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Re-tubularization of highly-ischemic anti-mesenteric border (ReHAB)

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ABSTRACT

Complex gastroschisis and other etiologies of intestinal compromise present a difficult medical and surgical challenge in the neonatal and pediatric population. Aggressive resection of intestinal length in these cases can lead to significant short bowel syndrome and prolonged or lifelong dependence on parenteral nutrition. This method of bowel preservation previously described has led to additional patients achieving enteral autonomy and we present their cases and most recent outcomes.

1. Introduction

In neonatal and pediatric patients, enteral nutrition is vital to the growth and development. This population of patients is vulnerable to congenital anomalies and physiologic insults which can compromise intestinal function and integrity. One such anomaly, gastroschisis, is the most common abdominal wall defect seen across the world [1]. These cases are often managed by placement of extruded abdominal viscera in silos and slowly reducing until abdominal domain is achieved. Complex cases involving long segments of compromised bowel warrant salvage techniques to prevent the development of short bowel syndrome and intestinal failure. Many complications related to long-term parenteral nutrition are described in the literature. In addition, the financial cost of home parenteral nutrition has been described to be very steep for families [2,3].

A previously described technique involving resection of significantly ischemic anti-mesenteric border of intestine followed by re-tubularization, also known as ReHAB, has provided some benefit of these patients that would otherwise develop intestinal failure and short bowel syndrome [4]. This method is based on the previously described techniques of intestinal lengthening to improve intestinal function in these patients. In these patients, salvage of native bowel provides patients with more physiologically active length as well as improved likelihood of enteral autonomy [5–7].

1.1. Case one

An 11-month-old male presented with 32% TBSA severe submersion burns to his extremities. Within the first 48 hours of admission and re-

suscitation, he developed worsening respiratory status and abdominal distention. A CT scan of his abdomen/pelvis demonstrated diffuse pneumatosis and portal venous gas. As such, operative intervention was indicated. A midline laparotomy incision was made and there was an immediate return of dark serous fluid that was foul smelling yet no succus encountered. From the jejunum to the ascending colon, there were signs of an inflammatory process as the bowel appeared purple with no signs of necrosis. There was no perforation. Due to the unstable nature of the patient, a silo (Specialty Surgical Products, Inc, Montana, US) was placed to keep the abdomen open as well as to visualize the bowel. In 48 hours, a second-look operation was performed. There were many areas of poor perfusion and some patchy areas of frank necrosis, although no perforation was seen. The stomach, duodenum, and proximal jejunum appeared healthy. The sigmoid and rectum was identified and appeared healthy as well. The left colon did not show any areas of ischemia, but the mid-transverse and right colon appeared frankly necrotic. Patchy anti-mesenteric necrosis of jejunum was resected and reapproximated. Frank necrosis of 90 cm of jejunum was resected. Patchy ischemia of the ileum was left in situ. The resultant anatomy was: from the ligament of Treitz, there was 40 cm of jejunum that was stapled off distally, an island of 5 cm of jejunum stapled off on both ends, a 15 cm segment of ileum that was stapled off on both ends, and finally transverse colon present down to the rectum. A silo was then placed. Upon operative exploration the next day, proximal jejunum appeared viable but had patchy necrosis of the anti-mesenteric surface. The distal jejunum appeared frankly necrotic. A resection of 9 cm of jejunum was performed using the GIA stapler (Covidien Surgical, Mansfield, MA, US). The areas of anti-mesenteric necrosis were excised and the bowel was reapproximated with running 5–0 PDS suture. This was

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performed for a 20 cm segment (Fig. 1). A jejunostomy and mucous fistula were created, a gastrostomy tube was placed for enteral access, and the abdomen was closed. Over the subsequent weeks, parenteral nutrition was required, and trophic tube feeds were tolerated. The decision was made to take the patient back to the operating room for stoma reversal. A 3 cm segment of bowel that had undergone the previous ReHAB procedure was noted to be severely stenosed. This segment was resected, and stoma takedown was performed as planned. At the conclusion, 25 cm of small bowel and the transverse colon remained. In the subsequent 5 months, transition to partial parenteral nutrition as well as enteral feeds was made, and the patient was discharged home. He did return later in the month with an intravenous line malfunction and infection, which was treated successfully with antibiotics, and was discharged home with parenteral nutrition as well as enteral tube feeds via the gastrostomy tube. He is being followed by the gastroenterology and nutrition teams as an outpatient. At the most recent follow-up appointment, weight gain is at the 50th percentile.

1.2. Case two

A full-term female with prenatally detected gastroschisis was born to a G3P1 mother via spontaneous vaginal delivery. At birth, the infant cried spontaneously (Apgar score at 1 minute: 8/10). Gastric decompression, fluid resuscitation, and spring-loaded silo placement were the next steps in initial management. The anus was patent. On examination of the gastroschisis, small intestine, large intestine, and stomach were outside abdominal wall, and noted to be pink and perfused. In the subsequent days, attempted reductions were difficult. An increase of abdominal pressure, need for increased respiratory support, and findings suspicious for ischemic intestine necessitated operative exploration on day of life 4. Once eviscerated the small bowel was examined and the anti-mesenteric portion of a significant portion of the small bowel appeared partially ischemic (Fig. 2). There was a frankly necrotic area in the very proximal small bowel at the jejunum. This was resected with a GIA stapler. The remainder of the bowel was examined and there was no perforation but rather 6 skip lesions of anti-mesenteric ischemia. Another silo was placed. In 48 hours, a second-look laparotomy was performed and the anti-mesenteric ischemia was again noted in addition to some frank necrosis at the mid-ileum. This was resected after decompression of thick meconium within the small bowel. After irrigation, an-

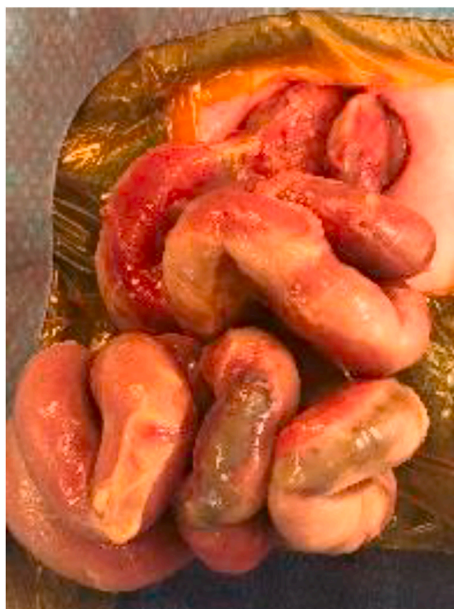


Fig. 1. Complex gastroschisis with patchy “skip” areas of ischemia and necrosis after attempted spring-loaded silo reduction.



Fig. 2. Small bowel after resection of highly-ischemic mesenteric border with re-tubularization in a patient that presented with severe extremity burns and subsequent hypotension.

other silo was placed. In 48 hours, another operative exploration was performed. Ischemia was again noted but no clear demarcations for resection were identified and a silo was placed. On day of life 12, operative exploration was repeated. Areas of ischemia on the anti-mesenteric border were identified. A wedge resection of the ischemic portion of the proximal jejunum and ileum (ReHAB) was performed. The bowel was then closed transversely with running 6-0 Prolene sutures. Bowel was flushed with saline to ensure no leak and a silo was then replaced. In 48 hours, operative exploration was again performed. One area in the proximal colon appeared necrotic, which had been noted previously. The anti-mesenteric necrotic area was excised. Due to the extension of this to the mesentery, the bowel was then brought together with multiple silk interrupted sutures and the silo replaced. In the subsequent weeks, attempts to control entero-atmospheric fistulas were made utilizing a wound vac. With abdominal domain becoming a challenge, the decision was made to return to the operating room to perform a creation of fascial and skin flaps. Additional wound vac therapy was attempted. At 3 months of life, she was noted to have developed multiple areas of intussusception. She returned to the operating room for exploratory laparotomy, extensive lysis of adhesions, reduction of 16 intussuscepted and fistulized bowel segments with resection and primary anastomosis, creation of jejunostomy and mucus fistula with Ladd's procedure, feeding gastrostomy, and appendectomy. She healed in the subsequent months and progressed to discharge home. Through multidisciplinary care and intestinal rehabilitation, she was weaned from parenteral nutrition, tolerating enteric tube feeds as well as oral solid foods, and had gained approximately 33 g per day in the month since her last follow up visit.

1.3. Previous case follow-up

In a previous series, we presented two patients with complex gastroschisis that underwent ReHAB procedures as a means of intestinal salvage [4]. In summary, the first patient was a formerly 34-week gestational age male who developed short bowel syndrome secondary to complex gastroschisis which was complicated by intestinal perforation and subsequent small bowel resections. He had undergone ReHAB procedure to attempt bowel salvage. This was complicated by small bowel obstruction due to adhesive disease which required an operative lysis of adhesions. Subsequently, the patient had progressed to discharge home. Early follow up this year was notable for the patient tolerating regular diet, passage of flatus and normal bowel function, and gaining weight appropriately.

The second patient reported was a 37-week gestational age male born with complex gastroschisis who underwent intestinal salvage with a ReHAB procedure. This was initially managed with silo but complicated by intestinal sepsis and intestinal ischemia. The patient's post-

operative course was complicated by a failure to advance on oral feeds. A subsequent exploration and extensive lysis of adhesions as well as a Ladd's procedure with gastrostomy tube placement for feeding was performed. The remainder of the post-operative course was unremarkable, and he progressed to discharge. The most recent follow-up appointment was notable for the patient having continued enteral autonomy; however, there are some behavioral challenges including distractions during meals, which are being addressed. Normal bowel function and weight gain are being documented.

2. Conclusion

Herein, we describe additional cases and updated outcomes of patients who underwent intestinal salvage via re-tubularization of highly-ischemic anti-mesenteric border (ReHAB) [4]. Although these patients have had differing post-operative and clinical courses, each had an increased potential for enteral autonomy, nutritional stability, and growth. Counseling these patients and parents about potential short and long-term complications is important moving forward. Follow-up with intestinal rehabilitation clinics and programs can also optimize nutritional status and weight gain in this population. Our technique has shown promise for not only gastroschisis patients, but also any patient who sustains an ischemic intestinal insult which would otherwise portend extensive resection and short bowel syndrome.

Our experience with this technique will involve continuing to follow these patients in the long-term to determine outcomes. With the multidisciplinary approach to treatment and nutritional optimization, it is our hope that we can provide a durable surgical option in selected patients at risk for intestinal failure and short bowel syndrome.

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Authorship

All authors attest that they meet the current ICMJE criteria for Authorship.

Consent

Patient consents were obtained prior to submission of this work. This report does not contain any personal information that could lead to the identification of the patients.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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