The prepurse-string suture technique for gastric defect after endoscopic full-thickness resection (with video)

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Abstract

Endoscopic full-thickness resection (EFTR) is the main treatment for gastric tumors originating from the muscularis propria or gastric extra-luminal growth tumors. Successful closure of the gastric wall defect is a critical step during EFTR.

The aim of this retrospective study was to evaluate the feasibility and safety of the endoscopic prepurse-string suture (p-EPSS) technique using an endoloop and several metallic clips during EFTR to close the perforation.

Twenty-five patients with gastric tumors originated from the muscularis propria or with gastric extra-luminal growth tumors who received EFTR were analyzed at the Renmin Hospital of Wuhan University from June 2016 to May 2017. Patient characteristics, tumor characteristics, operation time length, and postoperative complications were evaluated in all patients.

All the 25 patients underwent a successful EFTR. Complete closure of gastric defects was also achieved. The mean operation time length was 31 ± 14 minutes. The mean maximum size of tumor of was 1.7 ± 1.0 cm (range 0.5–4.5 cm). No severe postoperative complications occurred, such as massive bleeding, gastric leak, peritonitis, or abdominal abscess. No patient needed surgical intervention. Wounds were well healed 1 month after EFTR. No tumor metastasis and recurrence were observed during the follow-up period (median, 7 months).

The p-EPSS technique using endoloop and several sterile repositionable hemostasis clips is safe and feasible for closing gastric perforation during EFTR.

Abbreviations: CT = computed tomography, EFTR = endoscopic full-thickness resection, EMR = endoscopic mucosal resection, EPSS = endoscopic purse-string suture, ESD = endoscopic submucosal dissection, EUS = endoscopic ultrasonography, GISTs = gastrointestinal stromal tumors, OTSC = over-the-scope-clip system, p-EPSS = prepurse-string suture, SMTs = submucosal tumors.

Keywords: endoscopic full-thickness resection, endoscopic prepurse-string suture, perforation, sterile repositionable hemostasis clip

1. Introduction

Gastric submucosal tumors (SMTs) originate from submucosal or muscularis propria; they are mostly gastrointestinal stromal tumors (GISTs), most of which are located in the stomach (60%).[1] GISTs metastatic rate is strongly related with tumor size and mitotic activity. In general, GISTs are considered benign when tumors are smaller than 2 cm with a mitotic index of 5 or less per 50 high power fields, but are considered to a high risk of recurrence when larger than 2 cm with the same mitotic index.[2] The National Comprehensive Cancer Network guidelines recommend to resect all GISTs larger than 2 cm, but patients can choose endoscopic surveillance or resection if tumors are smaller than 2 cm.[1] However, surveillance is associated with patients' compliance, cost-effectiveness, and may lead to a delayed diagnosis of malignancy. Besides some patients strongly need an endoscopy to resect tumors as early as possible. Recently, endoscopic full-thickness resection (EFTR) and endoscopic submucosal dissection (ESD) have been widely applied to resect SMTs and gastric extra-luminal growth tumors. Compared with surgery, endoscopic resection is less invasive.

However, a higher risk of perforation of the muscularis propria layer is associated with ESD. Perforation is one of the main obstacles in the promotion and development of both EFTR and ESD. Thus, it is of utmost importance to close the gastric defect successfully and quickly, avoiding postoperative complications. In 2004, Japanese experts first reported the complete closure of a large defect after endoscopic mucosal resection (EMR) using an endoloop snare and several metallic clips.[3] Several studies reported a successful closure of perforations using endoscopic purse-string suture (EPSS) when perforations were larger than 2 cm.[4,5] However, how to manage perforations during operation is worth consideration. In our study, we proposed a new method to close the perforation during operation using pre-EPSS (p-EPSS), and turn passive perforation to active perforation.

2. Materials and methods

Inclusion criteria of this study were as follows:

The lesion was originated from the muscularis propria layer, as confirmed by endoscopic ultrasound (EUS).

Absence of lymph node metastasis, as confirmed by computed tomography (CT) and EUS.

Patients could tolerate anesthesia with tracheal intubation and they did not have blood coagulation disorders.

A total number of 25 patients (14 females and 11 males), mean age 59 ± 9 years (range 42–78 years), who underwent perforation during EFTR for gastric tumors, were analyzed at the Renmin Hospital of Wuhan University from June 2016 to May 2017. The study was approved by the Ethics Committee of Renmin Hospital of Wuhan University, and written informed consent was obtained from all patients. Patient characteristics, tumor characteristics, operation time length (from mucosa marking step to p-EPSS completion), and postoperative complications were evaluated in all patients.

2.1. Endoscopic equipment and accessories

The following equipment and accessories were used: a single-channel endoscopy (Q260j; Olympus, Tokyo, Japan), magnifying endoscopy (EC-590ZW/M; Fujinon, Fuji, Japan), EUS (SU-8000; Fujinon), transparent cap (Olympus), IT knife (Olympus), hook knife (Olympus), ERBE electrosurgical coagulation unit with a high-frequency generator (ICC-200; Elektromedizin GmbH, Tübingen, Germany), injection needles (NM-4L-1; Olympus), metallic clip (Olympus), sterile repositionable hemostasis clip (Nanjing Micro-Tech, Nanjing, China), endoloop (MAJ-254; Olympus).

2.2. Preoperative preparation

EUS and CT were used to identify the originating layer of gastric tumors and exclude lymph node metastasis. Blood routine test, coagulation function, liver function, kidney function, and electrolyte measurement were routinely examined to evaluate patients' basic conditions. All patients were informed of the relative complications associated to EFTR, such as massive bleeding, peritonitis or abdominal abscess, then written informed consent was obtained from all patients. All patients started to fast the night before the endoscopy, with no food and water at all.

2.3. Endoscopic procedures

Before operation, all patients underwent conscious sedation using propofol; the depth of sedation and signs of life were evaluated by an anesthesiologist. ESD procedure was as follows:

1. Mucosa marking: marks were placed 3 to 5 mm outside the circumference of the lesion.
2. Submucosal injection: diluted epinephrine in saline solution (1:100,000) was injected into the submucosal layer to raise the submucosa, and the gastric cavity was filled with carbon dioxide gas through the designated infusion system to keep the stomach dilated.
3. Precutting of the mucosal and submucosal layer was performed, and the part of mucosa was removed to expose the tumor, then the endoscopy was withdrawn after the tumor was exposed.
4. The sterile repositionable hemostasis clip was inserted into the biopsy hole of the single-channel endoscopy, and the clip was

opened when out of the hole. The endoloop was placed on the side of the clips wingspan, then delivered together in the gastric cavity using a forceps through the single-channel endoscopy.
5. The endoloop was anchored onto different sides of the normal mucosa near the resection margin with several clips, to prepare the area for the following EPSS.
6. The other endoloop was anchored onto the lesion, and the gastric extra-luminal tumor was turned endoluminal by pulling the endoloop.
7. Endoloop was immediately tightened, when the tumor was finally resected. An example of closure procedure is shown in Figure 1A–H and video.

2.4. Postoperative management

All patients needed to continue the fast, with no food and water for 48 to 72 hours, and a gastrointestinal decompression drainage tube was placed to reduce stomach pressure and monitor delayed bleeding. Intravenous infusion of proton pump inhibitors (PPIs), antibiotic, and hemocoagulase were routinely administered postoperatively. Patients were closely observed for abdominal signs, melena, and hematochezia. All patients resumed a liquid diet 48 to 72 hours after the procedure.

Melena, hematochezia, and hemoglobin decreased 2 mg/mL were considered as postoperative delayed bleeding. If patients had abdominal pain or any signs of peritonitis, blood routine test and abdominal X-ray were performed. Abdominal X-ray examination showed subphrenic-free air was a sign of postoperative perforation. Postoperative follow-up depended on the histopathology results, endoscopy was performed to evaluate the wound healing at 1 month after procedure, and abdominal CT and chest radiography were performed at 6 month to evaluate recurrence, lymphatic, and distant metastasis.

3. Results

A total of 25 patients (11 males and 14 females; mean age 59 years, range 42–78 years) successfully underwent this procedure for closure of gastric perforation during EFTR. The 25 gastric tumors included 7 located in the gastric corpus and 18 located in the fundus. The mean maximum size of the tumor was 1.7 ± 1.0 cm (range 0.5–4.5 cm). The closure procedure time length was measured from mucosa marking step to the complete perforation closure. The mean of the total procedure time length was 31 ± 14 minutes. The pathologic examination revealed GIST in 21 patients, leiomyoma in 2 patients, neurinoma, and calcifying fibrous tumor in 1 patient. The specimen histology showed a complete resection of all tumors (lateral and vertical tumor-free margins). The GISTs were of low risk or very low risk, with a low mitotic index, thus, no other treatments were given.

No severe postoperative complications occurred, such as massive bleeding, gastric leak, peritonitis, or abdominal abscess after EFTR. Four patients had abdominal pain or discomfort, and 2 patients had fever with body temperature between 38°C and 39°C. Body temperature dropped to normal during the following 3 to 4 days. The white blood cell count was increased in 2 patients, and after intravenous infusion of antibiotic, it dropped to a normal level during the following 3 days. No patient needed surgical intervention. All patients were scheduled for follow-up by outpatient visit 1 month after EFTR: the wounds were healed, some clips, and endoloops fell off spontaneously but parts of metallic clips and endoloops were left in situs. Mean follow-up period was 7 months (range 1–11 months). No tumors metastasis
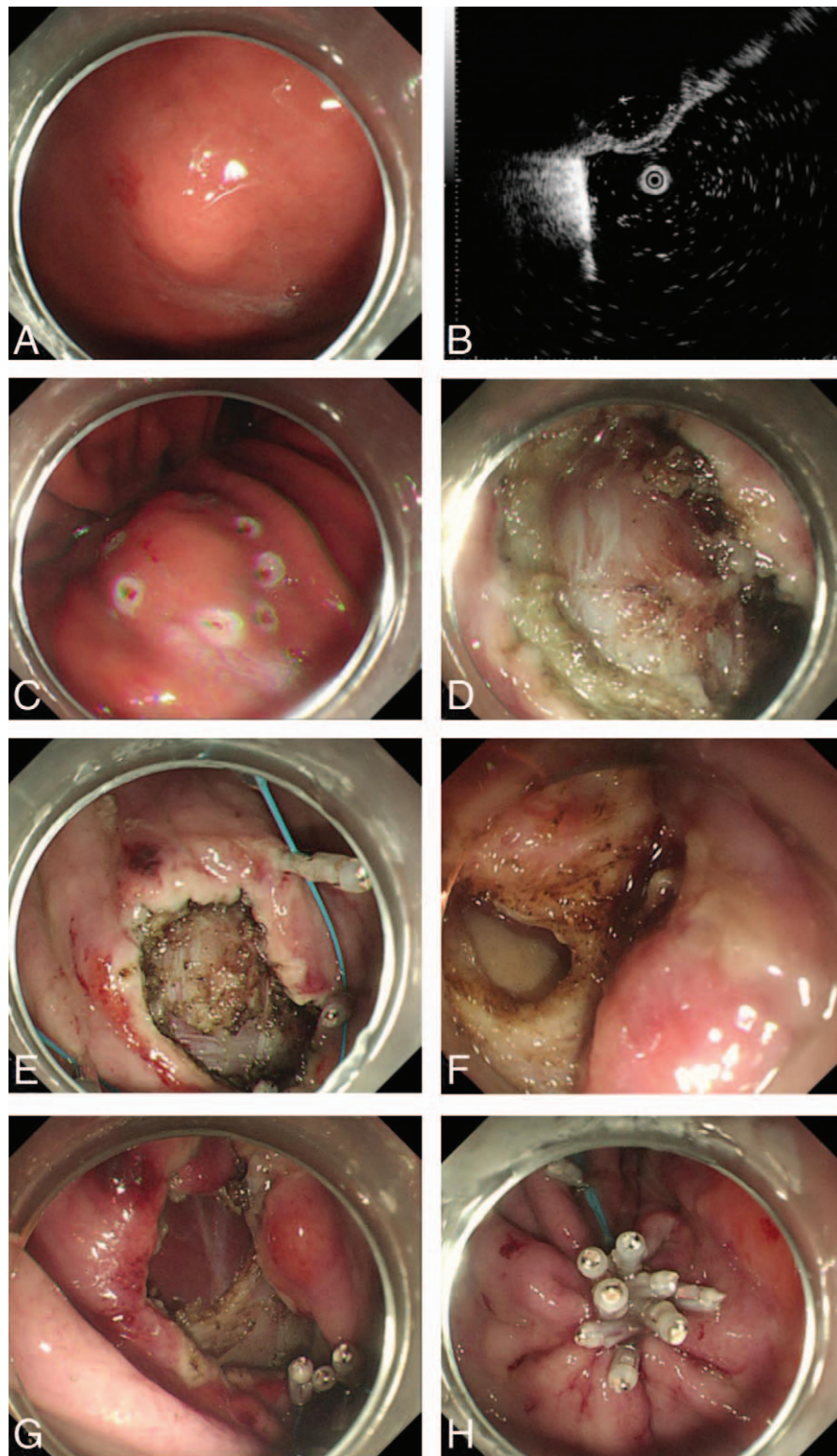
Figure 1. (A) The tumor located in gastric corpus. (B) Endoscopic ultrasonography shown that tumor originating from muscularis propria. (C) Dots were marked around the tumor. (D) The lesion was exposed after the mucosal and submucosal layers were resected. (E) Prepared for prepurse-string suture (p-EPSS) using an endoloop and several metal clips. (F) Performed endoscopic full-thickness resection (EFTR) to turn passive perforation to active perforation after p-EPSS. (G) Liver can be seen through the gastric defect after EFTR. (H) The perforation was immediately closed following EFTR by tightening endoloop.

Treatment outcome of EFTR for gastric tumors originating from the muscularis propria layer with perforation closure using p-EPSS.

Patients characteristics	
Mean age, y	59 ± 9
Male/female ratio	11/14
Tumor size, mm	
<20	16
>20	9
Mean length (diameter), cm	1.7 ± 1.0
Tumor locations	
Corpus	7
Fundus	18
Mean procedure time, min	31 ± 14
Histology diagnosis	
Leiomyoma	2
Neurinoma	1
Calcifying fibrous tumor	1
GIST	21
Low risk	5
Very low risk	16
Complication	
Abdominal pain	4
Fever	2
Elevated WBC count	2
Median follow-up periods, mo	7

EFTR = endoscopic full-thickness resection, GIST = gastrointestinal stromal tumor, p-EPSS = prepurse-string suture, WBC = white blood cell.

and recurrence were observed during the follow-up. Patients' characteristics are shown in Table 1.

4. Discussion

The GIST is the most common mesenchymal tumor of the gastrointestinal tract. Miettinen et al[2] performed a large retrospective study including 1765 patients, showing that GIST mortality was related to tumor size and mitotic activity. The mortality with tumors small than 2 cm was zero, but the tumor-specific mortality increased with increasing tumor size. According to this study, overall tumor-specific mortality was 17%, and the frequency of malignancy was high in GISTs located in gastric fundus and gastroesophageal junction-cardia region. Many experts recommend that GIST (<2 cm) could be follow-up by endoscopy, but this recommendation still remains a controversy. The benign or malignant nature of any GIST cannot be assessed before biospy. Since every GIST is regarded as potentially malignant, all GISTs may need to be removed, even small GISTs.

The EUS-guided fine-needle aspiration and bite-on-bite biopsies can provide a definitive histologic diagnosis. However, both these biopsies can lead to adhesion and inflammation, even tumoral rupture or intraperitoneal diffusion, which make EFTR operation difficult. Thus, preoperative biopsy is not routinely recommended.

In the past years, surgery and laparoscopic surgery were the major treatment for GISTs without evidence of metastasis. In recent years, many endoscopic techniques have been used to resect GISTs, such as ESD, endoscopic submucosal excavation and EFTR. ESD is feasible if tumor is restricted in the lumen. Compared with conventional surgery, ESD is less invasive and can maintain the normal structure of stomach. However, ESD is difficult for gastric extra-luminal growth tumors, and if the tumor tightly adheres to the muscularis propria or serosal layer of the stomach, ESD perforation rate is high.[6] Therefore, ESD is no more suitable in these patients. EFTR is developed from ESD for removing submucosal gastrointestinal tumors. In 2011, Zhou et al[7] firstly performed EFTR without laparoscopic assistance to treat gastric SMTs; 26 SMTs were successful removed by EFTR, which included 16 GISTs, and the complete resection rate was 100%, with no severe complication observed. In recent years, EFTR has been used for resection of gastric tumors in the muscularis propria; many studies proved EFTR safety and efficiency in treating GIST.

Bleeding and perforation are the main ESD complications,[8] and the frequency of perforation is reported as up to 20%.[9] Incomplete closure of gastric perforations may lead to serious peritonitis and abdominal abscess, which are the most relevant obstacles in performing EFTR.[10] Traditionally, gastric perforations should be managed by surgical intervention. However, recently, many methods and devices have been developed to successfully close gastrointestinal perforation, such as metallic clip, over-the-scope-clip (OTSC) system, and endoloop clips.

Metallic clip is the most commonly used device to close a gastrointestinal perforation. Indeed, closure of gastrointestinal perforations by metallic clip has been successfully applied in many studies. Suzuki and Ikeda[11] and Minami et al[12] reported a successful closure of gastric defect using metallic clip without any complication. Cho et al[13] reported that closure of perforation by endoclips can achieve a success rate of 92%, but 76% patients required medical clip closure and 24% patients had surgical treatment after endoscopic clips closure. Minami et al[12] performed a retrospective study regarding endoclips closure of gastric perforations. Among 2460 patients, 121 experienced a perforation (4.9%), of which 115 had a perforation successfully closed by endoclips. However, in animal studies, closure of perforations by endoclips still resulted in a high 20% leakage.[10] Clips can reach only the mucosal and submucosal layer because they slip away when trying to reach the deeper layers. When the diameter of the gastric defect is larger than the width of the clip wingspan, defect closure with clips can lead to gastric leak.

Traditionally, closure of gastrointestinal perforations (>1 cm) are managed by surgical intervention to maximize patients benefit.[14] Recently, multiple studies reported that OTSC application can successfully close larger lesion (>1 cm).[15–17] Complete closure of perforation using OTSC was inverted closure with serosa to serosa apposition, compared with mucosa to mucosa closure, was regarded to long-term reliability.[15] von Renteln et al[18] and Schlag et al[19] also reported defects closure using OTSC system after EFTR. Gubler and Bauerfeind[16] encouraged endoscopist to close perforations up to 30 mm diameter by OTSC system. However, OTSC system has some restrictions in some anatomic sites, such as pylorus or the proximal esophagus, edema, and tissue folding possibly narrowing the lumen. Besides, OTSC device is expensive in China.

In 2004, Endo et al[20] reported the closure of a large gastric defect using endoloops and metal clips after EMR. Shi et al[21] reported a new interrupted suture-like method of closing large defects using endoloops and metal clips after EFTR. They anchored an endoloop to the normal mucosa near the proximal resection margin using a clip, and repeated to anchor the same endoloop at the distal resection margin, then endoloops were slightly tightened. Zhang et al[4] reported the successful closure of gastric defects with EPSS method, using an endoloop and several metallic clips after EFTR. However, the EPSS method needs the use of a double-channel endoscopy. To reduce gastric leak and other complications, we present a new perforation closure with p-

EPSS method using an endoloop and clips; with this method we immediately closed the perforation after EFTR.

In this study, we show our results using p-EPSS, which confirmed the safety and efficiency of p-EPSS. The en bloc resection rate was 100%, the mean resected lesion size was 1.7 cm (range 0.5–4.5 cm), and the operation time length was 31 ± 14 minutes, shorter than other reports. Hu et al[22] performed endoscopic grasp-and-loop closure method after EFTR in 13 patients; the mean resected lesion size was 1.5 cm (range 0.5–3.5 cm), but the mean procedure time was 43.5 minutes. Zhang et al[4] successfully closed the perforation after EFTR or ESD using EPSS; the mean resected lesion size was 1.9 cm (range 0.3–4.2 cm), but the mean procedure time was 55.7 minutes. No severe complication was observed in our study. The side effects after operation were fever and slight abdominal pain in 4 patients. In addition, no omental arterial injure was observed in our study; when an arterial hemorrhage occurs during the operation, the hemostatic clip should be released at the bleeding point and the blood vessels should be clamped to achieve hemostasis. If endoscopy fails to stop bleeding, the patient should undergo surgical treatment. In our study, the maximum tumor diameter was 4.5 cm. The tumor was completely removed using p-EPSS. In the future, we are planning to perform a larger sample study to evaluate the safety and effectiveness of the p-EPSS for larger tumors. Compared with conventional EPSS, p-EPSS has the following advantages: first, we could perform p-EPSS using a single-channel endoscopy. For some tumors of inevitable perforation, we could prepare p-EPSS in advance; thus, perforation could be immediately closed when the resection was finished, preventing gastric fluid and gas escaping into the peritoneal cavity, consequently reducing the risk of peritonitis. In our study, 1 patient experienced abdominal pain when the tumor was smaller than 2 cm; 3 patients experienced abdominal pain for tumors larger than 2 cm, although the results of abdominal X-ray were normal. In addition, in our study, metallic clips and sterile repositionable hemostasis clips were used to deliver the endoloop. As compared to metallic clip, sterile repositionable hemostasis clip can be repeatedly opened and closed, make operation easier. For this reason, sterile repositionable hemostasis clip was used in most cases. Second, after p-EPSS, we could choose a suitable time of perforation, turn passive perforation to active perforation, which can provide sufficient time to prepare perforation closure. Finally, gastric extra-luminal growth tumors could be turned to endoluminal by pulling the endoloop, which could avoid intraoperative bleeding due to an accidental resection of blood vessels of the serosal layer, preventing the tumor from falling into the extra cavity and make the operation easier and shorten.

However, some limitations are also present in this work. First, our study was performed using a small sample size with only 25 patients enrolled. Therefore, a large-scale, randomized controlled trial is required to evaluate the safety and efficiency of this method in the near future. Second, the follow-up period was relatively short, thus, a long-term follow-up should be considered in the future.

In summary, according to the results of our study, p-EPSS technique using an endoloop and several metal clips is safe and effective for closing larger gastric defects during EFTR.

Author contributions

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