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Endoscopic colostomy with percutaneous colopexy: an animal feasibility study

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ABSTRACT

Background: Indications for colostomy in colorectal diseases are obstruction of the large bowel, such as in cancer, diverticular disease in the acute phase, post-radiotherapy enteritis, complex perirectal fistulas, anorectal trauma and severe anal incontinence. Some critically ill patients cannot tolerate an exploratory laparotomy, and laparoscopic assisted colostomy also requires general anesthesia.

Objective: To evaluate the feasibility, safety and efficacy of performing colostomy assisted by colonoscopy and percutaneous colopexy.

Materials and methods: Five pigs underwent endoscopic assisted colostomy with percutaneous colopexy. Animals were evaluated in post-operative days 1, 2, 5 and 7 for feeding acceptance and colostomy characteristics. On day 7 full colonoscopy was performed on animals followed by exploratory laparotomy.

Results: Average procedure time was 27 minutes (21-54 min). Postoperative mobility and feeding of animals were immediate after anesthesia recovery. Position of the colostomy, edges color, appearance of periostomal area, as well as its function was satisfactory in four animals. Retraction of colostomy was present in one pig. The colonoscopy and laparotomy control on the seventh day were considered as normal. A bladder perforation that was successfully repaired through the colostomy incision occurred in one pig. The main limitation of this study is its experimental nature.

Conclusion: Endoscopic assisted colostomy with percutaneous colopexy proves to be a safe and effective method with low morbidity for performing colostomy in experimental animals, with possible clinical application in humans.

Key words: Colostomy. Endoscopy. Colopexy.

INTRODUCTION

A colostomy is a surgical procedure that aims to divert the fecal stream to the outside through an orifice made in the abdominal wall, which may be temporary or permanent (1). Colorectal surgical procedures have been performed via minimally invasive techniques with increasing frequency (2). Although colostomy has traditionally required formal laparotomy, this procedure could be performed via an trephine, endoscopic or laparoscopic approach (3-8).

Endoscopic-assisted colostomy without general anesthesia and laparotomy was first reported by Mattingly and Mukerjee (3). However, percutaneous colopexy facilitates fixation of the colon to the abdominal wall on its anti-mesenteric side, adding important benefits.

The indications for the use of colostomy in colorectal diseases are colon, rectum or anus obstruction, diverticular disease in the acute phase, post-radiation enteritis, complex perirectal fistula, anorectal trauma, severe anal incontinence, non-healing sacral decubitus ulcers in patients with spinal cord injury, complicated anal Crohn's disease, recurrent rectovaginal fistula, pelvic floor dysfunction, and a dehisced coloanal anastomosis (2). This procedure is often necessary in critically ill patients who may not be able to tolerate a laparotomy or general anesthesia.

The aim of this study is to evaluate the feasibility, safety and efficacy of performing colostomy under colonoscopic visualization and the use of colopexy without additional morbidity of abdominal exploration and general anesthesia in laboratory animals.

METHODS

This was a prospective, experimental, phase-I, survival animal study. The study was conducted between May and July 2014 at the Experimental Surgery Unit, University of São Paulo Medical School, Brazil. The study was approved by the Institutional Animal Care and Use Committee of the University of São Paulo Medical School, and conducted in accordance with current legislation with regard to the care and use of laboratory animals.

Animal preparation

Five healthy domestic female Yorkshire race pigs were used. Animals had an average pre-procedure weight of 35 kg (range 31.4 to

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40.8 kg), and no previous surgery. Pigs were prepared at the experimental laboratory of the Clinics Hospital Complex, University of São Paulo Medical School. Animals were kept fasting 24 hours before the intervention, and received an enema one hour before the procedure to clean the rectum and distal colon.

In the lithotomy position with opened legs, all animals were submitted to tracheal intubation and mechanical ventilation, and maintained under general anesthesia with Ketamine Base® (intravenous 5 mg/kg) and Thiopental® (intravenous 10-30 mg/kg), followed by inhalation of Isoflurane®. All animals were kept alive 7 days after intervention for follow up.

Colostomy technique

Standardization of the technique was achieved by procedures performed in a pilot protocol prior to initiating the study.

Colonoscopic examinations were performed by a single endoscopist with advanced skills. Colostomies were done by an experienced colorectal surgeon.

The following steps were followed:

1. Transanal introduction to the descending colon with a gastroscope (Pentax EG - 290) (Fig. 1).
2. Identification of the anterior colonic wall and the best site for trans-illumination on the abdominal wall, suitable for colopexy (Fig. 1).
3. Cleansing and anti-sepsis of the abdominal wall with povidone-iodine and saline.
4. Puncture of the abdominal wall at the previously identified best place for trans-illumination with the Loop Fixture II Gastropexy Kit® (Fig. 2). In brief, this device has two needles, one which has a suture inserted immediately before the tip of the needle, and the other which has a suture-holding loop placed on it (Fig. 2).

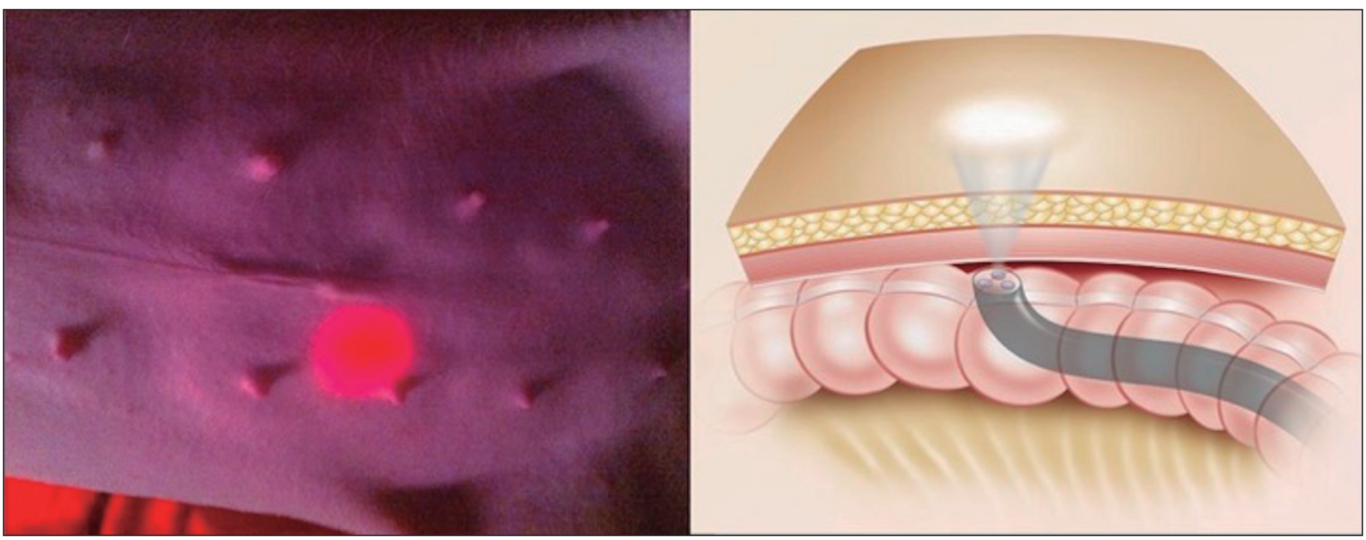

Fig. 1.

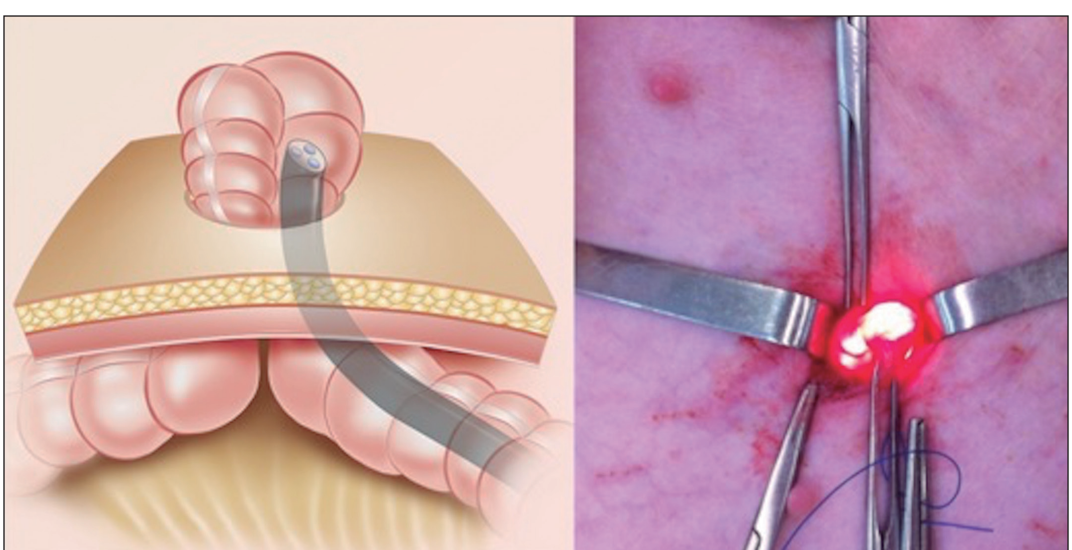

Fig. 2.

5. Under endoscopic visualization, the suture-holding needle was pushed down to form a loop for holding the suture (Fig. 3).
6. The suture was advanced down so that its distal end passed through the suture-holding loop.
7. After endoscopic visualization that the distal end of the suture had passed through the suture-holding loop, the loop was placed back in the puncture needle and pushed down to form a loop to release the suture. The free suture was knotted against the abdominal wall to hold the colon to the parietal peritoneum.
9. The endoscope was further withdrawn and a small disc of skin was removed proximal to the colopexy. A loop colostomy was performed in the anti-mesenteric wall, and the proximal-to-distal orientation of the intestinal loop was clearly identified aided by the colonoscope (Fig. 4).
10. The colostomy was fixed by stitching the anterior colonic wall to the aponeurosis and subcuticular layer circumferentially with polyglactin 910 (vycril 2-0) (Fig. 5).

Postoperative management

Oral feeding and mobility were started when animals were completely awakened. All animals were carefully observed and examined during a seven-day follow-up period to evaluate any changes in general condition, behavior and eating habits.

Animals received prophylactic antibiotic therapy and analgesia with dipirone 1 g intramuscular. During postoperative days 1, 2, 5 and 7, animal feeding and movements, presence of feces in the colostomy, color of the edges of the mucosa and sinking of the colostomy were evaluated.

Fig. 3. Under endoscopic visualization, the suture-holding needle was pushed down to form a loop for holding the suture.

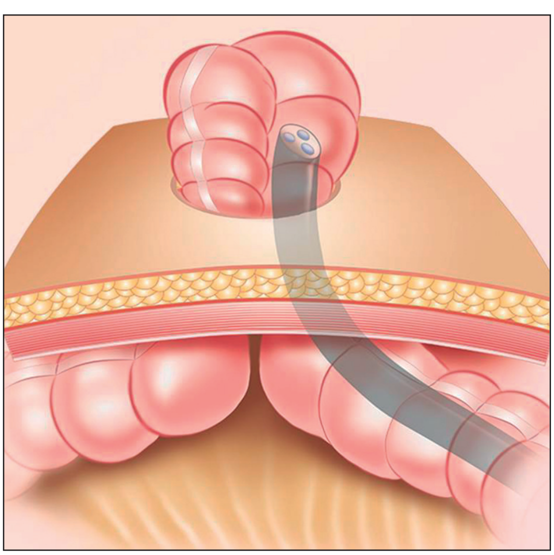

Fig. 4. A loop colostomy was performed in the anti-mesenteric wall, and the proximal-to-distal orientation of the intestinal loop was clearly identified aided by the colonoscope.

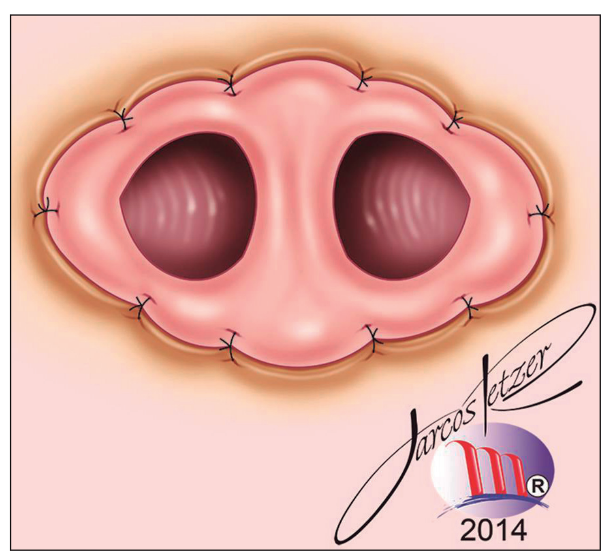

Fig. 5. The colostomy was fixed by stitching the anterior colonic wall to the aponeurosis and subcuticular layer circumferentially with polyglactin 910 (vycril 2-0).

On day 7 all animals were sedated to perform colonoscopy and an exploratory laparotomy. At colonoscopy, periostomal mucosa and colopexy were evaluated. Exploratory laparotomy confirmed the absence of peritonitis and peritoneal abscess, and allowed direct observation of intraperitoneal colostomy. Finally, animals were sacrificed.

Statistics

Results were reported as descriptive statistics, with means and ranges for quantitative variables.

RESULTS

A pilot protocol was conducted to learn the steps of the technique, observing potential problems in order to improve the procedure efficacy.

Five endoscopic colostomies were performed in five pigs. All procedures were completed as planned (Figs. 3 and 4). The average procedure time was 27 minutes (range 21-54 min).

Diet tolerance and mobility of the animal began in the immediate postoperative period post anesthesia recovery and were satisfactory in all pigs. Color of the edges, appearance of periostomal skin and its function were satisfactory in all animals during the follow-up period as well. Mucocutaneous separation of the colostomy with preservation of the stoma function occurred in one animal, with no sinking or stenosis (Table I).

Complications

During the pilot protocol stage, ileal interposition with perforation occurred in one animal. It was successfully repaired by laparotomy conversion. The bladder was perforated in the third pig. This perforation was successfully closed through the same incision in which the colostomy was made afterwards. The procedure was simple and fixation of the colostomy to the aponeurosis fascia was performed, without difficulty and with minimal bleeding.

Control colonoscopy on the seventh day confirmed the presence of normal mucosa around colostomy and effective colopexy in all animals. Exploratory laparotomies excluded the presence of a localized abscess or diffuse peritonitis (Fig. 5). Fixation of the colonic wall to the parietal peritoneum was excellent and colon integrity was confirmed.

DISCUSSION

The jury is still out for establishing the most effective surgical strategy for patients with partial obstructive left colon cancer. Colostomy has been described as a first step of a two-stage surgery on these patients (1,9,10). Moreover, neoadjuvant chemotherapy for locally advanced rectal and anal cancer has expanded the indications of a minimally invasive approach for fecal diversion, as it may avoid an additional surgery and the need of general anesthesia, serving as a bridge to oncologic surgical resection (11). Self-expandable metallic stents (SEMS) have been introduced as part of the management of complete or partial obstructive colorectal cancer, in order to avoid a two-step emergent surgical procedure that includes a colostomy (12). A recent meta-analysis demonstrated that colorectal SEMS as a bridge to elective surgery compared to emergency surgery in left-sided colorectal cancer obstruction showed a better prognosis in terms of lower postoperative morbidity, higher primary anastomosis rate and lower stoma rate. Despite these favorable immediate postoperative outcomes, a similar overall postoperative mortality of SEMS insertion as a bridge to surgery compared to emergency surgery was shown (10.7% *vs* 12.4%) (13). Furthermore, the long-term oncological outcome, such as disease recurrence, was worse in the group with SEMS as a bridge to surgery than in the emergency surgery group. Based on these unfavorable long-term oncological outcomes, the recent SEMS guidelines by the European Society of Gastrointestinal Endoscopy (ESGE) do not recommend routine SEMS insertion as a bridge to surgery in potentially curable left-sided obstructive colorectal cancer (CRC) obstruction (14). Additionally, a higher risk of perforation in patients treated with SEMS that were receiving antiangiogenic agents such as bevacizumab has been reported (15). Therefore, endoscopic colostomy can emerge as a minimally invasive alternative that can serve as a bridge

Table I. Post operative variables

Pigs	*Feeding*	*Presence of Feces*	*Animal movements*	*Colostomy mucosal color*	*Complications*	*Procedure weight (kg)*	*Post procedure weight (kg)*
1	Good	Yes	Yes	Red	No	37.3	37.1
2	Good	Yes	Yes	Red	No	31.4	31
3	Good	Yes	Yes	Red	Bladder perforation	40.8	40.3
4	Good	Yes	Yes	Red	No	32.4	32.5
5	Good	Yes	Yes	Red	Retraction	33.3	33.1

to oncologic treatment, potentially overcoming present limitations of SEMS without the additional morbidity of general anesthesia and surgery for fecal diversion.

Technical advantages and limitations of different approaches to perform colostomy have been described. Laparotomy allows a thorough evaluation of the abdomen, but causes more pain, longer recovery time, and a larger scar. In addition, there is a higher chance of wound infection and incisional hernia (1,16). Minimally invasive techniques like laparoscopy, gasless or trephine technique avoid large abdominal incisions and therefore reduce postoperative pain, ileus, and wound complications (3-6). Other advantages may include shorter hospital stay, and earlier initiation of other treatment such as chemotherapy or radiation therapy in patients with locally advanced rectal or anal cancer.

In the laparoscopic approach visualization is improved but costs are increased. Laparoscopy has been described as the best way to proceed for the formation of an intestinal stoma (17,18). In the gasless technique, there are no incisions other than the one that is done to create the stoma. Visualization is reasonable, recovery is faster, and pain is minimal. In addition, the procedure can be performed safely, with minimum morbidity. However, general anesthesia may be a drawback for critically ill patients (6,19).

The trephine colostomy technique does not allow easy identification of the colon segment, and differentiation between the proximal and distal ends of the sigmoid loop can be technically difficult (7,20,21).

Mattingly and Mukerjee first reported endoscopic-assisted colostomy without general anesthesia or laparotomy (3). Fifteen patients were involved in this study. Four cases were performed under local or regional anesthesia. Fecal stream was successfully diverted using this minimally invasive technique in all patients. No immediate perioperative complications related to this technique were described. However, a retrospective review of those patients reported retraction of the colostomy in 13% of cases (4).

Although endoscopic-assisted colostomy is not a new technique (22,23), percutaneous colopexy adds important technical advantages: strong and permanent attachment of the colon to the abdominal wall facilitates safe colostomy performance. Besides that, a pexy stitch on the colonic mucosa serves as a reference to the point that must be overcome for the creation of a colostomy proximal to the pexy. This approach does not require the creation of a pneumoperitoneum and allows the creation of a colostomy under conscious sedation, with regional or local anesthesia. This probably could account for a lower risk of anesthesia complications, a shorter recovery time and, thus, lower costs of hospital care. In addition, procedural time is reduced. We reported an average procedure time of 25 minutes, compared to longer times reported with others techniques (6,17,22).

Some of the patients who can benefit from this technique are those with important systemic comorbidities, ASA III or IV, as it would prevent the use of general anesthesia. Moreover, neoadjuvant chemotherapy for locally advanced rectal and anal cancer has expanded the indications of a minimally invasive approach for fecal diversion, as it may avoid an additional surgery and the need of general anesthesia, serving as a bridge to treatment for oncologic resection (11,24).

Bowel preparation was done with a rectal enema. That is because anterograde preparation is not feasible in most cases of partially obstructive tumors in humans. In some cases, the enema effect was not good enough and it was necessary to work with formed stool in the colon lumen. The endoscopist had no major problem to advance the scope over the feces. Considering that it is not a diagnostic procedure, we believe that working on a completely cleaned colon is not needed, favoring the use of the method in patients with partial colon or rectal obstruction. An important technical consideration regarding care for diminishing infectious risk is that the stoma is performed outside of the abdominal cavity, after having scope confirmation of the correct bowel segment to make the incision. Additionally, it is worth mentioning that a gastroscope was used instead of a colonoscope in order to reproduce the clinical scenario of having to overpass a stenosed rectal or colonic segment. Moreover the use of a slim gastroscope could be a reasonable option for this procedure in selected cases.

Potential limitations of this technique are the small exposure of the incision with lack of intra-abdominal exploration and technical difficulty for aponeurosis fixation. The orientation of the endoscopist to reach the anterior abdominal wall is an obstacle that can be overcome by gentle palpation of the abdomen at the maximum trans-illumination point. This maneuver can be an obstacle in obese patients, but does not preclude the procedure.

Besides, one of the major drawbacks of colostomy is shrinkage, and it is thought to be caused by mesenteric tension. Because of that we recommend that colostomy should be done between 20 and 30 cm from the anal verge, with the colonic wall directly against the abdominal wall and avoiding excess torque maneuvers of the scope. Of note, adequate patient selection should be considered, as multiple previous surgeries could preclude a successful mobilization and trans-illumination of the colon into the abdominal wall.

With regard to possible causes for complications, important differences of pig anatomy compared to humans should be mentioned. The bladder can reach the umbilical scar in pigs. We think this anatomic variation could have influenced the bladder perforation on the third animal. On the other hand, the descending colon of the pig is found on the right side of the abdominal cavity, which could predispose the ileal interposition that we experienced during the pilot protocol stage. The different location of the descending colon also explains why colostomies in animals were performed on the right iliac fossa.

Based on the need for alternatives to laparotomy and laparoscopy for the creation of ostomies, we made a technical breakthrough, and showed that endoscopic colostomy with percutaneous colopexy proves to be a simple, feasible and effective method with low morbidity for performing colostomy in experimental animals. Further studies will be needed to prove its successful clinical application in humans.

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