# Laparoscopic-assisted percutaneous endoscopic cecostomy in children with defecation disorders (with video)

**Leonel Rodriguez, MD, MS, Alejandro Flores, MD, Brian F. Gilchrist, MD, Allan M. Goldstein, MD**

Boston, Massachusetts; Manchester, New Hampshire, USA

**Background:** The antegrade continence enema (ACE) procedure has been widely used in the management of children with defecation disorders. The ACE procedure has undergone many technical modifications. We developed a safe and minimally invasive technique, the laparoscopic-assisted percutaneous endoscopic cecostomy (LAPEC).

**Objective:** To compare LAPEC to laparoscopic cecostomy in terms of operative time, hospital length of stay, and procedure-related morbidity.

**Design:** Retrospective review of children undergoing the ACE procedure.

**Setting:** Two tertiary-care centers.

**Patients:** This study involved children with defecation disorders.

**Intervention:** The ACE procedure.

**Main Outcome Measurements:** Procedure complications, length of stay, and operative time.

**Results:** Fifty patients underwent LAPEC, and 15 underwent laparoscopic cecostomy. Of the LAPEC patients, 70% were male, with mean age 12 ± 4.2 years, mean operative time 100.1 ± 16.6 minutes, and mean length of stay 3.4 ± 1.4 days. Of the laparoscopic cecostomy patients, 56% were male, with mean age 10.5 ± 4 years, mean operative time 100.8 ± 19.1 minutes, and mean length of stay 3.8 ± 1.6 days. There was no statistical difference between the 2 groups. The single intraoperative complication during LAPEC was a cecal hematoma. Postoperative complications after LAPEC included 6 patients with low-grade fever, 3 patients with tube dislodgement (2 treated by repeat LAPEC and the other by open surgery), and 2 patients with skin breakdown. Of the 50 LAPEC patients and their families, 48 were satisfied with the outcome.

**Limitations:** Retrospective study.

**Conclusion:** LAPEC is a safe, minimally invasive procedure for cecostomy placement in children with refractory constipation or fecal incontinence. (Gastrointest Endosc 2011;73:98-102.)

Originally described in 1990 by Malone et al[1] for the treatment of children with fecal incontinence, the antegrade continence enema (ACE) procedure has been widely used in the management of pediatric patients with defecation disorders for a wide variety of causes, including anorectal malformations, Hirschsprung disease, anomalies of the spine, perineal trauma, cerebral palsy, and intractable idiopathic constipation.[2,3] The technique, as originally

*Abbreviations: ACE, antegrade continence enema; LAPEC, laparoscopic-assisted percutaneous endoscopic cecostomy; PEC, percutaneous endoscopic cecostomy; PEG, polyethylene glycol.*

DISCLOSURE: *All authors disclosed no financial relationships relevant to this publication.*


0016-5107/$36.00
doi:10.1016/j.gie.2010.09.011

Received July 7, 2010. Accepted September 3, 2010.

Current affiliations: Division of Gastroenterology, Department of Pediatrics (L.R.), Children's Hospital Boston, Harvard Medical School, Department of Pediatric Surgery (A.M.G.), Massachusetts General Hospital, Harvard Medical School, Division of Gastroenterology, Department of Pediatrics (A.F.), Floating Hospital for Children, Tufts University School of Medicine, Boston, Massachusetts, Department of Pediatric Surgery (B.F.G.), Elliot Hospital, Manchester, New Hampshire.

Reprint requests: Leonel Rodriguez, MD, MS, Center for Motility and Functional Gastrointestinal Disorders, Children's Hospital Boston, 300 Longwood Avenue, Boston, MA 02115.

If you would like to chat with an author of this article, you may contact Dr Rodriquez at Leonel.rodriguez@childrens.harvard.edu.

described, involves removing the appendix and placing it in a reversed orientation within a submucosal tunnel within the cecum, creating a Mitrofanoff-like, nonrefluxing channel that can be catheterized.[1] This procedure has undergone many technical modifications, including use of a nonreversed continent appendicostomy,[3] use of tubularized cecum or ileum when the appendix is not available,[4,5] or placement of a button or catheter cecostomy.[6] More recent modifications include laparoscopic[7,8] and percutaneous[9] approaches. We have developed a novel, minimally invasive technique that combines laparoscopy and endoscopy for the safe placement of a cecostomy tube or button. We have performed this laparoscopic-assisted percutaneous endoscopic cecostomy (LAPEC) technique in 50 children. We also compare the LAPEC experience to that of patients undergoing laparoscopic cecostomy without endoscopic assistance. Based on our results, we recommend LAPEC as a safe and reliable ACE procedure in children.

**Take-home Message**

- This study describes a safe and minimally invasive method for the placement of cecostomy tubes for antegrade enemas in children with refractory constipation or fecal incontinence. This technique is associated with low morbidity and brief hospitalization.

## METHODS

Institutional review board approval was obtained for a retrospective review of patients who underwent placement of a cecostomy tube for antegrade colonic enemas from January 2004 to January 2009 at 2 pediatric tertiary-care centers. Patients were identified by searching a hospital-based procedure database and physician records. All patients had severe constipation and/or fecal incontinence refractory to maximal medical therapy. A total of 74 patients underwent the following surgical procedures for antegrade colonic enemas: 15 laparoscopic cecostomy tubes placed without endoscopic assistance, 5 open appendicostomies, 4 open cecostomies, and 50 LAPECs. We compared the operative time and hospital length of stay between LAPEC and laparoscopic cecostomy by using the nonparametric Wilcoxon-Mann-Whitney test for independent samples. We also report the complications observed in the 2 groups. All procedures were performed by 2 pediatric gastroenterologists (L.R., A.F.) and 2 pediatric surgeons (B.F.G., A.M.G.), all of whom have extensive experience treating children with severe disorders of defecation.

Patients scheduled for LAPEC were admitted 1 to 2 days preoperatively for bowel cleanout with polyethylene glycol (PEG) via nasogastric tube. When necessary, additional rectal irrigations with saline solution were performed in the operating room. After induction of anesthesia, parenteral antibiotics were administered.

The procedure begins with placement of a 5-mm port in the umbilicus, followed by colonoscopy. The umbilical trocar is placed before endoscopy, because colonic insufflation can make trocar placement technically difficult and potentially risky. Endoscopic insufflation is used as necessary until the cecum is reached, at which point the colonic gas is removed and minimal insufflation is used while the cecostomy tube is placed, to maximize visualization. If necessary, 2 additional 5-mm ports are placed in the left lower quadrant and suprapubic area. Although the procedure can be performed with a single laparoscopic port for the camera, we have found that the addition of 2 extra ports is useful for (1) guiding the colon over the endoscope in children with extremely redundant and tortuous colons, (2) holding the cecum in order to facilitate needle insertion, and (3) suturing the cecum to the abdominal wall. Once the cecum is identified laparoscopically and endoscopically, a percutaneous endoscopic gastrostomy kit (16F, 20F, depending on patient size) is selected. Under direct laparoscopic visualization, a needle is placed percutaneously through the right lower quadrant into the cecum, and then a wire is advanced. The endoscopist snares the wire and pulls it out of the colon, secures it to the cecostomy tube, and then pulls the tube through the colon and out the right lower quadrant. The tube is secured at the appropriate position with an external bolster. In some patients, the cecum is sutured laparoscopically to the anterior abdominal wall or with external sutures placed through the abdominal wall and grasping the cecum. This was done in the last 15 patients in response to 3 dislodged tubes, which had not been sutured. The pneumoperitoneum is then evacuated and the incisions closed (Video 1, available online at www.giejournal.org).

As an alternative approach, we have placed a Mic-Key Low Profile Gastrostomy button (Kimberly Clark Healthcare, Roswell, GA) by using a similar technique. This method involves advancing a guidewire from a Cook dilator set (Cook Medical, Bloomington, IN) into the cecum. With traction maintained on the cecum by using a grasper, and with the endoscopist maintaining tension on the wire, the tract is sequentially dilated, a 14F Mic-Key button inserted, and the balloon inflated.

Postoperative management included standard enteric tube care, with daily irrigations by using 10 to 15 mL of saline solution starting on postoperative day 1 to maintain tube patency. Parents were trained on the care and use of the cecostomy tube. One week after surgery, the first enema was given in the office with 10 to 15 mL/kg of PEG solution, and caretakers were trained in the administration of antegrade enemas as well as the identification of potential complications. Those patients with a tube, rather than a button, were brought to the endoscopy suite 6 to 8

**Table 1. Patient demographics by procedure**

| | LAPEC | Lap-Cec |
|---|---|---|
| Age, mean (± SD), years | 12 ± 4.2 | 10.5 ± 4 |
| Sex, male, % | 70 | 53 |
| Weight, mean (± SD), kg | 42.0 | 47.3 |

*LAPEC,* Laparoscopic-assisted percutaneous endoscopic cecostomy; *Lap-Cec,* laparoscopic cecostomy.

weeks after surgery for colonoscopic-assisted replacement of the tube with a Mic-Key Low Profile button.

## RESULTS

Of the 50 LAPEC patients, 35 (70%) were male; the mean (± SD) age was 12 years (± 4.2 years), and the mean weight was 42 kg (range, 17-81 kg). Table 1 compares the demographics of these patients with those undergoing laparoscopic cecostomy alone. The most common indications for the LAPEC procedure were as follows: constipation with secondary fecal incontinence in 28 (56%), constipation alone in 20 (40%), and constipation with fecal incontinence in 2 (4%). Preoperative diagnoses included idiopathic refractory constipation in 40 patients (80%), anorectal malformation in 4 (8%), spina bifida in 3 (6%), Hirschsprung disease in 2 (4%), and internal anal sphincter achalasia in 1 (2%). Preoperative medications at the time of surgery included PEG in 15 (30%), bisacodyl in 9 (18%), a combination of PEG and laxative (bisacodyl or senna) in 14 (28%), and other medications in 7 (14%); no medications were given in 5 (10%). Physical examination results on admission were normal in 31 (62%) and notable for significant abdominal distention in 16 (32%) and a fecal mass in 3 (6%). Rectal biopsy was done in 24 patients, and results were normal in 22 patients, with hypoganglionosis in 2. Abdominal radiography results were normal in 12 (24%), showed fecal impaction alone in 16 (32%), and showed fecal impaction with significant bowel dilatation in 7 (14%). Barium enema was done in 22 (44%), and results were normal in 17 (77%), with significant colonic distention and redundancy in 5 (23%). Anorectal manometry was performed in 31 patients, and results were abnormal in only 1 patient, who had internal anal sphincter achalasia with delayed rectal balloon expulsion. Colon manometry was performed in 37 patients (74%). Study results were abnormal in 28 patients, with most showing only partially propagated high amplitude contractions.

Of the 15 laparoscopic cecostomy patients, 8 (53%) were male; the mean age was 10.5 years (± 3.4 years), and the mean weight was 47 kg (range, 11-91 kg) (Table 1). The most common indications were constipation in 11 (73%) and encopresis in 4 (27%). Preoperative diagnoses included idiopathic refractory constipation in 12 (80%) and Hirschsprung disease in 3 (20%). Preoperative medications included PEG alone in 7 (47%) and bisacodyl in 3 (20%); no medications were given in 5 (33%). Physical examination was notable for significant abdominal distention in 1 (6%) and a fecal mass in 2 (12%). Rectal biopsy was done in 7 patients, and results were normal in all. Abdominal radiography was available in 6 patients and showed fecal impaction in 4, with significant bowel dilatation in 2. Barium enema was done in 5 and showed significant colonic dilatation and redundancy in 2. Anorectal manometry was performed in 7 patients and results were normal in all. Colon manometry was performed in 12 patients (80%), and results were abnormal in all.

Data on operative time and hospital length of stay were available in 47 of the 50 LAPEC patients and in all 15 patients undergoing laparoscopic cecostomy. For LAPEC, the mean surgical operative time was 100.1 ± 16.6 minutes (range, 50-135 minutes), and the mean length of stay was 3.4 ± 1.4 days (range, 1-7 days). The mean surgical operative time for laparoscopic cecostomy was 100.8 ± 19.1 minutes (range, 48-130 minutes), with a mean hospital stay of 3.8 ± 1.6 days (range, 2-8 days). No statistical difference was found between the 2 groups by using the nonparametric Wilcoxon-Mann-Whitney test (Table 2).

The single intraoperative complication during LAPEC was a hematoma in the wall of the cecum after insertion of the percutaneous needle. This required a small incision to place the needle and wire into the cecum under direct visualization. Postoperative complications included 6 patients with low-grade fever, 2 patients with inadvertent tube dislodgement requiring a second LAPEC procedure to replace the tube, 1 dislodged tube replaced with open surgery, 1 minor local skin erosion, and 1 case of significant local skin breakdown necessitating cecostomy tube removal (Table 3).

Among the 15 patients undergoing a laparoscopic cecostomy, the only intraoperative complication was bleeding and inability to complete the procedure laparoscopically, which required conversion to open cecostomy. Postoperatively, 2 patients required further surgery for cecostomy tube dislodgement.

The overall complication rate after laparoscopic cecostomy was 3 of 15 (20%) and after LAPEC was 12 of 50 (24%). When we consider only major complications (excluding postoperative fever with no signs of surgical site infection), the complication rate associated with LAPEC drops to 6 of 50 (12%). Figure 1 graphically compares the complication rates in the 2 groups.

Mean follow-up time after LAPEC and laparoscopic cecostomy was 32 and 37 months, respectively. Of the 50 LAPEC patients and their families, 48 were satisfied with the outcome, as determined by review of outpatient notes and discussion with patients and their parents. These patients all have effective colonic evacuation with antegrade enemas with significantly decreased soiling in those with a history of encopresis or incontinence. Two patients were

**Table 2. Comparison of LAPEC and Lap-Cec operative time and hospital length of stay**

| | No. | Mann-Whitney | Wilcoxon | Standard error | Asymptotic significance (2-sided test) |
|---|---|---|---|---|---|
| OT, minutes | | | | | |
| LAPEC | 47 | 389.500 | 509.500 | 63.067 | .727* |
| Lap-Cec | 15 | | | | |
| LOS, days | | | | | |
| LAPEC | 47 | 392.500 | 512.500 | 58.906 | .581* |
| Lap-Cec | 15 | | | | |

*LAPEC,* Laparoscopic-assisted percutaneous endoscopic cecostomy; *Lap-Cec,* laparoscopic cecostomy; *OT,* operative time.
*Differences were not statistically significant.

**Table 3. Complications of LAPEC**

| Complication | Intervention | Outcome | No. |
|---|---|---|---|
| Intraoperative | | | |
| Cecal hematoma | Skin incision | Successful LAPEC | 1 |
| Postoperative | | | |
| Fever | Antibiotics | Resolution | 6 |
| Tube dislodgement | Repeat LAPEC: 2<br>Open procedure: 1 | Successful cecostomy in all | 3 |
| Skin erosions | Conservative care: 1<br>Tube removal: 1 | Successful use of ACE<br>Symptom return: failure | 2 |

*LAPEC,* Laparoscopic-assisted percutaneous endoscopic cecostomy; *ACE,* antegrade continence enema.

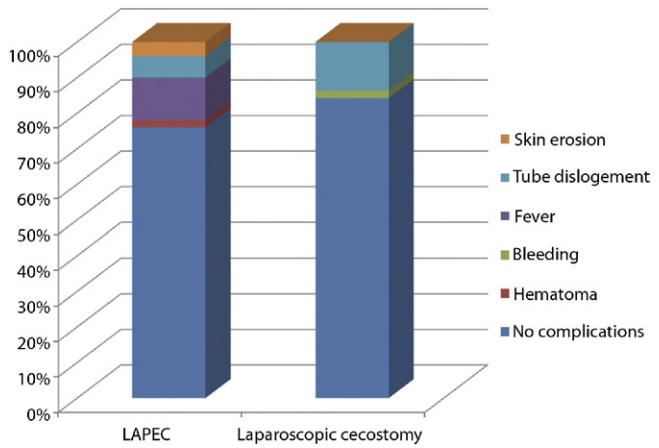


**Figure 1.** Comparison of complications between LAPEC and laparoscopic cecostomy. *LAPEC,* laparoscopic-assisted percutaneous endoscopic cecostomy.

dissatisfied. One patient subsequently underwent diverting colostomy because of lack of improvement with ACE. The second patient required tube removal for skin breakdown as described earlier, although the patient was doing well with antegrade enemas before the skin problem developed. Three patients have been successfully decannulated and continue to do well during follow-up. Of the 15 patients who had laparoscopic cecostomy, 13 are currently doing well by using the cecostomy for antegrade enemas, 1 failed to respond to antegrade enemas and ultimately required a diverting ileostomy to alleviate symptoms, and 1 died of causes unrelated to the procedure (mitochondrial dysfunction).

## DISCUSSION

The goal of an ACE procedure is to allow the patients and their families easy and comfortable access to the colon in order to permit effective and painless antegrade irrigations. Many operative approaches have been developed in order to achieve these goals in the safest and least invasive manner. The appendicostomy is the oldest technique and is still commonly used. It is associated with several potential complications, the most common of which is stomal stenosis, reported to occur in 11% to 27% of patients.[3,10,11] Additional complications associated with appendicostomies include stomal leakage, infection, prolapse, and less commonly, perforation.[2,3,11] Moreover, self-catheterization

can be uncomfortable and difficult for some children, particularly in children with developmental delay or behavioral problems.

Primarily because of the problem of stomal stenosis with the appendicostomy, tube cecostomy was developed as an alternate approach. Many variations of this operation have been introduced, including a percutaneous technique alone[12] and a combined percutaneous and endoscopic approach[13] as well as laparoscopic[8] and open[14] approaches. Tube cecostomy has several potential advantages over appendicostomy, including eliminating the risk of stomal stenosis as well as the need for catheterizing a stoma. Although the cecostomy requires the presence of a tube or button on the abdominal wall, children seem to adjust well to this, and we have not had problems with embarrassment or desire for removal for cosmetic reasons. However, regardless of the method of placement, cecostomies are associated with potential complications, including leakage, skin breakdown, infection, and accidental tube removal.[9,12,13,15,16] The rates of these complications do not change significantly when open-to-laparoscopic[14] or open-to-percutaneous nonendoscopic[15] approaches are compared.

Both percutaneous nonendoscopic and percutaneous endoscopic cecostomy (PEC) techniques are commonly used.[9,12,13] Chait et al[12] performed 124 PECs and reported 6% tube site infection, 10% tube failure, and 14% tube dislodgement requiring reinsertion. Rivera et al[9] reported 12 PECs, with 8% pressure necrosis and 8% failure to reach the cecum endoscopically. The lack of direct visualization with percutaneous approaches also increases the risk of injury to overlying or adjacent loops of bowel. A small series reports safe PEC placement by using US guidance.[17] The LAPEC technique we describe here has several advantages over both of these methods. First, LAPEC provides both endoscopic and laparoscopic visualization, thereby significantly decreasing potential risks by ensuring precise and safe access to the cecum. Second, laparoscopic assistance facilitates the colonoscopy by allowing the colon to be manipulated over the endoscope in cases in which the extreme tortuosity of the bowel, particularly the sigmoid colon, can make endoscopy very difficult. Third, visualization from both the outside and inside of the colon allows us to place an optimally sized cecostomy device and thereby decrease the risk of pressure necrosis and skin breakdown from a button that is too tight or leakage from one that is too loose. Furthermore, the length of hospitalization after LAPEC (3.4 days) is similar to that reported after laparoscopic and open cecostomy (3.2 and 3.5 days, respectively)[14] and PEC.[12] We recommend LAPEC as a safe alternative procedure for cecostomy placement in children with refractory constipation or fecal incontinence.

## REFERENCES


1. Malone PS, Ransley PG, Kiely EM. Preliminary report: the antegrade continence enema. Lancet 1990;336:1217-8.
2. Graf JL, Strear C, Bratton B, et al. The antegrade continence enema procedure: a review of the literature. J Pediatr Surg 1998;33:1294-6.
3. Squire R, Kiely EM, Carr B, et al. The clinical application of the Malone antegrade colonic enema. J Pediatr Surg 1993;28:1012-5.
4. Ellsworth PI, Webb HW, Crump JM, et al. The Malone antegrade colonic enema enhances the quality of life in children undergoing urological incontinence procedures. J Urol 1996;155:1416-8.
5. Koyle MA, Kaji DM, Duque M, et al. The Malone antegrade continence enema for neurogenic and structural fecal incontinence and constipation. J Urol 1995;154:759-61.
6. Fukunaga K, Kimura K, Lawrence JP, et al. Button device for antegrade enema in the treatment of incontinence and constipation. J Pediatr Surg 1996;31:1038-9.
7. Rongen MJ, van der Hoop AG, Baeten CG. Cecal access for antegrade colon enemas in medically refractory slow-transit constipation: a prospective study. Dis Colon Rectum 2001;44:1644-9.
8. Yagmurlu A, Harmon CM, Georgeson KE. Laparoscopic cecostomy button placement for the management of fecal incontinence in children with Hirschsprung's disease and anorectal anomalies. Surg Endosc 2006;20:624-7.
9. Rivera MT, Kugathasan S, Berger W, et al. Percutaneous colonoscopic cecostomy for management of chronic constipation in children. Gastrointest Endosc 2001;53:225-8.
10. Cascio S, Flett ME, De la Hunt M, et al. MACE or caecostomy button for idiopathic constipation in children: a comparison of complications and outcomes. Pediatr Surg Int 2004;20:484-7.
11. King SK, Sutcliffe JR, Southwell BR, et al. The antegrade continence enema successfully treats idiopathic slow-transit constipation. J Pediatr Surg 2005;40:1935-40.
12. Chait PG, Shlomovitz E, Connolly BL, et al. Percutaneous cecostomy: updates in technique and patient care. Radiology 2003;227:246-50.
13. Uno Y. Introducer method of percutaneous endoscopic cecostomy and antegrade continence enema by use of the Chait Trapdoor cecostomy catheter in patients with adult neurogenic bowel. Gastrointest Endosc 2006;63:666-73.
14. Wong AL, Kravarusic D, Wong SL. Impact of cecostomy and antegrade colonic enemas on management of fecal incontinence and constipation: ten years of experience in pediatric population. J Pediatr Surg 2008;43:1445-51.
15. Mousa HM, van den Berg MM, Caniano DA, et al. Cecostomy in children with defecation disorders. Dig Dis Sci 2006;51:154-60.
16. Youssef NN, Barksdale Jr E, Griffiths JM, et al. Management of intractable constipation with antegrade enemas in neurologically intact children. J Pediatr Gastroenterol Nutr 2002;34:402-5.
17. De Peppo F, Iacobelli BD, De Gennaro M, et al. Percutaneous endoscopic cecostomy for antegrade colonic irrigation in fecally incontinent children. Endoscopy 1999;31:501-3.