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Original Article

Newly designed coil tube for bowel decompression in patients with small bowel obstructions

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A B S T R A C T

Background: The purpose of this study was to clinically evaluate a coil tube that we recently designed for bowel decompression in patients with a small bowel obstruction.

Methods: The coil tube was composed of a stainless steel coil, a polyolefin tube, and a rubber adaptor. The tube was inserted under fluoroscopic guidance in 14 consecutive patients with small bowel obstructions. Technical success was defined as insertion of the distal end of the tube into at least the proximal jejunum, and clinical success was defined as intestinal decompression and relief of obstructive symptoms.

Results: The technical success rate was 100%. Clinical success was achieved in 12 patients (86%). The clinical failures were a patient with peritoneal carcinomatosis and an ileocolic fistula, and a patient with bezoars following intestinal hemorrhage. No coil-related complications occurred.

Conclusion: Our newly designed coil tube was safe and effective in patients with bowel decompression associated with a small bowel obstruction. In addition, our tube has several advantages over other currently used tube types.

Keywords: Conventional long intestinal tubes, Newly designed coil tube, Small bowel obstructions

Introduction

Long intestinal tubes are effective for initial conservative treatment of bowel decompression and for preoperative management of patients with a small bowel obstruction.[1–8] The reported clinical success rates for long intestinal tube decompression range from 73% to 90%.[8–12] However, the overall technical success rates vary from 52% to 89%,[11–13] indicating that it can be difficult and time consuming to advance a tube across the pyloric sphincter and the ligament of Treitz into the jejunum.[11–13] Endoscopy-guided intestinal tube placement has been developed to overcome these problems,[14–17] and has resulted in technical success rates greater than 90%, and a decrease in procedural time to less than 20 minutes.[8,17] However, transoral insertion of an endoscope requires a complicated oronasal transfer of the tube, influences cardiopulmonary parameters, and evokes anxiety, gagging episodes, and discomfort for patients.[17,18] We have designed a coil tube for bowel decompression that is placed under fluoroscopic guidance to overcome the problems associated with conventional long intestinal tubes. Two features of the tube are a guidewire to reduce friction and a flexible distal tip. These features make it easy to manipulate the tube through the pylorus and further into the ileum. The current study evaluated the use of our coil tube for bowel decompression in 14 consecutive patients with small bowel obstruction.

Methods

Patients

Between August 2011 and March 2013, 14 coil tubes were placed in 14 patients with small bowel obstruction who showed no improvement after placement of a nasogastric tube. The patients included seven males and seven females with a mean age of 50 years (range, 29–73 years). The underlying causes of obstruction were postoperative adhesions ($n = 8$), peritoneal carcinomatosis ($n = 3$), benign stricture ($n = 1$), and unknown ($n = 2$). A diagnosis of small bowel obstruction was established based on clinical and radiological evidence. Informed consent was obtained from each patient, and this prospective study was approved by our institutional review board.

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Coil tube construction

The coil tube was constructed at our research institute. The total length of the tube was 300 cm. The tube was composed of three elements: a 0.2-mm stainless steel coil (Dowon Engineering, Chungju, Korea), a polyolefin tube (GSHS-1625; LG cable, Anyang, Korea), and a rubber adapter (S&G Biotech, Seongnam, Korea). The tube had three regions: a distal uncovered coil region, a middle covered coil region, and a rubber adapter region (Fig. 1). The distal region was 5 cm long and very soft and flexible because it was not covered by the polyolefin tube. The middle region was composed of a stainless steel coil covered with the polyolefin tube, and had an inner diameter of 2.0 mm and an outer diameter of 3.0 mm. A radiopaque marker (a gold plate) was attached at the distal end of the middle region and was 0.1 mm thick and 1.0 mm wide. There were nine side holes (2.2 mm in diameter) for drainage along the 11 cm from the distal end of the middle region. The proximal end of the middle region was connected to a rubber adaptor that allowed connection to a suction device.

Coil tube insertion technique

A topical aerosol spray anesthetic was applied to the nasal cavity. A 260-cm exchange guidewire (Radifocus M; Terumo, Tokyo, Japan) was inserted through the nose and into the stomach. A 150-cm multifunctional catheter (S&G Biotech) was passed over the guidewire into the stomach. The guidewire, with the help of the coil catheter, was then introduced across the duodenum into the jejunum. The guidewire was replaced with a 450-cm Jagwire (Boston Scientific, Natick, MA, USA), and then the multifunctional coil catheter was removed and the guidewire was left in place (Fig. 2). A 300-cm coil tube was inserted under fluoroscopic guidance to pass over the guidewire into the jejunum. The coil tube was then advanced as far as possible with the help of the Jagwire, and then the Jagwire was removed. Tubography was performed using 30 mL of water-soluble contrast medium after the procedure to confirm location and patency of the coil tube. Patients underwent follow-up abdominal radiographic examinations each day post-procedure to determine the location of the distal end of the tube and to detect any complications.

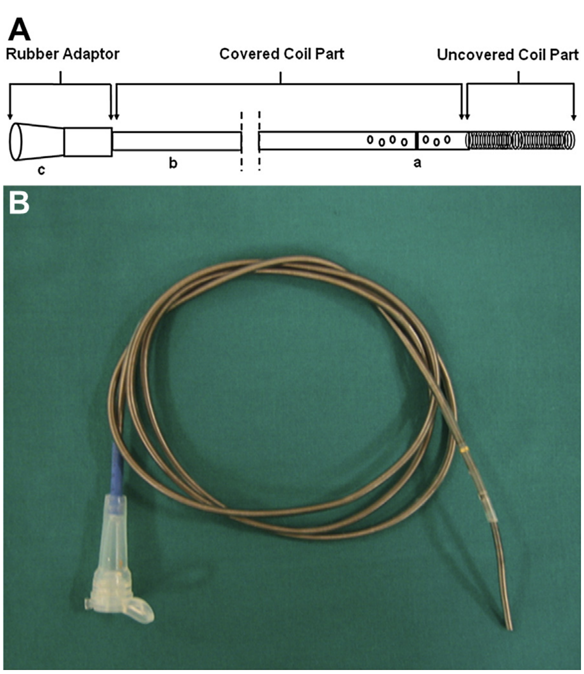

Fig. 1. Coil tube. (A) Diagram of the coil tube. (a) Side holes for drainage at the distal end of the middle covered coil region. (b) A radiopaque marker at the distal end of the middle covered coil region. (c) The proximal end of the coil tube with a rubber adaptor for a suction device. (B) Photograph of the coil tube.

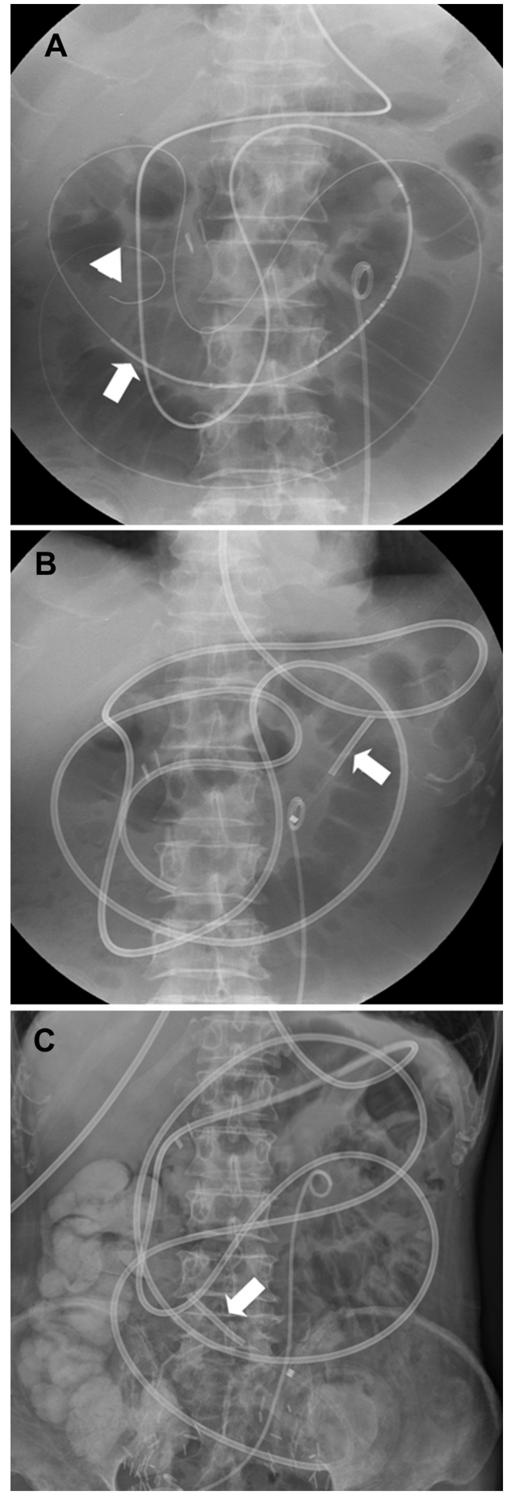

Fig. 2. Treatment of a 67-year-old man with a small bowel obstruction. (A) A 450-cm Jagwire (arrowhead) was placed through a multifunctional coil catheter (arrow). (B) Placement of the coil tube. The distal tip (arrow) of the coil tube was placed in the proximal jejunum. (C) Abdominal radiograph 1 day after tube placement. Note the improved ileus and further movement of the distal tip (arrow).

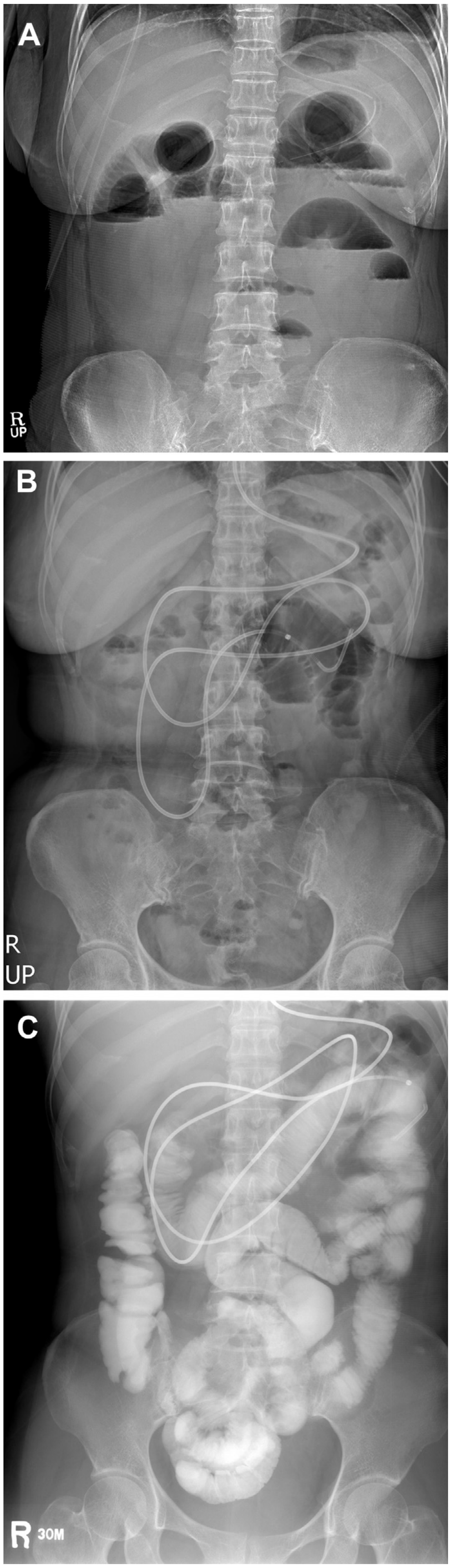

Fig. 3. Pretreatment and post-treatment upright abdominal radiographs of a 47-year-old woman with a small bowel obstruction secondary to a postoperative adhesion. (A) Prior to coil tube placement. Note the multiple air fluid levels. (B) Seven days after placement. Note the reduction in obstruction and lack of significant air fluid levels. (C) Small bowel series showing good passage of contrast medium.

Evaluation of outcome

We analyzed technical success, clinical success, procedure time, complications, distal tip location, total volume of drained fluid, nature of the drained fluid, and tip movement after tube placement. Technical success was defined as insertion of the distal end of the tube into the proximal jejunum. Clinical success was defined as intestinal decompression and relief of obstructive symptoms such as abdominal pain or vomiting following a clinical assessment of symptoms and radiographic observations. Total procedure time was calculated from insertion of the guidewire to placement of the coil tube. The following procedure was used to determine the location of the tube distal tip after placement. A Jagwire was inserted through the coil during the procedure. Following coil tube placement, the Jagwire was pulled under fluoroscopic guidance until the tip reached the tube tip. We then pulled the Jagwire tip further to reach the Treitz ligament, and measured the pulled length. The pulled length was the distance from the Treitz ligament to the tip of the coil tube. The standard length of the jejunum is 140.2 cm in males and 138.6 cm in females.[19]

Therefore, the tube distal tip was considered to be in the ileum if the pulled length was >140.2 cm in males and 138.6 cm in females. If the pulled length was <70 cm in males or <69 cm in females, the distal tip of the tube was considered to be in the proximal jejunum. Any further movement of the tube tip after placement was evaluated using follow-up abdominal radiographs.

Results

Procedural results

Fourteen coil tubes were placed in 14 patients under fluoroscopic guidance. Coil tube placement was technically successful in all patients (100%). Mean procedure time was 21 minutes. The coil tube was advanced as far as the ileum in five patients.

Clinical success

Clinical success was achieved within 7 days of coil tube placement in 12 of 14 patients (clinical success rate, 86%) (Fig. 3). No tube-related complications were observed. Both patients who experienced clinical failure underwent surgery. One of the patients had thick, black intestinal fluid as a result of formation of a hematoma and bezoars after intestinal hemorrhage, and the other had fecal material in the intestine because of an ileocecal fistula. The associations between clinical success and the underlying causes of obstruction are summarized in Table 1. The coil tube was placed in patients with peritoneal carcinomatosis as palliative treatment, and two of three patients achieved clinical success. Additional treatments for bowel obstruction after coil tube placement are summarized in Table 2. Three patients who realized successful preoperative bowel decompression underwent subsequent surgery for adhesiolysis. One patient with tuberculosis peritonitis showed improved symptoms after tube placement, but underwent emergency surgery 5 days later because of a bowel perforation. The perforation site was 15 cm proximal to the site of the ileal stricture, which was 30 cm

Table 1 Clinical Success Rates and Underlying Causes of Obstruction

Causes of obstruction	No. of patients (*n*/total)	%
Adhesion	7/8	87.5
Peritoneal carcinomatosis	2/3	66.7
Benign stricture	1/1	100
Unknown (mechanical)	2/2	100

Table 2 Clinical Data of 14 Patients With Small Bowel Obstruction

Patient No./Age/Sex	Underlying disease	Cause of obstruction	Drainage nature	Outcome	Additional treatment
1/41/F	Recurred cervical cancer	unknown	Greenish	Improvement	None
2/40/F	Colorectal cancer	Peritoneal carcinomatosis	Thick fecal materials	Nonimprovement	Tube jejunostomy
3/44/F	Colorectal cancer	Postoperative adhesion	Greenish	Improvement	None
4/64/M	Colorectal cancer	Postoperative adhesion	Greenish	Improvement	None
5/47/F	Colorectal cancer	Postoperative adhesion	Greenish	Improvement.	Adhesiolysis
6/59/M	Colorectal cancer	Peritoneal carcinomatosis	Brown	Improvement	None
7/31/F	Rectal ovarian cancer	Peritoneal carcinomatosis	Greenish	Improvement	None
8/46/M	Colorectal cancer	Postoperative adhesion	Greenish	Improvement	Adhesiolysis
9/53/M	Liver transplant status	Postoperative adhesion	Thick black	Non-improvement	Surgery
10/73/F	Tuberculosis peritonitis	Benign stricture	Greenish	Improvement, but with perforation	Emergency operation
11/67/M	Ureter cancer	unknown	Greenish	Improvement	None
12/29/F	Small bowel obstruction	Postoperative adhesion	Greenish	Improvement	None
13/48/M	Colon cancer	Postoperative adhesion	Greenish	Improvement	Adhesiolysis
14/51/M	Recurred colon cancer	Postoperative adhesion	Greenish	Improvement	None

from the ileocecal valve. During the surgical procedure, the distal end of the tube was in the distal jejunum, which was far from the perforation site. The cause of the perforation was intestinal tuberculosis. The tube was removed 9 days after surgery.

Discussion

Long intestinal tube decompression effectively resolves a small bowel obstruction and optimizes general patient condition during conservative management.[1–13,20,21] Despite these advantages, long intestinal tube decompression has not been widely accepted because of the technical difficulties of tube placement because of acutely angled gut structures (e.g., esophagus, gastric antrum, duodenum, and small bowel) and the tendency of long tubes to form loops in an extremely dilated stomach.[22] A number of tube modifications have been tested to make placement easier, such as changes in tube diameter, length, composition and rigidity, the use of weighted devices on the tip, and the addition of more lumens.[15,23,24] However, these modifications are ineffective, expensive, or not generally available. Alternative techniques for tube placement have been developed but are limited. Changing body position results in a low technical success rate and an increase in procedure time.[22] Transoral endoscopy-guided tube placement is not well tolerated by patients without sedation, which puts patients at risk of hemodynamic and respiratory complications.[25–27] Long intestinal tube insertion with the help of a guidewire using a transnasal ultrathin endoscope has been developed. However, friction between the guidewire and the tube makes the wire uncontrollable, and insertion goes deeper.[26,27] We observed a clinical success rate of 86% with the coil tube, which compares well with the 73–90% success rates reported by others using other conventional long intestinal tubes.[9–12] Moreover, the coil tube had several advantages over conventional long intestinal tubes. First, it was easy to manipulate a guidewire through the coil tube because there was less friction between the tube and the wire. Using the guidewire with improved torque made it easy to place the coil tube further into the small bowel. Second, flexibility of the uncovered distal tip made it easy to advance the coil tube through the lumen of the small intestine, prevented wedging of the distal tip in the mucosal folds, and reduced mucosal injury. Third, the smaller outer diameter of the coiled tube (9 French) and the smooth distal tip reduced patient discomfort compared to using conventional intestinal tubes such as the Gowen (18 French) and Miller Abbott (16 French) tubes. In addition, the inner-to-outer diameter ratio of the coil tube (0.67) was larger than that of the Gowen (0.28) or Miller Abbott (0.56) tubes because the coil tube does not need an additional lumen for balloon inflation to assist peristaltic passage of the tube. Thus, the coil tube is thinner and has a larger inner lumen, resulting in better tolerance by patients and effective bowel decompression. Furthermore, using a coil tube can avoid uncommon yet significant complications associated with balloon inflation at the tip of conventional tubes.[28]

A limitation of this study was the relatively small sample size. The small size reflected that patients included those who showed no improvement after nasogastric tube placement or had metastatic cancer with no available treatment options. Because previous studies excluded patients with malignant obstructions such as recurrent cancer or peritoneal carcinomatosis,[8–12] comparing the effectiveness between tubes is of secondary importance. The important point is that the coil tube could be used as palliative therapy for patients with small bowel obstruction due to advanced cancer. Therefore, additional clinical studies are required before the present observations can be considered established. We found that our newly designed coil catheter was safe and effective for bowel decompression, and it was placed with ease when compared with conventional long tubes. We believe our coil tube will be broadly applicable in patients with small bowel obstructions.

Conflicts of interest

The authors declare that they have no conflicts of interest.

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