



Use of magnets in gastrointestinal surgery

Ramon Diaz¹ · Gerardo Davalos¹ · Leonard K. Welsh¹ · Dana Portenier¹ · Alfredo D. Guerron¹

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Abstract

Background Laparoscopic and endoscopic surgery has undergone vast progress during the last 2 decades, translating into improved patient outcomes. A prime example of this development is the use of magnetic devices in gastrointestinal surgery. Magnetic devices have been developed and implemented for both laparoscopic and endoscopic surgery, providing alternatives for retraction, anchoring, and compression among other critical surgical steps. The purpose of this review is to explore the use of magnetic devices in gastrointestinal surgery, and describe different magnetic technologies, current applications, and future directions.

Methods IRB approval and written consent were not required. In this review of the existing literature, we offer a critical examination at the use of magnets for gastrointestinal surgery currently described. We show the experiences done to date, the benefits in laparoscopic and endoscopic surgery, and additional future implications.

Results Magnetic devices have been tested in the field of gastrointestinal surgery, both in the contexts of animal and human experimentation. Magnets have been mainly used for retraction, anchoring, mobilization, and anastomosis.

Conclusion Research into the use of magnets in gastrointestinal surgery offers promising results. The integration of these technologies in minimally invasive surgery provides benefits in various procedures. However, more research is needed to continually evaluate their impact and implementation into surgical practice.

Keywords Magnet · Minimally invasive surgery · Anastomosis · Magnetic retraction · Single port

The thoughtful surgical team must always be on the search for new techniques and technologies that improve patient outcomes. In this pursuit, many devices and techniques have been promoted to improve surgical results such as postoperative pain, scars, and procedure duration. Laparoscopic and endoscopic gastrointestinal surgery have undergone vast progress during the last 2 decades, translating to many of the aforementioned improvements. A prime example of this development is in the use of magnetic devices. Magnetic devices have been developed and implemented for both laparoscopic and endoscopic surgery, providing instrument alternatives for retraction with reduce number of incisions, and compression among other critical surgical steps.

The history of surgical magnet use is relatively recent. Equen et al. published their experience in 1957 in which

foreign bodies were extracted from the digestive tract with the use of magnets [1]. Since that time, the explanation behind the slow adoption perhaps lies in the perceived potential dangers of magnetic fields in the human body or in complications derived from the experience in the pediatric population with the ingestion of magnetic foreign bodies [2, 3]. However, with the extensive use of magnetic fields in magnetic resonance imaging machines, there is strong evidence to sustain safety of magnetic fields relating to humans [4]. Moreover, population studies have not been able to associate cell damage due to magnetic fields or the exposure can lead to cancer or other diseases [5, 6].

The purpose of this review is to explore the current and future use of magnetic devices in gastrointestinal surgery and describe different magnetic technologies, how they are currently being used, and their future direction. In addition, our group proposes a classification for the different groups of magnets that have been introduced at the time of publication (Table 1).

✉ Alfredo D. Guerron
alfredo.guerron-cruz@duke.edu

¹ Division of Minimally Invasive, Metabolic and Weight Loss Surgery, Department of Surgery, Duke Health System, Duke University, 407 Crutchfield Street, Durham, NC 27704, USA

Table 1 Classification of magnets in GI surgery

Function	Device
Intra-abdominal	
Traction (reduced port and single-site surgery)	LEVITA®* TD-MAGNET MAGS
Magnetic sphincter augmentation	LINX®*
Endoluminal	
Intestinal anastomosis	Magnamosis Wilson cook magnet device MCAs
Intestinal bypass	I-MASG (GI Windows)
Endoluminal traction	MAG-ESD

*FDA approved

MAGS magnetic anchoring and guidance system, TD-MAGNET tandem-domínguez, MCAs magnetic compressive anastomats, I-MASG incisionless magnetic anastomosis system, MAG-ESD magnetic-anchor-guided endoscopic submucosal dissection

Methods

Institutional Review Board approval and written consent were not required for this comprehensive review of published studies. Articles were obtained via PUBMED search and using cross-referenced materials.

Intra-abdominal

Reduced port, natural orifice, and single-site surgery

Laparoscopic surgery requires the installation of working ports through the abdominal wall in order to introduce instruments to manipulate tissues and generate exposure of the surgical field. To triangulate the instruments safely, it is necessary to position the ports at adequate distances from

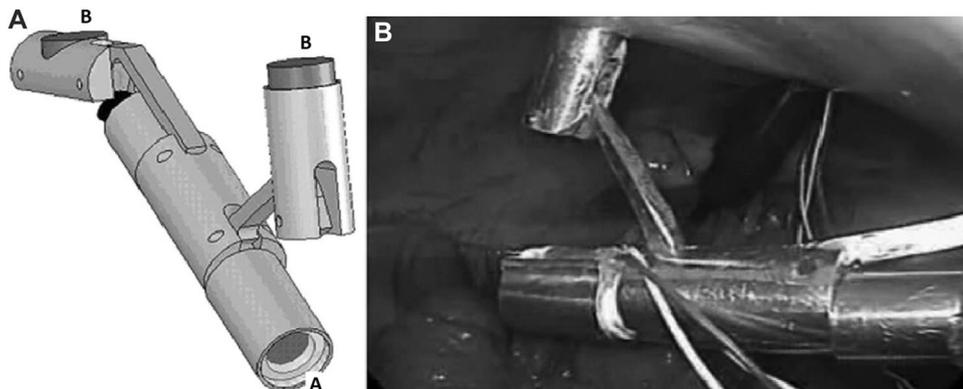
one another, so that the devices do not collide with each other or cross in the operative field. Although the advantages of laparoscopic surgery over open surgery are well established [7], installation of working ports limits the range of motion and also are not exempt from complications such as hernia, infection, bleeding, injury to underlying viscera, in addition to the aesthetic appearance by the scar, which is an often neglected issue of relevancy for many patients [8].

In order to reduce these potential complications, reduced port or natural orifice techniques have been proposed. Natural orifice transluminal endoscopic surgery (NOTES) has been shown to be feasible in different abdominal procedures such as cholecystectomy, hysterectomy, nephrectomy, and other urological procedures [9, 10], but has never gained universal acceptance partially due to unique technical difficulties [11]. A more common alternative to NOTES is laparoendoscopic single-site surgery (LESS), which consists of the introduction of instruments by multi-lumen ports, which theoretically produce less pain with better cosmetic results [12–14]. To achieve safe and adequate NOTES and LESS procedures, special instrumentation and advanced technical skill are required. Consequently, the creation of magnetic instruments that help with tissue manipulation presents new ways and incentives to perform procedures that involve fewer laparoscopic ports.

Early attempts of magnetic retraction

In 2007, a group from UT Southwestern Medical Center and UT Arlington led by Jeffrey Cadeddu developed a magnetic anchoring and guidance system (MAGS). This device was used to actively control an intra-abdominal endoscope and multiple working instruments through a single trocar in the abdominal cavity [15–17]. The MAGS device was constructed by packaging a commercially available camera within an enclosed aluminum body attached to an internal magnetic platform (Fig. 1). The device could then be inserted through a 15-mm port and manipulated with an external magnet by an assistant [17]. Two years later, an

Fig. 1 Fully deployed prototype internal camera. **A** Schematic. A, lens. B, magnetic anchors. **B** Internal view. Reprinted from The Journal of Urology, Vol 178, Zeltser, et al. Single Trocar Laparoscopic Nephrectomy Using Magnetic Anchoring and Guidance System in the Porcine Model. Copyright 2007, used with permission from Elsevier



initial experience in a human nephrectomy and appendectomy demonstrated safe and successful use. The use of a MAGS camera resulted in fewer instrument collisions, improved surgical working space, and provided an image comparable to that in standard laparoscopy [18].

In addition to cameras and graspers, electro-surgical dissectors have been designed in different configurations. The previous spring-loaded design was adequate but was prone to lodging on surrounding tissues during insertion and removal. Subsequently, a new design allowed the instrument to be placed in a collapsed configuration with the deployment of the energy arm into a 45° position once coupled to the abdominal wall. All dissectors were moved by using the external magnets and deformation of the abdominal wall allowed for angulation [15]. Scott et al. in their experience with porcine NOTES cholecystectomy used the MAGS tissue retractor in two configurations: an attachable magnet and a flexible grasper cradle. The attachable retractor included a magnet that was positioned on the gallbladder using endoscopically deployed clips (QuickClip2™, Olympus, Tokyo, Japan). The gallbladder fundus could then be retracted above the costal margin by coupling the internal component to an external magnet. The flexible grasper included an interior base plate containing magnets and a cradle configuration that allowed suspension and passage of one or two standard endoscopic biopsy forceps for retraction [15].

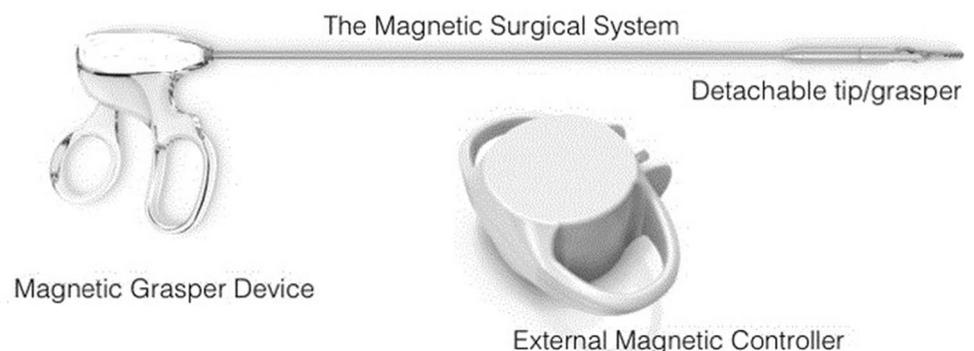
Dominguez et al. published their experience in humans using a prototype magnetic retractor in LESS [19]. In 40 cholecystectomies, the authors used two neodymium magnet forceps (TD-Magnet; Tandem-Dominguez) that were passed under direct visualization through an access port. These magnets are handled by specially designed forceps (Thomas-forceps) made with austenitic surgical steel not affected by the magnet field. The TD-Magnets are then positioned on the fundus and infundibulum of the gallbladder, allowing for maneuvering through the abdominal wall with corresponding external magnets. All the procedures were reported successful as there were no complications related to the use of the magnets and in all cases and the assistants handled the devices easily. Choi et al. proposed

another magnetic retractor in an animal nephrectomy LESS model. This device was composed of six pieces of cylindrical neodymium internal magnets with a central opening (5 mm outer diameter) that were fixed to the renal parenchyma with a 1–0 Vicryl Suture (Ethicon, Somerville, NJ, USA). The kidney could be moved through the abdominal wall, as the external magnet was repositioned [20]. At the present time, it is important to mention that these prototypes are not approved to use by the FDA, as none of them has proven safety and efficacy in a rigorous study. Nevertheless, all these experience gives support to the use of magnets in surgical procedures.

In an effort to facilitate tissue retraction and reduce invasiveness, the Levita Magnetic Surgical System (Levita Magnetics Corp. San Mateo, CA) was introduced as a magnetic grasper device and is the only magnetic surgical device that has received clearance by the Food and Drug Administration (FDA). The system consists of an external magnet and grasper with a detachable grasper tip and handle. The grasper device is compatible with a 10-mm laparoscopic port and deploys a detachable grasper tip to the tissue that can then be manipulated (Fig. 2).

Rivas et al. published the first pivotal trial using this device with 50 reduced-port cholecystectomies. They reported three adverse events, each not related to the use of the magnet grasper. The authors concluded that the procedure was feasible and safe [21]. Haskins et al., reported the first U.S. experience using this magnetic retractor in 10 LESS cholecystectomies with no perioperative adverse events related to the magnets. Of note, an intraoperative cholangiogram was performed in one patient, and the magnet did not interfere with the equipment or imaging [22]. Subsequently, our group published the first single-incision robotic cholecystectomy using this magnet in a 48-year-old woman with cholelithiasis. The procedure was successful and it was concluded that the combination of these two technologies was feasible and allows for a simpler single-incision technique [23]. Likewise, we have shown our experience with this magnetic device in bariatric surgery in a recently published series describing the use of magnetic

Fig. 2 Levita device



liver retraction in bariatric surgery [24]. The same magnetic device was used during sleeve gastrectomy (29 patients), gastric bypass (24 patients), duodenal switch (10 patients), and revisional surgery (10 patients). All procedures were completed laparoscopically without the need of an additional device for retraction or complication related to the use of the magnet. The magnetic instrument allowed for optimal exposure and visualization while decreasing abdominal incisions. Recently, the FDA approved the device for use in bariatric procedures and it is expected that the future indications will expand.

Steinberg et al. [25] described their experience in robotic prostatectomy. Three patients underwent robotic-assisted radical prostatectomy for prostatic adenocarcinoma, and the magnet allowed for successful operations without the need of a fourth robotic arm. The magnetic grasper was used to retract bowel, peritoneum, seminal vesicles, and the prostatic capsule. No injuries to the retracted tissues by the magnet were identified.

Magnetic sphincter augmentation

Gastroesophageal reflux disease (GERD) is a prevalent disease that affects approximately 10–20% of the population [26] and Nissen fundoplication is the gold standard in surgical treatment of GERD with well-documented long-term results supporting its effectiveness [27]. The LINX® device (Torax Medical, Shoreview, MN, USA) was designed as an attractive tool for magnetic sphincter augmentation. It consists of a series of titanium beads with a magnetic core. These beads are interlinked with independent titanium wires to form a flexible and expandable ring with a “Roman Arch” configuration. Each bead moves independently of each other, which allows the collar to expand and returns to its original shape after the passage of a bolus through the gastroesophageal junction. The device is typically laparoscopically placed, with the advantage of not requiring alteration of the anatomy of the stomach [28]. A recent meta-analysis by Skubleny et al. concluded that the procedure is useful in the short term, with results comparable to Nissen fundoplication; however, long-term follow-up is necessary to better evaluate effectiveness and safety [29].

Intraluminal

Intestinal anastomosis

For more than a century, surgeons have tried to find the ideal intestinal anastomosis technique [30]. The introduction of the mechanical stapler (linear and circular) has allowed for dramatic advancements in minimally invasive surgery anastomosis techniques. However, the use of this technology

in laparoscopic surgery requires advanced skills and may result in longer operative times. The concept of a compression anastomosis through the use of magnets has emerged in response to the search for new tools for safer and faster anastomoses.

The notion of constant and controlled compression anastomosis dates back to the nineteenth century. In 1826 Felix-Nicholas Denan introduced the “Denan’s ring” [30]. In 1892, Murphy showed the results of his button, which consisted of two metal rings screwed together through the tissue [31]. Since then, multiple devices have been created and primarily tested in animals with variable effectiveness and reproducibility at best [32].

Magnamosis (Magnamosis Inc., San Francisco, California, USA) is a device consisting of two rings of self-aligned magnets, called Harrison rings. The rings are composed of neodymium-iron-boron of N35 or N50 force, encased in a polycarbonate cover (Fig. 3). The magnets can be applied through both open and minimally invasive surgical approaches. Due to a specifically designed geometric configuration, once aligned they produce gradual compression between the tissues which leads to tissue ischemia and subsequent necrosis at the center of the ring. Simultaneous peripheral tissue remodeling results in a patent lumen.

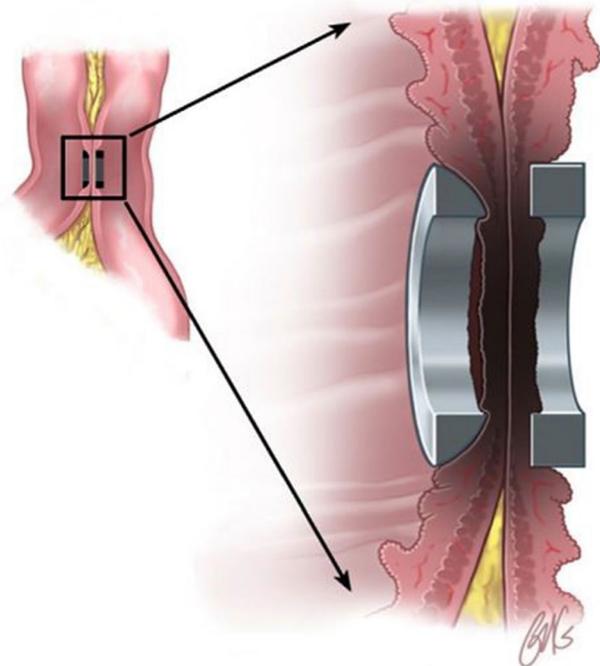


Fig. 3 Gradient magnetic device situated in intestine, depicted in cross-section. Greatest compression is applied along the inner circumference with non-linear radial decrease towards the outer circumference. Reprinted from Journal of Pediatric Surgery, Vol 44, Jamshidi, et al. Magnamosis: magnetic compression anastomosis with comparison to suture and staple techniques. Copyright 2009, used with permission from Elsevier

The magnets are then eliminated through the digestive tract [33–36].

In 2009, Jamshidi et al. published the results of their first experience with the Magnamosis device in 16 pigs. An anastomosis was performed using magnets with no evidence of leakage or stenosis in the analyzed specimens. The histological samples demonstrated robust epithelialization between the intestinal lumens and less inflammatory reaction compared to a conventional stapled anastomosis [33]. Other similar animal experiences with the use of Magnamosis have been published and the results are summarized in Table 2.

The device later gained FDA approval for human tests after animal models demonstrated safety and efficacy. In 2016, Graves et al. published the first experience in humans in a case of a patient with neurogenic bladder and a catheterizable ileal conduit. The patient tolerated the procedure well without evidence of leakage or other complications associated with the use of this device [37]. In 2017, Toselli et al. applied the use of magnets in two pediatric patients with high output loop ileostomies that necessitated closure. Magnetic functional undiversion (FUN) was chosen as the first step in bowel reconstruction. Both patients tolerated the process, which allowed the output through the ileostomies to decrease to a tolerable amount without evidence of leakage or stenosis [38]. During the same year, Graves et al. published a case series of five patients who underwent functional side-to-side or end-to-end small bowel anastomoses performed again without evidence of leakage or other complications with 18 months of follow-up [39].

Intestinal bypass

In 2016, Ryou published his experience with a purely endoscopic device and methodology for creating intestinal bypass (Incisionless Anastomosis System [IAS]) using self-assembling magnets in an animal model. These smart magnets are positioned endoscopically that once placed on the desired site, self-assemble in pairs creating an anastomosis with a larger diameter than the Magnamosis device (Fig. 4). Side-to-side jejuno-colonic anastomoses were performed without complications or leaks and optimal patency at 90 days of follow-up [40]. The same group published a follow-up

study with animal models using the same concept of self-assembling smart magnets to create a jejunoileal anastomosis in eight pigs without complications. However, the ileal magnet could not be positioned through colonoscopy due to anatomical issues and a laparotomy had to be performed. At the 90-day follow-up, all the anastomoses were patent with an average diameter of 30 mm and displayed mature epithelialization [41].

Machytka et al. described similar results with this device in patients with obesity and diabetes [42]. They performed a partial jejunal diversion (PJD) using the same method with some modifications, including a nitinol skeleton with configuration memory that allowed positioning linearly through an endoscope and then transformed into an octagon (incisionless magnetic anastomosis system [IMAS]; GI Windows, West Bridgewater, MA, USA). Unlike the classic jejunoileal bypass, the partial diversion anatomy created by the IMAS preserves the natural pathway for improved absorption of nutrients and avoids blind loop syndrome (Fig. 5). The procedure was carried out in 10 patients with some degree of obesity, two of whom had diabetes mellitus. In addition to fluoroscopy, correct positioning of the magnets was confirmed by laparoscopy in all patients. At 1 year of follow-up, patients experienced an average weight loss of 17.6 kg, and the diabetic population had a significant reduction in fasting glucose and hemoglobin A1c levels. Nevertheless, all patients had postoperative diarrhea in the short term, and four had recurrent diarrhea [42].

Other magnetic anastomosis

Congenital malformations

The use of magnet devices has been applied to perform other types of gastrointestinal anastomoses as well. Zaritzky et al. published their novel experience in the treatment of esophageal atresia (EA) with magnets [43]. They designed magnetic catheters (Wilson Cook Medical, Bloomington, IN; USA) with a 10F upper catheter that allowed suctioning of saliva from the mouth and atretic proximal esophagus. The lower device had a three-way 21F catheter inserted through

Table 2 Magnamosis studies in animal models

Author	Year	Model/number	Magnet type	Diameter outer/inner (mm)	Anastomosis type	Leak
Jamshidi et al. [33]	2009	pig/16	Neodymium-iron-boron	25/Not reported	Side-to-side small bowel [16]	No
Pichakron et al. [34]	2011	pig/21	Neodymium-iron-boron	21/12	J-J [8]/G-J [13]	1 G-J
Gonzalez et al. [35]	2012	pig/8	Neodymium-iron-boron	23/12	G-C [2]/D-C [6]	No
Wall et al. [36]	2013	pig/16	Neodymium-iron-boron	23/12	C-R [16]	1

J-J jeunojeuno anastomosis, *G-J* gastrojejuno anastomosis, *G-C* gastrocolonic anastomosis; *D-C* duodenocolonic anastomosis, *C-R* colorectal anastomosis

Fig. 4 **A** Fluoroscopic image of two incisionless anastomosis system (IAS) magnets coupled and aligned (appears as one). **B** Day 4. Colonoscopic view showing ischemic necrosis in the center of coupled IAS magnets. **C** Day 12. Coupled magnets have been spontaneously expelled, and an anastomosis is fully formed. **D** Day 90. Anastomosis is fully re-epithelialized and widely patent. Reprinted from *Gastrointestinal Endoscopy*, Vol 83, Ryou, et al. Endoscopic intestinal bypass creation by using self-assembling magnets in a porcine model. Copyright 2016, used with permission from Elsevier

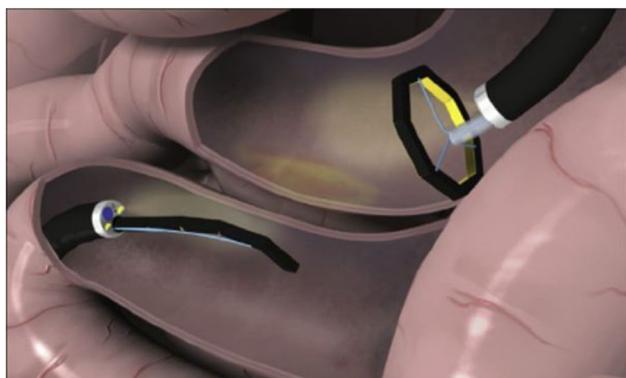
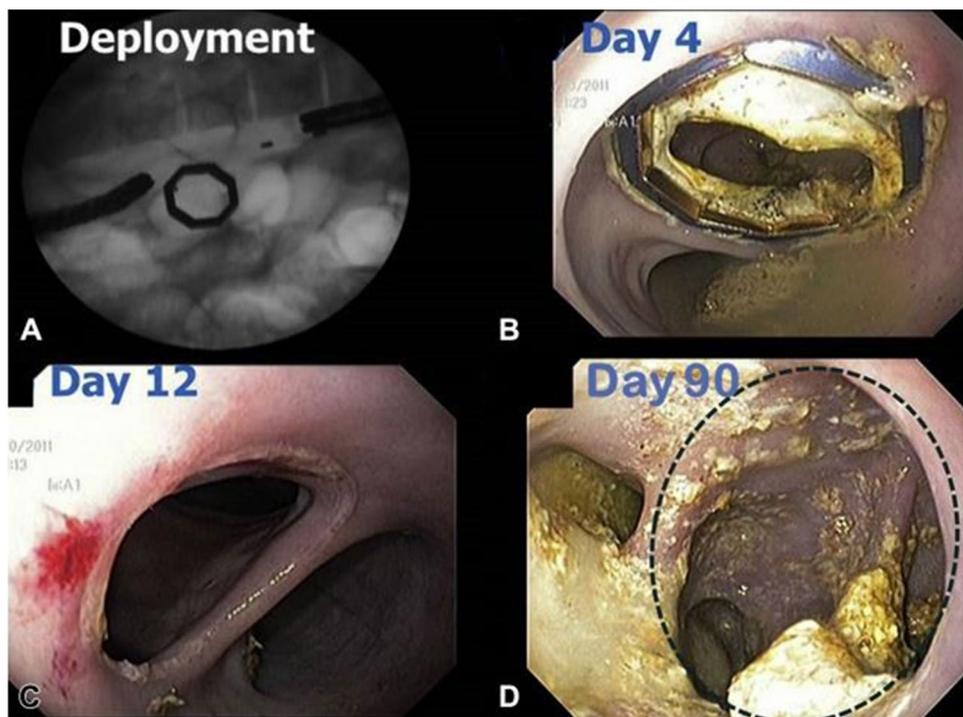


Fig. 5 Deployment of the octagonal self-forming magnet device with the deployment tool. The magnet device incorporates an exoskeleton that directs self-assembly. The device can be delivered in a linear configuration using an endoscope working channel, at which time the device self-assembles into an octagonal ring when fully deployed. Reprinted from *Gastrointestinal Endoscopy*, Vol 86, Machytka, et al. Partial jejunal diversion using an incisionless magnetic anastomosis system: 1-year interim results in patients with obesity and diabetes. Copyright 2017, used with permission from Elsevier

a gastrostomy with a balloon for retention and a lumen for feeding. Both catheters allowed the placement of bullet-shaped neodymium-iron-boron magnets. The procedure was carried out in five patients with EA, and esophageal anastomosis was successful in all five patients. Nevertheless, in the long-term follow-up, two patients required balloon dilatation due to recurrent stenosis and one needed surgery due

to recurrent stenosis [43]. Similar experiences using these principles have been published with good results, including in patients with tracheoesophageal fistula [44, 45].

Hepatobiliary

In 2001, Takao et al. issued a case report where a two magnet coupling system was used to treat a benign obstruction of the common bile duct. A parent magnet was placed endoscopically into the afferent loop of the duodenum through a gastrojejunostomy (the patient had prior gastric cancer surgery with Billroth II reconstruction). Later, the daughter magnet was attached to a guide wire and was placed in the obstructed common bile duct through a percutaneous transhepatic cholangiographic drainage tube. The magnets were attached transmurally, and a choledochoduodenal anastomosis was established 32 days after the procedure [46].

Other authors have shown excellent outcomes in the treatment of biliary obstruction, which included duct-to-duct anastomosis after liver transplantation [47, 48]. Bilioenteric applications using magnet devices have also been explored. Zhang et al. published a cholangiojejunostomy series in four dog models using a magnetic compression device. They successfully completed the procedure in all models without complications [49]. Fan et al. designed a trial also using dogs. Thirty-six dogs were divided randomly into two groups. After obstructive jaundice was induced, a Roux-en-Y hepaticojejunostomy (RYHJ) was performed with magnetic compression anastomosis (magnetic compressive

anastomats; MCAs) in the study group or with a hand-sewn anastomosis in the control group. Both groups were followed for 1, 3, and 6 months after RYHJ showing promising results supporting that the newly designed MCAs can simplify anastomotic construction in RYHJ in obstructive jaundice. Owing to the precise alignment of tissue layers and absent of suture-induced foreign-body reaction, the anastomotic healing was better and faster in the MCA group suggesting an exciting potential for clinical use [50].

Recently, Liu et al. published the first human prospective trial using compression anastomosis (Magnamosis) for a bilioenteric anastomosis [51]. Authors performed 41 biliojejunostomies due to both malignant and benign jaundice. The mother magnet was placed in the common bile duct, which was closed with a purse-string suture around a drainage tube. Then, the tube was passed through the jejunum wall where the anastomosis was planned. The tube served as a guide to introduce the daughter magnet, which was assembled to the mother magnet in order to complete the site of the anastomosis. The drainage tube was fed through the jejunal wall as an external biliary drainage tube, which was also used to do cholangiography postoperatively. The procedure was successful in all patients. No biliary fistulas were described, but two anastomotic strictures developed at 4 and 14 months after surgery. The median time for a patent anastomosis was 19 days and median magnet discharge time was 35 days.

The same group published a series of four patients that underwent a pancreaticoduodenectomy [52]. The authors used the same compression anastomosis concept to create the hepaticojejunostomy and pancreatojejunostomy. The procedures were completed successfully, and had one stricture at 11 months. The median time of complete hepaticojejunostomy and pancreatojejunostomy anastomosis creation was 17 and 11 days, respectively.

Endoluminal traction

Endoscopic submucosal dissection

Endoscopic submucosal dissection (ESD) is an advanced endoscopic maneuver that allows en bloc resection of early tumors of the digestive tract and has shown superior curative and recurrence results over endoscopic mucosal resection alone [53–56]. This technique was created in Japan and its adoption in the western world has been slow due to lack of suitable patients and learning curve limitations. During open or laparoscopic surgery, proper tissue counter-traction is fundamental for dissection and avoiding inadvertent injuries to adjacent organs. However, these principles are particularly challenging during endoscopic procedures because of the limitations posed by single

instrument use. Given this, multiple devices have been created to improve ESD performance [57].

Magnetic-anchor-guided ESD (MAG-ESD) was designed and published by Kobayashi [58] and involves an extracorporeally controlled electromagnet that handles an endoscopically positioned magnet. The latter is attached to gastric mucosa with a thread and microforceps (endoscopic clips). During the procedure, the physician or an assistant is able to move the gastric mucosa by manipulating the external magnet. Kondo et al. published the first clinical trial in humans using the MAG-ESD concept in 25 patients without any reported complications or adverse events. The authors concluded that MAG-ESD is feasible in humans and resulted in excellent visualization of the tissue during dissection [59]. Further animal studies evaluating this magnetic device have shown promising results related to visualization and maneuverability of the dissection plane [60, 61]. Matsuzaki et al. recently published a clinical trial with 50 patients using the same device for MAG-ESD. The procedure was carried out successfully in the 50 patients and en bloc resections were possible in all patients without adverse events [62] (Fig. 6).

Conclusion

The development and adaptation of magnetic devices represent a significant advance in minimally invasive surgery. Their varied use provides several advantages from improved surgical field and tissue maneuverability to fewer abdominal incisions. Magnet technology can provide a safe and feasible alternative for more complicated procedures including anastomosis creation. Like any emerging technology, limitations exist. The concept of a delayed anastomosis may not be applicable in cases in which an immediate anastomosis may be required, so its use may be limited to certain situations. In addition, these magnetic anastomosis procedures often involve blind anastomosis creation, thus they need strict monitoring to avoid undetected leaks during the days of anastomosis maturation. Moreover, many surgical instruments are composed of alloys that may interfere with magnetic systems and conversion to non-magnetic instruments requires increased costs. Likewise, protocols will need to be implemented to identify patients with contraindications such as cardiac implants. Furthermore, many neodymium magnets are nickel coated to avoid toxic corrosion, which poses issues for patients with nickel allergies. Future research should focus on larger case series and randomized control trials that compare these devices to the current standard of care and better define the role of this new technology in surgical practice.

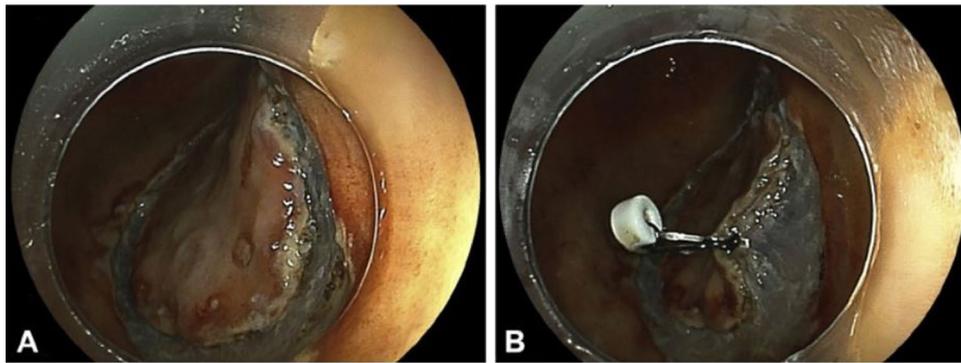


Fig. 6 Magnetic anchor-guided endoscopic submucosal dissection in the greater curvature of the gastric angle. **A** After partial dissection, the mucosal edge before attaching the magnetic anchor. **B** Direct visualization of the submucosal layer by the magnetic anchor facilitated

the submucosal dissection. Reprinted from *Gastrointestinal Endoscopy*, Vol 87, Matsuzaki, et al. Magnetic anchor-guided endoscopic submucosal dissection for gastric lesions (with video). Copyright 2018, used with permission from Elsevier

Compliance with ethical standards

Disclosures Dr. Portenier reports Medtronic/Consulting/Research Grant; Intuitive Consulting/Research Grant; Levita/Education Grant; Teleflex/Consulting. Dr. Guerron reports Levita/Consultant; Medtronic/Speaker; Gore/Speaker. Dr. Diaz, Dr. Davalos, and Dr. Welsh have nothing to disclose.

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