



Mucous fistula refeeding in neonates with enterostomies^{☆,☆☆}



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ABSTRACT

Background/Purpose: Neonates with intestinal pathology may require staged surgery with creation of an enterostomy and mucous fistula (MF). Refeeding (MFR) of ostomy output may minimize fluid and electrolyte losses and reduce dependence on parenteral nutrition (PN), though a paucity of evidence exists to support this practice. The purpose of this study was to assess the outcomes of infants undergoing MFR and document associated complications.

Methods: With REB approval, infants with intestinal failure undergoing MFR between January 2000 and December 2012 were identified. A chart review was conducted and relevant data were collected. Descriptive statistics were used. **Results:** Twenty-three neonates underwent MFR. Mean gestational age and birth weight were 35 weeks and 2416 grams. Pathologies included intestinal atresia ($n = 12$), necrotizing enterocolitis ($n = 5$), meconium ileus ($n = 4$), and other ($n = 6$). Seven patients were able to wean from PN. Four patients had complications: 3 had perforation of the MF, 1 had bleeding. Four patients died, with one death directly attributable to MFR.

Conclusions: In this cohort MF refeeding was associated with significant complications and ongoing PN dependence. With advances in intestinal rehabilitation and PN, the benefit of MF refeeding must be weighed against the potential complications.

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Neonates with small bowel obstructions, including intestinal atresia, meconium ileus, volvulus, and abdominal sepsis secondary to perforated necrotizing enterocolitis (NEC) often require staged surgical management with creation of an enterostomy and mucous fistula (MF) [1,2]. This is a diverse and complicated population of patients who have complex surgical and nutritional needs. The presence of a proximal small bowel enterostomy typically results in poor tolerance of enteral feeding owing to high stoma losses and associated fluid and electrolyte imbalances. These patients often rely on temporary or long-term parenteral nutrition (PN) for growth and development which carries the risk of significant complications including sepsis and PN associated cholestasis [1,3]. Refeeding of ostomy losses into the distal MF (MFR) has been used to minimize fluid and electrolyte losses as well as dependence on PN. There is little evidence to support the safety and efficacy of this practice [4–11].

Modern PN strategies, including alternate lipid sources and the introduction of multidisciplinary intestinal rehabilitation teams have significantly improved the safety of PN and the nutritional outcomes of infants with intestinal failure [3,12–14]. Given the paucity of data on jejunoileal feeding of ostomy output and the changing paradigm of

infant nutritional support, evaluation of the practice of MFR and the associated outcomes and complications is warranted. The purpose of this study was to describe a series of infants managed with MFR and assess the associated nutritional outcomes and complications.

2. Materials and methods

A single center retrospective review of neonates undergoing MFR between January 2000 and December 2012 was conducted with Research Ethics Board approval (H14-01422). Cases were identified for inclusion from the Neonatal Intensive Care Unit (NICU) discharge database. These were cross-referenced with the enterostomal clinic records where cases were separately documented. Demographic, clinical and outcome data were collected including sex, gestational age, birth weight, diagnosis, presence of prenatal diagnosis, number of operative interventions, duration of parenteral nutrition, duration of MFR, complications, nutrition on discharge, duration of hospital and NICU stay and mortality. Long-term follow-up was recorded where available.

At our institution MFR is considered in selected neonates after surgical creation of enterostomies and distal mucous fistulae. The decision to proceed with MFR is made based on surgical anatomy of the patient (distance of the ostomy from the ligament of Treitz) and observation of the ostomy losses after a period of enteral nutrition. Prior to initiation of MFR, patency of the distal bowel is ensured by means of a contrast fluoroscopy study through the MF. Once patency has been established proximal stoma output is collected and delivered into the distal MF

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through a variety of feeding catheters, in either an intermittent or continuous fashion, depending on the rate of stoma losses and surgeon preference. The rate of MFR is advanced according to tolerance with an ultimate goal to match the proximal enterostomy output. The infants are supported with PN until enteral autonomy is achieved. Mucous fistula refeeding catheters are placed by a variety of personnel including the surgical team in the operating room or the enterostomal therapist or nurses at the bedside. When frequent catheter dislodgement is an issue or there is significant back flow around the catheter, tubes have been advanced down the MF under fluoroscopic guidance by an interventional radiologist.

The primary outcomes of interest were the rate and nature of complications associated with MFR. Secondary endpoints included describing the nutritional and clinical outcomes including maximal enteral caloric intake during MFR, nutrition on discharge, duration of MFR and PN administration, number of operative interventions, as well as length of stay in the NICU and total length of hospital stay.

3. Results

During the twelve-year study period 25 neonates managed with MFR were identified. Two were excluded because of inadequate documentation leaving a study population of 23 subjects. The mean gestational age and birth weight were 35 weeks (range 23–40) and 2461 grams (range 585–4294 grams) (Table 1). Females made up the majority of the population (57%). Underlying intestinal pathology included intestinal atresias (jejunal, ileal and colonic) ($n = 14$), necrotizing enterocolitis ($n = 5$), meconium ileus ($n = 4$), complicated gastroschisis ($n = 2$), small bowel volvulus ($n = 2$) and rotation abnormalities ($n = 2$). These patients were treated with a median of three operative interventions each (range 2–54). Ten patients presented with perforation at the time of initial surgery. In the majority of cases (65%) there was a prenatal diagnosis of bowel obstruction, perforation or gastroschisis.

These patients were all complex and ill, suffering from a variety of complications of the underlying intestinal failure (Table 2). The most common complication was PN associated cholestasis (17, 74%), of which three patients (13%) progressed to liver failure and the need for transplant assessment. Twelve (52%) central line complications were identified including 10 patients with central line associated infections, one who had a catheter associated thrombosis and one patient whose line migrated extravascularly and developed a PN associated pleural effusion. Other complications included surgical site infection, dehiscence, anastomotic stricture, gastrointestinal hemorrhage and transfusion reaction.

Seventeen percent ($n = 4$) of patients suffered major complications directly associated with MFR. Several different types and sizes of MFR catheter were inserted into the MF around the time of these complications including a 5 and 6.5 French silastic feeding tube, a 5 French

Table 2
Complications.

	n (% of patients)
Mucous fistula refeeding-associated complications	
Perforation	3 (13.0)
Bleeding requiring transfusion	1 (4.3)
Total	4 (17.4)
Other complications	
PN ^a cholestasis	17 (73.9)
Liver failure with transplant assessment	3 (13.0)
Catheter associated sepsis	10 (43.5)
Sepsis - other	9 (39.1)
Line complication - other	2 (8.7)
	1 IVC ^b thrombosis
	1 PN pleural effusion
Surgical site infection	9 (39.1)
Stricture	2 (8.7)
Dehiscence	2 (8.7)
GI ^c bleed requiring transfusion	2 (8.7)
Abdominal wall necrosis	1 (4.3)
Transfusion reaction	1 (4.3)
Total	58
Mortality	
MFR ^d associated	1 (4.3%)
Total	4 (17.3%)

^a PN = parenteral nutrition.

^b IVC = inferior vena cava.

^c GI = gastrointestinal.

^d MFR = mucous fistula refeeding.

silicone Foley catheter and a 12 French MIC gastrostomy® tube (Kimberly-Clark, Roswell, Georgia). These were placed by a variety of techniques and team members including an enterostomal therapist, pediatric surgery fellow, interventional radiologist, and a staff surgeon. The first refeeding associated complication involved recurrent MF hemorrhage requiring multiple blood transfusions (secondary to PN associated liver failure and portal hypertension). Three patients sustained enteric perforations of the mucous fistula, one of whom was managed medically while the other two required operative intervention. In one case, an initial attempt was made to manage nonoperatively with broad spectrum antibiotics owing to patient stability. Unfortunately, within four hours he developed septic shock and abdominal compartment syndrome requiring an open abdomen and the subsequent development of associated complications including abdominal wall necrosis and enterocutaneous fistulae with need for recurrent operative interventions, 54 in total. Peritoneal cultures taken at the time of decompressive laparotomy grew the following enteric flora: *Enterococcus faecalis*, *Enterobacter aerogenes*, *Escherichia coli*, and *Candida albicans*. This patient remained PN dependent and subsequently developed PN associated liver failure. He developed a peripherally inserted central catheter-associated Budd Chiari with extensive inferior vena cava thrombus, recurrent bacteremia, portal hypertension and multiple episodes of gastrointestinal bleeding. Ultimately, death resulted from multiorgan failure. This mortality was considered directly attributed to MFR.

Three other mortalities occurred in this cohort. These deaths were not felt to be directly related to MFR. One patient, with a history of NEC, died of multiorgan failure after stoma closure complicated by hemorrhagic shock secondary to PN associated liver disease. A patient with meconium ileus and PN associated cholestasis died as a result of cystic fibrosis associated respiratory failure. The fourth mortality occurred in a patient with complex jejunal atresia and congenital heart disease who died from sepsis leading to cardiorespiratory failure. The overall mortality rate for neonates undergoing MF refeeding was 17.4%.

Of the 17 patients who developed PN associated cholestasis, eight patients were able to achieve greater than 50% of their nutrition enterally; five achieved complete enteral autonomy (Table 3). Overall, the mean proportion of enteral caloric intake achieved during refeeding was 64%. For all 23 subjects the mean maximum rate of refeeding through the MF was 10.5 ml/h (range 0.5–23 ml/h). Mucous fistula

Table 1
Clinical characteristics.

	n = 23 (range) (%)
Mean gestational age (weeks)	35 (25–40)
Mean birth weight (grams)	2416 (585–4294)
Gender	
Male	10 (43.5)
Female	13 (56.5)
Diagnosis	
Jejunal/ileal atresia	12 (52.2)
Necrotizing enterocolitis	5 (21.7)
Meconium ileus/CF ^a	4 (17.4)
Colonic atresia	3 (13.0)
Gastroschisis	2 (8.7)
Malrotation	2 (8.7)
Small bowel volvulus	2 (8.7)
Perforation at presentation	10 (43.5)
Prenatal diagnosis	15 (65.2)

^a CF = cystic fibrosis.

Table 3
Nutritional and clinical outcomes.

	n (%)	
Nutritional outcomes		
Mean duration of PN ^a (days)	132.8	
Mean duration of MFR ^b (days)	36.2	
Mean maximum rate of MFR (ml/h)	10.6	
Mean maximum enteral caloric intake achieved during MFR (%)	64.3	
Mean maximum MFR volume achieved ^c (%)	66.1	
Mean maximum enteral caloric intake during MFR in patients with PN cholestasis ^d (%)	61	
Nutrition on discharge ^e	Supplemental PN	1 (5.2)
	Continuous feeds	7 (36.8)
	Bolus or ad lib	12 (63.2)
Clinical outcomes		
Mean duration of NICU ^f stay (days)	116.7	
Total duration of hospital stay (days)	158.7	

^a PN = parenteral nutrition.^b MFR = mucous fistula refeeding.^c Calculated as percentage of enteral volume.^d Calculated from n = 16 as data were missing for one patient.^e Calculated from n = 19 as four patients did not survive to discharge.^f NICU = neonatal intensive care unit.

refeeding was utilized for a mean duration of 36 days (range 10 to 79 days). The mean duration of PN delivery was 133 days (range 18–319 days). Of 19 patients ultimately discharged from hospital one remained on supplemental PN, seven were on continuous feeds and 12 were receiving measured bolus or ad lib feeds. Mean lengths of NICU and total hospital stay were 117 and 159 days, respectively.

Nineteen patients were initially available for long-term follow-up, however one patient went overseas and was lost to follow-up. The majority of these patients (15 of 18) were reviewed in the outpatient setting at some point following discharge from hospital. The mean follow-up period was 8.5 months (range 8 months to 14 years). The two surviving patients with MFR complications are included in this group. One patient (last seen 13 months after discharge) was still on gastrojejunostomy tube feeds at the time of assessment while the other (last seen 9 months after discharge) had recently started taking all of her nutrition orally and had her gastrojejunostomy tube removed.

4. Discussion

The neonatal population requiring surgical management for potentially catastrophic intestinal pathology resulting in bowel obstruction or perforation is a diverse and highly morbid group [1,15–17]. The thread bringing these patients together is the common need for staged surgical management with the creation of a proximal enterostomy and distal mucous fistula. Given the degree of gastrointestinal pathology, or by virtue of operative intervention, this group is subject to intestinal failure leading to PN dependence [18–20]. Depending on the level of the enterostomy as well as the absorptive function of the proximal bowel, nutritional challenges as well as electrolyte and fluid derangements may occur. Unfortunately, PN has long been associated with its own set of devastating complications including sepsis, cholestasis and liver failure.

Since Puppala's introduction of MFR in the 1980s this method has been employed to theoretically avoid reliance on PN by simulating an intact gastrointestinal tract, thereby minimizing fluid and electrolyte losses, and inducing intestinal adaptation for eventual reanastomosis [4–11,21,22]. Little data support the safety and efficacy of this practice. In a systematic review Richardson et al. summarize the findings of what has been considered a completely safe practice of MFR with no complications described in any of the five studies included [7]. More recently, Pratap et al. have described complications including a pelvic collection requiring sonographically guided drainage as well as two stomal strictures requiring revision in their ten patient series [9]. The current study documents some devastating complications in our own MFR population.

In our population of 23, four patients (17%) suffered major complications caused by MFR. This included three intestinal perforations and one hemorrhage requiring transfusion. Minor bleeding (not necessitating transfusion) was not considered a complication. One of the three perforated patients ultimately died as a result of a series of complications stemming from the original perforation. This mortality was considered to be directly attributable to MFR. Of the other two perforations, one was managed medically and the other was taken to the operating room for an exploratory laparotomy with lavage and resection of the perforated segment of small bowel. Mucous fistula refeeding should not be viewed as a harmless practice given the potential for such significant complications including mortality. Like any other intervention with potential risks refeeding should be carefully evaluated.

Even with the theoretical benefit of preventing the detrimental hepatic effects of PN through MFR, we identified seventeen patients (74%) with PN-induced cholestasis. This is in spite of the fact that eight of the seventeen patients achieved greater than 50% of their caloric intake enterally with five patients reaching complete enteric autonomy. The necessity of the MFR practice should be further questioned in the era of modern parenteral nutrition delivery with multidisciplinary intestinal rehabilitation teams who employ a variety of strategies to prevent the well-known septic and cholestatic complications historically associated with PN. This includes the use of alternative lipid sources, PN cycling and antibiotic or ethanol locking of central lines used for PN. Consideration may also be given to intestinal lengthening procedures [3,12,14,23,24].

Part of the rationale for MFR is a theoretical benefit of refeeding partially digested feeds with gastric, pancreatic, and biliary fluid into the jejunum or ileum [4]. However, there is a possible risk of bacterial overgrowth in the stomal output if there is a delay between collection and refeeding of the stoma effluent. Thus, in the event of perforation there is potential for delivering a high microbial load of incubated gastrointestinal flora within the feed along with gastrointestinal fluid directly into the peritoneal cavity, regardless of proximal diversion. Our case of the patient with MF perforation and gastrointestinal pathogens growing from his peritoneal cultures would appear to support this theory. Based on this rationale it may be prudent to consider early operative intervention in these patients rather than waiting to see if they can be stabilized with antimicrobial therapy. Perhaps if this immediate operative strategy had been employed in the case of our patient who ultimately died as a result of his perforation, the clinical outcome may have been different.

There are several limitations to the current study. This is a retrospective descriptive study, and as such vulnerable to bias. Our sample size was small and heterogeneous owing to the relatively uncommon presentation of this spectrum of disease. The review was restricted to the experience of a single center potentially limiting the general applicability of our findings. Selection of patients for MFR was primarily by surgeon preference and experience. Route of delivery as well as types of refeeding tubes used was highly variable, again depending on surgeon experience and preference. No reliable information was available which documented how long enterostomy outputs were stored before being delivered to the distal mucous fistula, which should be evaluated prior to acceptance of this practice in order to ensure its safety.

5. Conclusion

The routine use of mucus fistula refeeding needs to be questioned owing to the potential for serious morbidity and mortality. Further support for the avoidance of MFR arises as there is continued progress and advancement in the care of infants and children with intestinal failure. Alternatively, in the future, increased understanding of how to optimally manage distal, defunctioned bowel may result in modifications in the type of feed delivered or the technique of mucous fistula refeeding, resulting in improved safety and efficacy in this patient population. As a result of the extraordinary harm documented in some of our patients, our group has placed a moratorium on mucous fistula refeeding at

British Columbia Children's Hospital. Future prospective studies are needed to more closely investigate this matter.

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