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Ultrasound-guided contrast enema for meconium obstruction in very low birth weight infants: Factors that affect treatment success

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ABSTRACT

Introduction: This study aimed to assess the therapeutic results of ultrasound (US)-guided water-soluble contrast enema in very low birth weight (VLBW) preterm infants (<1,500 g) with meconium obstruction and to study factors that affect therapeutic results.
Methods: This study included a total of 33 consecutive VLBW infants with clinically diagnosed meconium obstruction underwent US-guided water-soluble contrast enema, from April 2007 to March 2014. Patients were classified into two groups based on to procedure outcome: the success group (evacuation of the meconium plug resolution followed by improved bowel distention within 2 days of the procedure, without additional interventions), and the failure group (the contrast enema failed to relieve the obstruction, or other procedure-related complications occurred). Patient- and mother-related clinical factors and procedure-related factors were compared between both groups.
Results: Overall success rate was 54.5%, with 18 successful (M:F = 10:8), and 15 failure (M:F = 7:8) cases. When compared with the failure group, the success group patients showed statistically significant older gestational age (29^{+1} vs. 27 weeks; $p = 0.028$), larger birth weight (1023.1 g vs. 790.3 g; $p = 0.048$), and higher body weight on the day of the procedure (1036.2 g vs. 801.6 g, $p = 0.049$). However, no statistically significant differences were seen between other patient and maternal factors. Among the procedure-related factors, retrial of contrast injection during the procedure was associated with significantly higher success than the single trial ($p = 0.027$). The presence of refluxed contrast into the distal ileum was the statistically significant predictor for success of the procedure ($p = 0.038$). There were three cases of bowel perforation (9.1% per person).
Conclusion: US-guided water-soluble contrast enema in VLBW infants with meconium obstruction showed a 54.5% success rate and a 9.1% perforation rate per person. Among the procedure-related factors, retrial of contrast injection during the procedure and the presence of refluxed contrast into the distal ileum were related to the success of the procedure.

1. Introduction

A thick and sticky inspissated meconium can cause bowel problems with a wide spectrum of severity in neonates, ranging from transient functional ileus and meconium plug syndrome (MPS) to meconium ileus associated with cystic fibrosis [1,2]. Among them, meconium obstruction of prematurity (MO) was first reported by Clatworthy et al. and in preterm infants, it is now considered to be a distinct entity of meconium disorder, having several different characteristics, when compared with the MPS [1,2]. Unlike MPS which is the preferred term for full-term infants, diagnosis of MO in preterm infants is made when there developed obstructive symptoms with progressed abdominal distention several days after having passed some initial meconium without definite underlying condition that

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can cause bowel distention such as congenital bowel obstruction, necrotizing enterocolitis (NEC) or hypothyroidism [3–5]. MO is thought to be due to the highly viscid meconium and the immature, poor motility of the bowels in preterm infants [4,6]. A few reports suggest that poor bowel motility can be associated with the immaturity of ganglia [6–8]. Whether this disease is the same or a separate entity compared to MPS is still debated [5,9,10]. However, it is undoubtedly important to discuss this disease entity due to its increasing incidence [1–3], along with the appropriate management needed to prevent associated complications owing to the increased intraluminal pressure that can lead to bowel ischemia and result in necrotizing enterocolitis (NEC) or sepsis [11,12].

Our institution has introduced the routine glycerin enema until 7 days after birth in order to prevent MO in very low birth weight (VLBW) infants (birth weight < 1500 g) [13]. However, glycerin enemas did not prevent all cases of MO and several cases required further interventions, such as warm saline enema, water-soluble contrast enema, oral administration of 10% *N*-acetylcysteine, and surgical intervention [3]. These additional interventions could be decided on within 7days after birth, if symptoms progressed despite the routine glycerin enema [3]. Among these, water- soluble contrast enema has been thought to be an effective way to treat many kinds of meconium-related diseases, especially MO [2,5,14,15].

Several previous studies have reported on water-soluble contrast enema performed under fluoroscopic guidance; however, it could be risky for VLBW preterm infants to be transported to the fluoroscopic room due to their coexisting respiratory problems and vulnerability to the uncontrolled temperature and humidity [1,14]. Therefore, at our institution, most cases of water-soluble contrast enema were performed at the bedside in the neonatal intensive care unit (NICU), as a previous result established the safety and efficacy of the bedside procedure without fluoroscopic guidance [10]. Even though the water-soluble contrast enema is increasingly applied to preterm infants, in our knowledge, the factors that could affect the success of the procedure have not been thoroughly evaluated, especially in the procedure under the US guidance. Therefore, we tried to assess the therapeutic results of US-guided water-soluble contrast enema in VLBW infants with MO, and to uncover the factors that affected the therapeutic results.

2. Materials and methods

2.1. Study population

Our institutional review board approved this retrospective study and waived the requirement for the informed consent. From April 2007 to March 2014, among 474 VLBW infants (body weight at birth <1500 g) admitted to our NICU, a total of 36 VLBW infants with MO were referred for the US-guided water-soluble contrast enema. Two ileal atresia and 1 ileal stenosis cases (initially misdiagnosed as MO, but confirmed after operation) were excluded from this study. Finally, 33 patients were included: 17 male and 16 female infants. The mean gestational age was 28^{+4} weeks (range: $25^{+3} - 34^{+6}$ weeks), and the mean body weight at birth was 917.3 g (range: 650–1440 g).

MO was clinically suspected when the preterm infant had a problem with passing meconium and showed progressive abdominal distention and feeding intolerance despite glycerin enema [1,3]. Unlike in NEC, the patients showed a relatively good general condition without alteration of respiratory rate and heart rate, elevation of body temperature or color change of the abdominal wall. Their laboratory test results were within normal limits without evidence of infection, including leukocytosis or increased erythrocyte sedimentation rate or C-reactive protein level. Abdominal US and plain radiographs were performed in all the suspected MO patients. In imaging studies, MO was diagnosed, if persistent or progressive gaseous bowel distension was noted on plain radiography, along with the presence of hypoechoic meconium-filled bowel loops and distended proximal bowel loops seen sonographically, but with no findings of NEC (such as bowel thickening, intramural gas, portal vein gas or complicated ascites). As the next step for unresolved MO after routine glycerin enema, warm saline enema was performed. If these methods were ineffective, US-guided Gastrografin® (Bayer Healthcare, Newbury, England, 2150 mOsm/L) or Telebrix® (Guerbet, Roissy, France, 1710 mOsm/kg) enema was performed at the bedside.

2.2. Routine protocol of the US-guided water-soluble contrast enema

To achieve a slightly greater osmolality than the body fluid (about 500 moms/kg), we prepared a mixture of the contrast media, normal saline, and acetylcysteine (Mucomyst®, Boryung Pharm, Ansan, Republic of Korea) in a ratio of 1:2:1 respectively. We routinely prepared about 32 ml of the mixture, using 8 ml of contrast material, 16 ml of normal saline and 2 vials of Mucomyst® (800 mg acetylcysteine/4 ml in 1 vial). The contrast mixture was injected through an 8- or 10-Fr Foley catheter with its tip positioned in the rectosigmoid colon. Ballooning of the Foley catheter tip was decided by the person carrying out the procedure, after considering the patient's size and amount of back-flow of the mixture during injection. Under US guidance, the contrast mixture was manually injected slowly and carefully with about 1 ml/sec injection velocity. The progression of the contrast mixture was monitored. Injection was continued until a sufficient length of the distal small bowel loop was distended with the contrast mixture, or the total amount of prepared contrast mixture was injected. If any resistance was noted during the contrast injection, or bowel perforation was suspected due to sudden relief of resistance or increased amount of ascites on US, the procedure was immediately stopped. A portable radiograph was obtained to confirm the level of the contrast-filed bowel loops immediately after the procedure. If more than half of the contrast mixture flowed out during the procedure or the contrast advance was thought to be inadequate on radiograph, a repeat injection was given. No more than three repeat injections were given, considering the general condition and weakness of the bowel lumen of the VLBW infants. Follow-up radiographs were routinely performed 6 and 24 h after the procedure. The US-guided water-soluble contrast enemas were performed by experienced pediatric radiologists (CJE, CYH, CHH, and LSM, with 20, 9, 6, and 6 years of experience, respectively).

2.3. Group analysis

Patients were classified into two groups, according to the results of the procedures: the success and failure groups (Fig. 1). The success group was defined when a sufficient amount of meconium had passed during or shortly after the procedure, the abdominal distention resolved, and the distended loops of bowel normalized within 2 days of the procedure without another intervention. If patients showed no symptomatic improvement and needed additional procedures such as glycerin, warm saline enema, oral administration of N-acetylcysteine, and additional US-guided water-soluble contrast enema after a time interval or surgical intervention, these patients were classified into the failure group, regardless of the clinical outcome. The cases with bowel perforation during or immediately after the procedure were also categorized into the failure group. For the evaluation of factors that can affect the success of the procedure, we divided them into the patient, maternal, and procedure-related factors.