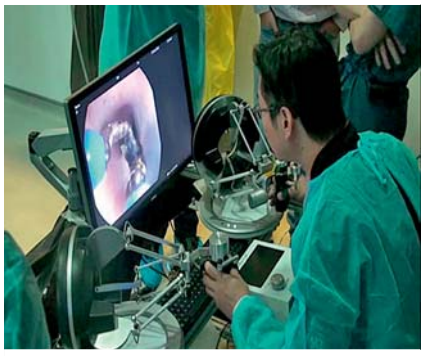
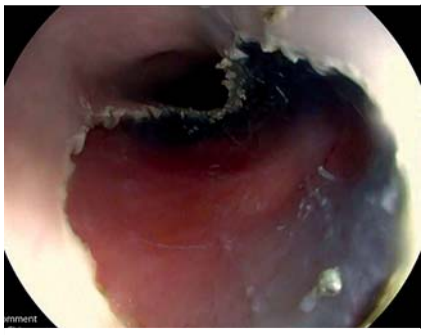
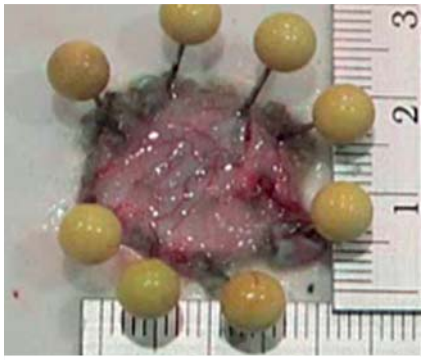
# Feasibility of performing esophageal endoscopic submucosal dissection using master and slave transluminal endoscopic robot



▶ **Fig. 1** Esophageal endoscopic submucosal dissection (ESD) being performed using the newly developed MASTER endoscopic platform.



▶ **Fig. 2** Endoscopic view of the post-endoscopic submucosal dissection (ESD) ulcer.



▶ **Fig. 3** The resected specimen, which measured 20 × 20 mm.

The feasibility of endoscopic submucosal dissection (ESD) using the master and slave transluminal endoscopic robot (MASTER) has been shown in our previous studies [1 – 3]. Compared with gastric ESD, esophageal ESD remains challenging because of technical difficulties and risks [4, 5]. The aim of this study was to evaluate the feasibility of using MASTER to perform esophageal ESD.

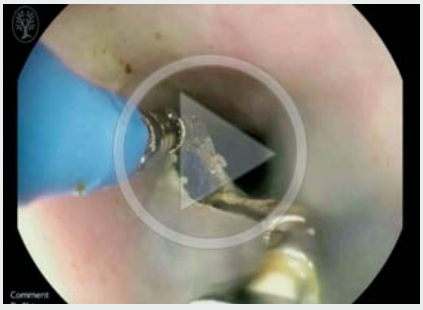
The new version of MASTER was used for esophageal ESD on one pig. The MASTER was redesigned to facilitate performance of ESD within a narrow working space. The main outcomes were: operating time, completeness of resection, and adverse events. The secondary outcomes included: clearance of operative field and limitation of robot arm manipulation in the narrow working space, assessed by counting the number of episodes of blind cutting. For the purpose of comparison with esophageal ESD, one gastric and one colonic ESD were performed by the same operator.

All procedures were successfully completed (▶ **Table 1**; ▶ **Figs. 1 – 3**; ▶ **Video 1**). It took 15, 63, and 45 minutes to complete the esophageal, gastric, and colonic ESDs, respectively. All lesions were excised en bloc; the specimen sizes were: 20 × 20, 50 × 45, and 35 × 35 mm, respectively. The dissection speeds were: 20.9, 28.0, and 21.4 $mm^2$/min, respectively. There were no adverse events. The number of episodes of blind cutting were: 2, 6, and 6 (0.13, 0.10, and 0.13/min).

In contrast to gastric and colonic ESD, the traction of the grasper during esophageal ESD tended to align with the long axis because of the narrow working space. There was no difference comparing esophageal against gastric and colonic ESD in terms of the speed of dissection, the rate of complete resection, the occurrence of adverse events, and the number of episodes of blind cutting.

In conclusion, performing esophageal ESD using the MASTER was feasible with a certain degree of adjustment for the narrow working space.

**VIDEO 1**



▶ Video 1: Esophageal endoscopic submucosal dissection (ESD) being performed. After marking and injections had been performed, the proximal mucosal incision was created. The mucosa was lifted by the grasper and the submucosa was dissected in parallel with circumferential mucosal cutting. The distal mucosal incision was finally completed and the specimen was resected.

▶ **Table 1** Outcomes of endoscopic submucosal dissection procedures using the MASTER.

| | Procedure 1 | Procedure 2 | Procedure 3 |
|---|---|---|---|
| Organ | Esophagus | Stomach | Colon |
| Location | Middle thoracic | Middle greater curvature | Sigmoid |
| Completion | Complete | Complete | Complete |
| Operation time, minutes | 15 | 63 | 45 |
| Size of specimen, mm | 20×20 | 50×45 | 35×35 |
| Dissection speed, $mm^2$/min | 20.9 | 28 | 21.4 |
| En bloc/piecemeal | En bloc | En bloc | En bloc |
| Uncontrolled bleeding | No | No | No |
| Perforation | No | No | No |
| Episodes of blind cutting | 2 | 6 | 6 |

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## Competing interests

P. W. Y. Chiu served on the scientific advisory board of EndoMaster Pte Ltd. S. J. Phee and K. Y. Ho are cofounders of EndoMaster Pte Ltd.

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