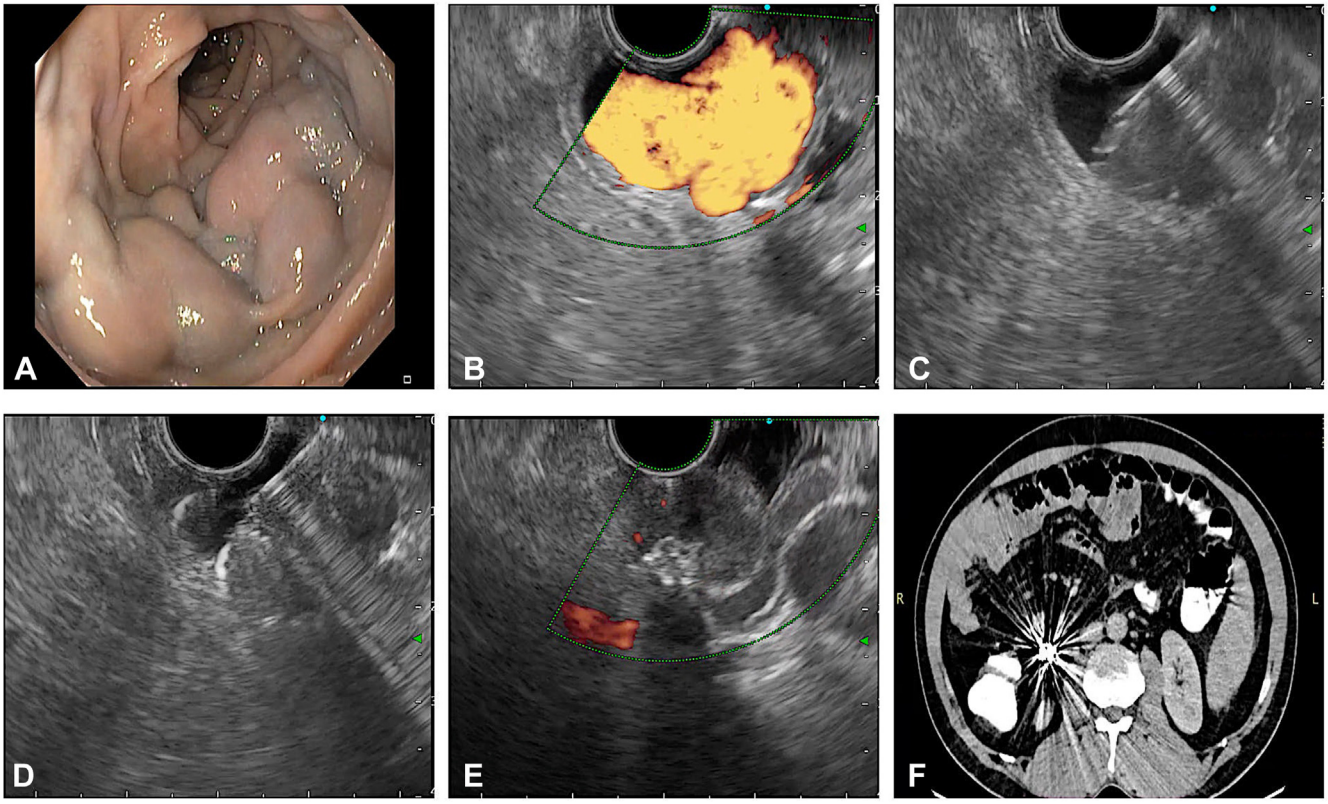

Figure 7. EUS-guided embolization of ectopic duodenal varices by direct varix puncture and embolization method. **A,** Endoscopic view of large varices (occupying more than one-third of circumference) in part 3 of the duodenum. **B,** EUS image showing strong Doppler flow within the large duodenal varix. **C,** Duodenal varix was punctured with a 19-gauge needle under EUS view. **D,** Coils were deployed into the varix with a 19-gauge needle. **E,** Complete thrombosis of the duodenal varix with absent Doppler flow, and coil–glue cast was seen on EUS. **F,** Follow-up contrast-enhanced CT scan of the abdomen showed complete obliteration of the varix with no flow in venous phase and coils in situ in part 3 of the duodenum.

EUS can help in detecting the duodenal varices, even those located on serosa.[27,28] Limited data exist on EUS therapy for ectopic varices due to their rarity. Nevertheless, the efficacy and safety of EUS-guided embolization for duodenal and rectal varices have been reported in a few case studies.[28-31]

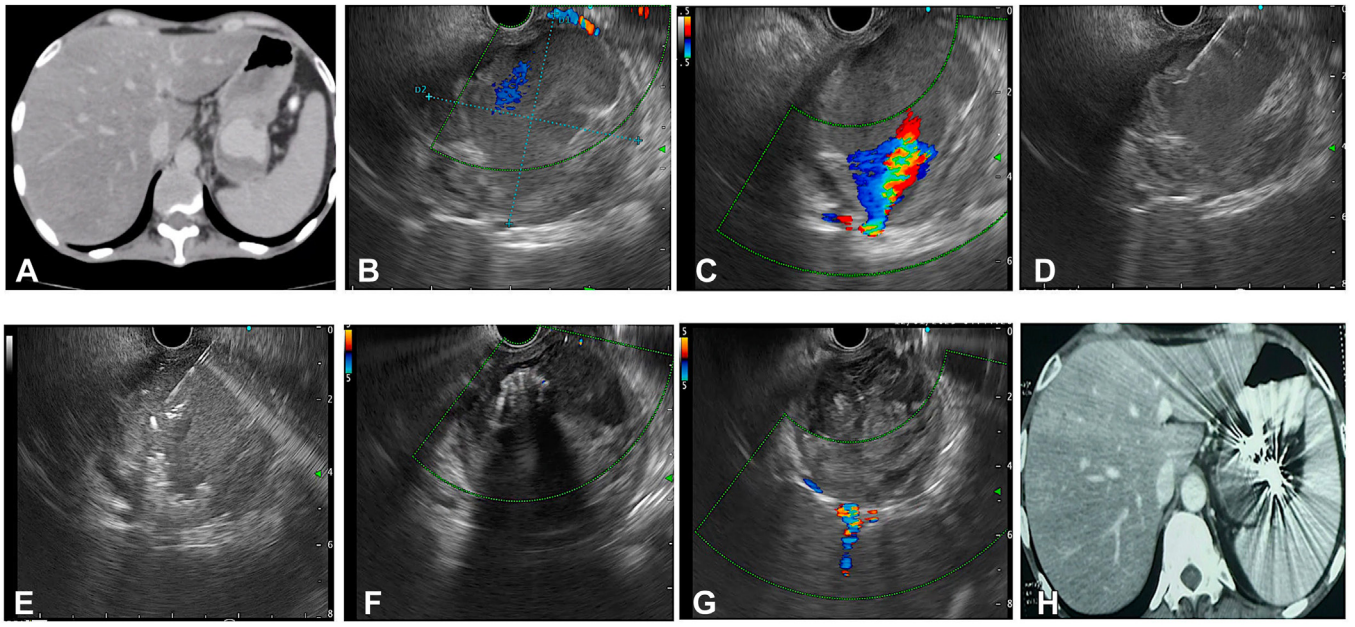

Figure 8. EUS-guided embolization of a large splenic artery pseudoaneurysm. **A,** Contrast-enhanced CT scan of the abdomen showing large vascular lesion at the tail, enhanced on venous phase. **B,** A large lesion was identified as a pseudoaneurysm on EUS. **C,** Doppler flow confirmed active ooze from the splenic artery into the pseudoaneurysm. **D,** The pseudoaneurysm was punctured with a 19-gauge needle on EUS. **E,** Coils were deployed under EUS guidance. **F,** After injection of coil and glue, EUS showed disappearance of Doppler flow within the pseudoaneurysm, with coil–glue complex seen within. **G,** Doppler flow confirmed cessation of the ooze from the splenic artery. **H,** Contrast-enhanced CT scan of the abdomen showed no flow within the lesion, with artifacts seen from the coils.

The technique of EUS-guided embolization is similar to gastric variceal therapy; however, some precautions must be taken during the procedure. For the descending duodenal varix, the echoendoscope will be in an angulated position, and manipulating accessories can be technically difficult. We recommend straightening the echoendoscope followed by extending the sheath into the lumen before puncture. Avoid making multiple punctures of the varix (Fig. 7).

PSEUDOANEURYSM

Visceral artery pseudoaneurysm is rare and is usually found in pancreatitis (10%), and rarely after surgery and abdominal trauma.[32] The splenic artery is commonly involved in pancreatitis (30%-50%) followed by the gastroduodenal artery, pancreaticoduodenal artery, superior mesenteric, left gastric artery, and so on.[33] Pseudoaneurysms are at high risk of rupture (50%), as they lack a true wall, and are associated with a high mortality rate (15%-40%).[34] Treatment options include interventional radiology–guided angioembolization or surgery. EUS-guided angioembolization has been reported to be safe and effective, even for large pseudoaneurysms (up to 6.5 cm).[35] EUS helps in identifying the lesion and distinguishing arterial lesions from venous lesions.[36,37] EUS can be considered for pseudoaneurysms with a small neck that prevents contrast filling during angiography and those arising from small arterial branches, especially when interventional radiology–guided angioembolization is challenging.

The technique of EUS-guided pseudoaneurysm embolization is similar to variceal embolization. Precautions include (1) avoiding puncture of the thinnest area of the pseudoaneurysm when no intervening organic parenchyma is present (it is advisable to use intervening parenchyma [pancreas or liver] as a safety net) and (2) preventing reflux of blood by positioning the thumb at the distal end of the FNA needle. Complete obliteration can be achieved with the first session in 93.8% of cases.[31] Large pseudoaneurysms (>4 cm) may warrant a second session of EUS-guided embolization.[35] For large pseudoaneurysms, multiple coils can be loaded within the needle at a time (Fig. 8). Alternatively, thrombin can also be used for pseudoaneurysm obliteration.[34]

FOLLOW-UP

Follow-up assessment can be done at 4 weeks, 3 months, and every 6 months thereafter with gastroscopy and EUS. Gastroscopy can reveal changes in varix size and surface pattern, whereas EUS can evaluate Doppler flow (Supplementary Fig. 2A-C). Reintervention with EUS may be considered based on Doppler flow. The overall risk of rebleeding with EUS-guided gastric variceal therapy is 5% to 12%.[1,11] Nevertheless, 80% of rebleeding can be successfully treated with repeated EUS-guided therapy.[12]

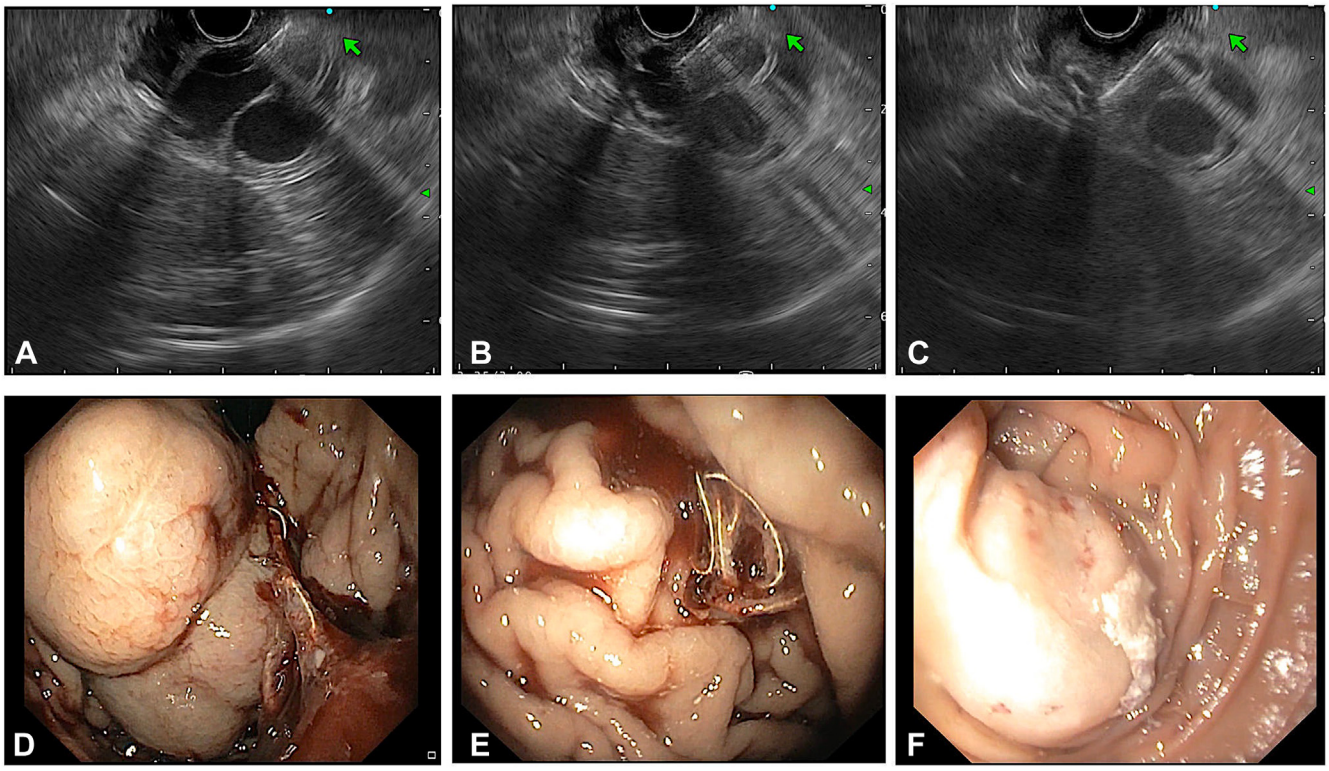

Figure 9. Precautions to be taken during EUS-guided embolization. **A,** A large gastric varix was seen on EUS. **B,** Direct puncture of the varix was attempted with a 19-gauge needle via the stomach (trans-submucosal). **C,** The varix was pushed away and compressed by the needle on the attempted puncture. **D,** During EUS embolization of a gastric varix, if the needle tip is at the wall rather than in the center, the coil can perforate the gastric varix. In one case, coils perforated the varix and extruded out of the varix, as observed during endoscopy. **E,** In the same case, extrusion/migration of the coil into the gastric lumen was observed on endoscopy image. **F,** Patients with ectopic duodenal varices required 2 trans-submucosal punctures during EUS-guided embolization. On glue injection after coiling, extrusion of the glue was seen through the first puncture.

PRECAUTIONS DURING EUS-GUIDED THERAPY

Certain precautions should be taken to prevent adverse events. Occasionally, direct transgastric puncture of the varix can be challenging, as the varix's luminal part tends to float and it gets pushed away on puncture (Fig. 9A-C). In such instances, assess the scope's angulation and consider changing the route from transgastric to transesophageal. Avoid forceful jabbing of the needle to prevent needle hypershooting and varix perforation (Fig. 9D). Challenges may arise during coil deployment, particularly with previous glue injections, larger coil sizes, and angulated scope positions, potentially leading to partial coil deployment (Fig. 9D and E).

It is recommended to embolize the whole varix in a single puncture if a direct trans-submucosal puncture is achieved. Multiple punctures can result in glue extrusion from some of the puncture sites, potentially causing scope damage (Fig. 9F; Supplementary Fig. 3).

Overall, EUS-guided adverse events are seen in 14% of patients.[10] As this procedure is based on a similar principle to conventional gastroscopic embolization, the rate of adverse events, although minimal, remains the same. These events include systemic embolization, transient abdominal pain, bleeding from the puncture site, needle impaction, and benign coil tip or glue extrusion.[16,38,39] If needle impaction is suspected, do not forcefully withdraw the needle, as it may lead to the laceration of the varix and torrential bleeding. It is advisable to have interventional radiologists and surgeons on standby; the impacted needle can be removed with minimal force.[20,40] Mild to moderate bleeding after needle withdrawal can be controlled by repeating EUS-guided glue or coil injection. However, severe bleeding may require interventional radiologist–guided procedures such as balloon retrograde transluminal obliteration or transjugular intrahepatic portosystemic shunt and, rarely, surgery. Therefore, it is strongly recommended to perform EUS-guided embolization at a tertiary care center under the supervision of a multidisciplinary team.

CONCLUSIONS

EUS-guided vascular therapy has demonstrated excellent outcomes. Proficiency in EUS-guided embolization is essential to reduce adverse events. Further standardization of the

technique is needed to optimize outcomes. Additional studies are required to establish the safety and efficacy of feeder vessel blockage and the treatment of pseudoaneurysms and ectopic varices in comparison with radiological intervention.

DISCLOSURE

The authors disclosed no financial relationships relevant to this publication.

REFERENCES

1. Mohan BP, Chandan S, Khan SR, et al. Efficacy and safety of endoscopic ultrasound-guided therapy versus direct endoscopic glue injection therapy for gastric varices: systematic review and meta-analysis. Endoscopy 2020;52:259-67.
2. Robles-Medranda C, Oleas R, Del Valle R, et al. EUS-guided therapy of gastric varices (with video). Endosc Ultrasound 2020;9:280-3.
3. De Angelis CG, Cortegoso Valdivia P, Rizza S, et al. Endoscopic ultrasound-guided treatments for non-variceal upper GI bleeding: a review of the literature. J Clin Med 2020;9.
4. Ryou M, DeWitt JM, Das KK, et al. AGA clinical practice update on interventional EUS for vascular investigation and therapy: commentary. Clin Gastroenterol Hepatol 2023;21:1699-705.e2.
5. Sarin SK, Lahoti D, Saxena SP, et al. Prevalence, classification and natural history of gastric varices: a long-term follow-up study in 568 portal hypertension patients. Hepatology 1992;16:1343-9.
6. Oleas R, Robles-Medranda C. Endoscopic treatment of gastric and ectopic varices. Clin Liver Dis 2022;26:39-50.
7. Sarin SK, Kumar A. Gastric varices: profile, classification, and management. Am J Gastroenterol 1989;84:1244-9.
8. Arakawa M, Masuzaki T, Okuda K. Pathomorphology of esophageal and gastric varices. Semin Liver Dis 2002;22:73-82.
9. Gralnek IM, Camus Duboc M, Garcia-Pagan JC, et al. Endoscopic diagnosis and management of esophagogastric variceal hemorrhage: European Society of Gastrointestinal Endoscopy (ESGE) guideline. Endoscopy 2022;54:1094-120.
10. McCarty TR, Bazarbashi AN, Hathorn KE, et al. Combination therapy versus monotherapy for EUS-guided management of gastric varices: a systematic review and meta-analysis. Endosc Ultrasound 2020;9:6-15.
11. Baig M, Ramchandani M, Puli SR. Safety and efficacy of endoscopic ultrasound-guided combination therapy for treatment of gastric varices: a systematic review and meta-analysis. Clin J Gastroenterol 2022;15:310-9.
12. Bazarbashi AN, Aby ES, Mallery JS, et al. Endoscopic ultrasound-guided coil injection therapy in the management of gastric varices: the first U.S. multicenter experience. Gastrointest Endosc 2024;99:31-7.
13. Giri S, Jearth V, Seth V, et al. Comparison of efficacy and safety of endoscopic and radiological interventions for gastric varices: a systematic review and network meta-analysis. Clin Exp Hepatol 2023;9:57-70.
14. Huang Z, Zhang W, Lv F, et al. Efficacy and safety of EUS-guided coil embolization combined with endoscopic cyanoacrylate injection versus balloon-occluded retrograde transvenous obliteration for gastric varices with high-risk ectopic embolism: a multicenter and retrospective cohort study. Endosc Ultrasound 2023;12:74-83.
15. Robles-Medranda C, Oleas R, Valero M, et al. Endoscopic ultrasonography-guided deployment of embolization coils and cyanoacrylate injection in gastric varices versus coiling alone: a randomized trial. Endoscopy 2020;52:268-75.
16. Romero-Castro R, Ellrichmann M, Ortiz-Moyano C, et al. EUS-guided coil versus cyanoacrylate therapy for the treatment of gastric varices: a multicenter study (with videos). Gastrointest Endosc 2013;78:711-21.
17. Sabry F, Seif S, Eldesoky A, et al. EUS-guided cyanoacrylate injection into the perforating vein versus direct endoscopic injection in the treatment of gastric varices. Endosc Int Open 2023;11:E202-10.
18. Saraswat VA, Verma A. Gluing gastric varices in 2012: lessons learnt over 25 years. J Clin Exp Hepatol 2012;2:55-69.
19. Chandrasekar TS, Kalamegam RY, Chandrasekar VT, et al. In vitro studies on technical determinants for avoiding immediate puncture-site bleeding in glue therapy for gastric varices with a correlational clinical study. Tropical Gastroenterol 2020;40:78-84.
20. Baliss M, Patel D, Madi MY, et al. EUS-guided vascular interventions. J Clin Med 2023:12.
21. Bazarbashi AN, Wang TJ, Jirapinyo P, et al. Endoscopic ultrasound-guided coil embolization with absorbable gelatin sponge appears superior to traditional cyanoacrylate injection for the treatment of gastric varices. Clin Transl Gastroenterol 2020;11:e00175.
22. Ge PS, Bazarbashi AN, Thompson CC, et al. Successful EUS-guided treatment of gastric varices with coil embolization and injection of absorbable gelatin sponge. VideoGIE 2019;4:154-6.
23. Barath S, Kheradia D, Gopalkrishnan SP, et al. Review of applied anatomy, hemodynamics, and endovascular management of ectopic varices. J Clin Interv Radiol 2021;6:106-18.
24. Saad WE, Lippert A, Saad NE, et al. Ectopic varices: anatomical classification, hemodynamic classification, and hemodynamic-based management. Tech Vasc Interv Radiol 2013;16:158-75.
25. Norton ID, Andrews JC, Kamath PS. Management of ectopic varices. Hepatology 1998;28:1154-8.
26. Sarin SK, Kumar CKN. Ectopic varices. Clin Liver Dis (Hoboken) 2012;1:167-72.
27. Rana SS, Bhasin DK, Sharma V, et al. Clinical, endoscopic and endoscopic ultrasound features of duodenal varices: a report of 10 cases. Endosc Ultrasound 2014;3:54-7.
28. Bahdi F, George R, Patel K. EUS-guided coiling and cyanoacrylate injection of ectopic duodenal varices. VideoGIE 2021;6:35-7.
29. Fujii-Lau LL, Law R, Wong Kee Song LM, et al. Endoscopic ultrasound (EUS)-guided coil injection therapy of esophagogastric and ectopic varices. Surg Endoscopy 2016;30:1396-404.
30. Mann R, Goyal H, Perisetti A, et al. Endoscopic ultrasound-guided vascular interventions: current insights and emerging techniques. World J Gastroenterol 2021;27:6874-87.
31. Dhar J, Samanta J. Endoscopic ultrasound-guided vascular interventions: an expanding paradigm. World J Gastrointest Endosc 2023;15:216-39.
32. Carr JA, Cho JS, Shepard AD, et al. Visceral pseudoaneurysms due to pancreatic pseudocysts: rare but lethal complications of pancreatitis. J Vasc Surg 2000;32:722-30.
33. Gurala D, Polavarapu AD, Idiculla PS, et al. Pancreatic pseudoaneurysm from a gastroduodenal artery. Case Rep Gastroenterol 2020;13:450-5.
34. Maharshi S, Sharma SS, Sharma D, et al. Endoscopic ultrasound-guided thrombin injection, a management approach for visceral artery pseudoaneurysms. Endosc Int Open 2020;8:E407-12.
35. Rai P, Kc H, Goel A, et al. Endoscopic ultrasound-guided coil and glue for treatment of splenic artery pseudo-aneurysm: new kid on the block. Endosc Int Open 2018;6:E821-5.
36. Samanta J, Dhar J, Bhowmick M, et al. Bleeding giant pseudoaneurysm non-visualized on arterial phase imaging: endoscopic ultrasound-guided angioembolization to the rescue. Endoscopy 2023;55:E739-40.
37. Samanta J, Dhar J, Mangipudi UK, et al. "Hunting" for the pseudoaneurysm in a vascular maze: endoscopic ultrasound solving the puzzle. Endoscopy 2023;55:E839-40.
38. Thiruvengadam SS, Sedarat A. The role of endoscopic ultrasound (EUS) in the management of gastric varices. Curr Gastroenterol Rep 2021;23:1.
39. Kouanda A, Binmoeller K, Hamerski C, et al. Safety and efficacy of EUS-guided coil and glue injection for the primary prophylaxis of gastric variceal hemorrhage. Gastrointest Endosc 2021;94:291-6.
40. Guo YW, Miao HB, Wen ZF, et al. Procedure-related complications in gastric variceal obturation with tissue glue. World J Gastroenterol 2017;23:7746-55.