Simulating a target lesion for endoscopic submucosal dissection training in an ex vivo pig model

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Background: Currently, there is no training model that simulates the target lesion encountered during endoscopic submucosal dissection.

Objective: To develop a novel method simulating a target lesion for endoscopic submucosal dissection.

Design: Training program with the use of an ex vivo porcine stomach model.

Setting: Clinical skills training center.

Intervention: A pseudopolyp was created by using an esophageal variceal ligation device to simulate a protruding (0-Ip) lesion, and the pseudopolyp was transected with a snare cautery to simulate a depressed (0-IIc) lesion.

Main Outcome Measurements: Evaluate the histological depth of the target lesions and resected specimens.

Results: Histological findings of the simulated targets showed artificial ulcerative or polypoid lesions involving the muscularis mucosa or superficial submucosa. The resected specimen was limited to the submucosal layer, and no perforation was noted.

Limitations: Pilot study in an ex vivo porcine stomach model.

Conclusion: The most important advantage of the model is to simulate realistic target lesions like those encountered in clinical practice in endoscopic submucosal dissection training. It allows trainees to practice how to make proper markings, delineate adequate safety margins, and properly manage different subtypes of early gastric cancer.

Endoscopic submucosal dissection (ESD) is an emerging technique for treatment of early digestive neoplasms and has been widely accepted.[1] However, ESD is a very operator-dependent technique and needs repeated practice to overcome its steep learning curve.[2] Training in animal models appears to be a compulsory step before trainees attempt performing ESD in patients.[3] Some experts suggest learning ESD initially in harvested pig stomachs and then in live pigs before doing the procedure in clinical practice.[4,5] Since the mid 1990s, an ex vivo porcine-tissue simulator has been widely used in many hands-on training programs.[6,7] Although the ESD maneuvers are somewhat similar in the human and porcine stomachs, there is no method to create a target lesion in the porcine stomach, which may cause drawbacks during ESD training.

Early gastric cancer (EGC) is subdivided into 3 main categories, based on whether the lesion is protruding, flat,

Abbreviations: EGC, early gastric cancer; ESD, endoscopic submucosal dissection; EVL, esophageal variceal ligation.

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or excavated.[8] Type 0-Ip lesions are based on the extent of the elevation of more than 2.5 mm from the adjacent surface, type 0-IIc lesions are based on the depth of the depression of less than 1.2 mm from the adjacent surface, and deeper lesions are classified as type 0-III.[9] In the previous training protocol, only the flat target lesion could be considered in the normal mucosa, which was marked with a needle-knife or argon plasma coagulation. We developed a novel method to simulate protruding or depressed target lesions in an ex vivo porcine stomach. As far as we are aware, this novel approach has not been described previously.

Take-home Message

- A protruding or depressed lesion can be created with the esophageal variceal ligation device and then resected with snare cautery. The cost of the entire setup for this study is relatively inexpensive, and the device is easily portable.
- Practicing endoscopic submucosal dissection with various subtypes of early gastric cancer in the ex vivo simulator might overcome the steep learning curve and result in earlier proficiency with the technique.

MATERIALS AND METHODS

The ex vivo porcine stomach simulator in our study was a modified version of the compact EASIE model (ECE-Training GmbH, Erlangen, Germany).[10] Fresh porcine stomachs, including short segments of the lower esophagus and duodenum, were placed in a hand-made container composed of layered polystyrene boards cut as to accommodate the shapes of tissue. It was irrigated copiously with tap water until clean. Defects in the viscera were closed by using appropriately sized Kelly forceps for a good, airtight effect. A flexible overtube (Sumitoma Corp, Tokyo, Japan) with an airtight valve was inserted into the short segment of the lower esophagus, and a plastic band was placed to seal the space between the overtube and esophagus. An electronic conduction pad was placed between the stomach and the polystyrene board, and an electrosurgical generator (VIO 200D; ERBE Corp, Tübingen, Germany) with standard settings was used. The endoscopes (GIF Q230; Olympus Optical Co Ltd, Tokyo, Japan) were retired from clinical use and all used exclusively in animals at the time of the study. The Institutional Review Board at Mackay Memorial Hospital approved the training project.

Creating simulated target lesions in ex vivo pig stomachs

A pseudopolyp was created in the upper corpus by using an esophageal variceal ligation (EVL) device (Fig. 1A) (MD-48709; Sumitoma Corp, Tokyo, Japan) to simulate a protruding EGC (0-Ip lesion) (Fig. 1B). For another section of training, we transected a pseudopolyp with an electrosurgical cutting device attached to the snare (Fig. 2A) and left a mucosal defect to simulate a depressed EGC (0-IIc lesion) (Fig. 2B).

ESD technique on simulated target lesions in an ex vivo porcine model

The ESD procedures were carried out by a single experienced endoscopist who had experience in clinical ESD practice. The maneuvers of ESD were similar to those of standard protocol. A needle-knife (KD 10Q-1; Olympus Corp, Tokyo, Japan) was used for marking the periphery, which was set to about 5 mm outside of the target. After the protruding or depressed targets were lifted with normal saline (Figs. 1C and 2C), the mucosa outside the markings was incised circumferentially (Fig. 2D), and the submucosal layer under the lesion was dissected by using the insulated-tip knife (IT-2, KD-610L; Olympus) (Fig. 1D). A transparent cap fixed on the distal end of the endoscope was sometimes used to help lift the submucosal tissue. In both models, the resected specimens were pinned on a cork and then were measured and sent for histological evaluation.

Outcome measurement

We used both simulation models during 3 sessions. The following variables were analyzed: size of specimens, en bloc resection rate, duration (time required from marking until the end of ESD), and the occurrence of perforation. Histological examination included the depth of simulated targets and resected specimens.

RESULTS

The en bloc resections were achieved in all 6 simulated targets. The mean (± SD) size of the resected specimens was 20.2 ± 7.8 mm (range 18-24 mm). The mean (± SD) time for total procedure was 30.5 ± 6.8 minutes (range 24-32 minutes). Histological examination of the simulated targets showed artificial protruding (Fig. 3) or ulcerative lesions (Fig. 4) involving the muscularis mucosa and superficial submucosa, with a mean (± SD) depth of 1.1 ± 0.2 mm. The resected specimens were all limited to the submucosal layer, with a mean (± SD) depth of 2.9 ± 0.4 mm, and no perforation was noted.

DISCUSSION

As far as we are aware, this novel approach has not been described previously. In previous training protocols, only a flat target lesion was considered in the normal mucosa, which was surrounded by small cautery burns to avoid losing track of the margins. This approach may cause some drawbacks for trainees. For example, they may lack the practice to