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Use of the magnetic compression technique in sleeve gastrectomy: a preliminary study

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To the Editor: Obesity is becoming a worldwide health issue, and the prevalence of obesity continues to increase.[1,2] Body weight reduction is one of the effective measures to solve this problem; however, only a small number of obese patients succeed in controlling their body weight without intervention. Sleeve gastrectomy (SG) is widely performed in obese patients for its excellent surgical result and easy surgical procedures. Unfortunately, stomach leakage may cause severe consequences, such as infection and death, although the incidence rate of this complication is 2.4%.[3]

The magnetic compression technique (MCT) is a novel technique that utilizes the attraction power between magnets to achieve the reconnection of lumens.[4] Constant pressure is exerted on the apposed walls of two visceral segments by magnetic devices leading to transmural ischemia, necrosis, and healing.[5] This new technique has been successfully applied in various fields such as gastrointestinal anastomosis, enteroenterostomy, and choledochojejunostomy. However, the MCT has never been used in SG. Therefore, the aim of this preliminary study was to determine the feasibility of using the MCT in SG. The study was approved by the Institutional Animal Care and Use Committee of Xi'an Jiaotong University Health Science Center (No. 2020-078).

As shown in Figure 1A, the magnetic compression device used in this study was a pair of cuboid magnets. The length, width, and height of the magnet were 100, 10, and 3 mm, respectively, and the weight was 26.5 g. The maximum magnetic flux density was about 100 to 200 mT. All magnets were made from neodymium ferrite boron, and each cuboid magnet was titanium nitride (TiN)-plated. In total, 20 male New Zealand white rabbits (2.5–3.5 kg) were obtained from the Experimental Animal Center, College of Medicine, Xi'an Jiaotong University. The rabbits were housed separately in a special breeding room under comfortable conditions. The rabbits were randomly divided into two groups by random number table method: group A and group B, each containing ten rabbits. In group A (MCT group), we performed SG in rabbits using our magnetic compression devices. In group B (control group), we performed SG in rabbits by using stapler. At the end of the study, all rabbits were euthanized by barbiturate overdose (intravenous injection, 150 mg/kg pentobarbital sodium), and stomach tissues were photographed and collected. In the control group, the stomach was temporarily clamped using the forceps, and the gastric tissue outside the forceps was then cut using scissors. After disinfecting with iodophor, the residual gastric margin was stapled by stapler. In the MCT group, the stomach was clamped using the magnetic compression device directly [Figure 1B]. Four weeks after the surgery, the rabbits in both groups were euthanized. The stomach was freed and resected. The anastomotic tissues of the gastric margin were resected and collected. Anastomotic specimens were fixed with formalin for histologic analysis and fixed with glutaraldehyde for electron microscopy. All data were expressed as mean ± standard deviation. Differences between groups were analyzed using the Student unpaired *t*-test. $P < 0.05$ was considered to be statistically significant.

As shown in Figure 1C, the rabbit stomach was clamped by the magnetic compression device, and ischemia was noted in the gastric tissue outside the magnets. Figure 1D shows the post-operative radiography of the rabbit stomach after intragastric administration of iohexol. No iohexol was found in the gastric tissue outside the magnets, which indicated that no stomach leakage occurred after MCT SG.

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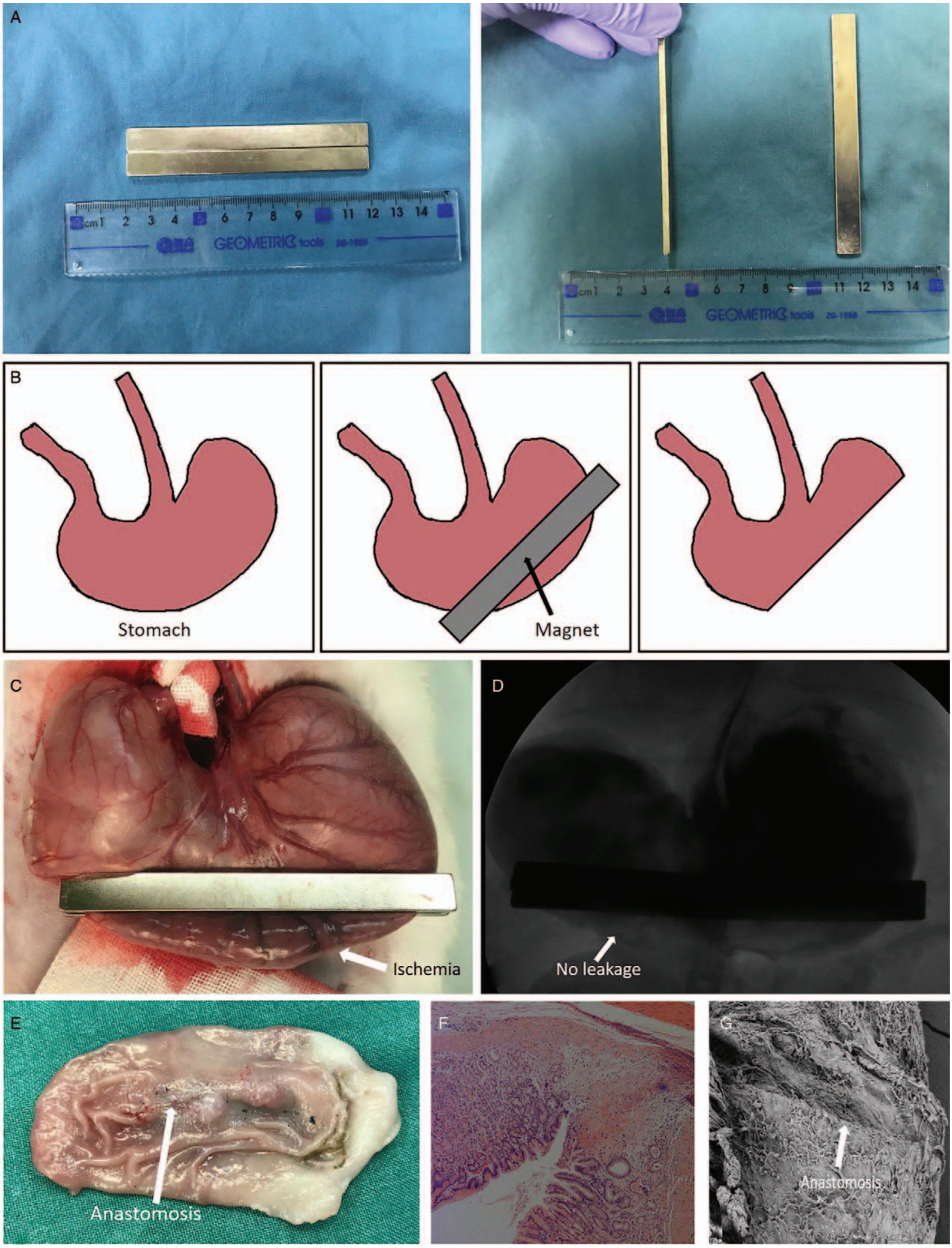

Figure 1: Use of the magnetic compression technique in sleeve gastrectomy. (A) The picture of the magnetic compression device. (B) The MCT sleeve gastrectomy procedure. (C) The photography of MCT sleeve gastrectomy. (D) The radiography of MCT sleeve gastrectomy; (E) Gross appearance of the anastomosis in MCT group. (F) Hematoxylin-eosin staining analysis of the MCT anastomosis (original magnification, $\times 100$). (G) Representative scanning electron micrograph of the anastomosis in MCT group (original magnification, $\times 100$). MCT: Magnetic compression technique.

The mean surgical time in the MCT group (1.52 ± 0.26 min) was significantly shorter than that in the stapling group (4.13 ± 1.53 min; $P < 0.01$). The survival rates were 70% and 90% in the control and MCT groups, respectively ($P < 0.01$). All the expired rabbits underwent autopsy to confirm the cause of death. In the control group, two rabbits died of peritonitis caused by stomach leakage, and one rabbit died of hemorrhage. In the MCT group, one rabbit died because of an infection caused by necrotic gastric tissue. The mean weight loss in the MCT group and control group was 0.72 ± 0.22 and 0.68 ± 0.31 kg, respectively. No significant difference was found between the two groups ($P > 0.05$). Four weeks after the surgery, all rabbits underwent autopsy, and the stomach specimens were resected and collected. Figure 1E shows the gross appearance of the anastomosis in the MCT group. The mucosa within the site of the anastomosis in the MCT group was grossly smooth and flat. Histological analysis of the anastomotic specimens showed that the mucosal layer of the residual stomach was continuous with a relatively smooth surface in the MCT group (Figure 1F). Four weeks after the surgery, the anastomotic site in the MCT SG had completely healed. As shown in Figure 1G, scanning electron microscopy indicated that the interior surface of the residual stomach had completely healed at the site of anastomosis. The mucosal layer of the residual stomach was continuous and smooth 4 weeks after the surgery.

The magnets used in our study were all plated with TiN, which was considered to protect magnets against corrosion and cause no harm to the animal body.[6] The photography and radiography showed that our magnetic compression device was reliable and effective in SG. The surgical time and survival rate indicated that MCT SG was quicker and safer than traditional stapling SG. Histological analysis and scanning electron microscopy verified our hypothesis.

Several limitations of this preliminary study should be acknowledged. First, due to the stomach shape in rabbits, the magnets consisting of two elements nicely fit and give a nice shape of the sleeve after the procedure. However, in humans, the creation of the sleeve is performed by multiple cartridges of stapling lines which allow the surgeon to smoothly form the sleeve aside the lesser curvature of the stomach. Consequently, the magnets should be assembled out of multiple elements that could facilitate to achieve a proper curved shape of the stapling line for the big animals and humans. Furthermore, concerning endoscopic approaches of magnet-based creation of a gastrointestinal anastomosis the magnets are placed inside the lumen of the corresponding hollow organ and are supposed to fall off and be excreted with the feces. In our study, the magnets are placed outside the serosa which would lead to a release of the metal in the abdominal cavity after necrosis and stapling line healing. Fortunately, this problem possibly could be solved by endoscopic sleeve gastroplasty, in which way the magnets could be placed inside the mucosa to avoid a second surgery.[7]

In conclusion, this preliminary study demonstrated that it is feasible to use the MCT in SG, and the MCT can shorten the surgical time and improve prognosis in rabbits. However, a better surgical method that is studied in a larger sample is needed in the future.

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Conflicts of interest

None.

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