Laparoscopic Appendicostomy Low-Profile Balloon Button for Antegrade Enemas in Children

David F. Grabski, MD,¹ Yinin Hu, MD,¹ Sara K. Rasmussen, MD, PhD,²
Eugene D. McGahren, MD,² and Jeffrey W. Gander, MD²

Abstract

Introduction: The Malone appendicostomy is a continent channel used for antegrade enemas. It requires daily cannulation and is susceptible to stenosis. We use an indwelling low-profile balloon button tube inserted through the appendix into the cecum for antegrade enemas. We hypothesized that this method is effective at managing constipation or fecal incontinence and is associated with a low rate of stenosis.

Methods: Children who underwent laparoscopic appendicostomy balloon button placement at our institution from January 2011 to April 2017 were identified. The primary outcome was success in managing constipation or fecal continence as measured by the Malone continence scale. Postoperative complications were analyzed.

Results: Thirty-six children underwent the procedure, 35 of which met the inclusion criteria. Thirty-one patients (88.5%) underwent the operation for idiopathic constipation, 3 patients (8.6%) for anorectal malformation, and 1 patient (2.9%) for hypermobility. Rate of open conversion was 3%. A full response was obtained in 24 patients (68.6%), partial response in 9 patients (25.7%), and 2 patients failed (5.7%). One patient developed an internal hernia requiring laparotomy and later developed mucosal prolapse. One patient developed a stricture noted at button change. Seven patients (20%) underwent reversal of their appendicostomy tube: 5 due to return of normal bowel function and 2 due to discomfort with flushes.

Conclusion: A laparoscopic appendicostomy with a balloon button tube is an effective means of addressing chronic constipation or fecal incontinence. The stenosis rate associated with tube appendicostomy may be lower than those reported for Malone antegrade continence enema procedures.

Keywords: laparoscopic appendicostomy, MACE procedure, antegrade enema, pediatric colorectal surgery

Introduction

THE MALONE ANTEGRADE CONTINENCE ENEMA (MACE) is a continent catheterizable channel used for antegrade enemas in children with constipation or fecal incontinence. First described in 1990, Malone developed the technique for children with anorectal malformations or neuropathic sphincter abnormalities.¹ Indications for the procedure have expanded to include multiple causes of constipation, including chronic idiopathic constipation as well as gastrointestinal, metabolic, and other neuromuscular disorders. The original procedure achieved a continence success rate of 79%, and a number of studies continue to note improved continence and quality of life in children.^{2,3}

Several procedural modifications now exist with a trend toward more minimally invasive techniques and modifications that reduce complications. While Malone et al. first described

using the appendix as a continent conduit utilizing the Mitrofanoff principal,^{1,4} alternative conduits such as the cecum,⁵ the sigmoid colon,⁶ and the small bowel have been described.⁷

Leaving the appendix *in-situ* for antegrade enemas has also been shown to have similar success rates as the original open MACE procedure.⁸ This rapidly led to the laparoscopic creation of antegrade continent enemas using the *in-situ* appendix as a conduit.⁹ Concurrently, Shandling et al. described the use of a percutaneous cecostomy for antegrade colonic lavage.^{10,11} These works culminated in Georgeson reporting the first series of laparoscopically inserted cecostomy buttons.¹²

The adoption of button cecostomy tubes was driven by the desire to avoid stoma stenosis, which complicates 11%–39% of MACE operations.^{13–15} Stenosis of the stoma tract between flushings results in painful catheterization or even complete occlusion.¹⁶ An indwelling low-profile balloon button through the appendix and into the cecum can obviate

Departments of ¹General Surgery and ²Pediatric Surgery, University of Virginia, Charlottesville, Virginia.

these complications. Several studies examining stenosis rates of cecostomy and appendicostomy balloon buttons have demonstrated stenosis rates between 0% and 5%.^{14,17} However, the majority of the published studies report either open or combined open and laparoscopic results.

Herein, we describe the largest series of laparoscopically placed appendicostomy balloon button (LABB) tubes for bowel management. We hypothesized that a laparoscopically placed indwelling low-profile balloon button tube inserted through the appendix into the cecum for antegrade enemas would have low stenosis rates, while effectively managing constipation or fecal incontinence.

Patients and Methods

We conducted a retrospective analysis of all children up to 18 years of age who underwent a planned LABB at our institution from January 2011 through April 2017. Demographic and clinical data were collected for all patients, including age and weight at time of procedure, sex, clinical indication for procedure, procedure details, operative complications, postprocedure continence data, short-term complications, and need for reversal of the appendicostomy. The primary outcome was successful in managing constipation or fecal continence as measured by the Malone Continence Scale (full, partial or failure).¹⁸ Success was defined as full or partial response. Complications—specifically operative and postprocedural complications—were analyzed. Data collection and analysis were performed using Microsoft Excel 2016 (Redmond, WA) and Stata IC 14 (College Station, TX).

Procedure Details

All LABB procedures were performed using two or three ports. The first port is placed near the umbilicus for the laparoscopic telescope. A second 5 mm port is placed at the intended position of the balloon button in the right lower quadrant of the abdomen. Occasionally, an additional port is used in the left lower quadrant to assist with mobilizing the appendix. The appendix is grasped and pulled out through the anterior abdominal wall until the cecum is flush with the underside of the peritoneal cavity. The appendix is then secured to the fascia with polyglactin suture. The excess appendix is resected so that the appendiceal stump is flush with the dermis. Full thickness appendix is matured to the dermis with polyglactin. This allows for slight retraction, which decreases the incidence of serous leakage and mucosal prolapse. Imbrication or antireflux techniques are not performed. The abdomen is reinsufflated to confirm that the cecum is flush with the abdominal wall. This step is critical, as a gap between the cecum and the abdominal wall leaves viscera susceptible to internal herniation. A Foley catheter is placed through the conduit and measured to determine the length of the balloon button. This is typically 1.5–5.5 cm depending on the size of the abdominal wall and varies proportionally to the age of the child. The appropriate length 14 Fr balloon button tube (Mini-One; Applied Medical Technology, Brecksville, OH) is then inserted through the appendix conduit and into the cecum. Sounding the tract with Hegar dilators beforehand can facilitate the passage of the button. Air is inflated through the tube under laparoscopic visualization to confirm appropriate placement. Figure 1 demonstrates a child with a low-profile balloon button after undergoing a LABB.

FIG. 1. Low-profile balloon button after laparoscopic appendicostomy procedure.

If the appendix is not present, the right lower quadrant laparoscopic incision is slightly enlarged and the cecum pulled up to the level of the dermis. Similar to a Stamm gastrostomy, purse-string sutures are placed at the intended position of the tube. Tacking sutures outside of the purse-string are used to secure the cecum to the peritoneum. The appropriately sized button is placed and all of the sutures are tied.

Patients are generally discharged on postoperative day 1. Follow-up occurs at 1 week to begin antegrade flushes. The patient and family meet with Pediatric Gastroenterology Service on the same day and a flush regimen is calculated. We typically begin with 250–500 mL of free water flushes mixed with 20–40 g (one or two cap-full) of polyethylene glycol. Once the tract is mature, button exchanges are performed during office visits, typically every 3 months. As the patient grows, a longer tube is placed if necessary. When the appendicostomy tube is no longer necessary, we remove the button and perform a closure at the stoma site, including resection of the appendiceal remnant, as an outpatient procedure.

Results

Thirty-six children underwent the procedure over the study period (Fig. 1). One patient moved after the operation and was lost to follow-up. Thus, 35 patients were included in the analysis (Table 1). Males made up 68.6% of the group ($n=24$). Mean age at time of operation was 8.6 years (range 4–16), and mean weight was 31.0 kg (range 16.4–98.8).

TABLE 1. RESULTS OF LAPAROSCOPIC APPENDICOSTOMY BALLOON BUTTON PROCEDURE BY INDICATION

Diagnosis	<i>Fecal continence postprocedure (MCS)</i>				
	<i>Patients, n (%)</i>	<i>Full, n (%)</i>	<i>Partial, n (%)</i>	<i>Failure, n (%)</i>	<i>Total success %</i>
CIC	29 (82.9)	19 (65/6)	8 (27.6)	2 (6.9)	93.1
ARM	3 (8.6)	2 (66.7)	1 (33.3)	—	100
HD	1 (2.9)	1 (100)	—	—	100
Other	2 (5.7)	2 (100)	—	—	100
Total	35	24 (68.5)	9 (25.7)	2 (5.7)	94.3

ARM, anorectal malformation; CIC, chronic idiopathic constipation; HD, Hirschsprung disease; MCS, Malone Continence Scale.

Twenty-nine patients (82.9%) underwent the operation for idiopathic constipation, 1 patient for constipation associated with myelomeningocele, and 1 patient for constipation following sacrococcygeal teratoma excision. In addition, 3 patients (8.6%) had LABB placed for anorectal malformation (2 for incontinence, 1 for constipation) and 1 (2.9%) for hypermobility following a pull through for Hirschsprung disease. Median follow-up was 23 months (range 1–41 months).

Thirty-two patients (91.4%) underwent a LABB. Two patients did not have an appendix due to previous appendectomy and underwent laparoscopic cecostomy with balloon button placement. One patient had a previous anorectal malformation repair, which involved a previous colostomy and multiple laparotomies. Dense right lower quadrant adhesions on laparoscopic evaluation of the abdomen were encountered, and the procedure was converted to an open cecostomy.

A full response was obtained in 24 patients (68.6%), and 9 patients (25.7%) had a partial response. Two patients failed (5.7%). Both of the failures were due to reluctance of the parents to use the appendicostomy button. The overall success of the procedure was 94.3% (Table 1).

One patient (2.9%) had stenosis of the appendicostomy channel noted at button exchange (Table 2). This complication occurred in a morbidly obese child whose button had become too short for the tract, although the longest balloon button available (6.5 cm) was utilized. This allowed the tract distal to the button to close. After 2 failed fluoroscopy-guided attempts to reestablish the tract, the family elected not to have the minibutton replaced due to symptomatic improvement.

Two patients developed wound infections (5.7%) at the ostomy site, which responded to antimicrobial therapy. There were no incidents of intra-abdominal abscess or peritonitis in the postoperative period. Minor complications included excess granulation tissue ($n=8$, 22.8%) treated with silver nitrate and

minor serous drainage around the minibutton ($n=8$, 22.8%). There were no instances of major bleeding, fistula formation, perforation, creation of false passage during catheterization, or compression ulcer at the cecostomy tube site.

One patient developed a small-bowel obstruction resulting from internal herniation around the appendicostomy and the lateral abdominal wall. This required laparotomy and reduction. This was our only Clavien–Dindo Class IIIB complication.¹⁹ The patient later developed mucosal prolapse of the appendicostomy and a ventral hernia, which was corrected with surgery.

Five patients (14.3%) underwent reversal of their cecostomy due to improvement of their chronic constipation or fecal incontinence. Two patients (5.7%), both categorized as failure on the Malone continence scale, were reversed as a result of discomfort with flushes and lack of therapeutic benefit.

Discussion

The MACE operation has undergone a number of procedure modifications since its original description. The trend has been toward minimally invasive procedures, including laparoscopic approaches and percutaneous endoscopic cecostomy buttons, given the inherent advantages in shorter hospital courses and better cosmetic appeal. Given the complications of stenosis, infection, and leakage that persist in all variations of the MACE operation, multiple procedural modifications continue to arise. The present study represents the largest series of laparoscopic appendicostomy balloon button placement in children for antegrade enemas. Our success in treating chronic constipation or fecal incontinence with this technique and in our patient population approached 95%. By leaving the button in place, we had a very low stenosis rate of 3%. We had 2 superficial wound infections (5.7%) treated with antimicrobial

TABLE 2. COMPLICATIONS OF LAPAROSCOPIC APPENDICOSTOMY BALLOON BUTTON PROCEDURE

<i>Complication</i>	<i>n (%)</i>	<i>Outcome</i>	<i>Clavien–Dindo Classification</i>
Stenosis	1 (2.9)	Unable to recannulate at exchange-closed spontaneously	Grade I
Mucosal prolapse	1 (2.9) ^a	Operative correction	Grade IIIB
Internal hernia w/SBO	1 (2.9) ^a	Operative correction	Grade IIIB
Superficial wound infection	2 (5.7)	Antimicrobial therapy	Grade II
Minor complications		Outcomes	
Granulation tissue	8 (22.8)	Silver nitrate	Grade I
Minor serous drainage	8 (22.8)	Observation	Grade I

^aComplication in same patient at different time points in postoperative course. Clavien–Dindo Classification of surgical complications.¹⁹ SBO, small-bowel obstruction.

therapy and had no incidences of intra-abdominal infection or peritonitis. Leakage around the appendicostomy minibutton was 22.8% in our series.

An evaluation by Curry and colleagues of the original patients who underwent the MACE procedure in the United Kingdom revealed a success rate (full and partial responds) of 79%. Most current MACE procedures, regardless of clinical indication or procedural variation, continue to find success rates ranging between 80% and 95%.^{14,20,21} Describing their experience with a laparoscopic-assisted MACE appendicostomy without a button left in place, Lawal et al. noted a success rate of 100%.²² In contrast, Defreest noted that the success rate, when performing a laparoscopic-assisted percutaneous cecostomy button, was 69%.²³ Mugie et al. reported their 10-year results of a combination of open and laparoscopic cecostomy buttons with success rates of 91%.²⁴ Our success rate of 95% measures favorably compared to recently published literature.

Stenosis of the channel remains one of the most common complications of all MACE procedures. Without use of an indwelling catheter, stenosis rates range between 11% and 39%.^{14,15} Stenosis of the channel often requires a step-up approach to management depending on the degree. Mild stenosis may be treated with increased catheterization frequency combined with topical steroids. Moderate stenosis may require fluoroscopic-guided catheterization and operative dilation of the channel under general anesthesia. Significant stenosis often requires formal operative revision of the appendicostomy.

One of the modifications of the MACE procedure for antegrade enemas is the introduction of a balloon button tube directed into the cecum with or without the use of the appendix as a channel. In one of the earlier studies directly comparing open cecostomy buttons to open MACE procedures, Cascio et al. compared their institutional experience and found stenosis rates were 0% versus 11% in the respective groups.¹⁴ This is supported by literature that report on cecostomy or appendicostomy buttons in children with stenosis rates ranging between 0% and 5%.^{14,17,23,24} In comparison to the LABB technique with a balloon button left in place, Lawal et al. describe their experience performing a laparoscopic-assisted MACE appendicostomy, in which the button is removed after 2 weeks when the tract matures.²² They report a long-term stenosis rate of 18.2%. Our stenosis rate of 3% with the button left in the appendicostomy falls within the expected literature range and is much lower than rates reported by series that do not leave a button in place.

One of the theoretical advantages of using the appendix as a conduit is that the intestinal tract is opened outside of the peritoneal cavity. We believe that this may potentially reduce the risk of intraperitoneal contamination. In our series, we had 2 superficial skin infections (6%) requiring treatment with antimicrobial therapy. We had no incidence of intra-abdominal infection, abscess, or peritonitis. It is difficult to compare current literature on infection rates as many series on variations of MACE procedures do not differentiate between type and location of infections. Many series also include multiple MACE techniques in their analysis. However, series that report primarily on the utilization of an appendicostomy for their MACE procedure generally note peristomal or superficial infection rates between 10% and 30%.^{17,25,26} None of these series reports any intra-abdominal infections, abscesses, or cases of peritonitis. Although this remains a rare complication in all reported

series, literature on cecostomy techniques note intra-abdominal infection, peritonitis, or intra-abdominal abscess rates ranging from 0% to 7%.^{23,24,27,28}

There is some concern that performing a laparoscopic MACE procedure without an imbrication technique increases the risk of stomal leakage.¹⁷ This could potentially negate some of the positive effects of decreased stenosis rates associated with LABB, in which we do not use an imbrication technique. However, Henrichon et al. performed an in-depth review, including the creation of a staging system, of stomal leakage after MACE procedures.²⁹ The authors found that, while open MACE procedures with imbrication had no incidence of stomal leakage, laparoscopic MACE procedure with an appendix conduit had ~90% clean or grade I leakage—classified as having a drop at the stoma or fluid on clothing only once a month. Our study corroborates this finding. Eight patients (22.8%) noted serous drainage around their balloon button at time of clinic visit, but none of these patients was affected by this complication long term.

As a retrospective, single-institution descriptive review without a control arm comprised patients who underwent the MACE procedure, this study has inherent limitations. The retrospective nature of our study eliminated our ability to collect and analyze information on patient and parent satisfaction of the low-profile button. Furthermore, there is the potential for reporting bias in our complication rates, specifically stomal leakage, which may be underreported by families.

Conclusion

Performing a laparoscopic appendicostomy balloon button is a safe and effective way of facilitating antegrade enemas in children with chronic constipation or fecal incontinence. The technique maintains a high level of success and is associated with a very low rate of stomal stenosis and intra-abdominal infection rates compared with similarly described techniques.

Disclosure Statement

No competing financial interests exist.

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Address correspondence to:
David F. Grabski, MD
Department of General Surgery
University of Virginia
1215 Lee Street
Charlottesville, VA 22904
E-mail: dfg6j@virginia.edu