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Editorial Board Member of *World Journal of Gastroenterology*, Kok Yang Tan, FRCS (Ed), MBBS, Associate Professor, Chief Doctor, Senior Lecturer, Surgeon, Department of Surgery, Khoo Teck Puat Hospital, Singapore 768828, Singapore. kokyangtan@gmail.com

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Y-Z deformable magnetic ring for the treatment of rectal stricture: A case report and review of literature

Miao-Miao Zhang, Huan-Chen Sha, Yuan-Fa Qin, Yi Lyu, Xiao-Peng Yan

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Miao-Miao Zhang, Huan-Chen Sha, Yuan-Fa Qin, Yi Lyu, Xiao-Peng Yan, Department of Hepatobiliary Surgery, The First Affiliated Hospital of Xi'an Jiaotong University, Xi'an 710061, Shaanxi Province, China

Miao-Miao Zhang, Yi Lyu, Xiao-Peng Yan, National Local Joint Engineering Research Center for Precision Surgery & Regenerative Medicine, The First Affiliated Hospital of Xi'an Jiaotong University, Xi'an 710061, Shaanxi Province, China

Corresponding author: Xiao-Peng Yan, MD, PhD, Associate Research Scientist, Department of Hepatobiliary Surgery, The First Affiliated Hospital of Xi'an Jiaotong University, No. 277 West Yanta Road, Xi'an 710061, Shaanxi Province, China. yanxiaopeng9966@163.com

Abstract

BACKGROUND

Treatment of postoperative anastomotic stenosis for colorectal cancer is often challenging, especially for patients who do not respond well to endoscopy. In cases where patients have undergone an enterostomy, the stenosis can be easily resolved through magnetic compression. However, common magnetic compression techniques cannot be performed on those without enterostomy. We designed a novel Y-Z deformable magnetic ring (Y-Z DMR) and successfully applied it to a patient with a stenosis rectal anastomosis and without enterostomy after rectal cancer surgery.

CASE SUMMARY

We here report the case of a 57-year-old woman who had undergone a laparoscopic radical rectum resection (Dixon) for rectal cancer. However, she started facing difficulty in defecation 6 months after surgery. Her colonoscopy indicated stenosis of the rectal anastomosis. Endoscopic balloon dilation was performed six times on her. However, the stenosis still showed a trend of gradual aggravation. Because the patient did not undergo an enterostomy, the conventional endoscopic magnetic compression technique could not be performed. Hence, we implemented a Y-Z DMR implemented through the anus under single channel. The magnetic ring fell off nine days after the operation and the rectal stenosis was relieved. The patient was followed up for six months and reported good defecation.

CONCLUSION

The Y-Z DMR deformable magnetic ring is an excellent treatment strategy for patients with rectal stenosis and without enterostomy.

Key Words: Anastomotic stenosis; Colorectal cancer; Magnetosurgery; Magnetic compression technique; Magnetic surgery clinic; Case report

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Core Tip: The magnetic compression technique can be used to treat patients with rectal stenosis that have also undergone an enterostomy. However, the existing magnetic ring cannot be used in patients without enterostomy. We designed a Y-Z deformable magnetic ring (Y-Z DMR), which can realize the single channel of the magnet placed through the anus. This paper reports the first successful clinical case of using the Y-Z DMR for the treatment of rectal stenosis.

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INTRODUCTION

Rectal stenosis is a common postoperative complication of rectal cancer. Endoscopic treatment is generally preferred for such conditions. Balloon dilation[1,2], stent placement[3,4], and endoscopic radial incision[5] are some of the commonly used procedures that provide satisfactory treatment results in most patients. However, these procedures still lead to poor results in some patients, resulting in the need for surgical resection of anastomotic stenosis[6] or even permanent enterostomy. In addition, patients who have not undergone a prophylactic ileostomy or in whom stenosis occurs after ostomy reduction need urgent treatment.

Magnetic compression anastomosis (MCA) is a novel technique for the anastomosis of cavity organs through “non-contact” magnetic force. The current basic and clinical studies on MCA cover esophageal anastomosis[7-9], gastrointestinal anastomosis[10,11], and colorectal anastomosis[12,13] of the digestive system. MCA can be used for vascular anastomosis[14-16] and therapeutic ostomy[17-19] for non-gastrointestinal conditions. Magnetic compression technique can be used for stricture diseases such as the biliary stricture after liver transplantation[20-22], ureteric occlusion[23], esophageal stricture[24-26], colorectal stricture[27], and hypopharynx stenosis[28]. As for the basic research on MCA, some scholars have extensively discussed the characteristics of tissue healing in different periods and established the stage of digestion for magnetic anastomosis (Yan-Zhang’s stage)[29].

Herein, we present a patient with the stenosis of rectal anastomosis and no enterostomy. For this case, we specially designed a Y-Z deformable magnetic ring (Y-Z DMR) and successfully achieved narrow recanalization in a single passage through the anus. The defecation status remained good even after 6 months of follow-up. This is the first study to report the clinical application of Y-Z DMR, which is of great clinical significance.

CASE PRESENTATION

Chief complaints

A 57-year-old woman presented to us in May 2023 for having difficulty in passing stools. She had undergone laparoscopic rectal cancer surgery 16 months ago (January 2022) and had started facing difficulty defecating 4 months after the surgery.

History of present illness

The patient had undergone laparoscopic radical rectum resection (Dixon) for rectal cancer at a local hospital 16 months ago and had recovered well after surgery. This patient did not undergo chemo-radio therapy before or after surgery. However, she started facing difficulties in defecation 1 year ago (May 2022). As a result, a colonoscopy was performed on her at a local hospital, which indicated stenosis of the rectal anastomosis. She underwent endoscopic balloon dilation treatment six times for the condition. However, the results were not satisfactory. For further treatment, the patient was admitted to the Magnetic Surgery Clinic of the First Affiliated Hospital of Xi’an Jiaotong University.

History of past illness

The patient had no history of acute or chronic infectious diseases, heart disease, hypertension or diabetes, or surgery other than laparoscopic radical rectum resection.

Personal and family history

The patient did not have any relevant family medical history.

Physical examination

The patient's vital signs were stable, with no obvious abnormalities in the physical examination of both her lungs and heart. Her abdomen was flat and soft, with no abdominal tenderness. Shifting dullness in the abdomen was negative, and bowel sounds were also normal.

Laboratory examinations

The patient's hematology results were normal.

Imaging examinations

After admission to our hospital, the patient underwent further colonoscopy. The result indicated that the rectal anastomosis was severely narrowed (5 cm) from the anus. In addition, no obvious lumen was observed. Hence, an attempt was made to insert a 14 Fr nasogastric tube through the anus to pass through the stenosis. Colography was performed by injecting approximately 100 mL of iohexol through the nasogastric tube. The results showed that the stenosis of the rectum was 0.4 mm in diameter and 1 cm in length (Figure 1).

FINAL DIAGNOSIS

The patient was diagnosed with rectum stenosis based on her medical history and the imaging examination and colonoscopy results.

TREATMENT

The patient refused further endoscopic treatment and surgery. Instead, she opted for minimally invasive magnetic surgery technique. The surgical plan was decided after a discussion with the Magnetic Surgery Multi-Disciplinary Treatment of the First Affiliated Hospital of Xi'an Jiaotong University (Figure 2). The patient agreed to the surgical protocol and signed the informed consent. The surgical plan was also approved by the Medical Department of the First Affiliated Hospital of Xi'an Jiaotong University. The S-O-shaped magnetic anastomosing ring designed by the author was used in the surgical plan. As the magnetic ring was designed, we named it the Y-Z DMR, also referred to as the Y-Z DMR. The Y-Z DMR was composed of two semicircular magnetic rings. The daughter magnetic ring was "S" shaped during the implantation process. It passed through the narrow section of the rectum in a serpentine motion. The daughter magnetic rings were manipulated by a control line to transform it from the "S" to the "O" shape. After adjusting the daughter magnetic ring to a suitable position, the two O-shaped parent magnetic rings were inserted through the anus. The daughter magnetic ring and the parent magnetic ring attracted each other and compressed the narrow section of the rectum. After a certain period, the scar of the narrow section and the magnetic rings fell off and were discharged through the anus.

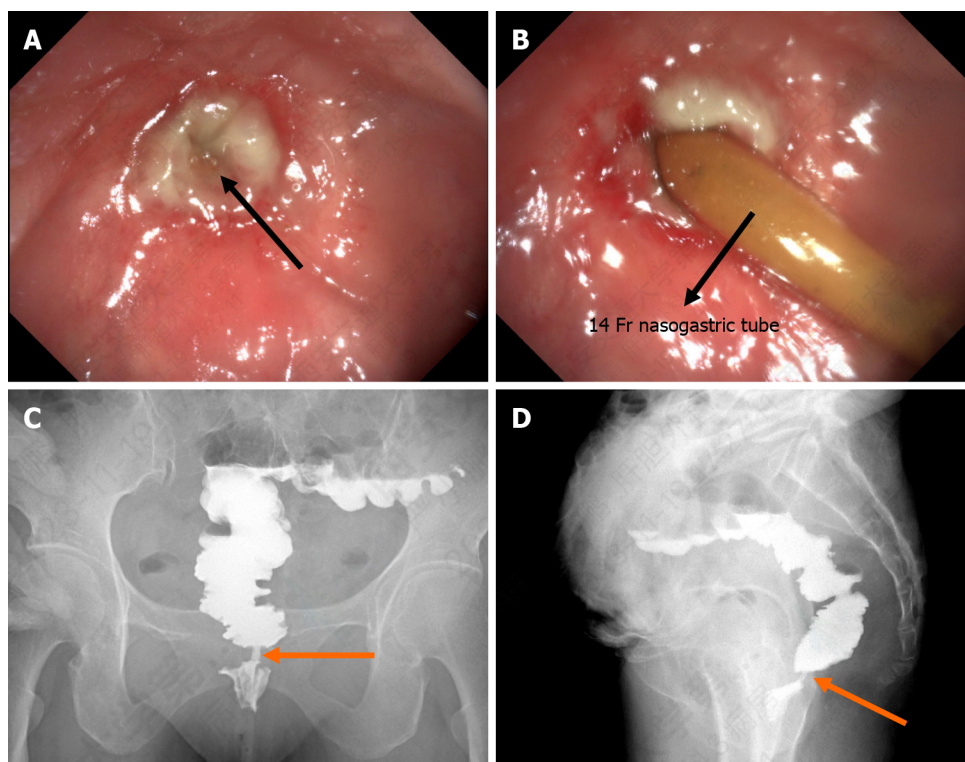
The patient was administered intravenous anesthesia and the lithotomy position was adopted. A disposable anoscope was inserted through the anus. Rectal stenosis could be seen directly with the naked eye. An S-shaped magnetic ring was inserted through the anus, which was passed through the narrow part of the rectum under X-ray surveillance (Figure 3A). After the control line was pulled, the magnetic ring changed its S shape to O shape (Figure 3B). The catheter was inserted through the anus so that the balloon passed through the narrow part of the rectum and the center of the O-ring. The catheter balloon was dilated by injecting 10 mL of diluted iohexol solution. The catheter was vertically pulled so that the O-shaped magnetic ring became perpendicular to the longitudinal axis of the rectum and close to the rectal stenosis (Figure 3C). Two O-shaped parent magnetic rings were inserted through the end of the catheter and pushed along the catheter to the narrow anal side of the rectum. The daughter and parent magnetic rings were attracted toward each other, compressing the narrow section of the rectum (Figure 3D). The catheter was placed in the rectum and the procedure was completed. On the 9th day after surgery, the magnet rings and catheter were pulled out through the anus (Figure 4A), establishing the MCA. Colonoscopy showed no bleeding, mucosal edema, or erosion at the anastomotic orifice (Figure 4B). The colonoscope successfully passed through the anastomotic orifice (Figure 4C). Further colonography showed that the stenosis of the rectum widened significantly (Figure 4D and E). The patient was discharged 10 d after surgery. The patient was strongly advised to use a 20-mm-diameter anal reaming stick 3 times a day for 5 min each time for 3 months after discharge to prevent restenosis.

OUTCOME AND FOLLOW-UP

The 6-month follow-up of the patient showed a generally good condition with normal bowel movements.

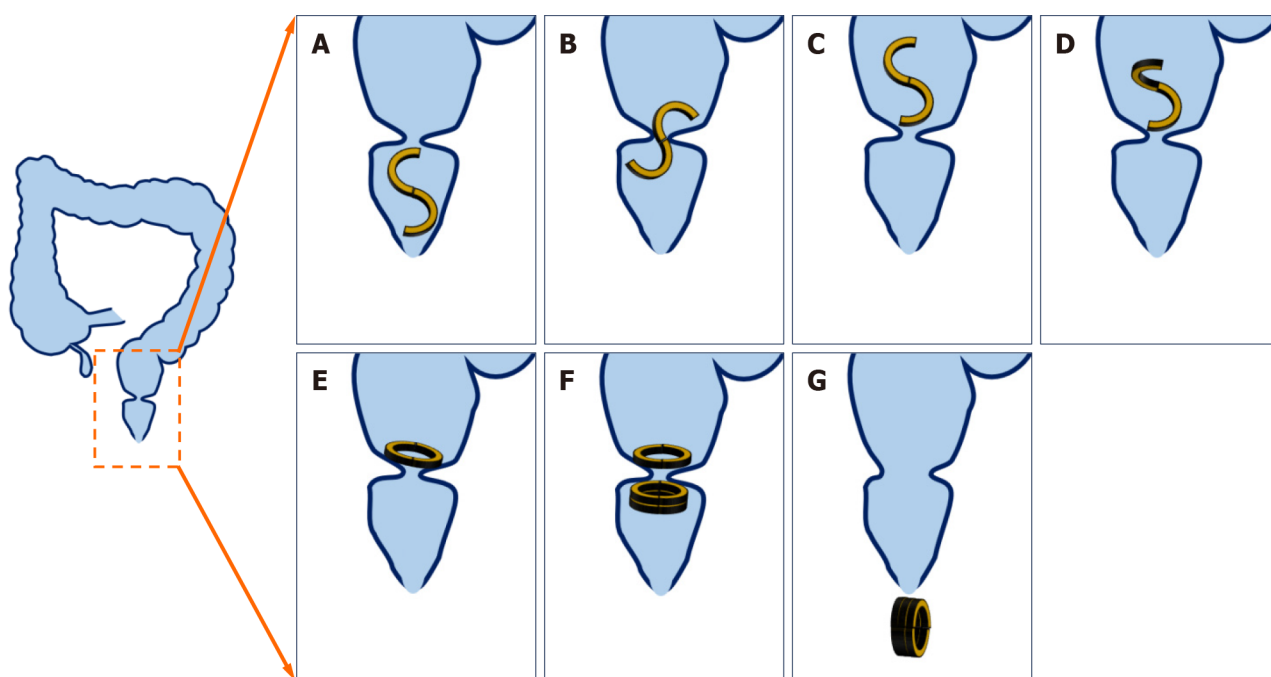
DISCUSSION

Before admission to our hospital, the patient had undergone balloon dilations six times. However, the stenosis kept



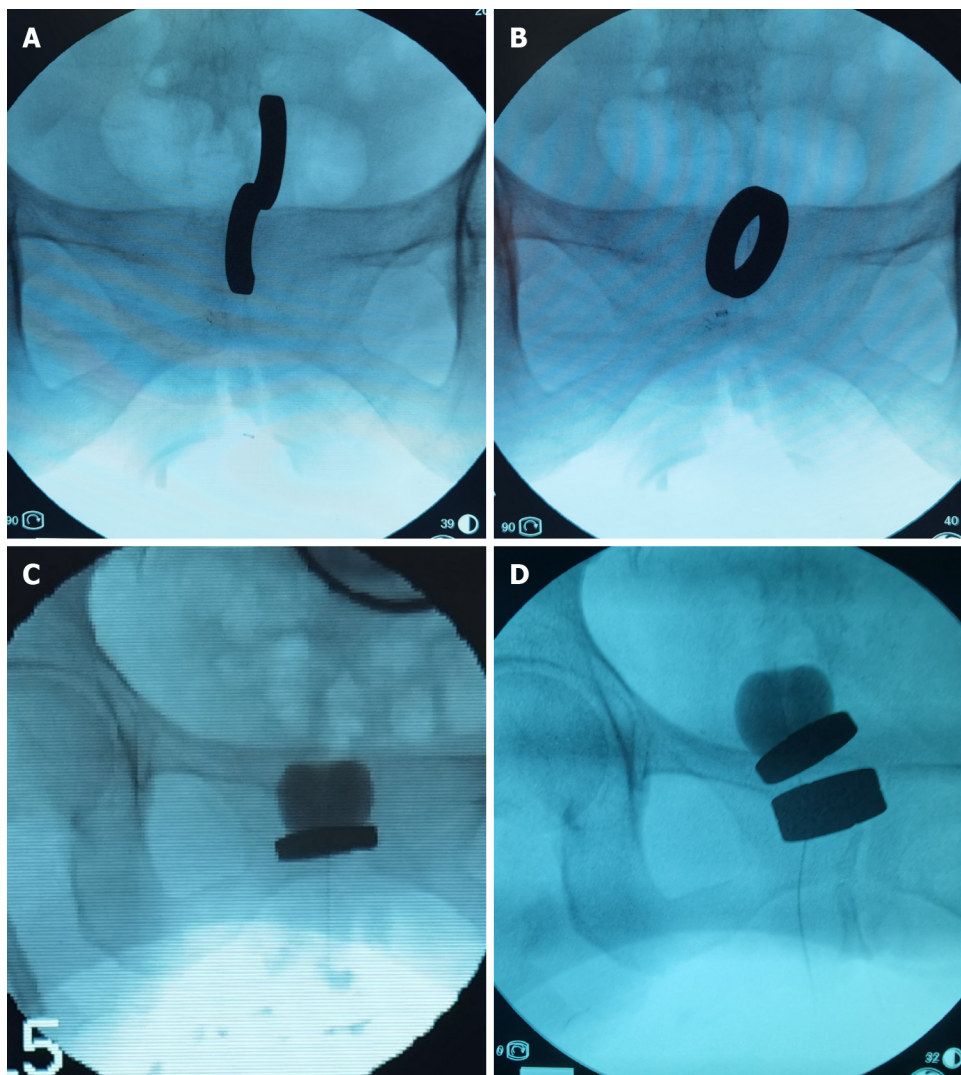
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Figure 1 Colonoscopy and colography. A: Rectal anastomosis stoma; B: Rectal stenosis can only be achieved through a 14 Fr nasogastric tube; C: Anteroposterior colography; D: Lateral colography.



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Figure 2 Operation plan. A: An S-shaped magnetic ring is inserted through the anus; B: The S-shaped magnetic ring passes through the rectal stenosis; C: The S-shaped magnetic ring successfully passed the narrow rectum; D: Deformation of the S-shaped magnetic ring; E: The S-shaped magnetic ring deforms to an O-shape; F: The daughter ring and the parent ring attract each other and compress the narrow section of the rectum; G: Rectum stenosis recanalizes and the magnetic ring is discharged through the anus.



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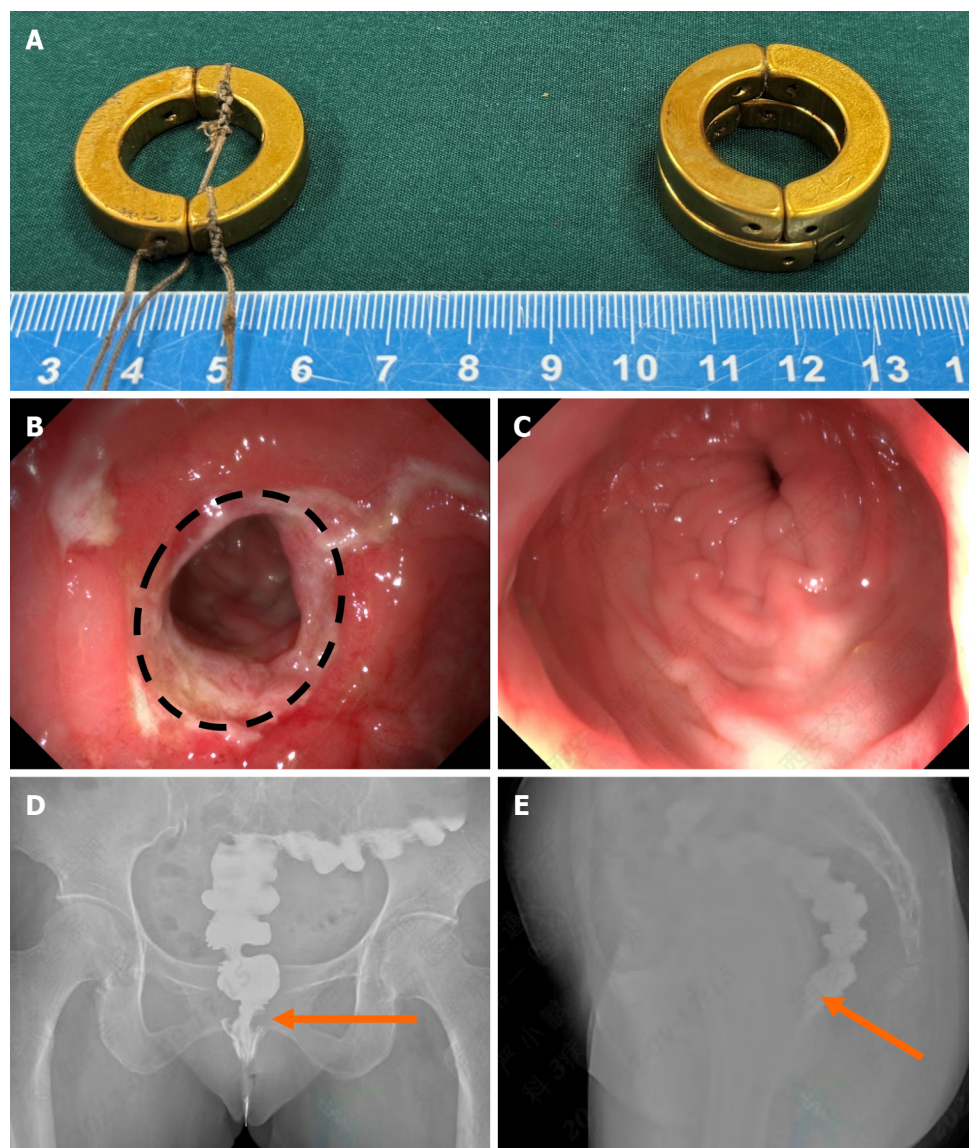
Figure 3 Surgical procedure. A: The S-shaped magnetic ring passes the narrow rectum; B: The S-shaped magnetic ring becomes O-shaped; C: The catheter assists in adjusting the magnet position; D: The daughter ring and the parent ring attract each other and compress the narrow section of the rectum.

gradually worsening, forcing the patient to rely only on a slag-free nutrient solution. As the patient refused other treatment options, she was offered the Y-Z DMR procedure. Thus, she became the first patient to benefit from the Y-Z DMR procedure.

In the previously reported cases of colorectal stenosis treated by the magnetic compression technique, all patients had undergone enterostomy. The resulting stoma provided an important access for placing magnets[30,31]. In the magnetic anastomosis of the digestive tract, the area of compression of the magnetic anastomosis ring is an important factor that determines the size of the final anastomosis. Therefore, to achieve the optimum magnet placement, clinicians tend to choose as large a magnetic ring as possible so as to obtain a larger anastomotic diameter. For those with a stoma, magnets can be easily inserted both through the anus and the stoma on either side of the rectum stenosis. In patients with rectal stenosis but without a stoma, conventional magnets cannot be inserted into the side of the rectal stenosis. Therefore, passing a large magnetic ring through the narrow section is a major research topic.

Inspired by the serpentine movement of snakes, we designed a Y-Z DMR with the following characteristics: First, it is composed of two semicircular magnetic rings. It forms an S-shaped structure when its one end is fixed and the other end is rotated by 180°. As a result, the cross-section of the magnet becomes significantly small, allowing the deformable magnetic ring to pass through the narrow section. Second, as the S-shaped magnetic ring adopts the serpentine movement, the whole S-shaped magnetic ring can be passed through the narrow section by constantly adjusting the direction of the magnetic ring. Third, the control wire was loaded on the end face of the semicircular magnetic ring and the S-shaped magnetic ring, which has reached the narrow section, can be deformed and reassembled into an O-shaped magnetic ring through wire pulling. The above three-point design is key to passing a large magnetic loop through a small channel.

Although we have treated only one patient at our clinic so far, our results show that it is possible to deform the Y-Z DMR from the S shape to the O shape. Satisfactory results were obtained at the 6-month follow-up. This is the first-generation Y-Z DMR. We believe that further optimization of the magnetic ring structure would increase the applications of the Y-Z DMR.



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Figure 4 Postoperative anastomosis. A: Daughter and parent magnetic rings expelled from the body; B: Rectal anastomosis stoma; C: The colonoscope smoothly passes the stenosis; D: Anteroposterior colography; E: Lateral colography.

CONCLUSION

This study described the procedure and outcome of the first successful treatment of rectal stenosis using a Y-Z DMR through a unique anal access. The controllable deformation ability of the Y-Z DMR made this treatment strategy successful. We believe that our case report will provide more options to colorectal surgeons to treat rectal stenosis.

FOOTNOTES

Co-corresponding authors: Xiao-Peng Yan and Yi Lyu.

Author contributions: Lyu Y and Yan XP designed and coordinated the study; Yan XP and Zhang MM designed the deformable magnetic ring, Zhang MM, Sha HC, Qin YF, Yan XP performed the operation; Zhang MM, and Yan XP wrote the manuscript; Yan XP and Lyu Y conceived of the study and contributed to the study design, the interpretation of the results, and the critical revision of the manuscript; all authors read and approved the final manuscript. The reasons for designating Yan XP and Lyu Y as co-corresponding authors are as follows: Yan XP and Lyu Y have equal contributions in study design and making critical revisions to the manuscript. The two co-corresponding authors ensures effective communication and management of post-submission matters, ultimately enhancing the paper's quality and reliability. Yan XP and Lyu Y contributed efforts of equal substance throughout the research process. Therefore, Yan XP and Lyu Y are designated as co-corresponding authors in this manuscript.

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Country/Territory of origin: China

ORCID number: Miao-Miao Zhang 0000-0001-5679-7061; Huan-Chen Sha 0000-0002-8183-2591; Yi Lyu 0000-0003-3636-6664; Xiao-Peng Yan 0000-0002-0335-829X.

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