Utilizzo dei magneti nel tratto gastroenterico

Dott.ssa Roberta La Mendola

UOC Chirugia Generale

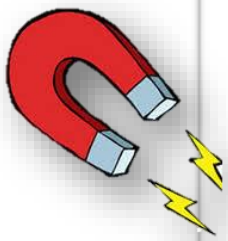
Rovigo

REGIONE DEL VENETO

ULSS5 POLESANA

Once upon a time…

1957



J.A.M.A., Sept. 28, 1957

Magnetic Removal of Foreign Bodies: The Use of the Alnico Magnet in the Recovery of Foreign Bodies from the Air Passages, the Esophagus, Stomach and Duodenum. By Murdock Equen, M.D., F.A.C.S., Chief of Staff of Ponce de Leon Infirmary, Atlanta, Ga. Cloth. $4.50. Pp. 94, with 119 illustrations. Charles C Thomas, Publisher, 301-327 E. Lawrence Ave., Springfield, Ill.; Blackwell Scientific Publications, 24-25 Broad St., Oxford, England; Ryerson Press, 299 Queen St.. W.. Toronto 2B. Canada, 1957.

The dark side of magnets

Table 2.1 List of possible toxicities related to magnets

Elemental toxicities	Device toxicities
Oxidative stress to cells	Tissue injury (magnet shatter)
Pulmonary embolism (inhaled magnet dust)	Gastrointestinal complications following ingestion
Toxicity to alveolar macrophages (inhaled magnet dust)	Possible carcinogenicity

Case Reports › MMWR Morb Mortal Wkly Rep. 2006 Dec 8;55(48):1296-300.

Gastrointestinal injuries from magnet ingestion in children--United States, 2003-2006

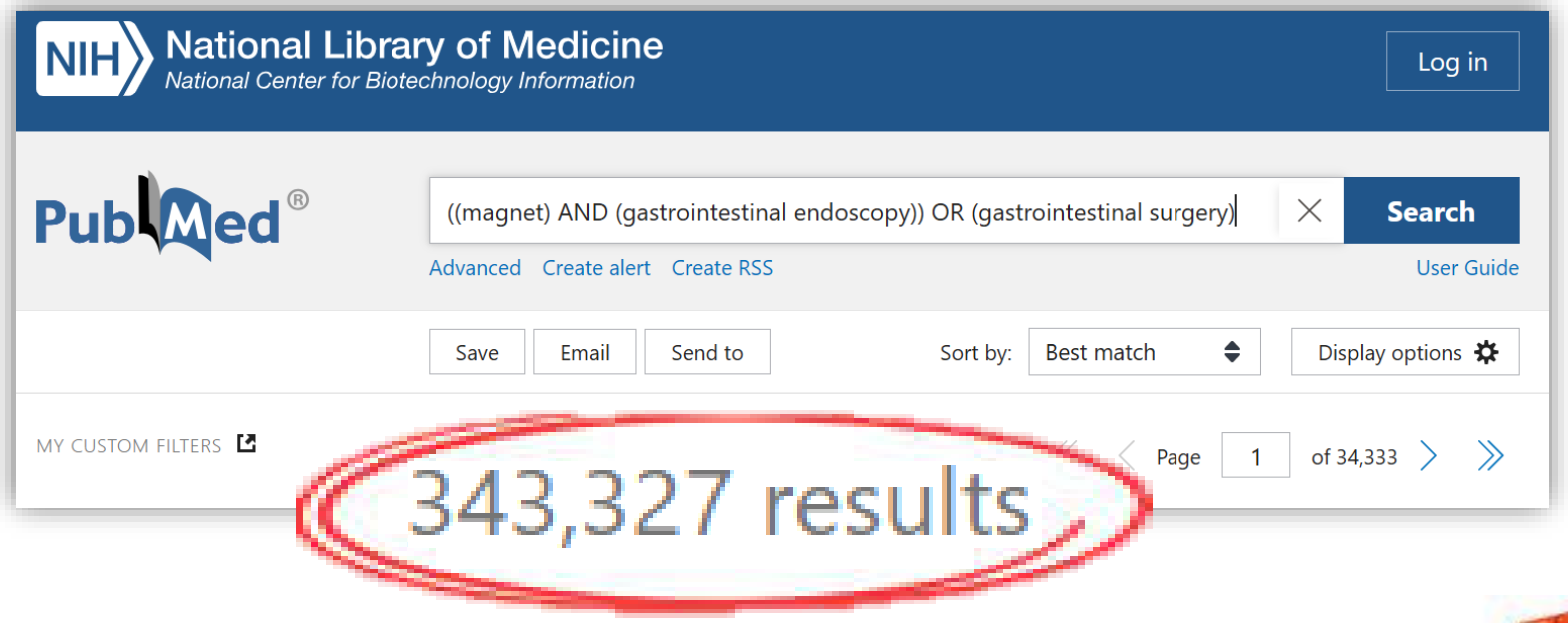
Centers for Disease Control and Prevention (CDC)

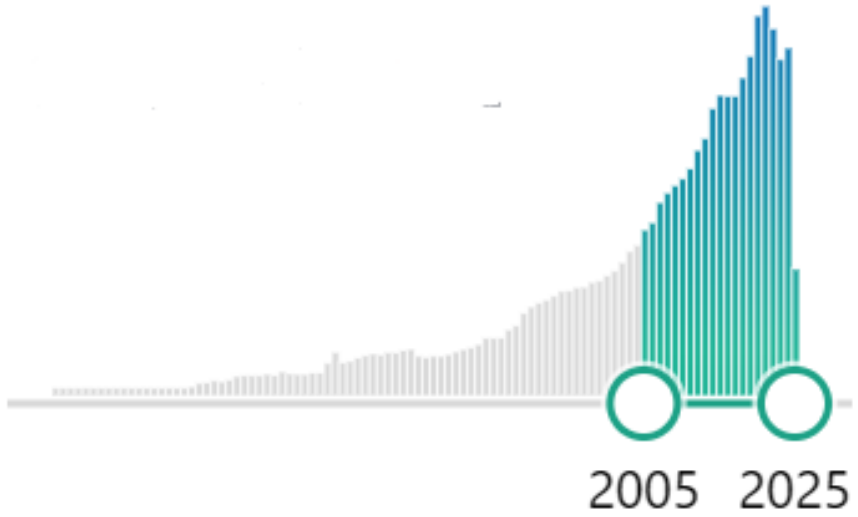
Case Reports › Eur J Pediatr Surg. 1995 Apr;5(2):119-20. doi: 10.1055/s-2008-1066183.

Intestinal obstruction in an infant due to magnet ingestion

Y Kubota [1], K Tokiwa, S Tanaka, N Iwai

Over the past 20 years





Application of magnets

I. Anchoring

II. Traction

III. Compression without anastomosis

IV. Compression anastomosis

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-dominguez, *MCAs* magnetic compressive anastomats, *I-MAS* incisionless magnetic anastomosis system, *MAG-ESD* magnetic-anchor-guided endoscopic submucosal dissection

I - Anchoring
Foreign bodies removal

Table 10.1 MAFBORE remarks

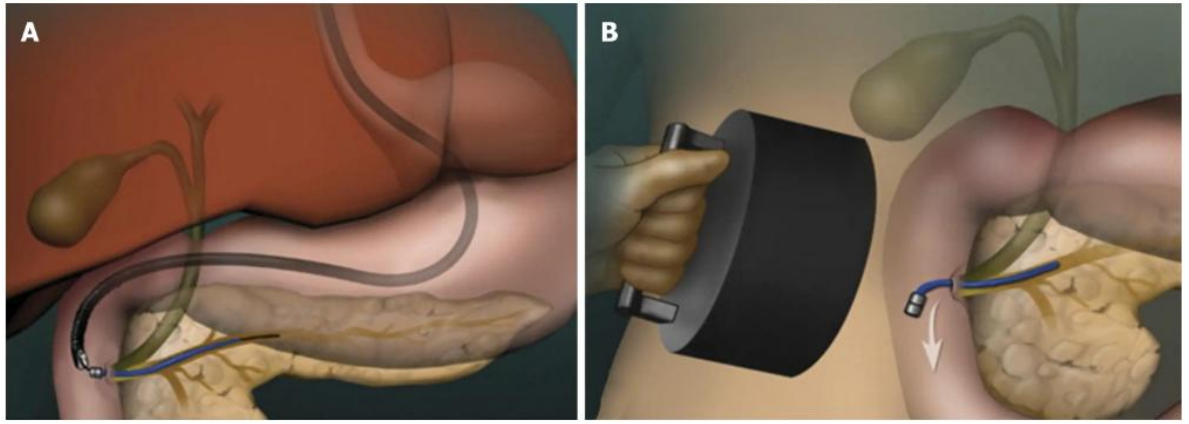
Advantages	Disadvantages
Could reduce endoscopy time and sedation	Additional cost
In some cases, no need for endoscopy and sedation[a]	Cannot be used in patients with cardiac devices
Avoid surgery for challenging circular, metallic, and flat foreign body removal	

For pancreatobiliary stents

Gastrointest Endosc. 2012 Apr;75(4):888-892.e1. doi: 10.1016/j.gie.2011.09.051. Epub 2012 Jan 5.

Magnetic pancreaticobiliary stents and retrieval system: obviating the need for repeat endoscopy (with video)

Marvin Ryou [1], Padraig Cantillon-Murphy, Sohail N Shaikh, Dan Azagury, Michele B Ryan, Jeffrey H Lang, Christopher C Thompson



I - Anchoring
Magnetically Assisted Capsule Endoscopy

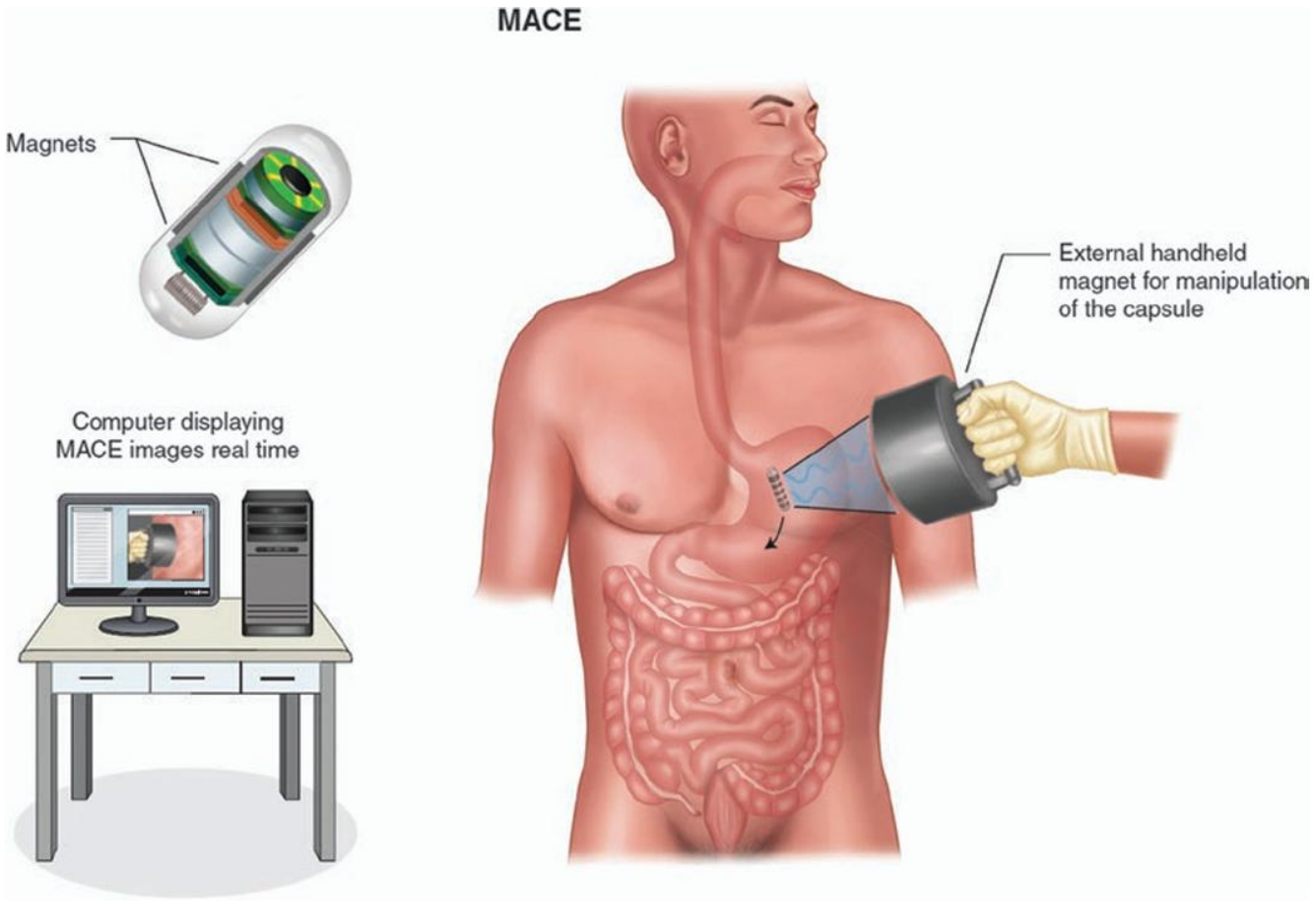
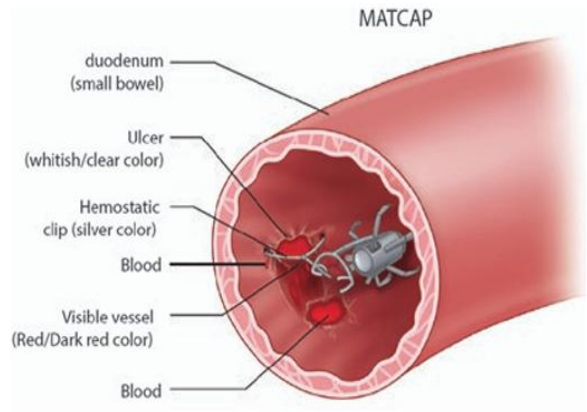


Table 10.2 MACE remarks

Advantages	Disadvantages
Wireless virtual examination with multiple passes	Limited visulaization due to rapid passage in the esophagus
Maneuverable device	Therapeutics still needs to be developed (tissue sampling and accurate clipping)
No sedation	Time consuming/needs learning curve to maneuver
Triage for acute GI bleed	Lack of RCTs
Screening for luminal cancers or precancerous conditions (Barrett's esophagus)	
Potential targeted delivery of compounds	
Noninvasive nonradioactive (compared to gastric emptying study)	
New use for GI motility assessment	
Growing evidence/studies	



I - Anchoring
Magnetically Assisted Capsule Endoscopy

Digestive Endoscopy 2020; **32**: 557–564 doi: 10.1111/den.13520

Original Article

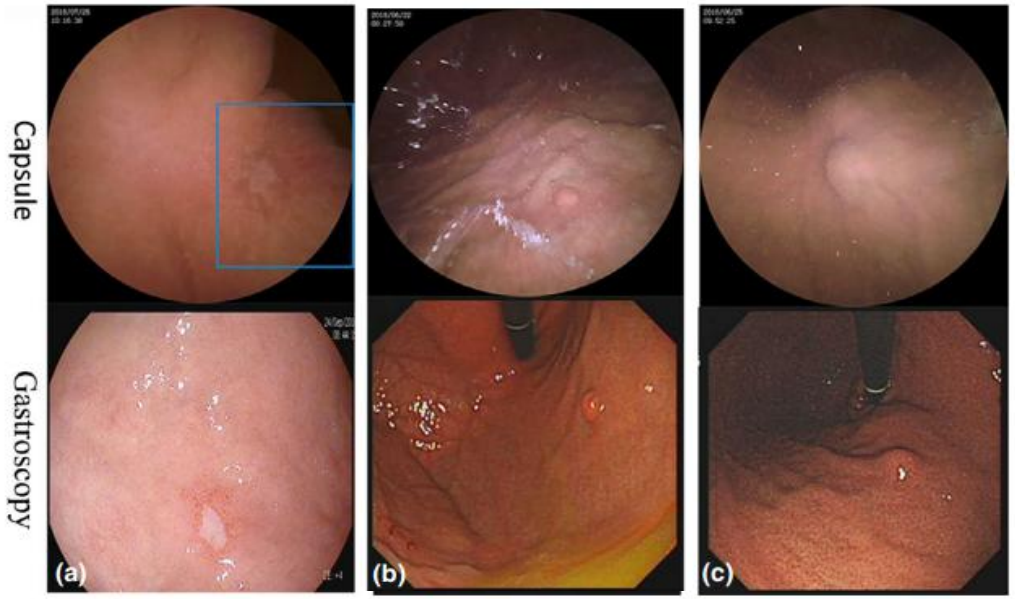
Standing-type magnetically guided capsule endoscopy versus gastroscopy for gastric examination: multicenter blinded comparative trial

Hua-sheng Lai,[1] Xin-ke Wang,[1] Jian-qun Cai,[1] Xin-mei Zhao,[1] Ze-long Han,[1] Jie Zhang,[1] Zhen-yu Chen,[1] Zhi-zhao Lin,[1] Ping-hong Zhou,[2] Bing Hu,[3] Ai-min Li[1] and Si-de Liu[1]

Table 2 Classification of 64 lesions diagnosed by SMCE and standard gastroscopy

Lesion	SMCE only, *n*	Gastroscopy only, *n*	Both SMCE and gastroscopy, *n*
Erosion	5	1	23
Polyp	1	2	15
Ulcer	1	0	0
Atrophic gastritis	0	1	2
Protuberance	0	3	9
Heterotopic pancreas	0	0	1
Bleeding	0	0	0
Total (abnormal)	7	7	50

SMCE, standing-type magnetically controlled capsule endoscopy.



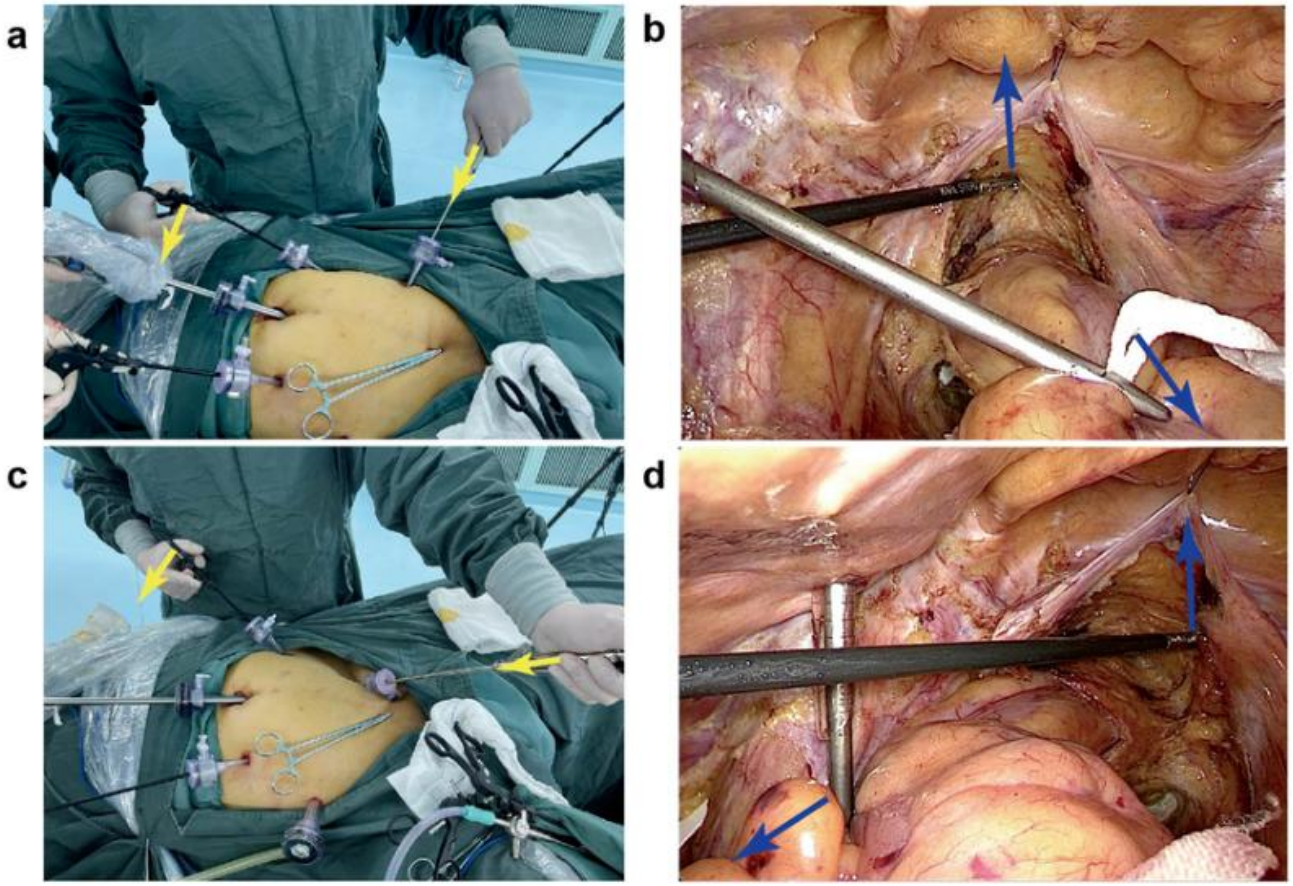
Overall agreement of 94.41%

3 adverse events due to gastric preparation, no capsule retention

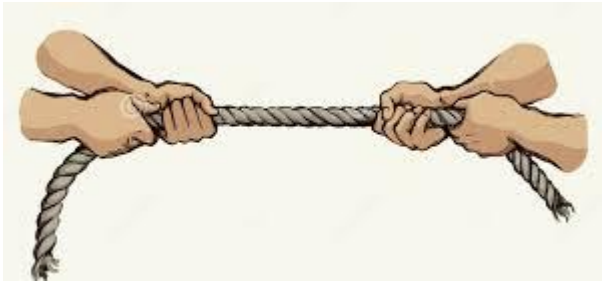
60% of patients preferred SMCE

3 EGC missed by SMCE!

II - Traction



The
«traction and countertraction»
issue



ESD

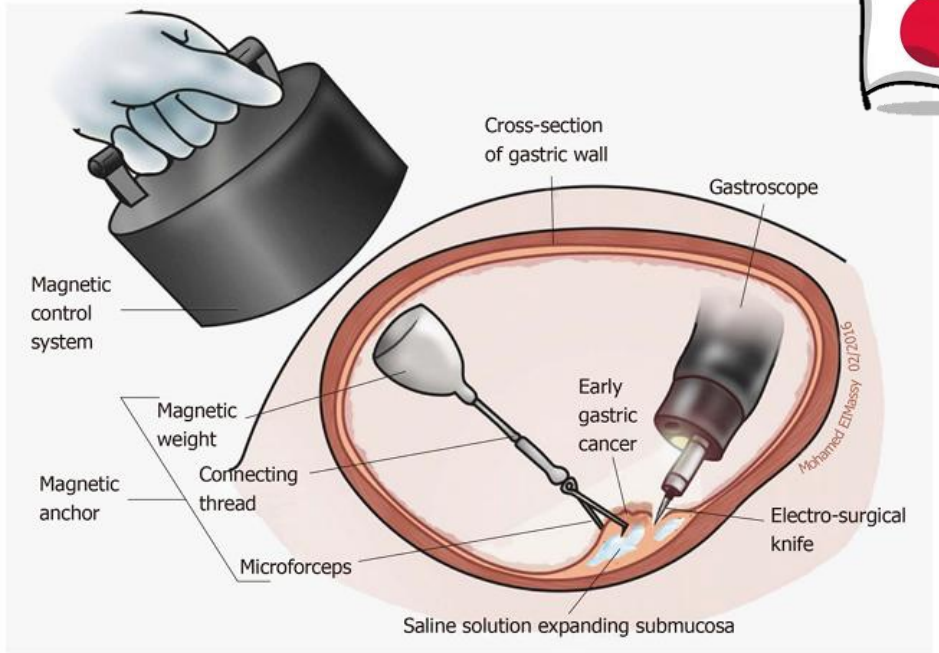
Incision-less surgery
(Single port and NOTES)

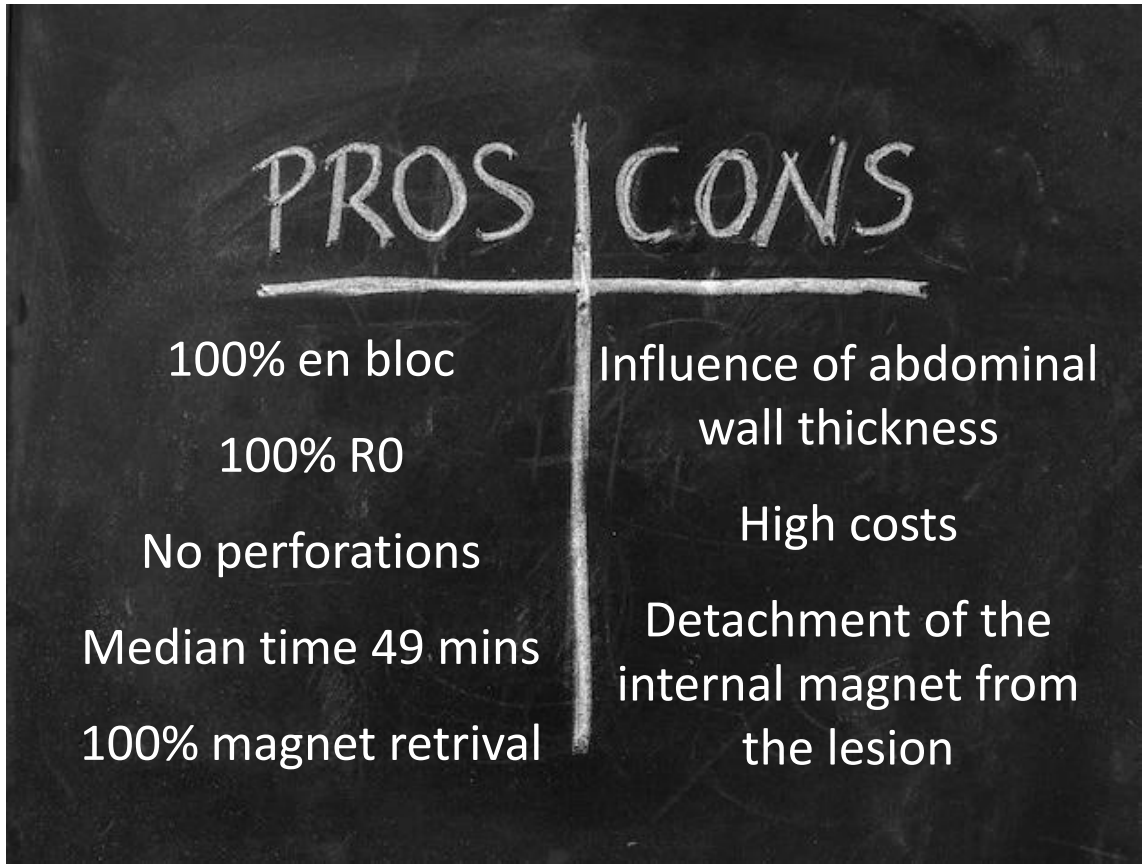
II – Traction
MAG-ESD

Gastrointest Endosc. 2018 Jun;87(6):1576-1580. doi: 10.1016/j.gie.2018.01.015. Epub 2018 Jan 17.

Magnetic anchor-guided endoscopic submucosal dissection for gastric lesions (with video)

Ippei Matsuzaki [1], Masashi Hattori [1], Ken Hirose [1], Masaya Esaki [1], Masakatsu Yoshikawa [1], Takio Yokoi [2], Makoto Kobayashi [3], Ryoji Miyahara [4], Yoshiki Hirooka [5], Hidemi Goto [4]





II – Traction
MAG-ESD

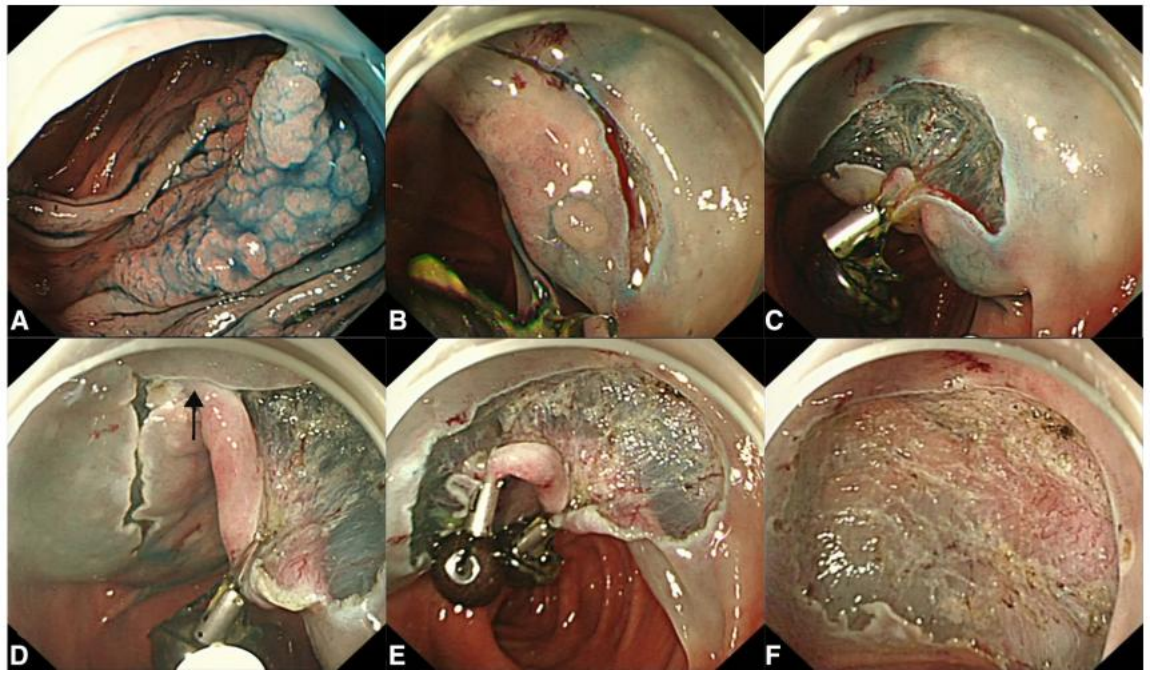
Surgical Endoscopy (2019) 33:2034–2041
https://doi.org/10.1007/s00464-019-06799-7

NEW TECHNOLOGY

Magnetic bead-assisted endoscopic submucosal dissection: a gravity-based traction method for treating large superficial colorectal tumors

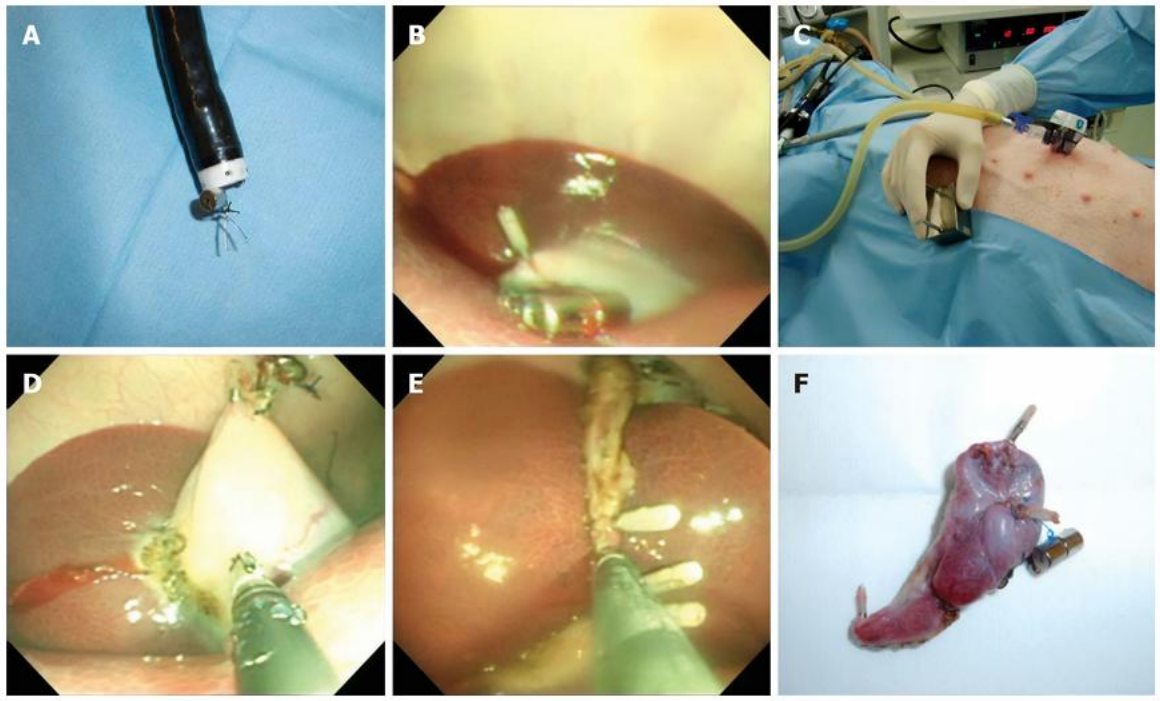
Liansong Ye[1] · Xianglei Yuan[1] · Maoyin Pang[2] · Johannes Bethge[3] · Mark Ellrichmann[3] · Jiang Du[1] · Xianhui Zeng[1] · Chengwei Tang[1] · Stefan Schreiber[3] · Bing Hu[1]

	MBA-ESD ($n=13$)	Conventional ESD ($n=13$)	P value
En bloc resection	13 (100%)	12 (92.3%)	1.000[F]
R0 resection	13 (100%)	12 (92.3%)	1.000[F]
Curative resection	11 (84.6%)	12 (92.3%)	1.000[F]
Overall complications	0 (0%)	5 (38.5%)	0.039[F]
Immediate bleeding	0 (0%)	2 (15.4%)	0.480[F]
Delayed bleeding	0 (0%)	2 (15.4%)	0.480[F]
Immediate perforation	0 (0%)	0 (0%)	–
Delayed perforation	0 (0%)	1 (7.7%)	1.000[F]
Muscularis injury	0 (0%)	1 (7.7%)	1.000[F]
Follow-up period (month[a])	10 (6–13, 4–16)	6 (6–12, 3–21)	0.452[W]
Tumor recurrence	0 (0%)	0 (0%)	–



II – Traction
Natural Orifice Transluminal Endoscopic Surgery (NOTES)

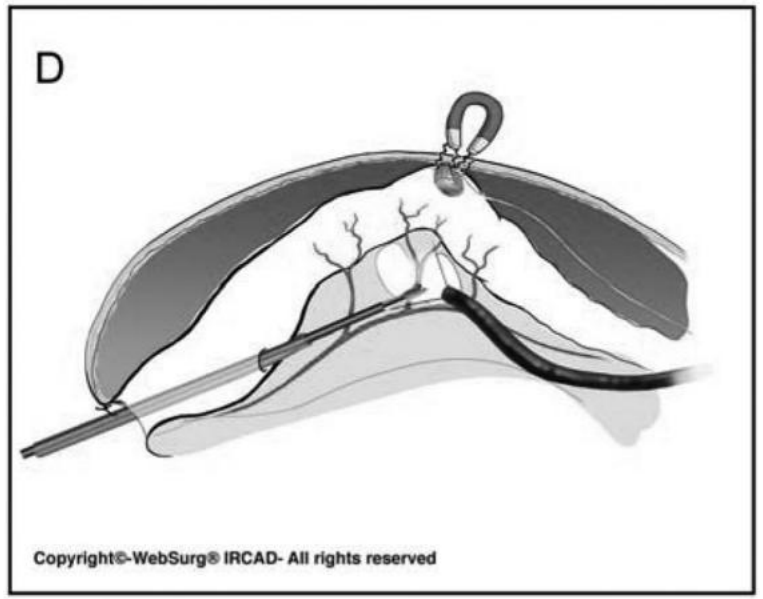
Magnetic retraction in natural-orifice transluminal endoscopic surgery (NOTES): addressing the problem of traction and countertraction



Surg Innov. 2012 Jun;19(2):109-16.

An Original Endoluminal Magnetic Anastomotic Device Allowing Pure NOTES Transgastric and Transrectal Sigmoidectomy in a Porcine Model: Proof of Concept

Joël Leroy, MD, FRCS[1], Silvana Perretta, MD[1], Michele Diana, MD[1], James Wall, MD[1], Veronique Lindner, MD, PhD[2], Michael Harrison, MD, FACS[3], and Jacques Marescaux, MD, (Hon) FRCS, (Hon) FACS, (Hon) JSES[1]

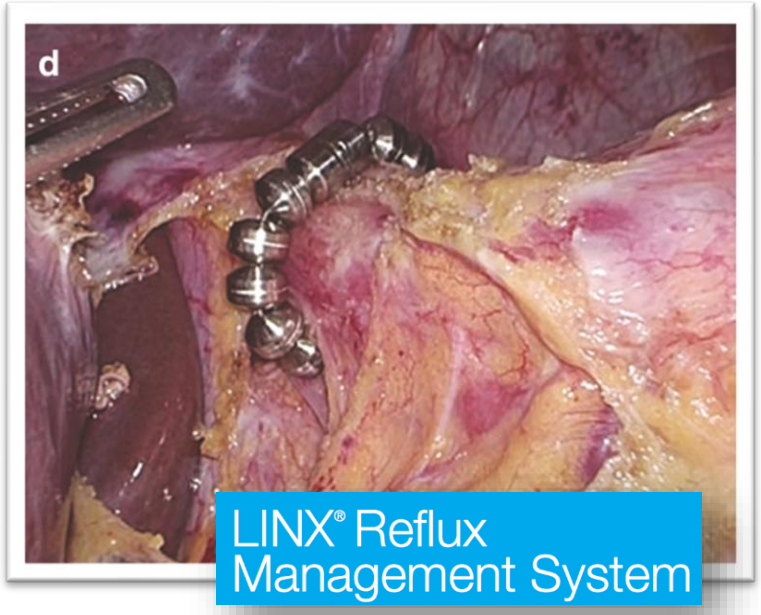


III – Compression without anastomosis
Magnetic sphincter augmentation in GERD…

J Am Coll Surg. 2013 Oct;217(4):577-85. doi: 10.1016/j.jamcollsurg.2013.04.039. Epub 2013 Jul 12.

One hundred consecutive patients treated with magnetic sphincter augmentation for gastroesophageal reflux disease: 6 years of clinical experience from a single center

Luigi Bonavina [1], Greta Saino, Davide Bona, Andrea Sironi, Veronica Lazzari



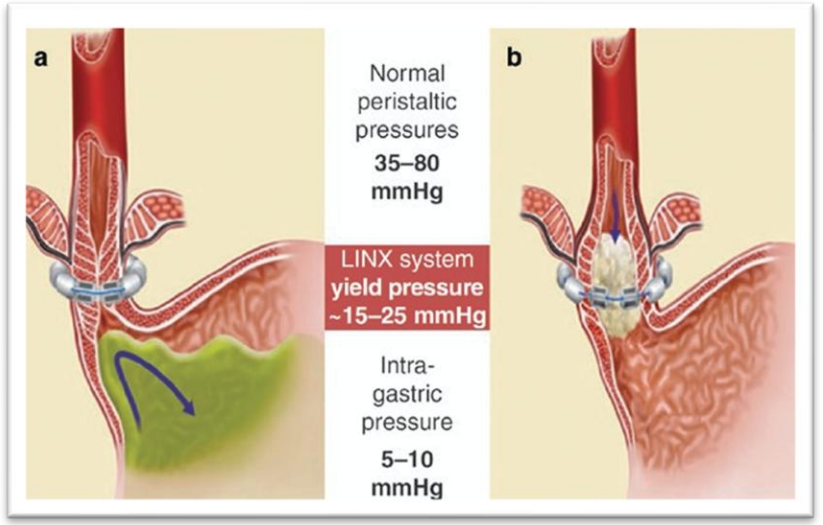


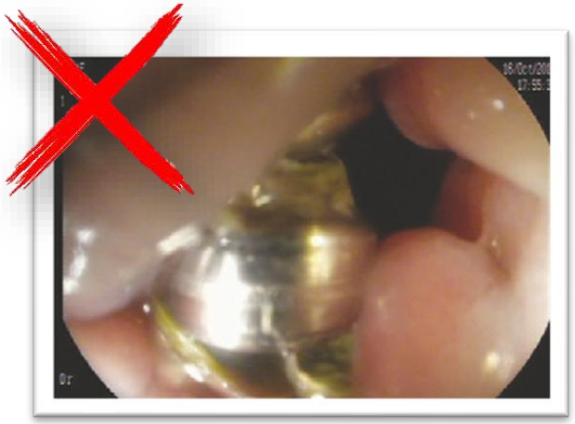
Table 4. Esophageal pH Measurements

Measure	Baseline	Last follow-up*	p Value†
Total time pH <4, %‡	8.0	3.2	<0.001
Total upright time, %	9.2	3.8	<0.001
Total supine time, %	3.5	0.4	0.002
Total reflux episodes, n	51.7	31.5	0.002
Reflux episodes >5 min, n	4.0	1.0	<0.001
Longest reflux episode, min	35.3	9.5	0.024
DeMeester score	30.1	11.2	<0.001

Not inferior to fundoplication

Complete PPI cessation in 88% of patients

Extended indications over the years



III – Compression without anastomosis
…and in faecal incontinence

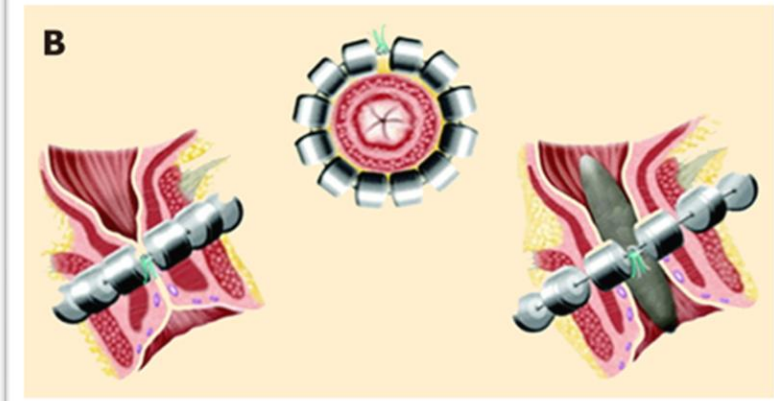
Colorectal Disease

Original Article

The magnetic anal sphincter in faecal incontinence: is initial success sustained over time?

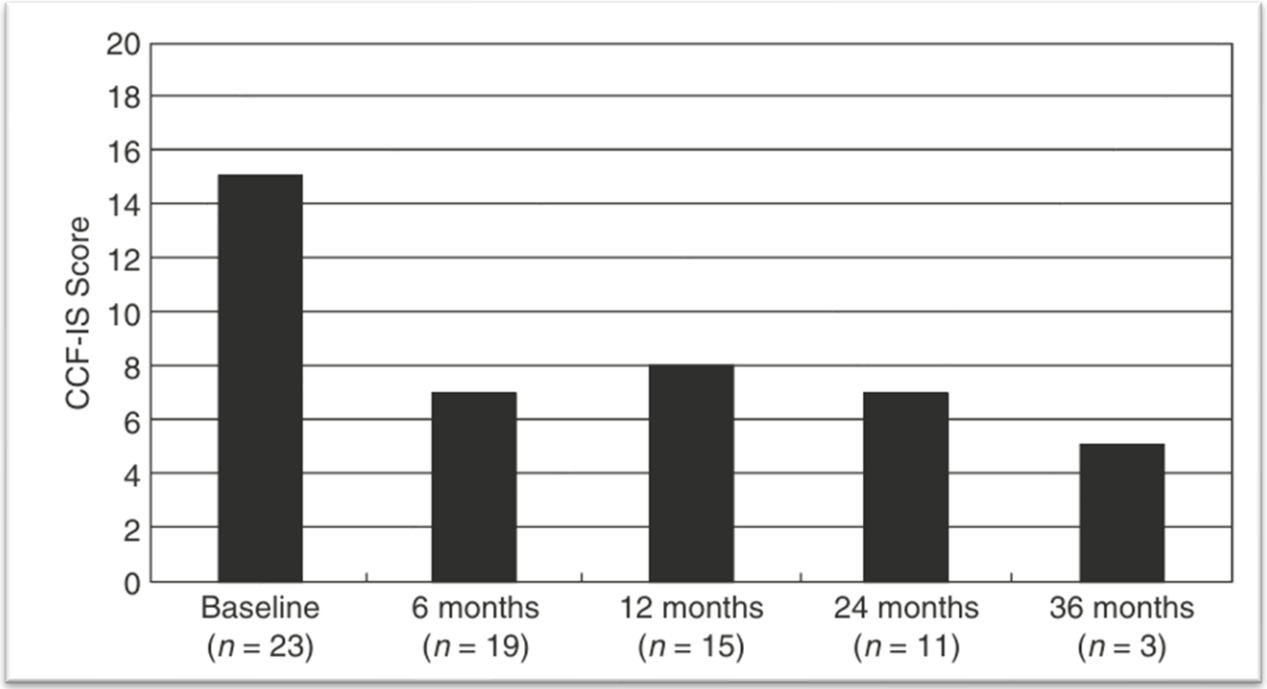
M.-L. Barussaud, S. Mantoo, V. Wyart, G. Meurette, P.-A. Lehur

First published: 18 September 2013 | https://doi.org/10.1111/codi.12423 | Citations: 50

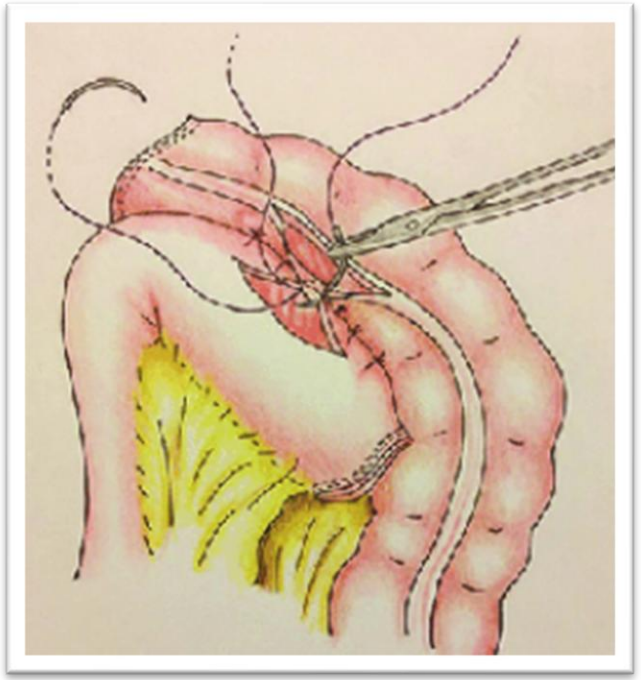


FENIX®

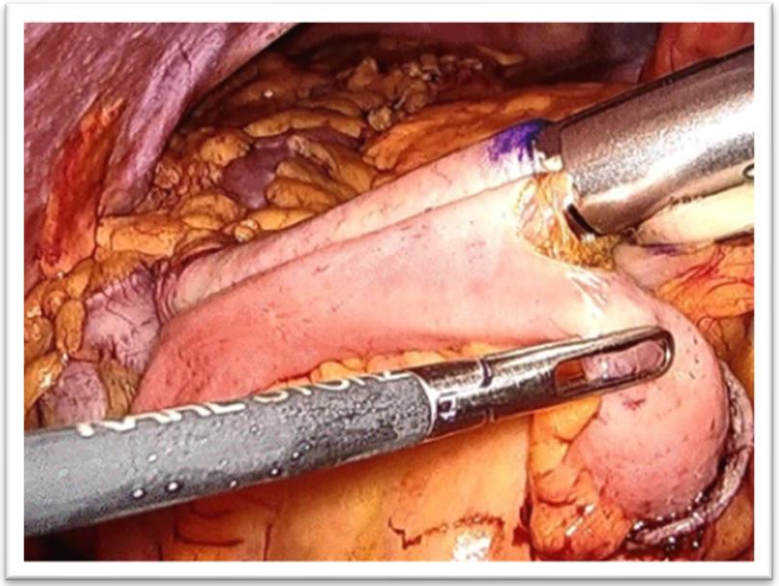
CONTINENCE RESTORATION SYSTEM



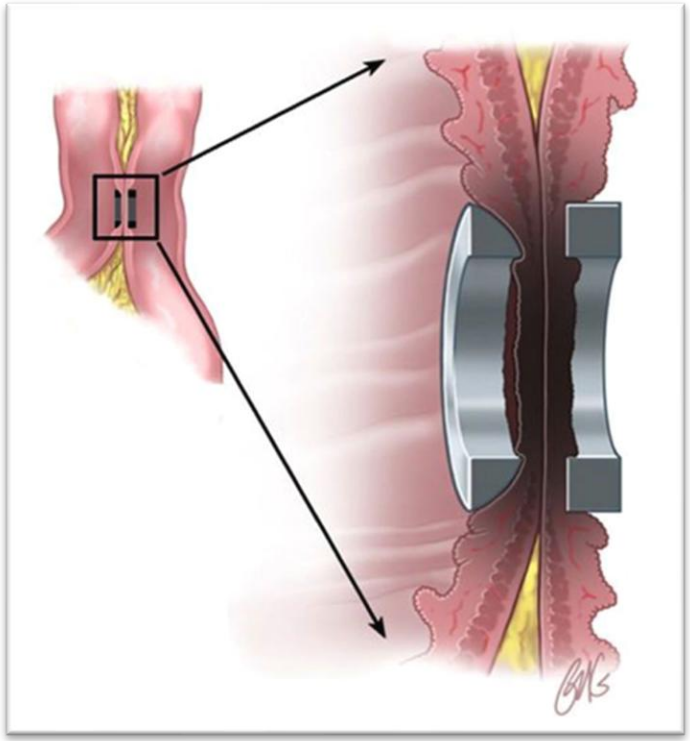
Searching for «the perfect anastomosis»



1826

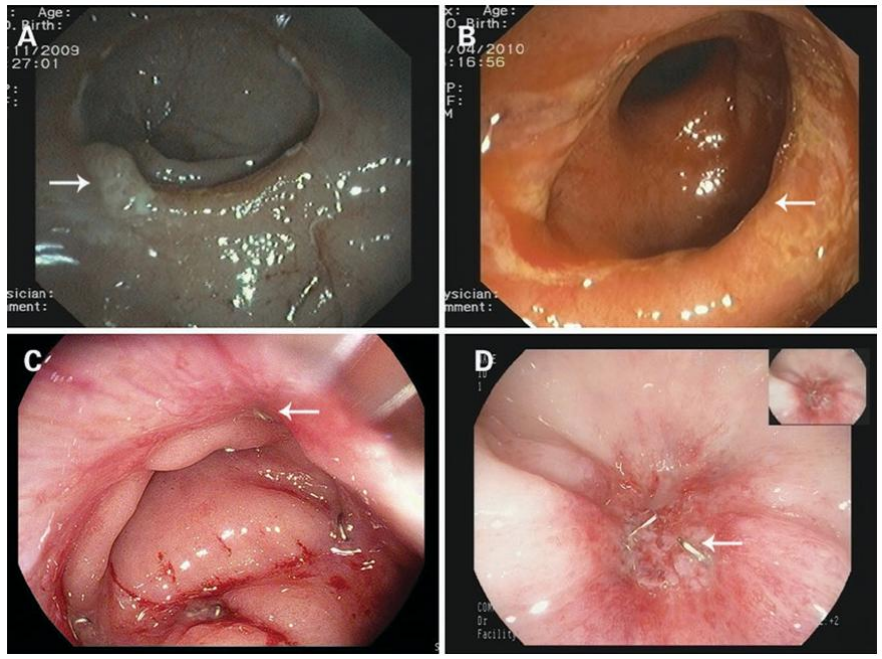


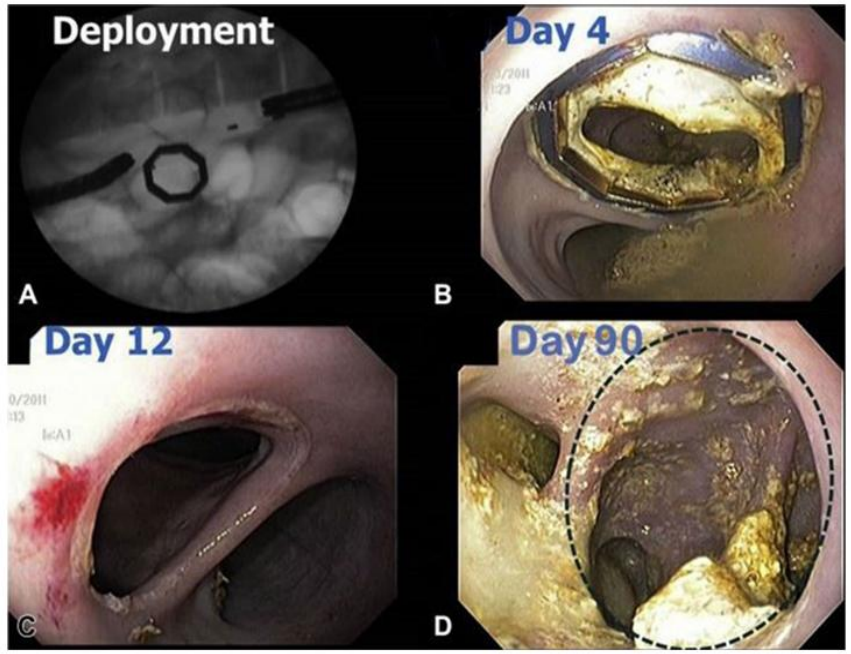
1908

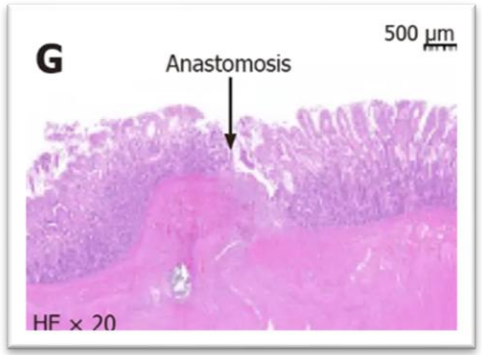


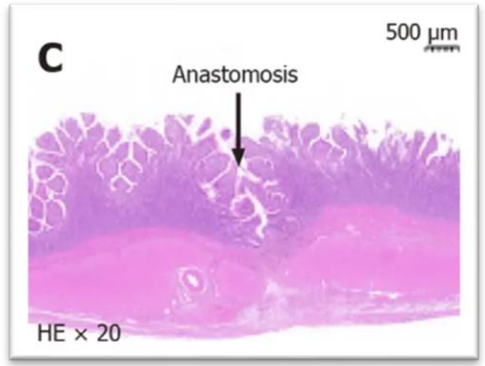
1998

Magnetic compression anastomosis



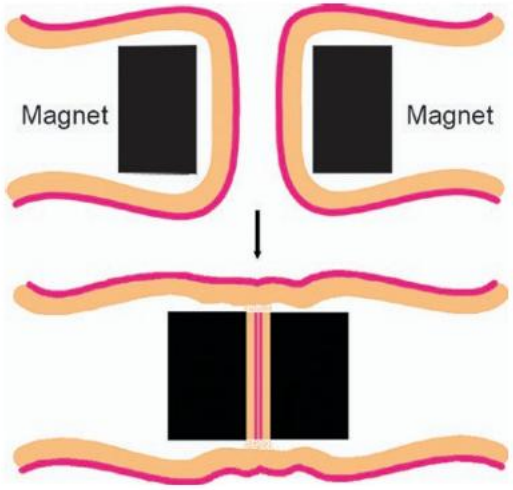






Magnetic compression anastomosis

- **Hepatobiliary** (bilio-biliary or bilioenteric)
- **Esophageal**
- **Gastroenteric or entero-enteric**: gastrojejunal, gastrocolonic, duodenocolonic, jejunojejunal, jejunoileal, jejunocolonic, colorectal



Anastomosis forming in 3-7 days…

…up to 10-14 days in some experimental models!!!

Hepatobiliary MCA

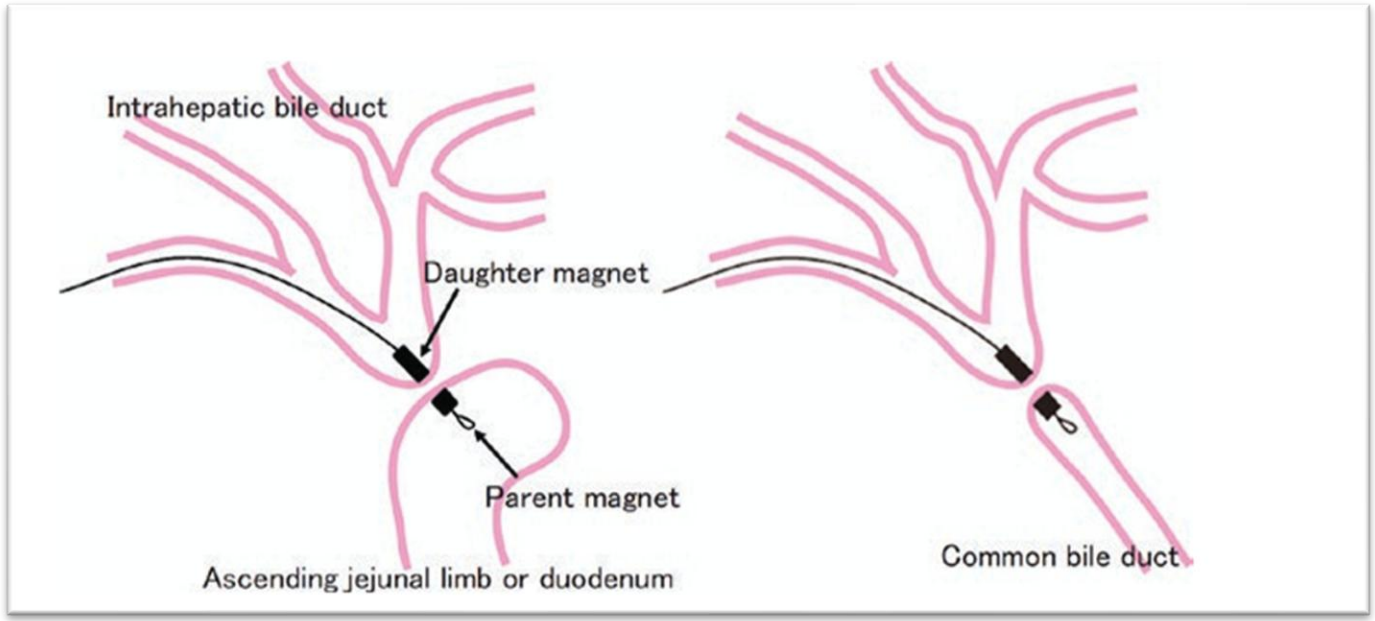
Gastrointest Endosc. 2017 May;85(5):1057-1066. doi: 10.1016/j.gie.2016.08.047. Epub 2016 Sep 9.

Treatment of completely obstructed benign biliary strictures with magnetic compression anastomosis: follow-up results after recanalization

Sung Ill Jang [1], Kwang-Hun Lee [2], Hong Jin Yoon [3], Dong Ki Lee [3]

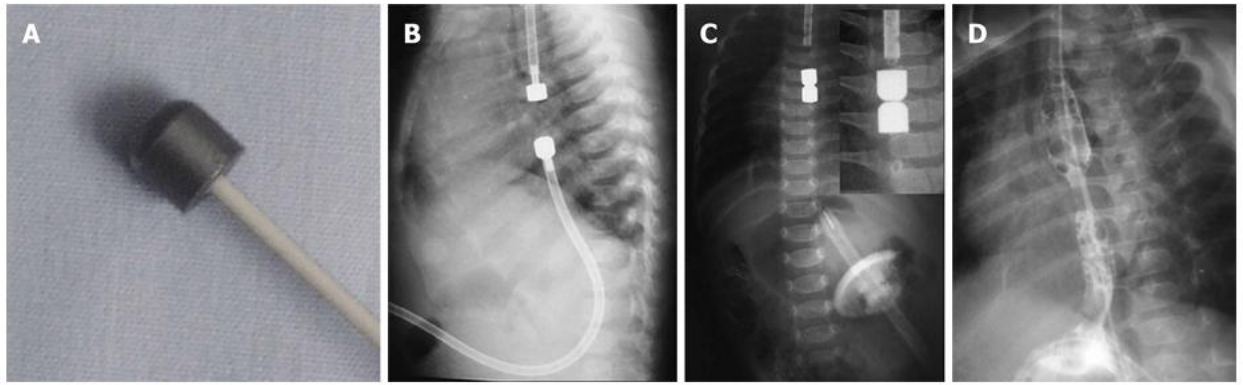
39 patients with postoperative strictures

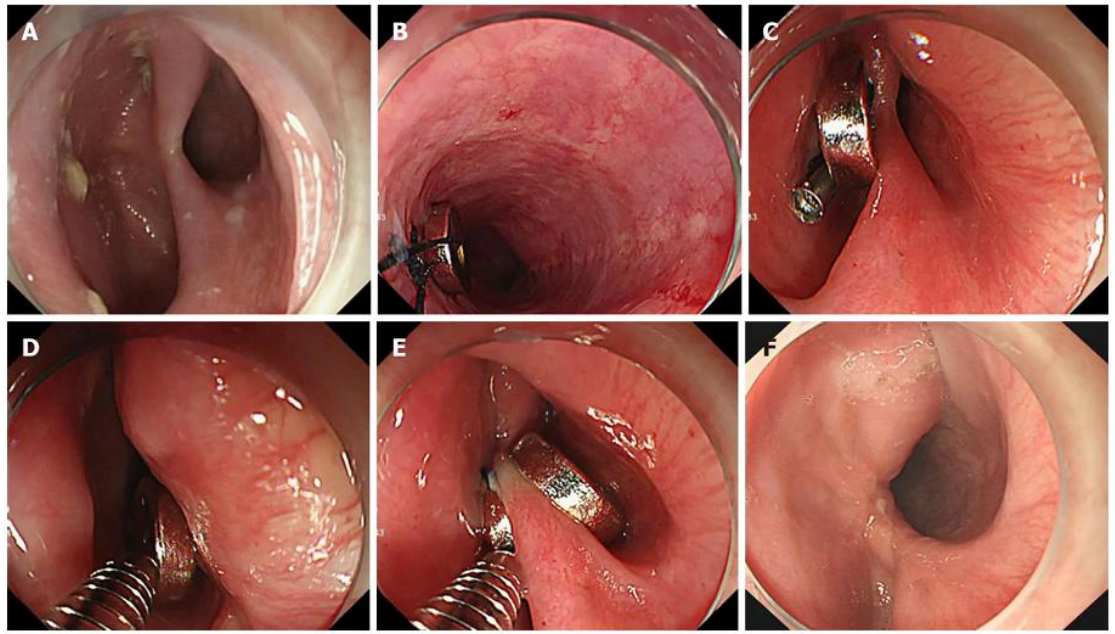
35 successful MCA



Adverse events	
Early	
Cholangitis	1
Pancreatitis	0
Mortality	0
Late	
Recurrence of anastomosis site stricture	1
Partial re-stenosis	1

Esophageal MCA





Clinical Trial > Pediatr Radiol. 2009 Sep;39(9):945-9. doi: 10.1007/s00247-009-1305-7. Epub 2009 Jun 9.

Magnetic compression anastomosis as a nonsurgical treatment for esophageal atresia

Mario Zaritzky [1], Ricardo Ben, Gaston I Zylberq, Brian Yampolsky

Case Reports > Endoscopy. 2018 Jul;50(7):E170-E171. doi: 10.1055/a-0600-9483. Epub 2018 May 9.

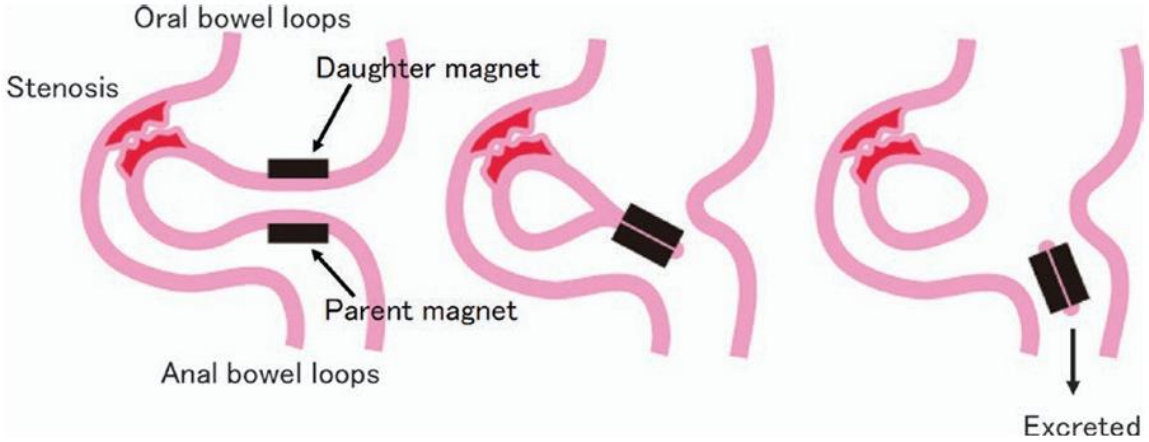
Magnet-assisted diverticuloplasty for treatment of Zenker's diverticulum

Liansong Ye [# 1], Hongze Zeng [# 1], Shuifang Wang [1], Jingsun Jiang [2], Hong Tang [3], Chuanhui Li [1], Bing Hu [1]

Gastroenteric MCA
Gastric outlet obstruction

Table 10.4 M-GEC remarks

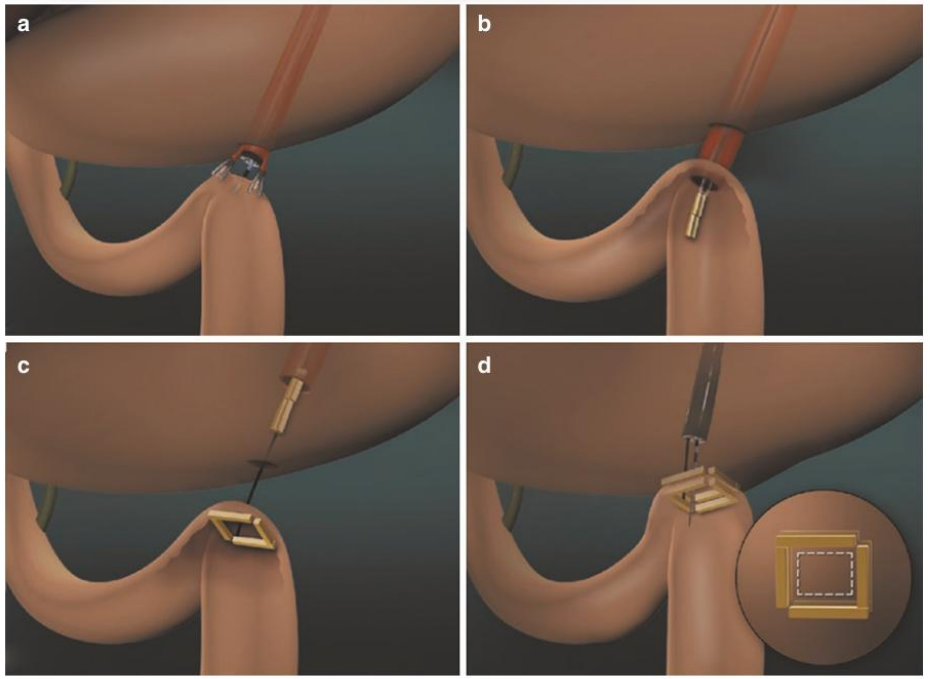
Advantages	Disadvantages
Once natural fistula is formed, magnets are removed without any need for permanent stent or prosthesis utilization	Learning curve of new technology can be harder to implement (compared to EUS knowledge +30 years)
Potential access of more challenging GI tract (jejunoileal bypass) areas than other approaches	



Comparative Study > Gastrointest Endosc. 2011 Feb;73(2):353-9. doi: 10.1016/j.gie.2010.10.024. Epub 2010 Dec 22.

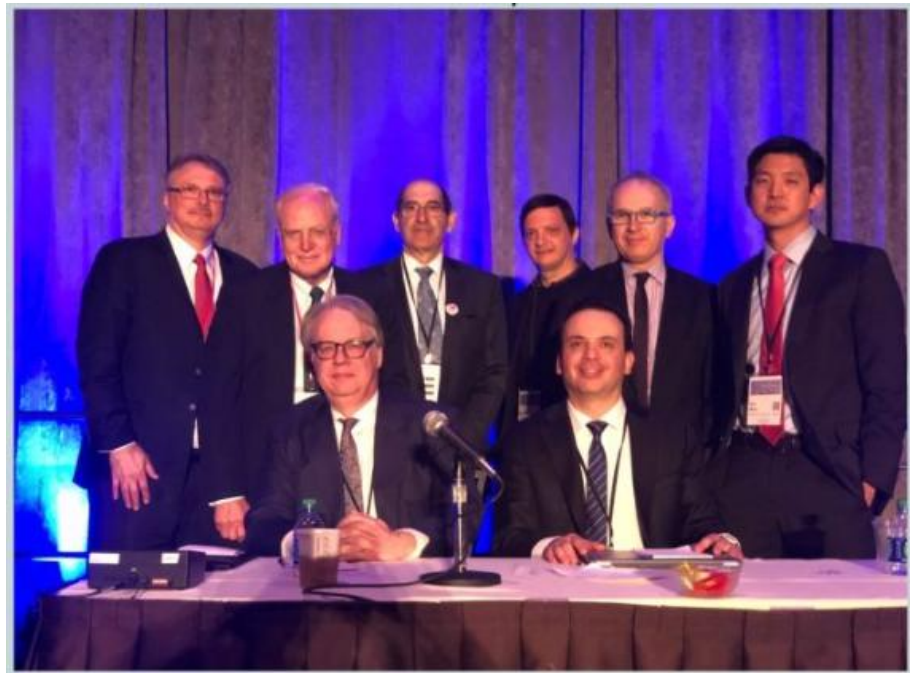
Smart Self-Assembling MagnetS for ENdoscopy (SAMSEN) for transoral endoscopic creation of immediate gastrojejunostomy (with video)

Marvin Ryou [1], Padraig Cantillon-Murphy, Dan Azagury, Sohail N Shaikh, Gabriel Ha, Ian Greenwalt, Michele B Ryan, Jeffrey H Lang, Christopher C Thompson



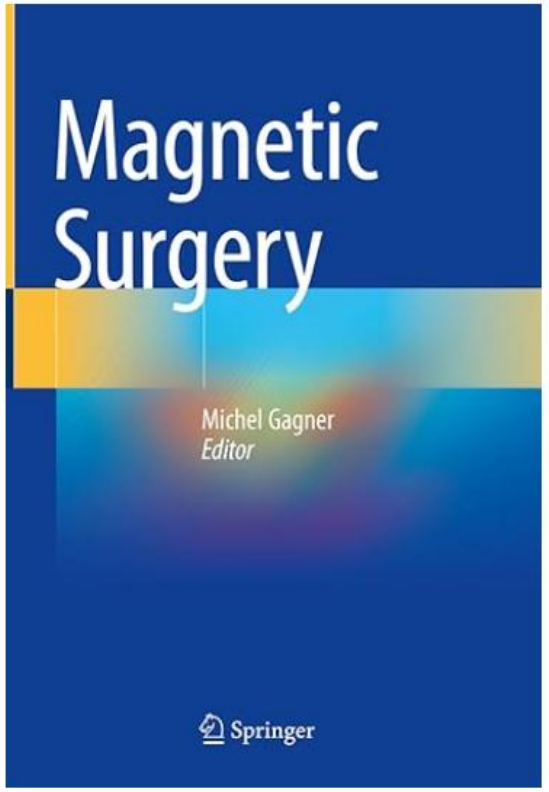
Gagner M, Magnetic Surgery. Springerhttps://doi.org/10.1007/978-3-030-73947-8

Gastroenteric MCA
Obesity and type 2 diabetes



Seattle 2018, 16th World Congress of Endoscopic Surgery

Magnetic surgery: what's the attraction?



Gastroenteric MCA
Obesity and type 2 diabetes

Obesity Surgery (2023) 33:2282–2292
https://doi.org/10.1007/s11695-023-06708-x

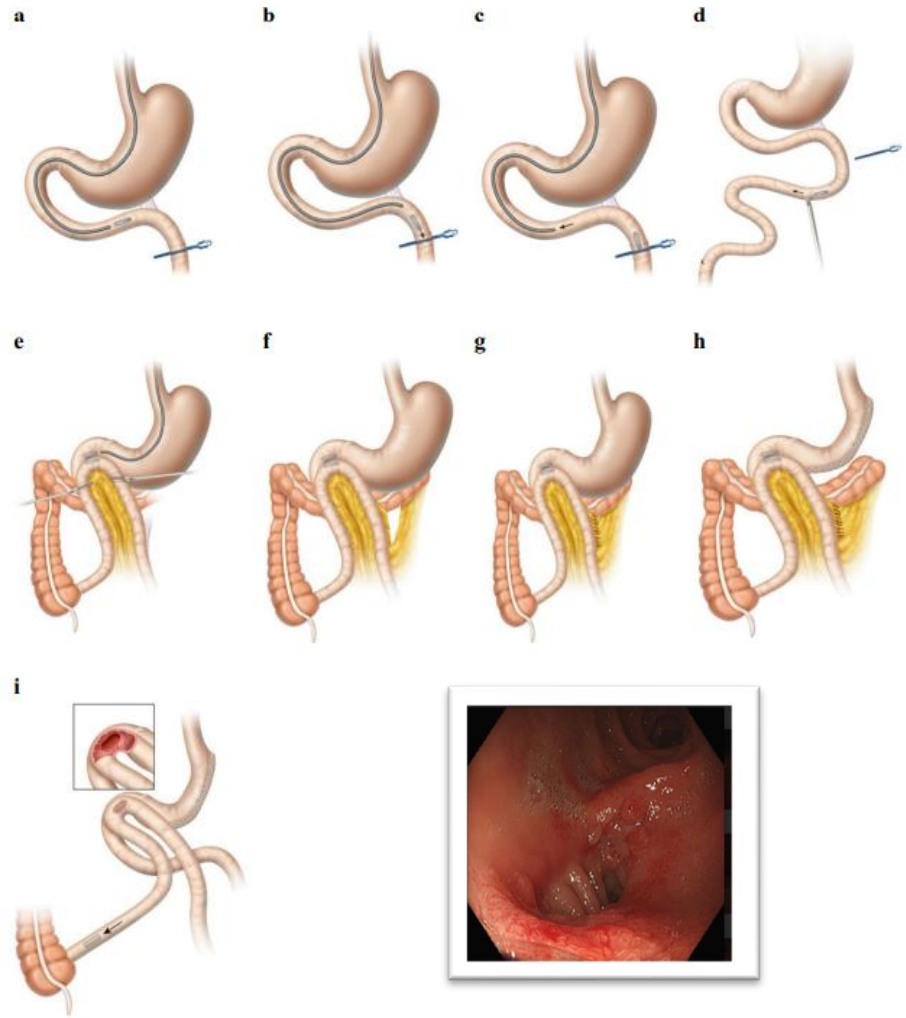
ORIGINAL CONTRIBUTIONS

First-in-Human Side-to-Side Magnetic Compression Duodeno-ileostomy with the Magnet Anastomosis System

Michel Gagner[1] · David Abuladze[2] · Levan Koiava[2] · J. N. Buchwald[3] · Nathalie Van Sante[4] · Todd Krinke[5]

Table 2 Adverse events by number and severity post side-to-side magnet system duodeno-ileostomy with sleeve gastrectomy through day 360 by Clavien-Dindo Classification

	All patients ($N=5$) n (%)					
Adverse event	Grade I	Grade II	Grade III	Grade IV	Grade V	Total
Mucosal tear of upper esophagus due to overtube insertion	1	0	0	0	0	1 (6.3)
Serosal tear of ileum (5 mm) due to laparoscopic forceps	0	0	1	0	0	1 (6.3)
Mild abdominal pain from procedure wounds	3	0	0	0	0	3 (18.8)
Intra-abdominal hematoma at sleeve staple line, upper left quadrant	0	1	0	0	0	1 (6.3)
Vitamin B_{12} deficiency	3	2	0	0	0	5 (31.3)
Vitamin D deficiency	0	1	0	0	0	1 (6.3)
COVID-19 positive	3	0	0	0	0	3 (18.8)
Constipation	0	1	0	0	0	1 (6.3)
Number of adverse events	10 (62.6)	5 (31.2)	1 (6.2)	0 (0)	0 (0)	16 (100)



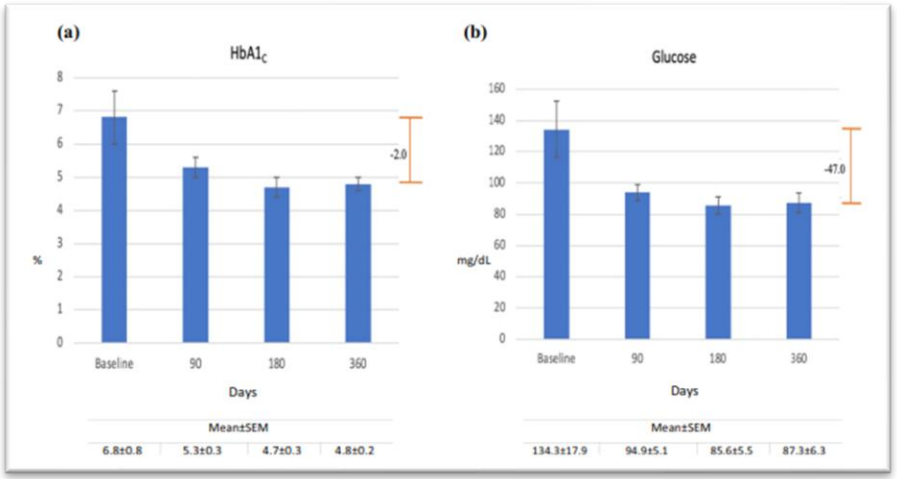
Gastroenteric MCA
Obesity and type 2 diabetes

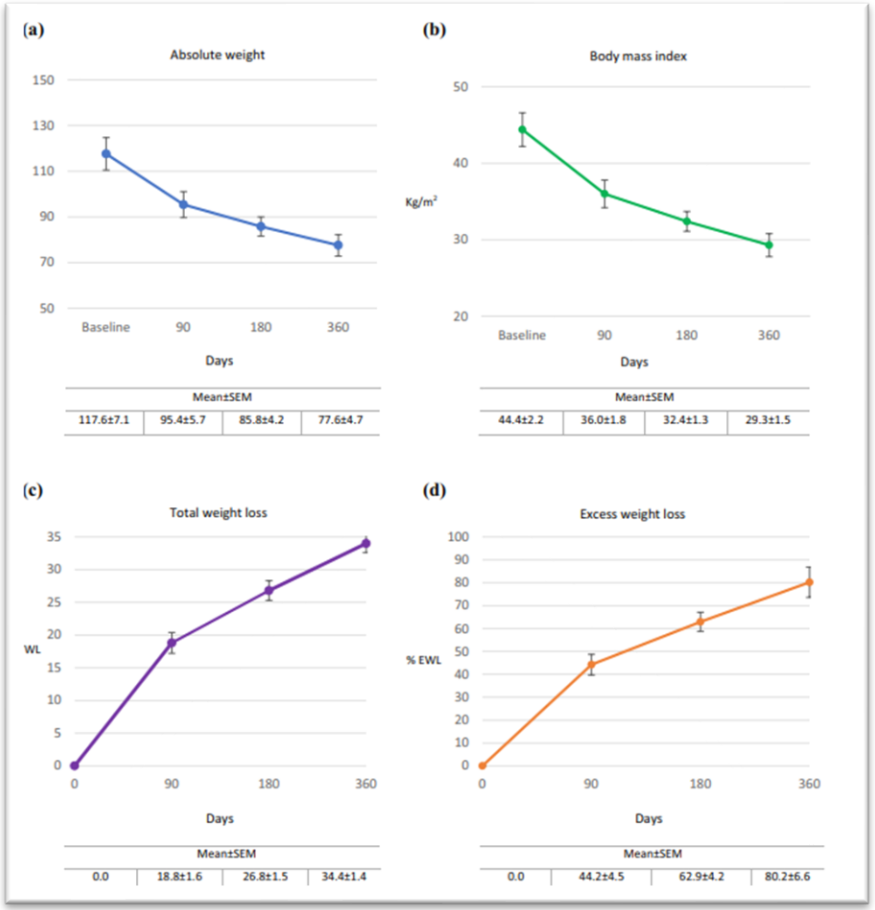
Obesity Surgery (2023) 33:2282–2292
https://doi.org/10.1007/s11695-023-06708-x

ORIGINAL CONTRIBUTIONS

First-in-Human Side-to-Side Magnetic Compression Duodeno-ileostomy with the Magnet Anastomosis System

Michel Gagner[1] · David Abuladze[2] · Levan Koiava[2] · J. N. Buchwald[3] · Nathalie Van Sante[4] · Todd Krinke[5]





Colorectal MCA

World J Gastrointest Endosc 2023 December 16; 15(12): 745-750

CASE REPORT

Magnetic compression anastomosis for sigmoid stenosis treatment: A case report

Miao-Miao Zhang, Yi Gao, Xiao-Yang Ren, Huan-Chen Sha, Yi Lyu, Fang-Fang Dong, Xiao-Peng Yan

World J Gastrointest Surg 2024 June 27; 16(6): 1926-1932

CASE REPORT

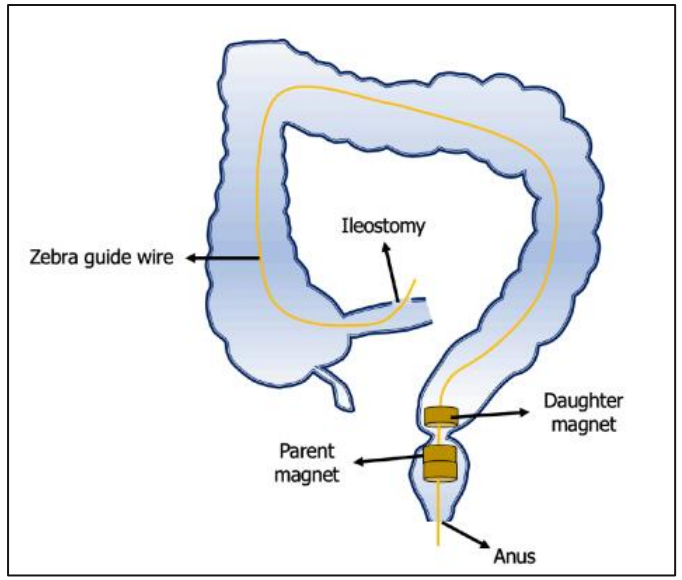
Novel magnetic compression technique for the treatment of postoperative anastomotic stenosis in rectal cancer: A case report

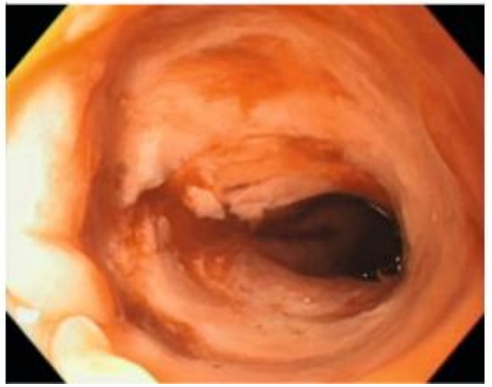
Miao-Miao Zhang, Huan-Chen Sha, Hai-Rong Xue, Yuan-Fa Qin, Xiao-Gang Song, Yun Li, Yu Li, Zheng-Wu Deng, Yu-Lin Gao, Fang-Fang Dong, Yi Lyu, Xiao-Peng Yan

Case Reports > Endoscopy. 2024 Dec;56(S 01):E462-E463. doi: 10.1055/a-2325-2464.
Epub 2024 Jun 5.

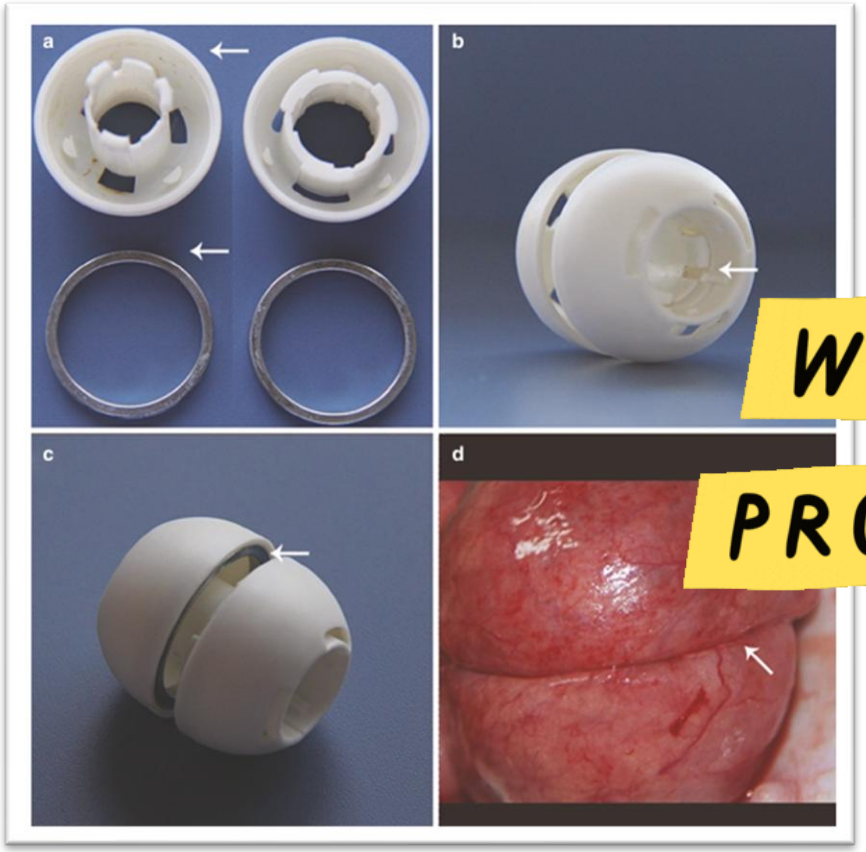
Endoscopic recanalization of a completely obstructed colorectal anastomosis using magnets

Willian F Igi [1] [2], Isabela Andrina Ribeiro da Silva [1]

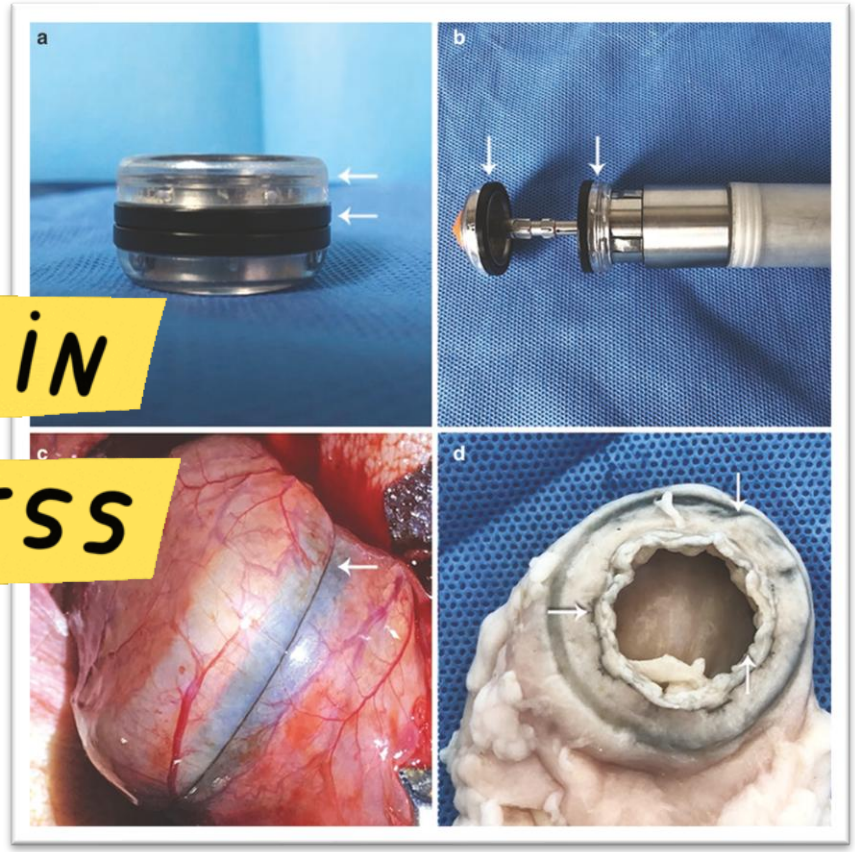




Colorectal MCA



WORK IN PROGRESS



Gagner M, Magnetic Surgery. Springerhttps://doi.org/10.1007/978-3-030-73947-8

Conclusions

- Applications of magnetic devices represent a further **advancement in the field of minimally invasive intervention**
- **More space to therapeutic endoscopy**
- **Agreement among endoscopists and surgeons** needed
- Encouraging data from literature but **long way to go with RCT**

thank you