

Endoscopic Management of Iatrogenic Duodenal Perforation With Linear-Probe Echoendoscope

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Endoscopic ultrasound (EUS) has become an important diagnostic and interventional tool for endoscopists. Initially used for diagnostic purposes, EUS has now expanded to include interventional applications (such as fine-needle aspiration, biopsy, and injection), therapeutic drainage procedures, and neurolysis.¹ In the hands of an experienced operator, complication rates are similar to those associated with standard upper endoscopy.¹ Possible complications of EUS include infection, sedation-related cardiopulmonary events, and perforation. Traditionally, iatrogenic gastrointestinal perforations secondary to endoscopy have been managed surgically. Recently, data have emerged revealing that immediate endoscopic treatment with an endoclipping device may be an acceptable alternative to surgery in select cases.²⁻⁵ Multiple reports have described perforation management, but there are limited data reporting cases of duodenal perforation specifically attributable to linear-probe echoendoscopes.²⁻⁵ We describe the endoscopic management of iatrogenic duodenal perforation during linear EUS examination with endoscopic clipping device placement and subsequent medical management.

Case #1

A 68-year-old woman with a history of gastric carcinoma presented for evaluation. The linear-probe echoendoscope (Pentax Medical Co.) was advanced to the second portion of the duodenum. A 7-mm transmucosal tear was immediately visualized in the postbulbar duodenum (Figure 1). A standard upper endoscope was used to deploy 7 endoscopic clipping devices (QuickClip HX-

200U-135; Olympus America, Inc.) to fully approximate the lesion (Figure 2). After admission, broad-spectrum antibiotics were administered and surgical consultation was obtained. Computed tomography (CT) scan at 24 hours did not reveal contrast leakage. The patient was discharged 3 days postprocedure, and follow-up at 120 days was uneventful.

Case #2

An 87-year-old woman underwent diagnostic EUS for evaluation of a suspected pancreatic mass. CT scan revealed common biliary duct dilatation. Examination with a linear-probe echoendoscope (Pentax Medical Co.) revealed a 1.5-cm irregular mass in the head of the pancreas. Prior to intervention, a 5-mm tear was visualized at the junction of the duodenal bulb and descending duodenum. The defect was approximated entirely with multiple



Figure 1. Transmucosal tear immediately visualized in the postbulbar duodenum.

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Figure 2. Endoclip deployment to the approximate defect.

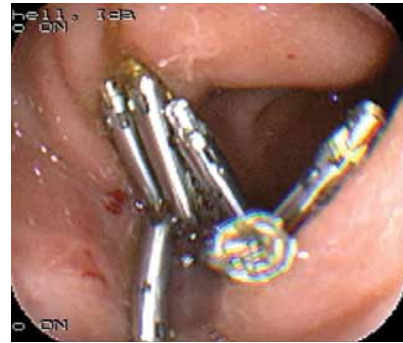


Figure 3. A 5-mm tear at the junction of the duodenal bulb and descending duodenum after deployment of multiple endoclips.

endoscopic clipping devices (QuickClip HX-200U-135; Olympus America, Inc.). Of note, the lumen was very difficult to insufflate prior to clipping; after clipping was performed, normal insufflation was possible (Figure 3). After admission, broad-spectrum antibiotics were administered. CT scan at 24 hours revealed no contrast leakage. The patient was discharged on postprocedure day 6, and follow-up at 120 days was uneventful.

Discussion

Our cases demonstrate the feasibility of endoscopic management in linear EUS-related perforations. In select patients, surgery can be avoided by using endoscopic clipping devices to repair the defect. The success of endoclipping depends on immediate recognition and closure of the defect. Theoretically, immediate closure of intestinal perforation minimizes leakage of digestive enzymes, bile, and bacteria to surrounding organs. With less inflammatory damage and bacterial contamination, antibiotics and symptomatic management may be sufficient to prevent further morbidity. In addition, the use of endoscopic clipping devices is safe, with a much lower rate of complications compared to emergent surgical intervention. Endoscopic clipping devices do not impair healing or re-epithelialization of the closed defect margins, and there have been no reports of clip impaction, perforation, or other significant complications.² The use of the endoscopic clipping device as a therapeutic tool was initially described in 1975 by Hayashi and colleagues, though clinical application of the device was initially limited. Advances in instrument design by the late 1980s enabled routine use for hemostasis in gastrointestinal bleeding.⁶ Uses have now expanded to include closure of tissue defects, perforations, and anastomotic leaks, as well

as prevention of postpolypectomy bleeding, placement of enteral feeding tubes, and marking sites for surgical excision and endoscopic re-examination.⁷ Binmoeller and colleagues reported the use of an endoscopic clipping device to close an iatrogenic gastric perforation after snare resection of a leiomyoma.⁸ Consequently, Kaneko and coworkers described endoscopic closure of a duodenal perforation secondary to endoscopy in 1999.⁹ Regarding EUS-related perforation, Seibert described the use of endoscopic closure of iatrogenic duodenal perforation during EUS examination.³ Our results concur with previous data that endoscopic intervention is a useful alternative for small perforations that are recognized immediately. In addition, these results are reported only in association with linear-probe echoendoscopes, for which data are limited.

The most commonly reported complication associated with EUS is esophageal perforation.¹⁰ Duodenal perforations have been reported with much less frequency, and data stratifying perforation by probe type (radial versus linear) are more limited. A recent retrospective study of 11,539 EUS procedures reported an overall complication rate of 0.12%, which included a 0.046% complication rate among 10,731 diagnostic EUS procedures.¹¹ With regard to probe type (radial versus linear), the study showed a 0.033% complication rate for radial-probe EUS, a 0.1% complication rate for diagnostic EUS using a linear probe, and a 1.11% complication rate after interventional EUS using a linear probe. Other data have reported a complication rate of less than 0.1% for diagnostic EUS and approximately 2% for therapeutic EUS.^{1,12} In a prospective study of 20,000 EUS procedures, 7 deaths (0.00035%) were attributable to duodenal perforation, all of which occurred with linear probes.¹ The study did not mention whether endoscopic intervention was attempted in any of the fatal cases. Our

Table 1. Factors Associated With Increased Risk of Duodenal Perforation During Endoscopic Ultrasound

- Operator inexperience (<100 cases total)
- Anatomical variation (ie, duodenal diverticula)
- Use of linear probe

endoscopy unit (2 endosonographers) has performed 3,791 EUS procedures over the last 4 years (average, 947/year). Eight perforations have occurred, resulting in a perforation rate of 0.13%, similar to the above study. In total, both endosonographers have performed nearly 11,000 EUS procedures.

Previous data have suggested that risk factors for duodenal perforation during EUS include operator inexperience (<100 cases) and the presence of duodenal diverticula (Table 1).^{11,13} The presence of these risk factors should be cause for additional caution during EUS examination. In addition to the above, the sudden inability to insufflate the lumen (case #2) should also raise suspicion for perforation.

If iatrogenic duodenal perforation is suspected, we suggest the use of an endoclipping device combined with medical management as a potential alternative to emergency surgery. This management, however, should only be pursued in the following cases: immediate recognition and visualization of a tear during the procedure; the presence of an endoscopist adequately trained in the use of the endoclipping device; perforation size less than 10 mm; and availability of surgical backup in-house. In cases of high surgical risk, these criteria may serve as guidance for nonsurgical management. Endoscopic intervention should generally be followed by inpatient medical management, including a nil-per-os regimen, nasogastric suctioning, intravenous fluids and antibiotics, and observation for signs of decompensation, including peritonitis, subcutaneous emphysema, hemodynamic instability, and/or sepsis. Contrast should be obtained

24 hours postprocedure, or earlier as dictated by signs and symptoms, to evaluate for contrast leakage.¹⁴ If imaging does not reveal extravasation of contrast, a liquid diet may be initiated shortly thereafter.

Our cases demonstrate the feasibility of endoscopic management in linear-probe EUS-related duodenal perforations. As EUS with linear probe becomes more common, clinicians should be aware of management strategies that may potentially preclude surgical intervention and subsequent morbidity.

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Review

The Use of Endoscopic Clipping Devices in the Treatment of Iatrogenic Duodenal Perforation

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Over the past 20 years, endoscopic ultrasound (EUS) has evolved from a novel imaging procedure to a clinical diagnostic test that is often essential for optimizing management of gastrointestinal diseases.¹ Currently, 2 different types of EUS systems are available for clinical use: radial and linear. Radial echoendoscopes are particularly useful for examining the esophagus, as they allow a complete circumferential assessment of the esophageal wall layers as well as the lymph nodes and other surrounding structures. Linear echoendoscopes provide a 120-degree ultrasound image parallel to the axis of the endoscope. This linear orientation allows for the passage of a fine aspiration needle through the endoscope's working channel and into targeted tissues.²

EUS is acknowledged to be a safe and tolerable procedure.¹ The complication rate associated with conventional EUS ranges from 0.04% to 0.6%,³⁻⁵ which is similar to the complication rate associated with upper gastrointestinal tract endoscopy (0.1–0.5%).^{6,7} A complication rate of 0.12% was reported in a retrospective study of 11,539 EUS examinations; this included a 0.046% complication rate among 10,731 conventional EUS procedures. When a linear probe was used, the complication rate was 0.10% for conventional EUS and 1.11% for interventional EUS, whereas the complication rate for a radial probe was 0.033% for both types of EUS procedures.^{1,5} From the above study, it appears that the complication rate associated with linear probes is greater than that associated with radial probes. However, the higher complication rate noted with linear EUS, compared to radial EUS, has not been proven to be statistically significant.¹

EUS-associated complications include infections, bleeding, pancreatitis, perforation, and sedation-related

cardiopulmonary events.^{1,5} In a prospective study of 1,034 pancreatic EUS–fine-needle aspiration procedures, the rate of overall major complications was 0.29%; this included a rate of 0.96% for hemorrhage, 0.19% for acute pancreatitis, and 0.09% for duodenal perforation.⁸ One of the most fatal complications that has occurred in relation to EUS is perforation.¹ The recognized risk factors connected to duodenal perforation include the lack of a trained endoscopist, the presence of duodenal diverticula, the failure to insufflate the lumen, and the presence of a biliary sphincterotomy.^{5,9,10} Seven deaths were reportedly caused by duodenal perforation in a prospective study examining 20,000 EUS procedures that used linear probes.^{1,5} Khokhar and colleagues reported a perforation rate of 0.13% among 3,791 EUS procedures.⁵ Based upon other prospective data, a perforation rate of 0.03% has been noted among 400 patients,¹¹ whereas an esophageal perforation rate of 0.04% has been reported in 37,915 EUS examinations, according to retrospective data.³

One of the most common sites for perforation caused by radial probes is the esophagus. By contrast, the duodenum is the most common site for perforation caused by linear probes. However, the occurrence of duodenal perforation with a linear probe is not well defined, due to limited studies.^{1,5}

The gold standard for treatment of iatrogenic duodenal perforation is surgical repair.¹²⁻¹⁴ However, in some cases, conservative medical management may be used for small perforations associated with unconfirmed or small leaks.¹²⁻¹⁵ Some physicians utilize surgical repair in all cases of duodenal perforation due to the lower rate of complications associated with early operation.¹⁴ The latest alternative to surgical or medical management of iatrogenic perforation is the endoscopic clipping device. No complications have been recorded to date with the use of this device for closure of iatrogenic perforations. Endoscopic clips were first introduced in 1975 by Hayashi and associates for marking sites for surgical excision and mechanical homeostasis in the gastrointestinal tract.¹⁶ In 1993, endoclips were used for the first time to close an iatrogenic perforation secondary to resection of gastric leiomyoma.¹⁷ Kaneko and colleagues¹⁸ and Roses and associates¹⁹ have used endoclips to treat duodenal perforation secondary to therapeutic endoscopy. Khokhar and coworkers have described 2 patients with iatrogenic duodenal perforation during linear EUS examination who were managed with an endoscopic clipping device.⁵ Furthermore, cases reported by Sebastian and associates,²⁰ Seibert,²¹ and others have demonstrated successful closure of an iatrogenic duodenal perforation with an endoscopic clipping device following EUS examination.¹⁶⁻¹⁸ No complications were reported in these case reports. Complete healing of the perforation site was observed by a 1-month

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follow-up endoscopy, and the clips were observed to dislodge spontaneously within 3 weeks of placement.

Immediate identification and closure of the perforation is the key to achieving success with endoclips.^{5,14} Instant closure of the intestinal tear reduces, in theory, the spread of digestive enzymes, bile, and bacteria to nearby organs. This may result in less inflammation and contamination of bacteria and may enable antibiotics and symptomatic treatment to guard against further morbidity.^{5,14}

In the above case reports, the intestinal perforation has been closed by endoclips using a through-the-scope system, which has certain limitations. Due to the low closure force and the limited opening distance between the clip jaws, multiple clips are required to close the defect. Moreover, only small defects (10 mm in size) can be closed using the above technique.²²⁻²⁴ In a recent study, a new over-the-scope clip system (by Ovesco Endoscopy) was used in 10 patients to manage larger leaks (range, 7–20 mm in size) by using only 1 or 2 clips.²² Successful healing of the leaks was accomplished without complications and was confirmed by endoscopy 3 months after treatment.²²

Recent studies recommend the use of an endocliping device for the management of iatrogenic gastrointestinal perforations in select cases that fulfill the following criteria: instant identification of the perforation during the procedure; a tear that is less than 10 mm in size; an endoscopy team that is experienced with using endoclips; and the availability of surgical help (if necessary).^{5,14} After the procedure, the patient should be admitted to the hospital for medical management (including nil-per-os, nasogastric suctioning, and intravenous fluids and antibiotics). Moreover, the patient should be closely monitored for signs of peritonitis, subcutaneous emphysema, hemodynamic instability, and sepsis. Imaging studies should be performed 24 hours after the procedure, and a liquid diet may be started if the imaging study does not show any leakage of contrast.⁵

The use of an endocliping device for the management of iatrogenic duodenal perforation will likely gain in popularity in the near future. Most of the authors mentioned above demonstrated the feasibility of using endoscopic management with an endoscopic clipping device in bowel perforation, though certain limitations still remain. Although there were no complications associated with the use of through-the-scope and over-the-scope systems, more studies are required to confirm the indications and safety associated with them. Moreover, it is still not clear whether the use of such a device is safe in unprepared bowel, and, unfortunately, only smaller perforations with a diameter of 10 mm or less can be closed due to the small size of the endoclips currently available.

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