

Chyme reinfusion in children undergoing temporary gastrostomy with a double enterostomy: A case report

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Abstract. Chyme reinfusion is an enteral nutrition technique that allows for the re-establishment of gastrointestinal continuity by reinfusing the chyme from the afferent to the efferent small bowel through an extracorporeal artificial tract. This leads to the improved intestinal absorption of the chyme, thus preventing water loss, disruptions in electrolyte balance, malnutrition and micronutrient deficiencies. This feeding method also minimizes the high costs and multiple complications related to conventional parenteral nutrition until the surgical re-establishment of intestinal continuity (SRIC). The aim of the present case report was to present an effective treatment approach, digestive fluid reinfusion, applied in a pediatric patient who underwent bowel resection due to midgut volvulus. The present study reports the case of a 2-month old male infant with a diagnosis of midgut volvulus who underwent surgery for resection of the necrotic bowel segment and closing of the duodenojejunal stump, namely a gastrostomy, and to bring the lower bowel segment out to establish an artificial anus. Pending for the SRIC, chyme reinfusion was applied in conjunction with the parenteral nutrition. Following 8 weeks of treatment, the nutritional status had improved and the patient underwent a successful SRIC. On the whole, in patients with temporary double enterostomy pending for SRIC, chyme reinfusion is an efficient and effective method which can be used to initiate early enteral feeding and reduce the need for parenteral nutrition.

Introduction

Double enterostomy or the creation of an artificial anus is commonly employed in gastrointestinal surgeries, particularly in cases of trauma or obstruction. While these procedures are often lifesaving, they disrupt gastrointestinal continuity, leading to a significant loss in water, electrolytes and nutrients, and are associated with an increased risk of developing severe complications or even mortality (1). The mortality rate in this group remains relatively high, ranging from 5 to 20% (1,2).

The main treatment strategies for patients following double enterostomy/artificial anus include fluid-electrolyte management, infection control, nutritional therapy and bowel anastomosis surgery. While pending the following surgical procedure, patients are typically provided with parenteral nutrition to ensure adequate energy intake (1). However, parenteral nutrition is often costly and is associated with multiple risks, such as infection, liver dysfunction and more (3). Therefore, early enteral nutrition is recommended, with benefits such as protecting the gastrointestinal tract, reducing infections, maintaining gut immunity and preventing intestinal mucosal atrophy. Furthermore, due to the complex nature of bowel resection surgery, a special method is required to keep the continuous flow of the digestive tract (1).

Chyme reinfusion (CR) is a method that involves the reinfusion of chyme from the afferent segment into the efferent segment of the small bowel. This technique helps to re-establish gastrointestinal continuity and revascularize the distal bowel segment (4). Additionally, CR reduces the volume of chyme lost through drainage, alleviates abdominal distension, improves liver function and enhances nutritional status (5,6). The general principle of this method is to use an artificial catheter connecting the two ends of the drained intestine, with a pump assisting in the infusion of digestive fluid through this artificial tract (Fig. 1). The application of this method should be based on the specific condition of each patient, requiring careful infection control and effective utilization of chyme. Worldwide, the CR method has been widely used in adults in numerous countries (7). However, its application in children remains limited and is less commonly practiced (7). Similarly,

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in Vietnam, the use of CR has begun to be implemented in adults in some hospitals; however, there are a limited number of reports available on its application in children.

The aim of the present case report was to highlight the practical implementation and outcomes of CR in an infant, a setting where this method has rarely been reported, particularly in Vietnam. The present study reports the case of a 2-month-old male infant admitted with a diagnosis of midgut volvulus. The child underwent surgery for the resection of the necrotic bowel segment and closing the duodenojejunal stump, a gastrostomy, and to bring the lower bowel segment out to create an artificial anus. The infant was nourished using the CR method while awaiting the following surgical procedure. To the best of our knowledge, the present case report constitutes one of the first documented cases in Vietnam, reporting the successful application of CR in an infant who underwent a temporary double enterostomy and gastrostomy. It contributes to the limited literature available on the pediatric use of this method and demonstrates its feasibility in resource-limited settings. The present case report was prepared in accordance with the CARE guidelines (8).

Case report

The patient was a 2-month-old male infant (weight, 3 kg) with no known comorbidities and a birth history of full-term vaginal delivery, an uneventful perinatal period and no prior hospitalizations. A 2-month-old male infant with a history of midgut volvulus due to Ladd's bands at 31 days of age at the Vietnam National Children's Hospital. The infant had undergone two surgical procedures for intestinal resection. The remaining upper bowel segment, located near the duodenojejunal junction, was closed, and a gastrostomy was performed using a Foley catheter. The distal end of the bowel segment, 70 cm from the ileocecal junction, was diverted to the abdominal wall (right flank). The distal segment exhibited multiple areas of necrosis, which were addressed during surgery by resecting a 5 cm segment of necrotic bowel, performing an end-to-end anastomosis, and debriding necrotic tissue, followed by primary repair of the muscle layer.

Post-operatively, the infant was treated in the intensive care unit. Due to the complexity of the surgery and to stabilize the remaining 70 cm of the small bowel, the infant was kept nil by mouth (NPO) and received total parenteral nutrition for 4 weeks. The energy requirements through intravenous nutrition alone were ~70-80 kcal/kg/day. The infant had an average physical condition, but did not exhibit any gain weight over the period of 4 weeks. Additionally, tests evaluating the nutritional status of the infant did not reveal any deficiencies in micronutrients.

The infant was indicated for a surgical procedure to perform an intestinal anastomosis. However, due to significant necrotic damage to the remaining small bowel, the child required time for recovery. It was deemed that prolonged parenteral nutrition may not ensure adequate energy supply and could lead to various complications. Furthermore, enteral feeding was challenging due to the very short remaining bowel segment near the duodenojejunal junction. The infant was prescribed treatment with the digestive fluid reinfusion method (CR). In Vietnam, this is a novel approach, and there

is a lack of systematic reports on its application in pediatric patients. Therefore, the treatment process faced a number of challenges, particularly concerning the required equipment and feeding techniques.

An anastomosis was performed between the Foley catheter, at the site of the upper gastrostomy and the ileal drainage below, using a three-way connector. The purpose of this method is to utilize the chyme from the upper bowel segment and reinfuse it into the lower bowel segment. Initially, the infant was fed minimally with fully hydrolyzed milk, 5 ml per meal (administered drop by drop over a period of 30 min), with meals spaced 3 h apart. The infant was administered a proton pump inhibitor (Esomeprazole) at a dose of 2 mg/kg, divided into two doses per day, to ensure the pH of the gastric fluid (pH >6). Furthermore, as the digestive fluid contains significant amounts of bile, its pH remains within a safe range of 6.0-6.5. The volume of chyme will flow through the three-way connector and gradually move into the lower bowel segment. The method of CR used in the patient is illustrated in Fig. 2.

Following 4 weeks of reinfusion feeding, the infant was fed orally with milk using the spoon-feeding method, gradually increasing to 60 ml per meal, equivalent to ~500-600 ml per day. The energy provided via the oral route accounted for ~80% of the total energy requirements of the infant. This helped improve the physical condition of the infant, it reduced the reliance on parenteral nutrition and contributed to the recovery of gastrointestinal function. Specifically, following 3 weeks of reinfusion feeding, the infant gained 500 g in weight. The status of the infant was adequate, and the lower bowel segment was sufficiently stable to proceed with the ensuing surgery.

Currently, the infant has successfully undergone the bowel anastomosis. Following surgery, the infant was started on early enteral feeding, with a gradual reduction in parenteral nutrition needs, and was discharged after 2 weeks following bowel closure. Enteral nutrition almost fully met the hydration, nutrient, and energy requirements of the infant. An image of the patient upon discharge is presented in Fig. 3.

In summary, the present study reports the case of a 2-month-old male infant who was admitted with vomiting, abdominal distension and signs of bowel obstruction. A physical examination revealed signs of peritonitis. The infant was diagnosed with midgut volvulus secondary to Ladd's bands. He underwent emergency laparotomy with the resection of necrotic bowel, formation of gastrostomy and temporary double enterostomy. Following CR and combined parenteral support, the patient exhibited weight gain, an improved nutritional status, and successfully underwent bowel reconstruction after 4 weeks.

Discussion

In pediatric patients with bowel drainage or artificial anus, malnutrition and complications are the leading causes of mortality. Definitive surgery is recommended to be delayed for at least 3 months after the last surgery. Therefore, nutritional support to prepare the patient for the next surgery is crucial (9). Parenteral nutrition is considered the standard method for treating patients with bowel drainage or an artificial anus (1).

Enteral nutrition provides superior benefits and should be implemented early after surgery if the condition of the patient permits. In addition to reducing complications caused by

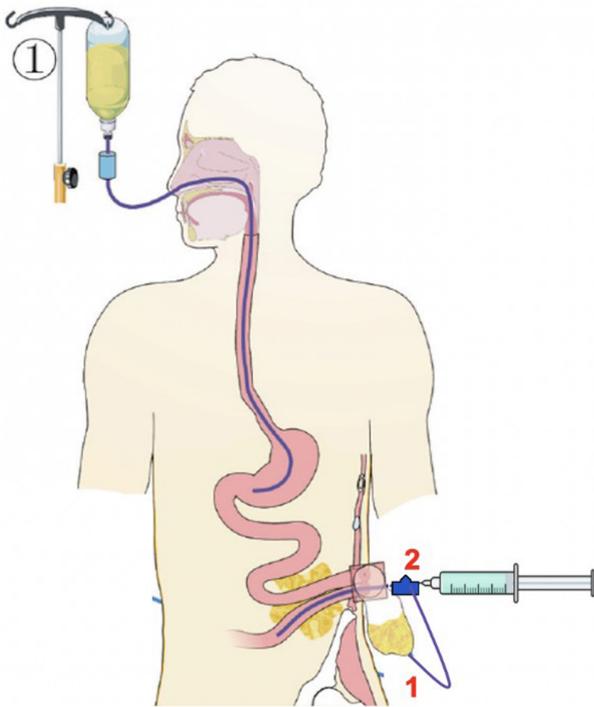


Figure 1. Mechanism of the method of chyme reinfusion. 1, Chyme from the upper bowel segment is drained externally through the artificial anus; 2, a feeding tube drains chyme from the pump to the lower bowel segment.



Figure 3. Image of the patient upon discharge.

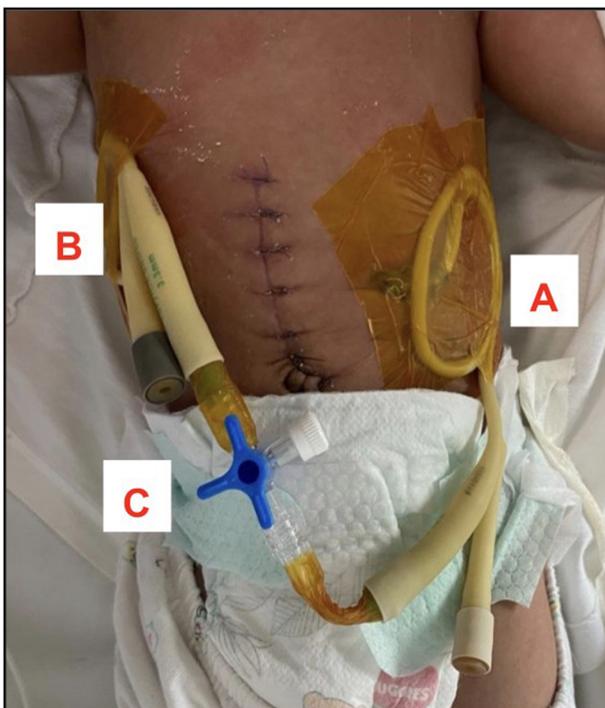


Figure 2. The patient in the present study treated with the method of chyme reinfusion. (A) Foley catheter tip, (B) ileal catheter tip, (C) T-shaped connector (three-way connector).

prolonged parenteral nutrition, enteral nutrition has been shown to be effective in improving intestinal barrier function and reducing inflammatory responses. However, enteral nutrition is also associated with the risk of dehydration and electrolyte

imbalance due to increased fluid loss through the artificial anus. As a result, the method of CR has been proposed as a way to establish early enteral nutrition and revascularize the bowel segment in cases of continuous gastrointestinal loss (4,7). CR not only provides the benefits of enteral nutrition, but also helps minimize fluid and electrolyte loss. There have been several reports of successful outcomes using this method (4-6).

CR helps reduce dehydration, electrolyte imbalance, digestive enzyme loss and bile fluid loss by utilizing fluid from the upper gastrointestinal tract. As a result, it reduces dependence on parenteral nutrition and the complications associated with it. This method also improves liver function by enhancing the enterohepatic circulation, improves the function of the remaining intestinal segment by increasing intestinal perfusion, facilitates later bowel closure surgery, reduces the incidence of anastomotic leak and stricture after bowel closure surgery and ultimately significantly reduces treatment costs (10).

There are two main methods of CR commonly reported in the literature. The first method involves manually collecting chyme from the upper bowel segment and infusing it into the lower bowel segment using a syringe or infusion bag, either manually or with an electric syringe pump. The second method involves the uses of a closed-loop reinfusion system that allows uninterrupted flow between the two anastomosed segments by employing a continuous suction system to remove digestive fluid from the proximal end and pump it into the distal end according to the normal peristalsis of the digestive tract (1,2). Currently, in Vietnam, there is no closed-loop system for this method; thus, the patient described herein had the digestive fluid drained from the stomach into the distal end via a Foley catheter three-way connector. This method has the advantage of ensuring the proper

and continuous flow of digestive fluids, is more convenient, aesthetically pleasing and reduces potential complications associated with CR, such as infection, bleeding or intestinal perforation. No reports in the literature have been found regarding CR using this method, at least to the best of our knowledge.

In the present case report, the reinfused chyme primarily consisted of gastric fluid and duodenal secretions, including bile. The pH was maintained between 6.0 and 6.5 using proton pump inhibitors to prevent mucosal irritation. The initial chyme volume reinfused was 5-10 ml per session, gradually increasing as tolerated. The composition and pH of chyme play an essential role in maintaining gut mucosal integrity and enzymatic activity. Future studies are required however, to better define optimal volume and composition in pediatric populations.

While CR has been more commonly studied in adults, particularly in patients with enterocutaneous fistulas or short bowel syndrome, its application in pediatrics remains limited. For example, the studies by Teubner *et al* (6) and Picot *et al* (10) in adults demonstrated significant reductions in parenteral nutrition dependence and improvements in liver function. In comparison, the present case report of a 2-month-old infant highlights the potential for similar clinical benefits, albeit with careful volume control and monitoring due to the smaller intestinal capacity in neonates and infants.

After almost 1 month of successful CR using this method, the child in the present study was able to consume large amounts of milk orally, ~500-600 ml per day, without vomiting. The peristalsis of the lower intestine was functioning well, and the need for parenteral nutrition was significantly reduced. The physical condition of the child was good, with adequate weight gain; thus the child was deemed suitable for intestinal anastomosis surgery and enabling an early discharge.

Despite its benefits, CR in pediatric patients presents several challenges, including limited availability of pediatric-specific reinfusion devices, technical difficulty in maintaining catheter patency, risk of infection and the lack of standardized protocols tailored to infants.

In conclusion, the present case report highlights that CR is a practical, safe, and effective method for early enteral nutrition in infants with temporary enterostomies. It reduces dependence on parenteral nutrition and facilitates timely bowel reconstruction. Pediatric surgeons and intensivists should consider this method as part of nutritional management in similar cases.

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Availability of data and materials

The data generated in the present study may be requested from the corresponding author.

Authors' contributions

All authors (HTTN, NTTD, DQL, ATT, DTT, ATN, HNV and LTN) contributed to the conception and design of the study. The collection of the patient's data was performed by NTTD, DQL, ATT, DTT and ATN. The first draft of the manuscript was written by HTTN and HNV, and all authors commented on previous versions of the manuscript. HTTN, NTTD and DQL were involved in the treatment of the patient. HTTN and DTT confirm the authenticity of all the raw data. All authors have read and approved the final version of the manuscript.

Ethics approval and consent to participate

The parents of the child were explained about the purpose of the study and were required to sign the consent forms. Written informed consent was obtained from the parents for the children participation in the present study.

Patient consent for publication

Written informed consent was obtained from the parents of the child for the publication of the present case report and any accompanying images.

Competing interests

The authors declare that they have no competing interests.

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