Simplified magnetic anchor-guided endoscopic submucosal dissection in dogs (with videos)

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Background: Magnetic anchor-guided endoscopic submucosal dissection (MAG-ESD) was developed to reduce adverse events such as bleeding and perforation and to facilitate ESD. However, the external electromagnet required miniaturization to make it suitable for daily clinical practice.

Objective: To evaluate the feasibility of simplified MAG-ESD using permanent magnets.

Design: Case series.

Setting: Nagoya University Hospital.

Subjects: Beagle dogs.

Interventions: The simplified MAG-ESD was performed on 10 representative areas of the stomachs of beagle dogs. The magnetic anchor consisted of an internal magnet attached to a hemoclip. The external and internal magnets were made from the rare earth neodymium.

Main Outcome Measurements: The feasibility of countertraction with good visualization using simplified MAG-ESD. The rate of perforation, the time required for preparation, and attaching the magnetic anchor were also evaluated.

Results: All lesions were successfully resected without perforation. The magnetic anchor could be controlled easily, and direct visualization was maintained by adequate counter traction. Preparing the magnetic anchor and grasping the mucosal edge using the hemoclip was easy and required a median of only 4 minutes (range, 2-7 minutes).

Limitations: Animal experiment, low number and lesion size.

Conclusions: This simplified MAG-ESD is feasible and allowed excellent visualization in the dog stomach. The feasibility of this system should be assessed in humans.

Endoscopic submucosal dissection (ESD) was developed to treat early gastric cancer by en bloc resection for accurate histopathologic diagnosis and reducing local recurrence. However, countertraction cannot be applied during conventional ESD, which is therefore associated with adverse events such as bleeding and perforation. This leads to longer procedure times and requires a high level of skill.[1-5]

To facilitate complicated ESD procedures, several countertraction methods have been reported.[6-11] Adequate

Abbreviations: ESD, endoscopic submucosal dissection; MAG, magnetic anchor-guided.

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countertraction of the lesions provides direct visualization of the submucosal layer and makes it easier to perform ESD. Kobayashi et al[12] and Gotoda et al[13] reported on a seminal method termed magnetic anchor-guided (MAG) ESD using a large external electromagnet to provide adequate direction and degrees of traction in various locations. However, this system needs to be miniaturized before it could be applied in daily clinical practice. Recently, MAG-ESD using a neodymium magnet was reported in the resected porcine stomach.[14] The aim of our study was to evaluate the feasibility of countertraction with a simplified MAG-ESD technique in a live animal experiment.

METHODS

Test subjects

This study was approved by the Institute for Laboratory Animal Research at the Nagoya University Graduate School of Medicine in Japan (no. 25267), and was conducted in compliance with the laws for the humane treatment and management of animals. Two female beagle dogs (17 and 18 kg) were laid in the left lateral position on an examination table under intravenous anesthesia using propofol and pentazocine in intubated animals. Ten different representative areas were predetermined with coagulation markers each of 2 cm diameter in the dog's stomach. This procedure was performed by 2 experienced endoscopists (R.M., M.K.) who had performed ESD for more than 300 gastric cancers.

Neodymium magnets

The external and internal permanent magnets were made from neodymium-iron-boron ($Nd_2Fe_{14}B$) (Fig. 1A and B, Table 1). Neodymium rare earth magnets are the strongest permanent magnets available. The neodymium magnets are highly resistant to demagnetization because of their atomic structure.[15]

External magnet

The external magnet was a handheld neodymium magnet. This external magnet could be locked by a flexible arm (FA-M-VC2; SFC Co Ltd, Kanagawa, Japan), so there was no need for an assistant to keep holding it in position during the procedure (Fig. 1C).

Magnetic anchor

The magnetic anchor consisted of an internal neodymium magnet attached to a hemoclip (HX-610-090; Olympus Medical Systems Corp, Tokyo, Japan) with 3-0 silk (Fig. 1D). Preparation of the magnetic anchor was as follows: A hemoclip applicator device (HX-110QR; Olympus) was inserted into the working endoscope channel. A hemoclip was then connected to the sheath and was pulled backward into the tip of the sheath. Next, the magnet was attached to the tip of the hemoclip using 3-0 silk. Finally, the hemoclip was withdrawn into the disposable transparent hood (F-030; TOP Co., Tokyo, Japan).

> **Take-home Message**
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> - Simplified magnetic anchor-guided ESD using neodymium was feasible and allowed excellent visualization in the dog stomach.
> - The simplified magnetic anchor-guided system was readily available and could be applied in daily clinical practice.

Simplified MAG-ESD procedure

A standard endoscope with a single working channel (GIF-Q240; Olympus) with a transparent hood was used for ESD. ESG-100 (Olympus) was used as the electrosurgical unit. First, a flexible overtube (TOP Overtube 16 double type; TOP) was used for smooth insertion of the endoscope with the magnetic anchor. Second, marks were made using a needle-knife (KD-1L-1; Olympus). An initial incision was then made by needle-knife after injection of indigo carmine in saline solution into the submucosa. After partial mucosal cutting at the periphery of the marks using a Flush knife BT (Fujifilm Co, Tokyo, Japan) or an SB knife Jr (Sumitomo Bakelite Co Ltd, Tokyo, Japan), the endoscope was retrieved and then reinserted equipped with the magnetic anchor (Fig. 1E). Inside the stomach, the magnetic anchor was pushed out from the transparent hood and attached to the mucosal edge of the lesion. The external magnet was maneuvered around the surface of the abdomen to apply adequate traction. Submucosal dissection was performed using the Flush knife BT or SB knife Jr. After dissection, both the resected tissue and the magnetic anchor were retrieved using a grasping forceps.

Outcome measures

The primary outcome measure was the feasibility of countertraction with good visualization using the simplified MAG-ESD. Secondary outcome measures included the rate of perforation, the time required for preparation and attaching the magnetic anchor, and the rate of retrieving the magnetic anchors.

RESULTS

Simplified MAG-ESDs using neodymium magnets were successfully performed in all cases without perforation (Fig. 2; Table 2; Videos 1 and 2, available online at www.giejournal.org). Adequate countertraction with good visualization was obtained using the external magnet.

In 8 cases, direct visualization was facilitated by an external magnet (magnetic attraction force, 382.9 N; magnetic flux density, 398 mT) (Fig. 1A, Table 1). However,