MECONIUM PERITONITIS *IN UTERO*—THE VALUE OF PRENATAL DIAGNOSIS IN DETERMINING NEONATAL OUTCOME

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SUMMARY

Objective: Meconium peritonitis (MP) is a chemical peritonitis caused by fetal intestinal perforation *in utero*. Its incidence is rare, but serious neonatal morbidity or even mortality can occur if the diagnosis is not made until after birth. Prenatal diagnosis is important in prompting early postnatal surgical intervention, and so improving neonatal outcome.

Materials and Methods: Fourteen cases diagnosed *in utero* with MP from January 1996 to December 2005 were enrolled in this study. The final diagnoses were established by surgical findings or postnatal radiography. The prenatal ultrasound features, neonatal birth characteristics, surgical findings, postnatal management and neonatal outcomes were reviewed.

Results: All infants received follow-up care at our hospital. Prenatal ultrasound findings included fetal ascites (100%), intra-abdominal calcification (93%), dilated bowel loops (57%), pseudocysts (29%), and polyhydramnios (50%). Four infants (4/14; 28.5%) did not undergo postnatal surgery, but survived well. The mean gestational age at detection was significantly earlier in the non-surgery group (23 ± 3.6 weeks) than in the surgery group (31.7 ± 2.5 weeks). One infant (7.1%) died because of sepsis after two neonatal operations. The overall survival rate was 92.9%.

Conclusion: MP can be diagnosed by prenatal ultrasound, and the neonatal outcome is favorable. Early detection is not associated with poor neonatal outcome, and selective termination is unnecessary. Resolution of dilated bowel loops and polyhydramnios predict a low rate of postnatal surgical intervention. [*Taiwan J Obstet Gynecol* 2008;47(4):391–396]

Key Words: calcification, fetal ascites, meconium peritonitis, prenatal ultrasound, pseudocyst

Introduction

Meconium peritonitis (MP) is rare and occurs in approximately 1/35,000 live births [1–3]. It is a sterile chemical peritonitis resulting from a small bowel perforation *in utero*, possibly due to a vascular accident, intussusception, an internal bowel hernia, small intestine atresia, meconium ileus or some other unknown complication [4–9]. A secondary inflammatory reaction results in intense chemical peritonitis [10].

Several reports have reported on the prenatal ultrasound findings in fetuses diagnosed *in utero* with MP [5,10–13]. A prenatal diagnosis of MP can be established by ultrasound findings of fetal ascites, intra-abdominal calcified lesions, dilated bowel loops, pseudocyst formation and/or polyhydramnios [10,14,15]. The neonatal outcomes of MP are much better if it is detected prenatally than if it is diagnosed after birth [12,13, 16–19]. In addition, the ultrasound features of MP vary with gestational age. Fetal ascites, polyhydramnios and dilated bowel loops can resolve spontaneously

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Table 1. The prenatal ultrasound features indicating fetal meconium peritonitis and their changes during the prenatal period

Case no.	GA at diagnosis (wk)	GA at birth (wk)	Ascites (D/B)	Calcification (D/B)	Dilated bowel loop (D/B)	Pseudocyst	Polyhydramnios* (D/B)
1†	20	37	+/−	−/+	+/−	N	−/−
2	31	37	+/+	−/+	−/+	Y	+/+
3	32	35	+/−	−/−	+/+	N	+/+
4	30	36	+/+	+/+	+/+	Y	−/−
5†	27	37	+/+	+/+	−/−	N	−/−
6	30	31	+/+	+/+	−/+	N	−/−
7	33	36	+/+	+/+	+/+	Y	+/+
8†	25	31	+/+	−/+	+/−	N	+/−
9	32	37	+/+	+/+	+/+	N	+/+
10	28	38	+/+	−/+	−/−	N	−/−
11	30	35	+/−	+/+	−/−	N	−/+
12	35	37	+/+	+/+	+/+	N	+/+
13	32	38	+/+	+/+	+/+	Y	+/+
14†	20	36	+/+	−/+	−/−	N	+/+

**Amniotic fluid index > 24 cm; †without postnatal surgery. GA = gestational age; D/B = diagnosis/birth; + = positive; − = negative; N = no; Y = yes.*

throughout the prenatal course. Ultrasound features might be related to the neonatal outcome and the need for postnatal surgical interventions. To our knowledge, few serial reports have demonstrated a relationship between the timing of detection and neonatal outcome. Early onset of MP has been associated with lower survival rates and poorer neonatal outcomes [13]. The purpose of this study was, therefore, to evaluate the relationship between the ultrasound features, the timing of detection and the neonatal outcome in fetuses prenatally diagnosed with MP.

Materials and Methods

Fetuses diagnosed with MP by prenatal ultrasound and delivered at Chang Gung Memorial Hospital from January 1996 to December 2005 were retrospectively enrolled in this study. This study was undertaken with the prior approval of the Institutional Review Board for Medical Ethics of Chang Gung Memorial Hospital. All patient ultrasound scans were carried out transabdominally by senior obstetricians. The ultrasound findings included fetal ascites, with or without intra-abdominal calcification, a hyperechogenic mass, pseudocysts, dilated bowel loops, and polyhydramnios (defined as an amniotic fluid index > 24 cm). Prenatal ultrasound was performed at 20–36 weeks of gestation. If MP was suspected, ultrasound examinations were performed every 2–4 weeks. In addition, the presence of congenital infection was carefully excluded by maternal serum screening, and fetal genetic karyotyping was performed during the prenatal or postnatal period, depending on the gestational age at diagnosis. Prenatal genetic testing for cystic fibrosis was not performed because of the low prevalence rate of this disorder in our local population [2,20]. Infants were delivered vaginally or abdominally, according to obstetric considerations. After birth, the babies were transferred to the neonatal care unit and abdominal radiographs were performed. The final diagnosis of MP was established by surgical findings, or by postnatal radiographs and computed tomography scans if the babies did not undergo postnatal surgery. All prenatal ultrasound features and postnatal surgical findings were recorded. The relationship between the ultrasound parameters and neonatal outcomes were analyzed statistically using the Mann-Whitney *U* test and Fisher's exact test.

Results

The prenatal ultrasound findings and clinical information of the cases diagnosed with MP are summarized in Table 1. Fourteen patients with MP were enrolled in this study. The ultrasound features identified at different gestational stages during the prenatal courses were recorded. The gestational ages at initial diagnosis ranged from 20–36 weeks, with a mean of 28.9 weeks. The mean gestational age at delivery was 35.8 weeks, with a range of 31–38 weeks. Four infants were delivered before 36 weeks of gestation, owing to preterm labor or premature rupture of the membranes. The mean birth weight was 2,820 g (range, 2,280–3,560 g).

Fetal ascites (14/14, 100%) was the most common ultrasound finding in MP (Figure 1) and was found in

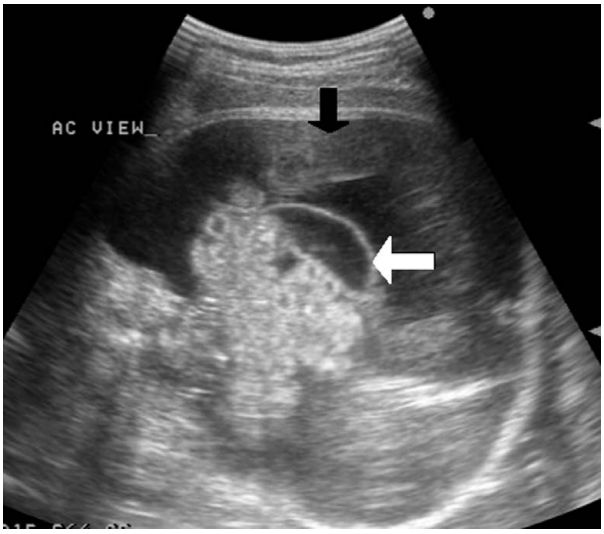

Figure 1. Massive ascites is the most common ultrasound finding in meconium peritonitis (black arrow). Dilated loops of intestine (white arrow) are indicative of intestine obstruction.

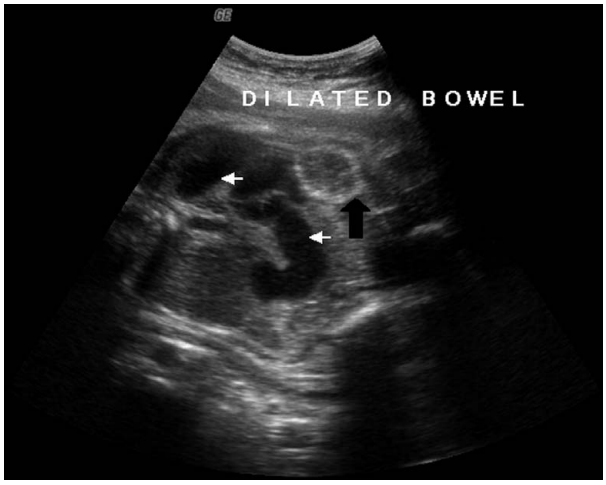

Figure 3. Prenatal ultrasound performed at 30 weeks of gestation in case 6. The longitudinal ultrasound scan shows obviously dilated bowel loops (white arrows). A calcified mass is also seen (black arrow). Ileal atresia was found during neonatal surgery.

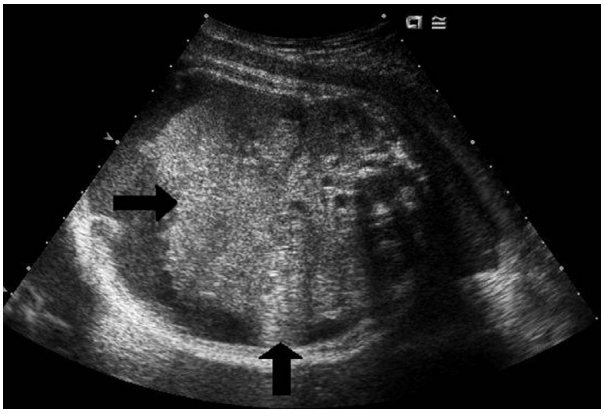

Figure 2. In case 11, the prenatal ultrasound shows diffuse intra-abdominal calcification without dilated bowel loops or pseudocyst formation (arrows). The hyperechoic mass occupies a large portion of the abdominal cavity. The postnatal surgical findings were jejunal and ileal atresia.

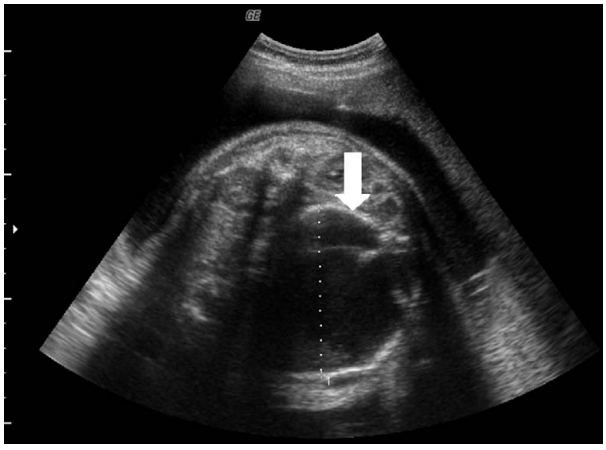

Figure 4. In case 13, a large intra-abdominal pseudocyst (arrow) is seen on prenatal ultrasound. The cyst is well encapsulated and measures 6.72 cm in diameter. The large cyst resulted in lung volume compression. After delivery, ileal atresia was noted during surgery and left lung hypoplasia was diagnosed postnatally.

all cases, but had resolved in subsequent scans in three cases (3/14, 21.4%). Two of these three infants still needed postnatal surgery. Thirteen of 14 (92.9%) cases presented with an intra-abdominal calcified mass or diffuse intra-abdominal calcified deposition (Figure 2). All intra-abdominal calcified lesions persisted throughout the whole prenatal course.

Dilated bowel loops were found in eight cases (Figure 3). Among these, two resolved spontaneously before birth and these patients survived without neonatal surgery. Pseudocysts (Figure 4) were identified prenatally in four (28.5%) cases, and polyhydramnios in seven (50%) cases.

Table 2 summarizes the neonatal birth characteristics and surgical findings of all infants enrolled in this study. All infants received neonatal care and follow-up in our pediatric department. The mean follow-up duration was 21.7 months, with a range of 3–94 months. Chloride sweat tests performed after birth were negative. Cytomegalovirus infection was diagnosed in one case (case 14). The final diagnosis was established by surgical findings in 10 cases and by postnatal radiographs or computed tomography in four cases.

Ileal atresia was the most common finding during surgery, and was detected in nine of the 10 surgical cases. Jejunal atresia was found in two infants, one of whom also had ileal atresia. Nine infants underwent one postnatal operation. One baby (case 4) underwent two surgical interventions, but unfortunately died because of uncontrolled sepsis. The overall

Table 2. Neonatal birth characteristics, postnatal surgical findings and outcomes of patients diagnosed with meconium peritonitis *in utero*

Case no.	Sex	BBW (g)	Apgar score	Surgical findings	Outcomes	Congenital infection
1	M	3,105	8–9	Nil	Recovered	N
2	M	2,920	9–10	Ileal atresia	Recovered	N
3	M	2,880	8–9	Ileal atresia	Recovered	N
4	M	2,740	8–9	Ileal atresia	Died	N
5	F	2,930	8–9	Nil	Recovered	N
6	F	2,320	7–9	Ileal atresia	Recovered	N
7	M	2,840	9–10	Jejunal atresia	Recovered	N
8	M	2,280	7–8	Nil	Recovered	N
9	F	2,810	9–10	Ileal atresia	Recovered	N
10	M	3,105	8–9	Ileal atresia	Recovered	N
11	M	2,410	9–10	Jejunal and ileal atresia	Recovered	N
12	M	2,800	8–9	Ileal atresia	Recovered	N
13	M	3,560	8–9	Ileal atresia	Living, with left lung hypoplasia	N
14	M	2,780	9–10	Nil	Living, with hearing impairment	CMV

BBW = birth body weight; M = male; N = no; F = female; CMV = cytomegalovirus.

Table 3. The prenatal ultrasound findings and obstetric birth information in the surgical and non-surgical infants

	Non-surgery group ($n=4$)	Surgery group ($n=10$)	p
Fetal ascites, *n*	4	10	NS*
Intra-abdominal calcification, *n*	4	9	NS*
Dilated bowel loops before birth, *n*	0	8	0.02*
Pseudocyst, *n*	0	4	NS*
Polyhydramnios, *n*	1	6	NS*
Diagnostic age, mean ± SD, wk	23 ± 3.6	31.7 ± 2.5	0.004†
Delivery age, mean ± SD, wk	35.3 ± 2.9	36 ± 2.1	NS†
Birth body weight, mean ± SD, g	2,773 ± 354	2,838 ± 343	NS†
Survival rate	4/4 (100%)	9/10 (90%)	NS*

**Fisher's exact test; †Mann-Whitney U test. NS = non-significant ($p > 0.05$); SD = standard deviation.*

mortality for cases prenatally diagnosed with MP was 7.1%.

Discussion

MP results from *in utero* bowel perforation, which is a frequent complication of congenital bowel obstruction. Bowel perforation may have mechanical causes, such as atresia, stenosis, meconium ileus, volvulus and internal hernia [21], or it may be due to intrauterine fetal congenital infections caused by cytomegalovirus or rubella [22]. Parvovirus B19 infection has also reportedly been associated with MP [23,24]. However, inflammatory sterile peritonitis is always caused by intestinal fluid and meconium extruding into the peritoneal cavity through a perforation in the fetal intestine. If the peritonitis persists long enough, a calcified mass can be produced in the abdominal cavity [11]. Fetal ascites and intra-abdominal calcification can, therefore, be detected by prenatal ultrasound.

Early onset of MP is reportedly associated with a lower survival rate [13]. In our study, early detection of MP correlated with a low rate of postnatal surgery and a favorable neonatal outcome (Table 3). The gestational ages at diagnosis in the non-surgical group were significantly lower than those in the surgical group ($p < 0.05$). We hypothesize that the perforated intestine can heal spontaneously *in utero* if the prenatal period is long enough. Ascites, increased amniotic fluid and dilated injured bowel loops then resolve, after the intestine heals. These babies do not need postnatal surgery to repair injured bowel loops. Because of the limited case numbers, we were unable to confirm the possibility that early detection of MP contributes to good neonatal outcomes. However, if the MP is detected

at an early gestational age, it is advisable to monitor fetal well-being throughout the rest of the prenatal period, rather than to terminate the pregnancy for fear of a poor prognosis.

As previously reported, fetal ascites and either calcification or dilated bowel loops are the minimal criteria for prenatal diagnosis of MP [11,13]. In our series, the sonographic images changed during prenatal follow-up. Fetal ascites, dilated bowel loops and increased amniotic fluid resolved in some cases. Fetal ascites resolved in three cases, though two of these infants still underwent surgical interventions to repair perforated bowels. Resolution of fetal ascites should not be used as an indicator for surgical intervention. Two cases (2/8, 25%) in which dilated bowel loops were initially detected resolved spontaneously before birth (cases 1 and 8). These two babies did not undergo postnatal surgery but survived well. We considered that the dilated bowel was caused by obstruction resulting from intestinal perforation. The resolution of dilated bowel loops was a sign of healing of the perforated intestines and was associated with a favorable prognosis. Polyhydramnios associated with MP occurs in 25–50% of cases, [10,12,13], and it can be absorbed spontaneously [15,25]. In our series, increased amniotic fluid resolved in one case, along with improvement of bowel loop dilatation.

Several case series studies have demonstrated a relationship between prenatal ultrasound features and postnatal outcomes [5,10–13,26]. Kamata et al [12] classified MP into three types: type 1 included cases with massive ascites, type II with giant pseudocysts, and type III with calcification and/or small pseudocysts. The results indicated that type I and type II MP had poor neonatal outcomes. Shyu et al [13] demonstrated that persistent ascites, pseudocysts and dilated bowel loops were most likely to predict the need for postnatal surgery. In our series, dilated bowel loops and pseudocyst formation were absent in all four cases that did not require postnatal surgery (Table 3). Pseudocyst formation was due to severe intestinal obstruction, resulting in intestinal fluid accumulation. A pseudocyst was a sign of severe fetal intestinal injury, which was predictive of the need for neonatal surgery and a poor neonatal outcome.

High mortality, ranging from 40–50%, has previously been reported in MP [9,27], though several studies have recently reported higher survival rates in MP if the diagnosis was made using prenatal ultrasound [3,9,12]. The overall survival rate in recent studies was around 85–90% [10,12,13,28]. Our series confirmed previous reports suggesting that the outcome of fetuses diagnosed prenatally with MP was favorable. Overall, 92.9% of patients survived well, even though some needed postnatal surgery to correct bowel obstruction or atresia. Brugman et al [29] reported an overall mortality of 62% in patients with MP who also had bowel atresia. In our series, 10 babies with intestinal atresia survived well after reconstructive surgery, and only one baby died owing to sepsis. This favorable survival rate was related to early prenatal diagnosis and improvements in pediatric surgery and neonatal care.

Cystic fibrosis has been associated with MP [30], and the incidence of cystic fibrosis with MP ranges from 15–40% [3,10,30]. We did not perform prenatal genetic mutation screening for cystic fibrosis because of the low rate of cystic fibrosis in our local population. Nevertheless, we suggest that postnatal chloride sweat tests should be performed to rule out the possibility of cystic fibrosis.

In summary, prenatally diagnosed fetal MP has a favorable outcome. Fetal ascites and abdominal calcifications are the most common ultrasound findings, while pseudocyst formation predicts an uncertain prenatal outcome. The resolution of dilated bowel loops and polyhydramnios are related to low rates of postnatal surgery. Early detection of MP is not indicative of poor neonatal outcomes, and selective termination is not necessary, unless indicated for other reasons.

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