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Offshoots of peroral endoscopic myotomy: Submucosal tunneling endoscopic resection, pyloromyotomy, and beyond☆

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ABSTRACT

The emergence of peroral endoscopic myotomy (POEM) marks the rising of a new branch of therapeutic endoscopy. Our group defines it as tunnel endoscopic surgery that includes several novel procedures utilizing a submucosal tunnel as an operating space. In 2010, we developed a new procedure that takes advantage of the submucosal tunneling technique popularized by POEM to achieve complete, full-thickness endoscopic resection of upper gastrointestinal submucosal tumors originating from the muscularis propria layer. Our group coined the acronym STER (submucosal tunneling endoscopic resection) for this procedure. Herein, we summarize this novel method and other offshoots of POEM.

Peroral endoscopic myotomy (POEM) has recently been described as a scarless and less invasive surgical myotomy option for treatment of achalasia [1]. This procedure incorporates concepts of natural orifice transluminal endoscopic surgery (NOTES) and expands upon techniques used in endoscopic submucosal dissection to achieve a division of the esophageal muscle fibers across the esophagogastric junction (EGJ) and caudally onto the stomach. Initial published experience in humans is more than encouraging despite relatively short follow-up [2-5].

The advent of POEM ushered in a new branch of therapeutic endoscopy. Our group defines it as tunnel endoscopic surgery, which includes several novel procedures utilizing a submucosal tunnel as an operating space and was initially developed for the purpose of establishing an access for NOTES [6-8]. In 2010, inspired by the success of submucosal tunneling in POEM and as an access technique for NOTES, our group developed a new method that utilizes submucosal tunneling to achieve endoscopic resection of upper gastrointestinal (GI) submucosal tumors (SMTs) originating from the muscularis propria (MP). We coined the acronym STER (submucosal tunneling endoscopic resection) for this technique [9]. Herein, we summarize this novel method and also review other offshoots of POEM.

1. STER

This novel technique was developed by our group [9] and similar techniques were also reported by other centers [10-12]. The advantage of STER is maintenance of GI tract mucosal integrity while achieving an en bloc resection of SMTs. This method will possibly reduce the risk of postoperative GI tract leakage and secondary infection. In contrast to conventional endoscopic procedures and NOTES, this technique is unique because it uses the submucosal space between the mucosal and muscular layers [9].

1.1. Indications

According to the American Gastroenterological Association Institute medical position statement, the small (< 3 cm) asymptomatic SMTs of the GI tract could be monitored by periodic endoscopy or endoscopic ultrasound or both [13]. However, this approach involves issues related to patient compliance, cost-effectiveness, and the risk associated with repeated endoscopic procedures and delayed diagnosis of malignancy. According to the recent National Comprehensive Cancer Network guidelines, all gastrointestinal stromal tumors > 2 cm should be resected; the treatment options for incidental tumors < 2 cm are resection or surveillance [14]. Especially, such tumors, particularly smaller ones, most of which are low-risk lesions, and SMTs at challenging locations for limited surgical resection, such as the EGJ [15] or esophagus [16], may benefit from a minimally invasive, scarless, endoscopic resection approach.

Upper GI SMTs originating from MP layer can be considered for STER when the tumors are located in the esophagus, cardia, gastric

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body, and gastric antrum. Routine endoscopic ultrasound examinations or computed tomography or both should be performed to confirm that the tumors originate from the MP. The maximum resectable lesion size is 5 cm because of the limited space of the submucosal tunnel. Large tumor size, irregular tumor shape, and difficult location (such as the EGJ) are factors associated with a more challenging or incomplete resection and STER-related complications. Therefore, such tumors should be treated by skilled and experienced endoscopists.

1.2. Equipment used for STER

A standard single accessory-channel gastroscope is used during the procedure. A transparent cap is attached to the front of the endoscope. Other equipment and accessories include a high-frequency generator, an injection needle, a hook knife, an insulated-tip (IT) knife, a snare, grasping forceps, and metallic clips. A CO_2 insufflator is used for carbon dioxide gas insufflation during the procedure. A mixed solution of normal saline containing 0.4% indigo carmine and 0.025-mg/mL epinephrine is used for submucosal injection.

1.3. STER technique

The patients are under general anesthesia with endotracheal intubation. Prophylactic intravenous antibiotics are administered 30 minutes before the procedure.

1.3.1. Step 1: Locating the tumor site

Submucosal injection of diluted indigo carmine or methylene blue is sometimes needed to mark the location of SMTs ≥2 cm distal to the EGJ to guide the submucosal tunnel dissection toward the tumor.

1.3.2. Step 2: Creation of a submucosal tunnel to expose the tumor

A fluid cushion is made by an injection needle at 5 cm proximal to the SMT. A 2-cm longitudinal mucosal incision is made by using a hook knife at the esophageal mucosa as the tunnel entry point. A submucosal longitudinal tunnel is created with a hook knife or hybrid knife between the mucosal and muscular layers. The tunneling ends 1-2 cm distal to the tumor to ensure a satisfactory endoscopic view of the SMT and enough working space for the resection. This precaution is vital to avoid injuring the overlying mucosa while tunneling. It is important to create the tunnel as close as possible to the MP not only to avoid injury to the mucosal flap but also owing to the lower vascularity adjacent to the MP.

1.3.3. Step 3: Resection of the SMT under direct endoscopic view

Endoscopic resection of the SMT is carried out by IT knife, Hook knife, or Hybrid knife. During the procedure, the highest priority is the safe and complete resection of the tumor without interrupting the tumor capsule. Unnecessary damage to esophageal adventitia or gastric serosa is cautiously avoided. However, if gastric SMTs are located in the deep MP layer close to the serosa, tumor dissection from the serosal layer is hard to perform, and therefore circumferential incision into the serosa is performed with the Hook knife or IT knife to complete the en bloc resection of such tumors. A dual-channel gastroscope is sometimes needed with grasping forceps stabilizing the tumor into the submucosal tunnel to prevent it from falling into the peritoneal cavity while, through the second channel, a snare is used to resect the tumor including its surrounding MP and serosa. If pneumoperitoneum develops, a 20-gauge needle is inserted in the right lower quadrant to relieve the pressure until there is no sign of gas escaping through it. Attention should be paid to hemostasis of the resection edge to prevent bleeding into the abdominal cavity.

1.3.4. Step 4: Closure of the mucosal incision site

After tumor resection, the submucosal tunnel is lavaged with normal saline if the esophageal adventitia or gastric serosa is intact. After hemostasis of any bleeding vessels within the tunnel using a coagrasper, the gastroscope is removed from the tunnel. Usually the mucosal incision site is closed with 4-6 hemostatic clips (Figure 1).

1.4. Postoperative care and clinical results

Postoperative medications include proton pump inhibitors, antibiotics, and hemocoagulase injection. Radiological examination, such as chest x-ray or computed tomography, is routinely used to detect pneumothorax or hydrothorax or both after STER. Postoperative observation includes monitoring for complaints of chest pain, dyspnea, abdominal pain, and abdominal distention. If a patient has obvious subcutaneous emphysema or pneumothorax, subcutaneous puncture or thoracic drainage is employed as needed. Thoracic drainage involves placement of a central venous catheter inserted at the third or fourth intercostal space instead of regular chest tube for drainage. After 2-3 days of drainage, with reexpansion of the lung, the drain is removed.

To date we have performed STER procedures in over 150 patients at our center. Our results suggest that STER can be a safe, easy, and feasible new method for providing accurate histopathologic evaluations, as well as radical treatments for SMTs from the MP layer. The maintenance of mucosal integrity and the longitudinal submucosal tunnel leads to effective closure without leaks and resultant pleural or mediastinal or abdominal infection, and rapid healing and recovery. Although the maximum resectable lesion size was 5 cm because of the limited space of the submucosal tunnel, this new method showed satisfactory initial results. A large-scale, randomized, control study is needed to evaluate the long-term outcome of STER compared with conventional treatments for SMTs originating from the MP layer.

2. Pyloromyotomy

Kawai et al. [17] recently demonstrated that peroral endoscopic submucosal pyloromyotomy appears to be technically feasible and effective in a porcine model, and may be considered as a new concept of minimally invasive surgery for pyloric stenosis.

Similar to POEM and STER, peroral endoscopic submucosal pyloromyotomy also uses the submucosal tunnel in order to maintain GI tract mucosal integrity and decrease morbidity. This procedure includes similar operation steps to POEM. In brief, submucosal injection and an initial mucosal incision were first done on the gastric antrum approximately 6 cm proximal to the pylorus. Then, similar to STER, a 5-cm submucosal tunnel was created passing over the pylorus using the endoscopic submucosal dissection method. After exposure of the muscular layer, selective dissection of the circular muscle bundles was attempted and the longitudinal muscle bundles were carefully protected and left intact at the limit of the dissected area. Once myotomy was completed, the mucosal incision was closed with endoscopic clips.

Although only a physiological animal model was used in this pilot study and comparisons with the clinical setting may not be valid, potential clinical applications, such as for infantile hypertrophic pyloric stenosis or delayed gastric emptying after esophagectomy, could be considered after confirmation of safety in additional survival studies.