

Expert consensus on treating esophageal stenosis in children by magnetic recanalization

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Postsurgical stricture is the most common cause of esophageal stenosis in children after congenital esophageal atresia repair,^[1,2] followed by congenital esophageal stenosis and chemical corrosion burns.^[3] Endoscopic or radiologic balloon dilation is the standard method for treatment of esophageal stenosis, but in some complicated cases with severe hyperplasia and severe restenosis and even occlusion, the effect of endoscopic treatment is limited. In 1993, Bulynin *et al*^[4] reported, for the first time, the successful use of magnetic recanalization technology to treat refractory esophageal stenosis in children and pioneered the history of magnetic surgery to treat pediatric esophageal diseases. This technology makes full use of magnetic devices and forces which can effectively remove the scar tissue in the anastomotic region without damaging the muscle layer of the digestive tract wall^[5] and obtain the ideal therapeutic effect after surgery. In the past decade, magnetic recanalization technology has been further developed for the treatment of esophageal stenosis in children,^[6-15] which is superior to endoscopic dilatation and other methods, providing a new tool for the treatment of recalcitrant esophageal stenosis in children.

Presently, the use of magnetic recanalization technology to treat esophageal stenosis in children has been clinically applied in many international medical centers, but there is a lack of uniform management and standardized clinical operating procedures; in addition, perioperative precautions are not clear. To this end, we strive to analyze the

literature and discuss with experts from many countries engaged in magnetic surgery to summarize the clinical experience of magnetic recanalization in the treatment of children with benign esophageal stenosis. We aimed to form the following consensus on issues such as case selection, magnetic stapler design, operation specifications, perioperative management, and prevention of complications to provide reference and guidance for clinical application.

Indications and contraindications: The indications are (1) various types of esophageal stenosis (postoperative/congenital/burn) generally < 2 cm, 2–3 cm can be tried; and (2) esophageal atresia up to 3 cm cannot be tried.

The contraindications are as follows: (1) combined esophago-tracheal fistula; (2) combined esophageal perforation; (3) all esophageal stenosis distances > 4 cm; and (4) presence of ectopic tracheal cartilage in congenital esophageal stenosis.

The design principles of the device referred to^[5]: (1) The outer diameter of the magnetic staplers should be consistent with the inner diameter of the digestive tube at the suitable anastomosis site; (2) The magnet should be easily removed through the digestive tract after anastomosis without damage to the digestive tract; and (3) The external surface of the magnetic staplers must be coated with anticorrosion layer.

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Magnetic recanalization technique of esophageal stenosis:

The preoperative evaluations are as follows: (1) Oral feeding is difficult due to the severity of esophageal stenosis, and endoscopic expansion was ineffective; (2) Location, length, and severity of stenosis are assessed using esophagogram as the first choice; and (3) Hyperplasia and severity of scars in the stenosis are by endoscopic observation.

The preoperative preparations needed are as follows: (1) nutritional support and correction of water and electrolyte disorders, gastrostomy, and enteral nutrition if necessary; (2) control of lung infections; and (3) measurement of the inner diameter of the esophagus according to the contrast examination and selection of the appropriate magnetic recanalization device.

The steps for operation are as follows: (1) Under general anesthesia, place an endoscope through the digestive tract to determine the esophageal stenosis; (2) Pull the gastric tube through the gastrostomy, insert the first magnet along the tube, and push it into the distal end of the esophageal stenosis with the assistance of the endoscope; (3) Push the second magnet down to the proximal end of the stenosis, where the magnet naturally meets and quickly compresses the scar tissue in the stenosis [Figure 1].

Postoperative managements include: (1) Enteral nutrition through the gastric tube or gastrostomy after operation; (2) Observation of the sputum volume and gastric tube patency in the children closely; (3) Chest X-ray to determine the state of magnet alignment in the esophagus and esophagogram, which is helpful to determine anastomotic complications; and (4) Pulling off the gastric decompression tube through the oral cavity or gastrostomy, after the magnet comes off naturally, to remove it.

Follow-up observation indicators are as follows: (1) symptoms related to esophageal stenosis; (2) nutrition status: body weight, height, body mass index; and (3) upper gastrointestinal exam.

Matters requiring attention: (1) The distance of esophageal stenosis before surgery must be accurately assessed; (2) In the process of pushing the magnet during surgery, it should be pushed along the axis of the esophagus and operated gently to reduce damage to the side wall of the esophagus; (3) The gastric tube should not be pulled violently after the operation; (4) After clearing the narrow part, the magnet should be able to be taken out by mouth or gastrostomy; and (5) Magnetic resonance examination is contraindicated while the magnet is in the body.

Prevention of complication: (1) Respiratory tract infection: The esophagus has not been fully recovered in the early stages after surgery, and oral secretions may be aspirated into the respiratory tract to cause lung infection; hence, oral and respiratory care should be strengthened; (2) Bleeding and incision infection: Complications related to gastrostomy, which can be avoided by relying on fine surgical operation and good perioperative management; (3) Restenosis: After the use of a magnetic tool to treat the esophageal stenosis, there is still a possibility of restenosis, and esophageal dilation or magnetic recanalization may need to be applied again^[6]; (4) Delayed magnet dropout: A magnet can be placed again above and/or below the stenosis to increase the magnetic force; and (5) Injury of esophageal wall: This may happen, but there are no prior reports of similar situations.

In summary, the magnetic recanalization technology is a new and effective treatment method for children with refractory esophageal stricture. With the continuous

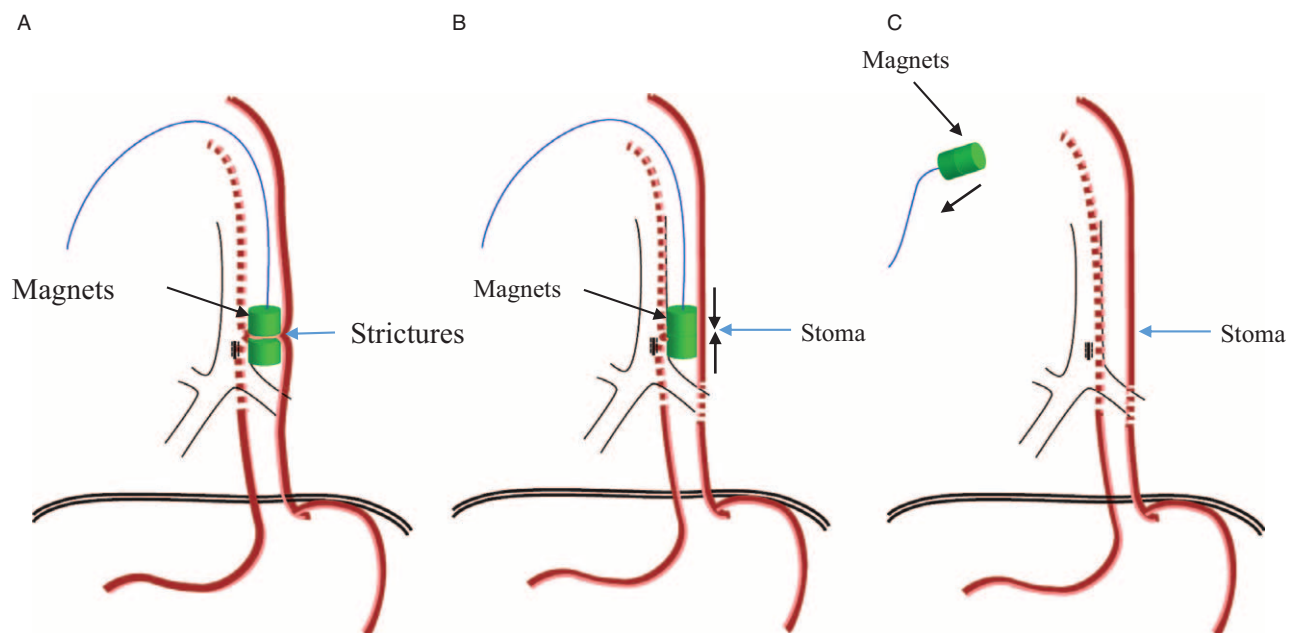


Figure 1: Schematic diagram of completing digestive tract anastomosis with magnetic anastomosis: (A) Magnetic implants were implanted at the stenosis site of the esophagus; (B) Local tissues were necrotic and fell off under mutual attraction of magnets, and adjacent tissues healed again; (C) After the anastomosis, the magnet was taken out of the body through the mouth, and no foreign body remained in the body.

optimization of magnetic recanalization equipment and accumulation of clinical experience, this technology will definitely play a more important role in the treatment of children with gastrointestinal malformations.

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Conflicts of interest

None.

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