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Magnetic compression technique for colonic anastomosis in rats



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ABSTRACT

Background: Magnetic compression technique (MCT) is useful for construction of digestive tract anastomoses in pigs and dogs. This study determined the efficacy of MCT for performing colonic anastomosis in rats.

Methods: Twenty male Sprague–Dawley rats (230–280 g) were randomly apportioned to a study group that underwent colonic anastomosis with MCT or a control group subjected to hand-sewn colonic anastomosis. The groups were compared for time to construct the anastomosis, survival rate, and postoperative complications. Animals were euthanized at 1 mo postsurgery to study the burst pressure and histology of the anastomoses.

Results: The study group required significantly less time to construct the anastomosis (6.50 ± 1.58 min) than did the control (15.6 ± 2.22 min). The survival rate of the study group (100%) was significantly higher than that of the control group (60%). In the control group, three rats developed anastomotic leakage and one rat developed anastomotic obstruction. No anastomotic leakage or obstruction was observed in the study group. The burst pressures of the two groups were similar. Histology showed that the study group had better alignment of the tissue layers and less inflammation compared with the control group.

Conclusions: MCT is a safe and feasible technique for colonic anastomosis in rats, with better postoperative outcomes compared with hand-sewn anastomosis.

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Introduction

Colonic anastomosis in rats is widely used for experimental studies. In these experiments, colonic anastomoses were most commonly performed by the traditional hand-sewn technique.¹⁻⁶ Some researchers have proposed a novel method for intestinal anastomosis in rats,^{7,8} but the thin colonic wall and small lumen in the rat presents technical difficulties.⁹ The traditional hand-sewn technique is time-consuming, highly technical, and subject to postoperative complications, and more importantly, in rats, there is a high incidence of anastomotic leakage and stenosis.¹⁰

At present, magnetic compression technique (MCT) is used for anastomoses in humans for esophageal atresia,^{11,12} biliary stenosis,^{13,14} vascular anastomosis,¹⁵⁻¹⁸ choledochojejunostomy,¹⁹ and rectovaginal fistula repair.^{20,21} The major advantages of the MCT are that it is simple, less traumatic, and reliable.

However, the success of magnetic compression anastomosis depends on the size of the lumen and the magnetic force of the magnetic anastomosis ring. Small magnetic rings have less magnetic force and are more likely to become occluded. The present study evaluated the feasibility of performing colonic anastomosis in rats using small magnets compared with hand-sewn colonic anastomosis.

Methods

The Committee on the Ethics of Animal Experiments at Xi'an Jiaotong University approved the protocol (Permit Number: 2018-001). This study was conducted in strict accordance with the recommendations of the Guide for the Care and Use of Laboratory Animals of Xi'an Jiaotong University Medical Center. From our past experience,^{19,22} if the difference between groups is 35% with a standard deviation of 25%, and set the desired power of 0.8, the minimum number of animals required is 10/group.

Animals

Twenty male Sprague–Dawley albino rats with a body weight of 230–280 g were obtained from the Experimental Animal Center, College of Medicine, Xi'an Jiaotong University (Xi'an, China).

Study design

The 20 rats were randomly and equally apportioned to either a study group or control group. The control group rats underwent colonic anastomosis using the conventional hand-sewing method, with 6-0 interrupted absorbable suture. The study group rats underwent colonic anastomosis using magnetic compression rings.

Magnetic compression rings

The MCT in this study involved a pair of magnetic rings constructed of sintered-type neodymium-iron-boron (NdFeB, N45) and nickel-plated to improve erosion resistance and

biocompatibility (Fig. 1). The rings have an outer diameter 6 mm, inner diameter 4 mm, and wall thickness 2 mm (Northwest Institute for Nonferrous Metal Research, Xi'an, China). The weight of the magnetic rings was 0.22 g.

Surgical procedure

The rats were fasted for 1 d, after which the rats were weighed and given intraperitoneal anesthesia with an injection of chloral hydrate (350 mg/kg). After confirmation of the loss of the paw withdrawal reflex, the animals were fixed in supine position to a temperature-controlled operating table and their abdomen was shaved. Sterile surgical instruments were used for the surgical procedures.

To acquire access to the abdominal cavity, a 3-cm cranio-caudal midline incision was made. The transverse colon was identified, pulled out of the peritoneal cavity, and placed on sterile gauze that was regularly hydrated with sterile saline solution to prevent dehydration. The transverse colon was transected by 1 cm, and an end-to-end anastomosis was performed.

In the control group (conventional hand-sewing method), the end-to-end anastomosis was constructed with 6-0 absorbable sutures (Ethicon, Johnson & Johnson, Somerville, New Jersey).

In the study group, end-to-end anastomosis was achieved through MCT (Figs. 2 and 3) as follows. An 8F gastric tube was slipped through a magnetic ring, inserted into the anus, and then into the proximal colon. This magnetic ring was pushed along the tube into the proximal colon (Fig. 2B and C). The proximal and distal colonic stump was lightly tied around the tube using 6-0 nonabsorbable suture (Hangzhou AIPU Medical Instrument; Fig. 2D). Through the anus, the distal magnetic ring was placed over the tube into the distal colonic stump (Fig. 2D and E). The colonic ends were compressed together between the magnets (Fig. 2E and F). The tube was removed through the anus. After performing the anastomosis, the abdomen was closed using 4-0 nonabsorbable suture (Hangzhou AIPU Medical Instrument). The interrupted sutures were placed in two layers.

Calculation of anastomosis time

The anastomosis time was calculated from the beginning of anastomosis construction until its completion. The anastomosis time of each rat was recorded.

Postoperative care

Immediately after the operation, a plain abdominal X-ray was taken to confirm accurate coupling of the magnetic compression rings. After the recovery from anesthesia, the animals were allowed a liquid diet and water. During the first three postsurgical days, the rats were fed with liquid, and thereafter normal feeding was given. A routine daily X-ray was taken to verify movement of the MCT in the digestive tract until it was passed from the body through the anus.

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