

Magnetic Use in Gastrointestinal Surgery

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There is continuous advancement and innovations in surgery and magnetic device used in GIT surgery is an innovation. The use of magnets started with the removal of foreign bodies from GIT in 1957.¹ But due to dangers of magnetic field and complications in children due to ingestion of magnets leading to perforation, leakage, and death; there was no clinical use for some time. The safety of magnetic field in the human body was established by the use of magnetic resonance imaging and the studies showing no cell damage or cancer due to exposure to magnetic field.²

There are limitations for magnets use in GIT. The magnets lead to the delayed anastomosis, so it can not be used when the immediate anastomosis is required. Magnets can not be used in patients with cardiac implants. The magnets are placed in GIT endoscopically but magnet location is difficult because the external view of the intestines is not visible and it increases the risk of intestines being caught between the magnetic forces. Thus laparoscopy is used for assistance and the fluorescence coated magnets and other methods are used for the location of magnets.³

Magnets are classified into two major types⁴

A. Intra-abdominal:

1. Traction
2. Sphincter augmentation

B. Endoluminal:

1. Intestinal anastomosis: Compression anastomosis
2. Intestinal bypass
3. Endoluminal traction

Traction: In laparoscopic surgery multiple ports are used for GIT surgery which leads to more infection, injury and scars. When magnetic ports are used and are manipulated by external magnets, the number of ports are

decreased. Magnetic anchoring and guidance system (MAGS) and the Levita Magnetic Surgical System have been used in natural orifice transluminal endoscopic surgery (NOTES) and single port cholecystectomy.³

Magnetic sphincter augmentation in Gastroesophageal reflux disease (GERD) and fecal incontinence.

The LINX® device was started in 2007 as magnetic sphincter augmentation in the lower esophageal sphincter in GERD and is placed laparoscopically. Short term data shows its efficacy but long-term data are not available.⁵

Magnetic anal sphincter is used for fecal incontinence to increase the tone of the anal sphincter. A study of fourteen patients implanted with artificial anal sphincter have been published with few complications and restoration of continence.⁶

GIT compression anastomosis

There are two main methods of gastrointestinal (GIT) anastomosis- sutures and staplers. The next disruptive innovation in GIT anastomosis is use of magnets in GIT anastomosis. Magnetic compression by using two symmetrical magnetic rings has been reported to create an anastomosis. The rings are delivered to the lumen of gut by endoscopy ; where the rings align and couple. Due to local ischemia necrosis process, the mucosa between the magnets necrose in 5-10 days, resulting in anastomosis and the magnets are released into the intestines and are excreted fecally or endoscopically removed .

The first known non magnetic compression anastomosis was made by Denans in 1826 and continued by Bonier in 1885 and Murphy in 1892. The procedure was repeated in the by the introduction of the Valtrac biofragmentable anastomotic ring in 1980s by Hardy et al. Other non magnetic compression anastomosis methods are the AKA-2 and memory shaped metal .⁷

Magnamosis device consists of two rings of magnets, and is modified through Magnamosis I to IV for optimal design and function. Magnamosis has been used in NOTES transgastric and transrectal sigmoidectomy.⁸

Intestinal bypass for gastric outlet obstruction and type two diabetes and obesity. In 2017, a study in humans was published by anastomosing the jejunum and ileum for treating type two diabetes.⁹

Endoluminal traction

Endoscopic submucosal dissection (ESD) lead to resection of superficial tumors of the GIT specially gastric and colonic tumours. Magnetic guided ESD (MAG-ESD) technique involves a small internal magnet attaching to tumour, and a large external magnet applied for retraction. A trial with 50 patients using the same device for MAG-ESD has been published with satisfactory results.¹⁰

Other uses of magnetic anastomosis are used in esophageal atresia, hepatobiliary anastomosis, and GIT endoscopy (capsule endoscopy manipulation, magnetic navigation colonoscopy and magnet assisted stent placement).

Conclusion

Experimental animal trials are successful but for use in humans further research and development is needed. Trials for long term safety and efficacy in humans are to be waited. Randomized control trials comparing to existing anastomosis methods are not present. Magnetic anastomosis and sphincter augmentation, which do not depend on long distance coupling will be the most successful disruptive technology of the future.

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