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# Neoappendicostomy in the management of pediatric fecal incontinence

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**Abstract**

**Purpose:** The Malone appendicostomy, for antegrade enemas, has improved the quality of life for many children with fecal incontinence. In patients whose appendix has been removed, a neo-appendix can be created. We describe our approach and experience with this procedure as an option for surgeons managing children with fecal incontinence.

**Methods:** The procedure involves creating a transverse flap of cecum that receives its blood supply by a transverse mesenteric branch. This flap is then tubularized around a feeding tube. The surrounding colon is plicated around the neo-appendix to prevent leakage of stool. The tip of the flap is then anastomosed to the deepest portion of the umbilicus. We reviewed our experience with this procedure, including results and complications. IRB approval was obtained.

**Results:** Eighty patients required a neo-appendicostomy. Sixty-six patients (82%) had an anorectal malformation, four had spina bifida, and ten had other diagnoses. The reasons for not having an appendix available included: "incidental" appendectomy (34, 42.5%), use of the appendix for a Mitrofanoff procedure (20, 25%), and Ladd's procedure (5, 6%). In fifteen patients (19%) we could find no appendix and assume that it was removed previously. Following neoappendicostomy, nine patients (11%) developed a stricture, and seven patients had leakage (9%). In 2004, we modified the appendiceal-umbilical anastomosis and among these patients, only one patient (3%) developed a stricture, compared with eight patients (18%) without the modification. All seven patients with leakage were within the first forty cases. No patient in the last forty cases had a leakage.

**Conclusions:** In patients with the potential for fecal incontinence, the appendix should be preserved. In patients without an appendix, the neo-appendicostomy is a valuable tool for fecally incontinent patients. We have found that the V-V anastomosis had a reduced rate of stricture, and the rate of leakage seems to be related to surgical experience.



The appendicostomy procedure for antegrade continence enemas (ACE), first introduced by Malone [1], has helped improve the quality of life for many pediatric patients. In particular, the procedure has helped children with anorectal malformations, spinal anomalies, and other diagnoses that

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suffer from fecal incontinence [2]. In many of these patients though, previous procedures have made the appendix unavailable or unusable for the appendicostomy procedure. Kiely et al described the formation of a neo-appendicostomy by using a flap of cecum [3]. We have adopted this approach, with some modifications, for children who are fecally incontinent and have no appendix available for an ACE. The purpose of this study is to describe our approach and review the outcomes.

## 1. Methods

We reviewed our entire experience with neo-appendicostomies from October 1994 to September 2009. Data extracted included: diagnosis, indication for neoappendicostomy, risk factors for incontinence, ultimate fate of the appendix (prompting the need for a neo-appendicostomy), complications following the procedure, and long term outcomes. Strictures were defined as a narrowing at the umbilico-appendicostomy anastomosis that prevented the insertion of the feeding tube for the administration of the daily antegrade enemas. Leakage was defined as leakage of stool through the appendicostomy between enema administrations, which was significant enough to warrant a redo operation. IRB approval was obtained prior to commencing the review.

### 1.1. Surgical technique

Once a child has been diagnosed as fecally incontinent in our center, he or she undergoes a bowel management program with daily enemas to keep him/her mechanically clean of stool [4-6]. After we have demonstrated that the patient can remain clean, we discuss the possibility of antegrade colonic enemas, which provides the patient with a more comfortable and independent route for enema administration. If the patient has had a previous appendectomy, then our approach is to use a neo-appendicostomy, using a flap of colon.

The day prior to surgery, the patient undergoes a bowel preparation. The patient is placed under anesthesia and is positioned supine. The procedure begins, as it would for a Malone appendicostomy, by creating a triangular flap in the umbilical skin for the eventual appendiceal-umbilical anastomosis (Fig. 1). Once the flap has been created, an infraumbilical midline laparotomy is performed from the umbilicus down. The right colon is identified. If no appendix is present, the right colon is mobilized off of its retroperitoneal attachments, in preparation for the neo-appendicostomy.

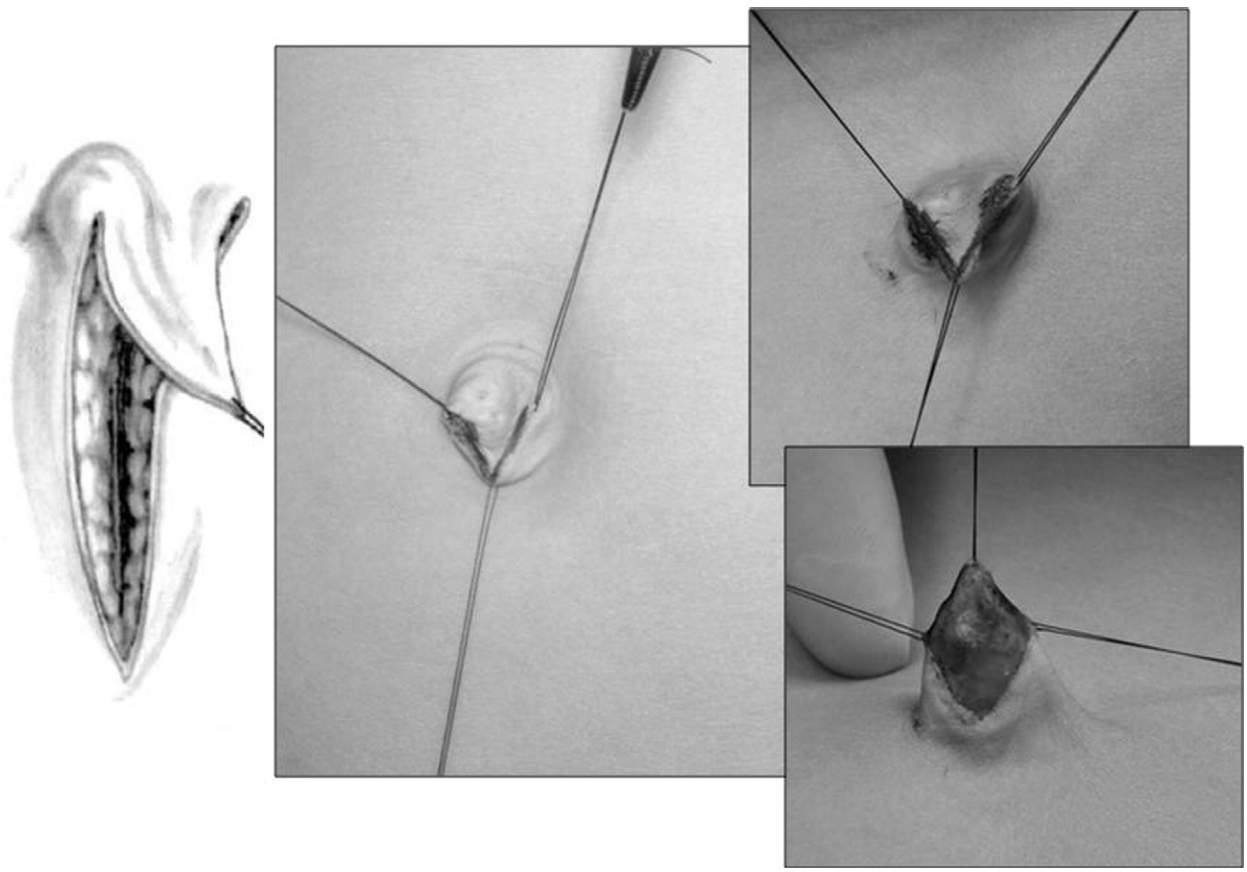

**Fig. 1** Triangular flap of skin is created at the umbilicus in preparation for the anastomosis.

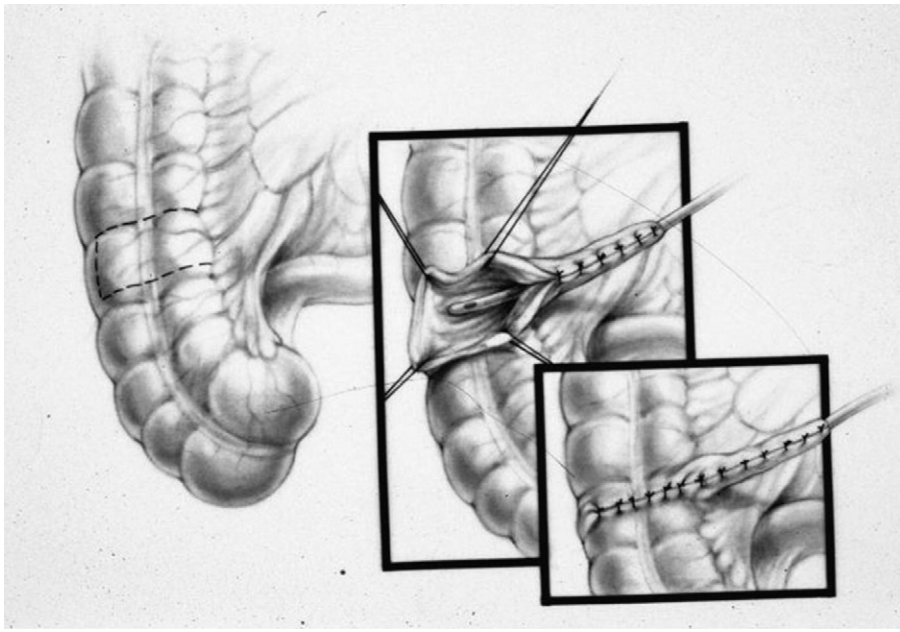

**Fig. 2** Flap of cecum created on a pedicled blood supply from the mesentery. The flap is then rotated out and closed around a feeding tube. Reprinted with permission from Elsevier [2].

The colon is inspected for an appropriate location for the flap, usually in the ascending colon, away from the ileocecal valve, with two feeding vessels from the mesentery (Fig. 2). The flap must be large enough that it will easily tubularize around an 8F feeding tube. Taking care not to injure the blood supply, the flap is created and reflected away (Fig. 3). The flap is then closed over an 8F feeding tube, simultaneously closing the colon in the transverse direction, in two layers (Fig. 4). The neo-appendix is then laid down and the colonic wall is plicated (wrapped) around it. Special care is taken to avoid leaving the suture line of the neo-appendix in contact with the colonic suture line, to avoid the risk of a fistula. This plication must be tight enough to prevent leakage, but not too tight that the feeding tube cannot pass through. We perform the plication with the feeding tube in place (Fig. 5), and pass the tube to check patency after each plication stitch.

The umbilical-appendiceal anastomosis is then performed. During our initial experience with appendicostomies and neo-appendicostomies, the tip of the appendix was sutured to the base of the umbilicus, forming a circular anastomosis. This early experience had a high rate of stricture formation, leading us to a change the type of anastomosis to one that involves a triangular flap of skin (V to V anastomosis) (Fig. 6). The tip of the neo-appendix is left open, forming a "V". The appendix is then positioned such that the triangular skin flap (created at the beginning of the laparotomy) will be anastomosed to the base of the "V". Using fine 6-0 vicryl sutures, each side of the triangular skin flap is anastomosed to either side of the appendiceal incision. At the end, the triangular flap forms one part of the orifice, as the floor of the tunnel, through which the catheter will be passed (Figs. 6, 7).

**Fig. 3** Flap of cecum reflected out prior to tubularization.

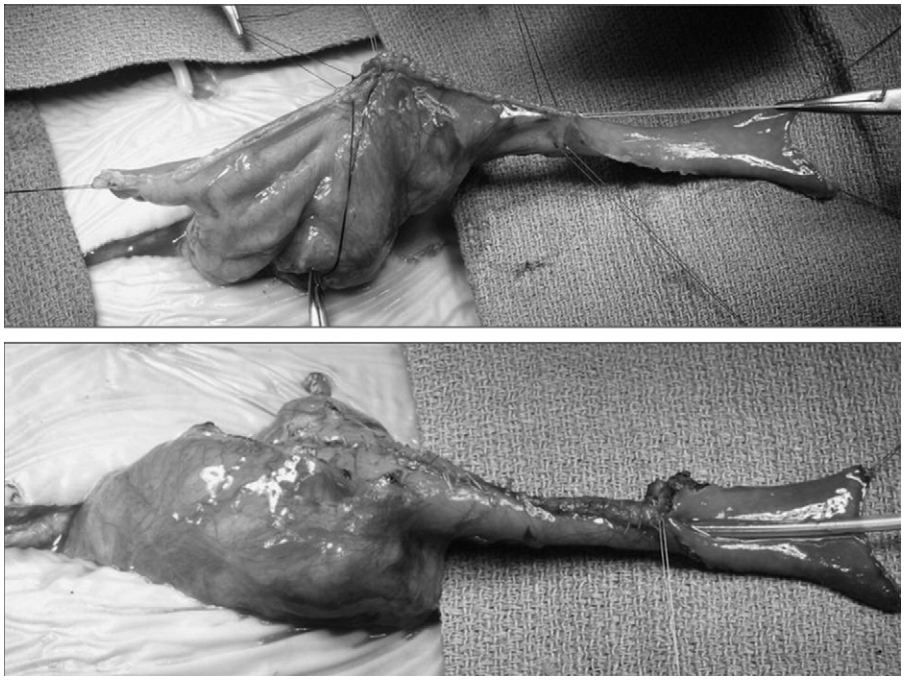

**Fig. 4** Closure of the flap over an 8F feeding tube. The cecal defect is closed at the same time.

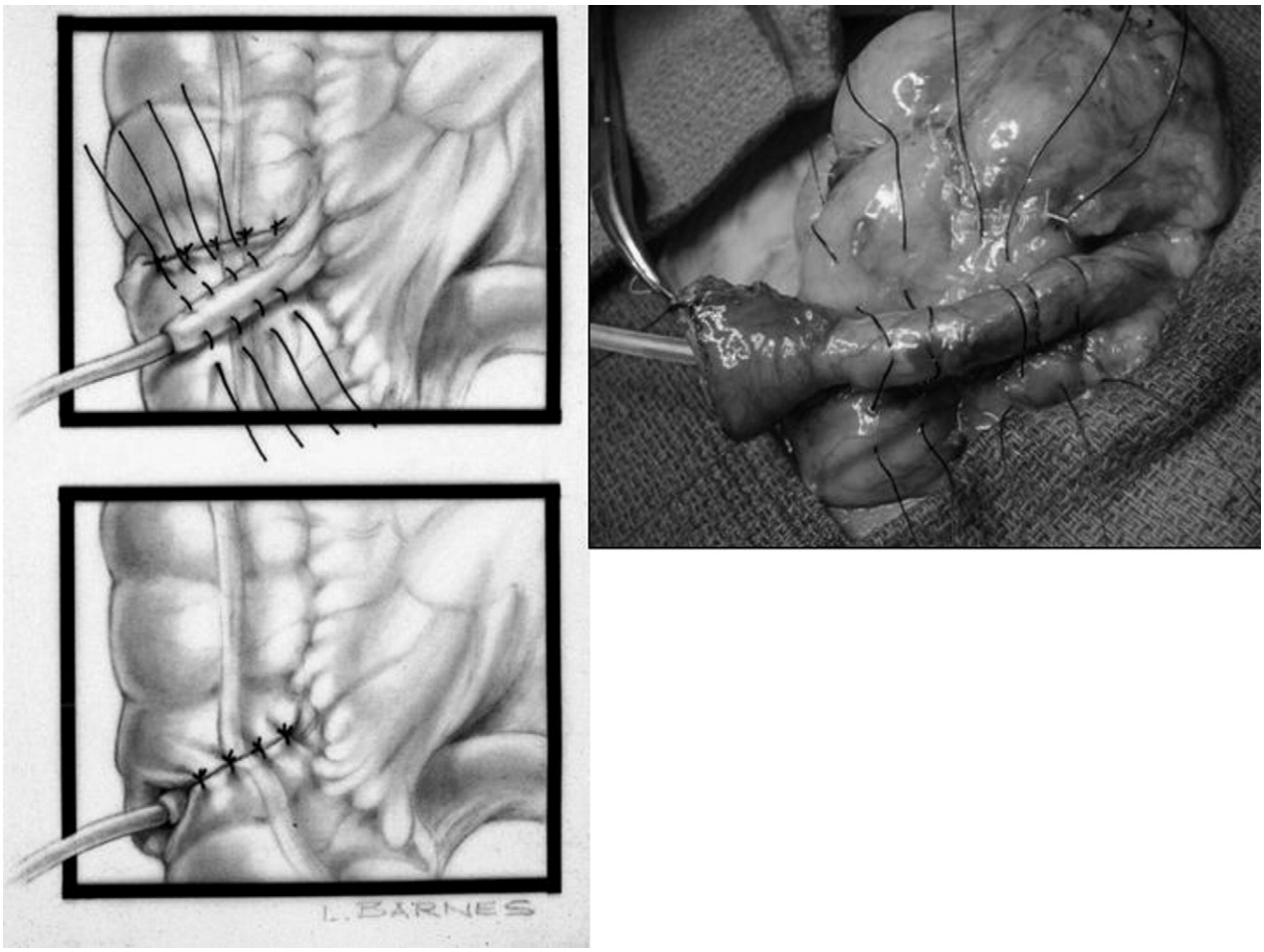


**Fig. 5** The neo-appendix is then wrapped by a segment of colon, creating a valve mechanism to minimize leakage. Illustration reprinted with permission from Elsevier [2].

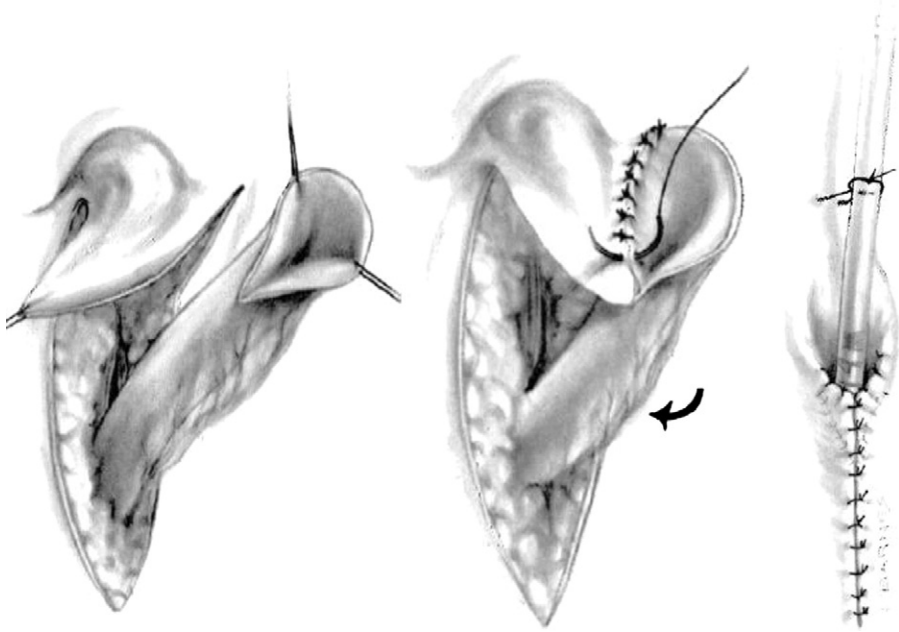

**Fig. 6** The V-V Umbilical-Appendiceal Anastomosis. This anastomosis incorporates umbilical skin to minimize stricture formation.

The patient usually stays in the hospital for 2 to 4 days. Once on a regular diet, we begin half volume enemas twice per day, through the neo-appendicostomy. They are discharged with the 8F feeding tube secured in place for a month. One month post-operatively, the catheter is removed and the family is taught how to introduce the tube through the healed neo-appendicostomy. Then the patient is placed on their routine enema, once daily.

**Fig. 7** The final appearance shows the stoma is hidden within the umbilicus. The 8F feeding tube is sutured in place, and left in the lumen of the neo-appendicostomy. Reprinted with permission from Levitt MA, Peña A. Laparoscopy in the Management of Fecal Incontinence and Constipation, In: Atlas of Pediatric Laparoscopy and Thoracoscopy. Holcomb, Georgeson, Rothenberg, eds. Saunders Elsevier, 2008, pp. 81-90.

## 2. Results

Eighty patients underwent a neo-appendicostomy at an average age of 11.7 years (47 were male, 33 female). Sixty-six patients (82%) had an anorectal malformation, 4 patients had spina bifida (5%), 3 had Hirschsprung disease (4%), and 2 had idiopathic constipation (2.5%). Five additional patients (7%) had the following diagnoses: presacral cystic teratoma, myelomeningocele, caudal regression, Currarino Triad, and developmental delay secondary to a chromosomal anomaly. Seventy-six patients (95%) were truly fecally-incontinent. Four patients had severe constipation requiring daily enemas because they were unmanageable on laxatives (5%).

In all cases, the appendix was either previously resected, or not usable for the appendicostomy. Thirty-four patients (42.5%) had undergone an "incidental" appendectomy during a previous procedure. In 20 patients (25%), the appendix was used in a Mitrofanoff procedure. In 15 patients (19%) we could find no appendix, and assumed that it was removed incidentally during one of the previous operations, even though it was not noted in the operative report, nor told to the family. Five patients (6%) had a failed Malone procedure performed previously at an outside institution, and during the redo operation, the appendix was found to be unusable. Five patients (6%) underwent a Ladd's procedure in which the appendix was removed as the routine part of the procedure, and one patient had an appendix with an obliterated lumen. In 5 patients, we converted a button cecostomy created elsewhere, into a neo-appendicostomy. The majority of patients had their neo-appendicostomy placed in the cecum or ascending colon (66 patients). Three patients had it placed in the sigmoid, 2 in the transverse colon, and 1 in the descending colon.

Following neoappendicostomy, 9 patients (11%) developed a stricture and 7 patients had leakage (9%). No patient suffered from an anastomotic dehiscence. All of these patients required a redo operation to correct the problem, which resulted in an overnight stay in the hospital. In 2004, we modified the appendiceal-umbilical anastomosis to utilize a triangular flap of umbilical skin, in an attempt to reduce the rate of stricture formation. In the 36 patients who had this V-V anastomosis, only 1 patient (3%) developed a stricture, compared with 8 patients (18%) without the V-V anastomosis ($P$ = .04). All 7 cases with leakage occurred within the first 40 cases; no patient in the last 40 cases had a leakage. Two patients had ischemia of their neoappendicostomy requiring urgent reoperation. In one of these patients, the neoappendicostomy was redone, and in the other, it was converted to a button cecostomy. Neither of these patients required admission to the intensive care unit. Two patients had a post-operative bowel obstruction that resolved spontaneously. Three patients were lost to follow-up. Currently, 70 of the 77 (91%) patients available for follow-up clean with their enema regimen; while seven patients require their regimens to be adjusted to optimize their social continence.

## 3. Discussion

Bowel management with enemas provides fecally incontinent patients with a method of staying clean of stool in their underwear for 24 hours [4-6]. Rectal enemas are easily administered to small children. However, as they grow up, it becomes more difficult, as they are difficult to administer by the patient alone, and usually requires the aid of a parent or caregiver. The Malone appendicostomy provides independence, as older children can then manage their enemas without assistance. The neoappendicostomy attempts to provide this same level of independence in patients who have had an appendectomy, or whose appendix was used for another purpose. A stoma hidden within the umbilicus presents a nice cosmetic option.

Due to our specialized practice, the vast majority of the patients had anorectal malformations. Many of these patients have had multiple prior operations, including urologic reconstructions, and so they may have lost their appendix incidentally, or it was used as part of a urinary continent diversion (Mitrofanoff procedure). In such patients, the neo-appendicostomy procedure has become our mainstay procedure.

The two main complications we encountered were stricture formation and leakage. We have found a statistically significant decrease in the incidence of stricture formation with the implementation of the V to V triangular flap into the anastomosis. We believe that this flap of skin acts like a wedge, keeping the edges of appendiceal mucosa from healing together and narrowing. In terms of leakage, the degree of plication appears to be the most important factor. There is certainly a balance between making the plication too tight, and risking compromise to the blood supply, and making it too loose and risking leakage. We believe that the two cases of necrosis were due to compression of the blood supply by a tight plication. The rate of leakage following neo-appendicostomy has decreased as our experience has grown; in the last half of our series, no leakages have occurred. Perhaps this learning curve explains the reduction in this complication.

Our approach is different than Kiely's original description in several ways [3]. We form our flap on the mesenteric, rather than antimesenteric, side of the bowel. We prefer this position as the mesenteric vessels feed the flap directly, rather than through intramural collateral flow. In order to limit leakage, we plicate the cecum around the base of the neoappendicostomy. Additionally, we attach the neoappendicostomy to the base of the umbilicus, to hide the stoma for better cosmesis. Finally, we perform a V to V anastomosis to reduce stricture. We have found that these modifications to Kiely's technique have helped to reduce the number of complications.

The button cecostomy is a common alternative for patients with no appendix available. These buttons can be placed open [7], laparoscopically [8], percutaneously [9] and endoscopically [10]. We have noted an increased number of patients attending our bowel management clinic, who have had this procedure done elsewhere. The reported advantages of the button cecostomy include a shorter operative time, and the ability to perform the procedure laparoscopically [11,12]. Noted complications include dislodgement, granulation tissue formation, leakage, pain, and ulcers (from pressure necrosis of the tube) and occur in nearly 50% of the patients [11-13]. Still, many of these complications can be managed in the clinic with simple maneuvers, including replacement and resizing. Many of these studies also show a subjective improvement in quality of life, but it is difficult to know if the improvement is due to the success of the antegrade colonic enemas, or to the button cecostomy itself. Our experience is that these tubes create foreign body reactions, similar to gastrostomy tubes, with leakage of stool, granulation tissue, and pain. In fact, Cascio et al warns the parents preoperatively, that leaking around the button is expected and that granulation tissue can develop in one third of cases [13]. We have removed several cecostomy buttons (3 in this series) at the request of the patient and family, because of these symptoms, and converted them to neo-appendicostomies. Anecdotally, these patients and families have preferred the cosmetic result of a neoappendicostomy to the button.

Interestingly, none of the patients in this series had their appendix removed for appendicitis. Over half the patients (n = 49) had their appendix removed incidentally. As a rule, we avoid incidental appendectomies in patients with risk factors for fecal incontinence (for example, anorectal malformation patients with prostatic or bladder neck fistulae,

poorly formed sacrums and tethered cords), even when performing a Ladd's procedure. We advocate against incidental appendectomies in these high-risk patients in case they turn out to require bowel management.

In 19 patients, the appendix was used in a Mitrofanoff procedure. Often, the appendix can be split and used for both the Mitrofanoff and Malone procedures [14]. With this in mind, we coordinate with the urologists regarding patients with urologic issues and fecal incontinence, to perform the Mitrofanoff procedure in conjunction with the Malone procedure, during the same operation.

## 4. Conclusion

The neo-appendicostomy is a valuable tool in the management of fecally incontinent patients who have had their appendix resected or reconstructed. We have found that the V to V triangular anastomosis reduces the risk of stricture and that the risk of leakage decreases with experience. If at all possible, patients with the possibility of fecal incontinence should have their appendix preserved, to allow for the potential for an appendicostomy procedure in the future.

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