Submucosal endoscopy as an aid to full-thickness resection: pilot study in the porcine stomach

Kohei Takizawa, MD,[1,2] Mary A. Knipschield,[1] Christopher J. Gostout, MD[1]

Rochester, Minnesota, USA

Background: Endoscopic full-thickness resection (EFTR) is commonly performed with laparoscopic assistance. Submucosal endoscopy with full-thickness resection (SEFTR) is a new technique that combines submucosal endoscopy with the mucosal safety valve flap method to enable EFTR.

Objective: Pilot evaluation of the feasibility and safety of SEFTR in an animal model.

Design: In vivo animal study.

Setting: Developmental endoscopy unit/animal research unit.

Intervention: Five domestic pigs, under general anesthesia, were used. A 2-cm gastric target area was marked. A circumferential mucosal incision was made. Two parallel submucosal tunnels on opposite sides of the incision were made. The mucosa at the proximal and distal tunnel ends was cut. A suture was passed through the tunnels encircling the target. T bars with sutures were placed full thickness outside the target and brought out of the mouth. Pulling the oral sutures raised the target while the targeted area was cinched serosa to serosa with the encircling suture. Full-thickness excision was then performed without closure.

Main Outcome Measurements: Rate of adverse events, procedure times, adverse events, and difficulty scales were recorded prospectively.

Results: Circumferential mucosal incisions, submucosal tunnels, and connections were completed in all. In the first case, looping of the target lesion failed. In the remaining 4 cases, looping, cinching, and lifting were completed. Full-thickness resections were completed in 3 of 4 pigs. There were no procedural adverse events and no damage to adjacent organs.

Limitations: Acute animal study. Procedures were performed by an endoscopist skilled in the submucosal endoscopy with the mucosal safety valve flap method.

Conclusion: This pilot experience suggests that SEFTR is feasible and could be safe.

Endoscopic resection is an established treatment for early GI neoplasms worldwide. Endoscopic submucosal dissection (ESD) allows for en bloc resection of lesions larger than 2 cm but is associated with a substantial risk of perforation.[1] It is very difficult to achieve en bloc resection without perforation and mucosal disruption of a lesion with submucosal fibrosis. Therefore, the balance between achieving a specimen large and deep enough to allow for histopathological assessment while avoiding perforation remains difficult. For subepithelial tumors,

Abbreviations: DS, difficulty scale; EFTR, endoscopic full-thickness resection; ESD, endoscopic submucosal dissection; SEFTR, submucosal endoscopy with full-thickness resection; SEMF, submucosal endoscopy with the mucosal safety valve flap; SFC, submucosal fluid cushion.

DISCLOSURE: *Dr Gostout is a medical officer of and an advisor to Apollo Endosurgery and is a consultant for and has received research support from Olympus Japan. All other authors disclosed no financial relationships relevant to this article.*

0016-5107/$36.00
http://dx.doi.org/10.1016/j.gie.2014.08.041

Received June 3, 2014. Accepted August 28, 2014.

Current affiliations: Developmental Endoscopy Unit, Division of Gastroenterology and Hepatology, Mayo Clinic, USA (1), Division of Endoscopy, Shizuoka Cancer Center Hospital, Shizuoka, Japan (2).

Reprint requests: Christopher J. Gostout, MD, Developmental Endoscopy Unit, Division of Gastroenterology and Hepatology, Mayo Clinic, 200 First Street SW, Rochester, MN 55905.

If you would like to chat with an author of this article, you may contact Dr Gostout at gostout.christopher@mayo.edu.

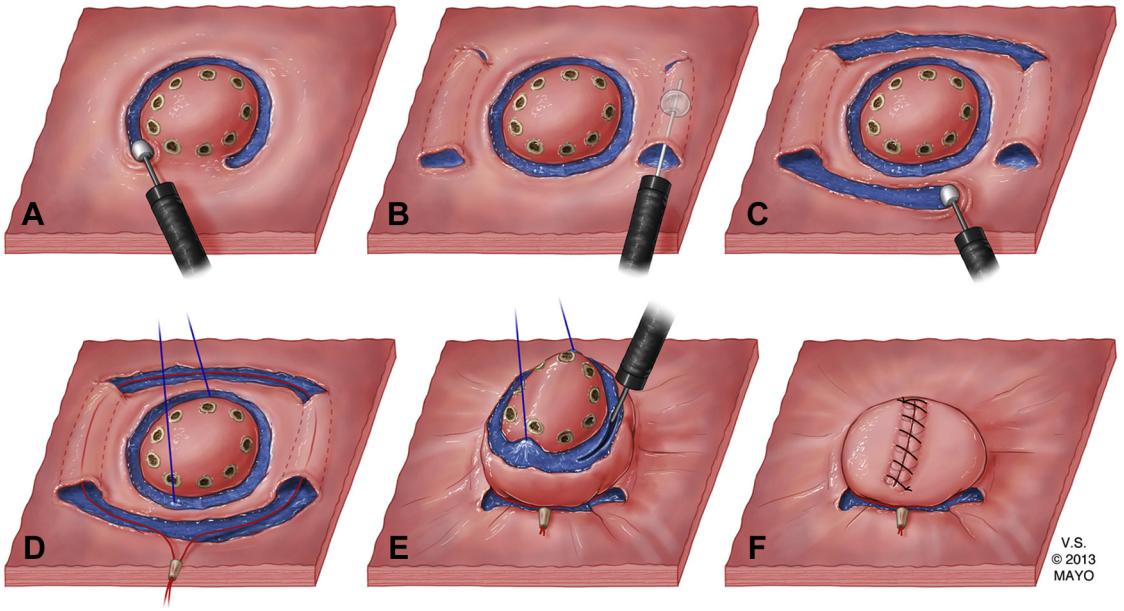

Figure 1. Submucosal endoscopy with full-thickness resection (SEFTR) technique: Idealized method. **A**, A circumferential mucosal incision is performed isolating the targeted area. **B**, The targeted area is straddled by 2 parallel submucosal tunnels made BY using balloon dissection. **C**, The mucosa between the proximal and distal ends of each tunnel is cut to allow encircling access. **D**, Suture (*red*) is passed through the tunnels to encircle the targeted area. A second set of sutures (*blue*), joined to full-thickness T tags, is drawn out of the mouth. **E**, The lesion is raised by pulling the oral sutures, followed by cinching the other suture surrounding the targeted area with serosa-to-serosa full-thickness wall apposition. A full-thickness incision is then performed over the underlying cinched gastric walls. **F**, (Optional step, not performed in this study.) The gathered full-thickness defect is supplementally closed by an endoscopic suturing device (Overstitch; Apollo Endosurgery, Austin, Tex).

transmural resection is desirable and is a growing clinical practice. Endoscopic full-thickness resection (EFTR) has the potential to overcome the limitations facing management of early gastric cancer. Most EFTR techniques require laparoscopic assistance.[2-5] EFTR without laparoscopic assistance is ideal and desirable.

Recently, we developed a hybrid technique, submucosal endoscopy with mucosal resection, which combines submucosal endoscopy with the mucosal safety valve flap (SEMF) method[6,7] with conventional ESD to ease and enhance the safety of ESD.[8-10] We have explored integrating the SEMF method to improve EFTR. In preliminary ex vivo experiments, we used submucosal endoscopy as an aid to full-thickness resection (SEFTR), which may offer added safety and simplification of EFTR. Our aim was to evaluate the feasibility and potential safety of SEFTR in a live animal model.

METHODS

This study was approved by the Institutional Animal Care and Use Committee and conducted at the Mayo Clinic Institute Hills Developmental Endoscopy Unit Laboratory facilities.

Animal preparation

Five domestic pigs were used. The animals were fasted for 2 days before the procedure. All animals underwent general endotracheal anesthesia induced with an intramuscular injection of telazol (5 mg/kg) and xylazine (2 mg/kg) and maintained with inhalation isoflurane.

Submucosal endoscopy with full-thickness resection

A standard therapeutic endoscope (Olympus XGIF-1TQ140; Olympus America, Center Valley, Pa) was used. All procedures were performed by the same endoscopist (K.T.) with extensive experience in ESD and SEMF procedures. CO_2 insufflation was used during whole process. The procedure tested was developed and tested during preliminary planned ex vivo studies, a routine experimental progression used in our Developmental Endoscopy Unit, and involved 4 steps: (1) circumferential mucosal incision of the target site, (2) creating straddling and connected submucosal tunnels, (3) looping, lifting, and cinching, and (4) full-thickness resection (Fig. 1) without closure of the resection site.

1. Circumferential mucosal incision. A 2-cm estimated area of gastric mucosa at the greater curvature side of the lower gastric body was marked by mucosal burns by using argon plasma coagulation (30 W soft coagulation; Genii, St. Paul, Minn). A circumferential submucosal fluid cushion (SFC), using 0.83% hydroxypropyl methylcellulose (Gonak; Akorn, Lake Forest, Ill) with added indigo carmine dye (American Regent, Shirley, NY), was created by injection. A circumferential mucosal incision (IT-knife