

**Curds in the Way:**

Establishing Normal Sonographic Appearances of neonatal bowel on Fortified Breastmilk Feeds Dr Lara Kimble

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**Milk Curd Obstruction:**

“Milk curd” here refers to a calcium soap formation in the premature gut when on fortified human milk feeds.1,2 This is thought to be caused by insufficient fat and calcium absorption in relation to feeds, or a differential absorption of the fluid and solid components of the milk. 3,4 Milk curd obstruction (MCO) is when a bowel obstruction occurs secondary to this. This may be in the small or large bowel, although it is more often distal small bowel. Gastric obstruction is reported with even greater incidence. 1,4–6 Complications such as pneumatosis or perforation may also occur, as with any cause of bowel obstruction.

Other names for MCO have been used in the literature: milk curd syndrome, inspissated milk syndrome, milk plug syndrome, and lactobezoar.

Affected babies are more likely to be premature or underweight neonates, on hypercaloric feeds, and have usually passed milk stools before developing symptoms and signs of obstruction. 1,6,7 There is also an increased risk if there are gastrointestinal motility issues.6 The average age of onset has been reported as 5-14 days of life. 1,4,7

In the late 1960s, milk curd obstruction in neonates was first described by Cook and Rickham. 8 It was initially a problem seen more with cows’ milk formula feeds rather than breastmilk, with one hypothesis being that human breastmilk fat is more easily absorbed by the neonatal gut than the fats in such formulae.4 The condition was always somewhat rare, but it almost disappeared in the period post-1980, presumably due to improved understanding of gastrointestinal and nutritional physiology of premature neonates, and also due to increased use of breastmilk in these populations.4,6,9–11 As medicine advanced, the gestational age at which newborns could be successfully supported ex-utero dropped and the question of optimal feeding of these babies became even more of a clinical and research concern.2 Breastmilk is the preferred food source due to the demonstrated reduction in risk of necrotizing enterocolitis in premature babies. However, in order to improve growth and support bone formation, fortification of expressed breast milk has become standard for low birth weight and premature infants. Several small studies have since reported recurrence of the MCO phenomenon. This may be because of increased calcium content of fortified feeds causing impaired fat absorption, but the pathophysiology is unclear with multiple factors probably at play. 3

Abdominal radiographs are the traditional diagnostic imaging modality for intestinal MCO, with the major sign being a right-sided abdominal mass surrounded by a halo of air in the setting of small bowel obstruction.10,12–14 Meconium masses are more likely to adhere to the lumen and so do not become surrounded by gas in this way, and are also more prone to containing gas pockets than small bowel milk curd.10 In MCO, barium enemas would typically show a normal calibre colon and small filling defects, and possibly help to identify alternative obstructive pathology such as ileal atresia. 7,10 Ultrasound has been suggested as the imaging choice for gastric lactobezoars, whereby highly echogenic air-trapping within the curd mass is diagnostic.6,14 It seems the curd appearances in the stomach and small bowel may be quite different.

**Baby S:**

Baby S was a premature neonate in the neonatal intensive care unit (NICU) of Auckland City Hospital. He had been on fortified expressed breastmilk when he developed feed intolerance and dilated bowel loops on abdominal x-ray. An abdominal ultrasound was conducted and several foci of homogeneously echoic solid intraluminal material were seen, with a particularly large focus noted in the small bowel of the right iliac fossa. It was advised that fortified feeds be temporarily halted for fear of early or impending MCO.14 He continued on breast milk alone for the next 72hours before resumption of fortification and no recurrence of symptoms.14

While the outcome here was excellent, the deviation from the nutritional guidelines had been based on a high level of suspicion and an unusual imaging investigation without a locally established consensus on what normal neonatal bowel contents would look like sonographically. If this investigation is to potentially be used in the future to identify babies at risk of MCO or with MCO, a clear idea of what normal appearances entail would need to be established to justify such deviation from protocol and potentially sacrifice much needed weight gains in the neonatal period.

**Auckland City Hospital Neonatal Intensive Care Nutritional Guidelines:**

Our local nutritional guidelines use 5g FM85 dissolved into 25ml of expressed breast milk as the fortified feed for neonates born <32 weeks or at a birthweight of <1 800g. This is started once feed volume reaches 5ml per feed.

Our protocol dictates a start with 1ml bolus feeds each 2 to 6 hours via a naso or orogastric tube, increasing until 1ml each 2 hours. Thereafter, the feed volume is increased by 1ml each 6 to 24 hrs as guided by the child’s weight. 15 By day 7, the guideline advocates a fluid intake of 180ml/kg/day, or 150ml/kg/day if ‘inappropriately’ crossing centiles upwards. 15

**Wagener et al. 2009**

The largest case study within the last 10 years that was not limited to gastric MCO was performed by Wagener et al 2009 at the Royal Children’s Hospital and Mater Children’s Hospital in Brisbane, retrospectively spanning 2000 to 2007.3 They found 9 neonates with MCO. The median gestational age was 27 weeks (24-30 weeks range) and a median birth weight of 717g (474 – 1291g range). All 9 were on fortified breast milk feeds at a minimum of 160ml/kg/day. None were on formula feeds, in contrast to most previous studies only reporting the phenomenon in high calorie formula-fed premature neonates.16 Abdominal distension was found to be the main symptom in all 9, and onset was on average at 14days old and 3-47 days after fortifier was added. Fortifier was only added after 150ml/kg/day was tolerated after an upward volume titration.

All cases were confirmed at laparotomy (bar one which had a pre-existing ileostomy washed out), with the only preoperative imaging being abdominal x-rays. These were non-specific, showing small bowel obstruction, pneumatosis, or perforation. Only 2 of 9 babies had the correct diagnosis suspected before surgery.

5 obstructions were ileal, 2 involved the entire small intestine, and 2 were colonic.

Surgery involved temporary ileostomies for 7 of 9 babies, and as previously noted, there was an additional baby with a pre-existing ileostomy. 2 babies died in the immediate postoperative period, presumably from sepsis, and 2 babies died within 6 months of surgery from respiratory compromise.

5 of 9 had prior abdominal surgery with bowel resections.

**Proposed Study: Establishing Normal Sonographic Appearances of the Neonatal Bowel when Fed Fortified Breastmilk**

*Rationale:*

There has been little published data on the neonatal sonographic bowel appearances in the setting of MCO. 14 As the diagnosis is very difficult, a high level of suspicion is required. Although abdominal x-ray the most widely reported investigation, the findings are often non-specific, and use of sonography in diagnosis of gastric lactobezoars suggests a possible role for this in intestinal obstruction.

We thought that ascertaining normal sonographic appearances of neonatal bowel would be useful for several reasons:

1. Perhaps ultrasound could, in the future, be found to have a higher specificity than abdominal radiographs for diagnosis of MCO. Any study with such a rare event rate would take longer than currently afforded, but establishing a normal baseline appearance could assist any future diagnostic studies.
2. If ultrasound were to become a suitable diagnostic imaging procedure for intestinal MCO, there would be less reliance on imaging with ionising radiation, especially in the earlier stages of suspected obstruction or when monitoring resolution.
3. If we could establish a normal bowel appearance, we could have more confidence in identification of at risk bowel. Thus, when suggesting temporary cessation of fortifier on these grounds, there would be greater justification for the removal of much needed calories in the underweight and premature.

*Method:*

20 neonates in the Auckland City Hospital Neonatal Intensive Care Unit will be selected. They will be on fortified breastmilk feeds as per local guidelines. 15 These babies will be born at <32 weeks gestation and/or of low birthweight (<1 800g). The estimated time period of recruitment is up to 4 months. This will be guided by the availability of suitable babies and guardian consent rates.

A baseline 4 quadrant abdominal ultrasound will be performed in all participants prior to addition of fortifier to the diet. Fortifier is added once bolus feeds reach 5ml given each 2 to 6 hours.

A follow-up 4 quadrant abdominal ultrasound will be performed in all participants at 10 to 14 days after fortifier has been started. The child will have had at least one milk stool (as opposed to transitional or meconium stool).

Exclusion from recruitment:

* Exclusive formula feeding
* Known chromosomal abnormality or heritable disease affecting gastrointestinal anatomy or function, or surgical gastrointestinal disease such as gastroschisis
* Lack of guardian consent (verbal or written)

Exclusion from analysis:

* Development of clinical bowel obstruction of any cause, or development of necrotising enterocolitis
* Abdominal or thoracic surgery
* Administration of medications that reduce gastrointestinal motility

*Information gathered:*

* Basic identifiers including NHI and birth date
* Ethnicity
* Gestation and birthweight
* Age at each scan
* Days between the scans (10-14 days)
* Whether or not formula has been used in top-up feeds
* Days taken for baby to transition from breastmilk to fortified breastmilk

Subjective description of the bowel appearance, mobility, and contents (with changes between the baseline and follow-up ultrasounds) will be noted. The number and appearance of solid intraluminal foci will be recorded, in addition to their estimated location within the bowel length. Where abdominal x-ray has been performed for unrelated clinical reasons such as line placement, these will be reviewed complementary to the ultrasounds. Clinical notes will be referred to with regard to feeds, ensuring absence of clinical signs and symptoms of bowel obstruction, and to note the type of stool occurring.

Sub-analyses by ethnicity are unlikely to be possible due to the small number of participants, but ethnic status will still be acquired. All aspects of the study will be conducted with observation of Tikanga Māori.

Information will be stored in a password protected folder within the Radiology folder on the Auckland City Hospital intranet. NHI number and birth date will be used as the patient identifiers only within the raw data. Any and all data included in the final study will be wholly de-identified.

Parents/guardians will be provided with a simple summary of the proposed study and an opportunity to ask questions. They will be reassured that their child may be removed from the study at any time as per their wishes, and they may request removal of any acquired data up to that point.

*End Point:*

A descriptive analysis of the normal neonatal bowel contents will aim to serve as a reference for future decisions on temporary cessation of fortified feeds in premature or low birthweight neonates suspected of having early milk curd obstruction. If little to no solid intraluminal contents are found in these asymptomatic babies, this may indicate that ultrasound could be a useful non-invasive and radiation-free method of assessing for early milk curd obstruction. If asymptomatic babies demonstrate large solid intraluminal contents with no sequelae, then it may be concluded that ultrasound is not a useful discriminator.

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