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Value of prenatal diagnosis of meconium peritonitis

Comparison of outcomes of prenatal and postnatal diagnosis

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Abstract

Advancements in diagnostic modalities have improved the diagnosis of meconium peritonitis (MP) both in utero and ex utero. This study aimed to determine the efficacy of prompt prenatal and postnatal diagnoses of MP on the postnatal outcomes of these patients.

We conducted a retrospective chart review of neonates with MP admitted to the Mackay Memorial Hospital Systems from 2005 to 2016. The prenatal diagnoses, postnatal presentations, surgical indications, operative methods, types of MP, operative findings, associated anomalies, morbidities, patient outcomes, and survival rates were analyzed. Morbidities included postoperative adhesion ileus, bacteremia, and short bowel syndrome. We also performed subgroup analyses of the morbidity and survival rates of prenatally versus postnatally diagnosed patients, as well as inborn versus outborn neonates.

Thirty-seven neonates with MP were enrolled. Of this number, 24 (64.9%) were diagnosed prenatally. Twenty-two (59.5%) were born preterm. The most common prenatal sonographic findings included fetal ascites followed by dilated bowel loops. Abdominal distention was the most frequent postnatal symptom. Thirty-four (91.9%) neonates underwent surgery, whereas 3 were managed conservatively. Volvulus of the gastrointestinal tract was the most frequent anatomic anomaly. The total morbidity and survival rates were 37.8% and 91.9%, respectively. The morbidity and survival rates did not differ significantly between prenatally and postnatally diagnosed patients (37.5% vs 33.3%, $P=1.00$; 91.7% vs 92.3%, $P=1.00$, respectively). Inborn and outborn patients did not differ in terms of morbidity and survival rates (27.3% vs 53.3%, $P=.17$; 100% vs 80.0%, $P=.06$, respectively).

Although not statistically significant, inborn MP neonates had higher survival rates when compared with outborn MP neonates. Prompt postnatal management at tertiary centers seemed crucial.

Abbreviation: MP = meconium peritonitis.

Keywords: inborn, meconium peritonitis, morbidity, mortality, MP, outborn, prenatal diagnosis, volvulus

1. Introduction

Meconium peritonitis (MP) is a sterile chemical peritonitis caused by antenatal perforation of the digestive tract and subsequent leakage of meconium into the peritoneal cavity.[1–3] The underlying etiologies include vascular insufficiency or obstruction secondary to meconium ileus, extrinsic peritoneal bands, intestinal atresia, stenosis, volvulus, internal hernia, intrauterine intussusception, gastroschisis, duplication, or Hirschsprung disease. Rare causes of MP include colonic atresia, torsion of a fallopian tube cyst, and fetus in fetu.[1–4] After leakage of meconium into the peritoneal cavity, a secondary inflammatory response occurs. This secondary inflammatory response results in ascites, fibrosis, calcification, and occasionally cystic formation.[5]

The incidence of MP is approximately 1:30,000. MP was classified into 3 types: generalized, fibro-adhesive, and cystic.[2] Characteristic prenatal sonographic findings are fetal ascites, dilated intestinal loops, intra-abdominal calcifications, echogenic bowel, polyhydramnios, and pseudocysts.[4–8] Postnatally, it has a wide range of presentations from asymptomatic with sealed-off peritonitis to severe peritonitis requiring emergent surgery.[5] The most common postnatal manifestations include respiratory distress, abdominal distention, bilious vomiting, and delayed meconium passage.[7]

Although the meconium is aseptic, bacterial overgrowth occurs and worsens the prognosis if gastrointestinal tract perforation persists after birth.[9] Therefore, early diagnosis and treatment to prevent sepsis and the subsequent morbidity and mortality is critical. Recently, improvement in diagnostic modalities has led to a more accurate prenatal diagnosis of MP. The survival rate for MP has improved to over 90%.[7] However, it remains unclear whether early detection of the disease has improved the

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Informed consents to the study were not mandatory because this was a retrospective analysis of anonymous clinical data of patients who consented to treatments.

The authors have no conflicts of interest to disclose.

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outcomes. The aim of this study was to determine the association between the prenatal and postnatal diagnoses of MP, as well as between the outcomes of inborn and outborn neonates.

2. Materials and methods

A retrospective chart review was conducted with neonates who were diagnosed with MP and were admitted to 3 Mackay Memorial Hospital Health Systems (Taipei, Tamsui, and Hsinchu) from January 2005 to December 2016. The annual numbers of birth were as follows: Taipei 4600/y, Tamsui 1200/y, and Hsinchu 2500/y. Our facilities deliver an average of 8300 births annually. The mothers of MP neonates received regular prenatal ultrasonography. The diagnosis was established in (1) the presence of prenatal sonographic features of MP confirmed by surgical findings; (2) normal prenatal ultrasounds with postnatal presentations of MP confirmed by surgical findings. Pregnancy was continued until term or until the presence of fetal distress. Neonates of all gestational ages with a diagnosis of perinatal bowel perforation characteristic of MP were enrolled. Postnatal imaging studies were performed to diagnose MP accordingly. All neonates with MP received conservative treatment unless there were signs of sepsis, bowel obstruction/perforation, or feeding intolerance. Neonates with diagnoses of necrotizing enterocolitis or spontaneous intestinal perforation were excluded. We analyzed gestational age, sex, prenatal diagnosis, postnatal presentation, presence/absence of surgical indication, operative method, types of MP, operative finding, anatomic anomalies identified, morbidity rate, and rate of survival to discharge. Antibiotics were prescribed as per hospital protocol. Different surgeons performed the operations. Patients were not screened for cystic fibrosis. Morbidities were defined as postnatal bacteremia, short bowel syndrome, ileal adhesion, anastomotic stenosis or leakage, wound infection, necrosis, and postoperative hemorrhage. The nutritional and neurodevelopmental statuses of the patients were followed up until the age of 1 year.

A 2-tailed Fisher exact test and an unpaired *t* test were conducted to calculate the differences in prognoses, including morbidity rates and survival rates, between prenatally versus postnatally diagnosed groups and inborn versus outborn neonates. Outborn neonates were defined as neonates who were transferred from a regional hospital or local clinic after delivery by our transferring team or on their own. Analyses were performed using the SPSS (24th edition). The significant *P* value was set at .05 on both ends.

3. Results

Thirty-seven neonates (19 males and 18 females) were included in the study. Of this number, 22 (59.5%) were preterm babies. The mean maternal age was 31.3 years (range, 23–41 years). The mean gestational age was 35.2 weeks (range, 24–41 weeks), and the mean birth weight was 2581 g (range, 578–3750 g). There were 22 (59.5%) inborn neonates. MP was prenatally suspected in 24 (64.9%) of 37 patients between 20 and 37 weeks of gestation. In the postnatally diagnosed group, 11 of 13 neonates were diagnosed within 1 to 3 days postnatally. The remainder was diagnosed on days 8 and 12. Three (8.1%) of the 37 patients were managed conservatively. Thirty-four (91.9%) patients underwent surgery, including resection and anastomosis of intestines with or without intraperitoneal drainage, enterolysis, ileostomy, and simple exploration. Thirty (88%) patients received surgical intervention within 3 days of life. Common operative findings included intestinal perforation, atresia, and volvulus. The types of MP were fibro-adhesive (15 neonates, 44%), generalized (13 neonates, 38%), and cystic (6 neonates, 18%). Anatomical etiologies were identified in 23 (68%) patients, occurring either alone or in combination with other anomalies. The remaining 11 cases were idiopathic in origin. The most commonly encountered anatomic abnormality was volvulus of the gastrointestinal tract. The identified anomalies were volvulus of the gastrointestinal tract (n = 13; 10 segmental, 2 midgut, and 1 T-colon), ileal atresia (n = 9), jejunal atresia (n = 3), prenatal intussusception (n = 4), and gastroschisis with perforation (n = 1). Five patients had volvulus and intestinal atresia, and another 2 had prenatal intussusception and ileal atresia. Hirschsprung disease was diagnosed in late infancy in one patient. Morbidities were detected in 14 (37.8%) neonates with cumulative episodes of short bowel syndrome (n = 7 patients), ileal adhesion (n = 5), sepsis (n = 3), wound necrosis (n = 1), and postoperative hemorrhage (n = 1). Three patients had combined morbidities. Two of these patients had short bowel syndrome with adhesion, and the other had short bowel syndrome with postoperative hemorrhage. Three patients developed sepsis during the perioperative period. *Escherichia coli* was the reported pathogen in 2 neonates, whereas the other neonate was infected with multiple organisms. Polymicrobial sepsis was the cause of death in 1 neonate, whereas extensive bowel necrosis secondary to volvulus resulted in the deaths of 2 other neonates. The overall morbidity and survival rates were 37.8% and 91.9%, respectively. Table 1 lists the basic characteristics of the prenatally and postnatally diagnosed groups. There was no significant difference between the prenatal and postnatal groups. The postnatal presentation of delayed meconium passage ($P = .04$) was significantly higher for patients diagnosed postnatally. The morbidity and survival rates were not different between the prenatally versus postnatally diagnosed groups (37.5% vs

Table 1

Comparisons between groups of antenatal and postnatal diagnosis.

Group	Prenatal diagnosis n = 24	Postnatal diagnosis n = 13	*P* value
Male (%)	10 (41.6)	9 (69.2)	.17
GA, wk, mean, (range)	35.2 (30–41)	35.2 (24–41)	.99
Preterm (%)	16 (67)	6 (46)	.30
BW, gm, mean (range)	2600 (1559–3732)	2544 (578–3750)	.83
Antenatal findings (%)	24 (100)	13	—
Fetal ascites	17 (70.8)	0	—
Bowel dilatation	11 (45.8)	0	—
Calcification	7 (29.2)	0	—
Echogenic bowel	7 (29.2)	0	—
Polyhydramnios	6 (25.0)	0	—
Pseudocyst	2 (8.3)	0	—
Postnatal manifestation (%)			
Abdominal distention	21 (87.5)	10 (76.9)	.64
Respiratory distress	15 (62.5)	8 (61.5)	1.00
Bilious vomiting	6 (25)	4 (30.8)	.72
Delay meconium passage	1 (4.2)	4 (30.8)	.04*
Transferred (%)	7 (29.2)	8 (61.5)	.08
Morbidities (%)	9 (37.5)	5 (38.5)	1.00
Survival (%)	22 (91.7)	12 (92.3)	1.00

BW = birth weight, GA = gestational age.
* Statistic significant.

Table 2

Comparisons in groups of inborn and outborn patients.

Group	Inborn n = 22	Outborn n = 15	*P* value
Male (%)	11 (50)	8 (53.3)	1.00
GA, wk, mean, (range)	34.3 (24–41)	36.5 (28–41)	.09
Preterm (%)	15 (68)	7 (47)	.31
BW, gm, mean, (range)	2425 (578–3688)	2808 (1206–3750)	.13
Antenatal diagnosis (%)	17 (77.3)	7 (46.7)	.08
Fetal ascites	14 (63.6)	3 (20.0)	.02*
Bowel dilatation	7 (31.8)	4 (26.7)	.73
Calcification	5 (22.7)	2 (13.3)	.68
Echogenic bowel	5 (22.7)	2 (13.3)	.68
Polyhydramnios	5 (22.7)	1 (6.7)	.37
Pseudocyst	0 (0)	2 (13.3)	.16
Postnatal manifestation			
Abdominal distention	19 (86.4)	12 (80.0)	.67
Respiratory distress	14 (63.6)	9 (60.0)	1.00
Bilious vomiting	4 (18.2)	6 (40.0)	.26
Delay meconium passage	2 (9.1)	3 (20.0)	.38
Morbidities (%)	6 (27.3)	8 (53.3)	.17
Survival rates (%)	22 (100)	12 (80)	.06

BW = birth weight, GA = gestational age.
* Statistic significant.

38.5%, $P = 1.00$; 91.7% vs 92.3%, $P = 1.00$, respectively; Table 1). Table 2 lists the characteristics of inborn and outborn neonates. The characteristics of the 2 groups were not statistically different. The detection of prenatal ascites was significantly higher ($P = .02$) in the inborn group compared with that in the outborn group. The morbidities of the inborn and outborn neonates were 27.3% vs 53.3% ($P = .17$), respectively, whereas their survival rates were 100% vs 80.0% ($P = .06$), respectively. Twenty-seven (79.4%) of the 34 surviving patients were followed up at our outpatient department at the age of 1 year. Overall, developmental delay was observed in 6 patients (17.6%), and 2 (5.9%) were underweight (less than the third percentile of weight) at the age of 1 year.

4. Discussion

Our series reported the incidence of MP as 3.7 in 10,000, which is higher than the 1 in 30,000 that was previously reported.[2] The prenatal diagnostic rate of MP in our patients was 64.9%. Preterm infants accounted for 59.5% of all the patients. MP has variable findings on prenatal ultrasound.[1] Fetal ascites was the most common antenatal ultrasonographic finding of MP.[7] This was compatible with our results that revealed that fetal ascites was most frequently observed, followed by dilated bowel loops, calcification, echogenic bowel, and polyhydramnios. Postnatally, MP can be completely asymptomatic, but it can also be serious.[9] Imaging studies are diagnostic in the absence of clinical signs characteristic of MP. Caro-Dominguez et al[10] reported that postnatal imaging findings that are predictive of the need for surgery include intestinal obstruction, ascites, pneumoperitoneum, and volvulus; however, the presence or distribution of peritoneal calcification was not predictive of the need for surgery.

Surgery is necessary when signs of intestinal obstruction or sepsis are present.[9] The surgical rates varied greatly in previous studies, ranging from 61.5% to 90%.[1,5,7,11]

According to recent literature, the underlying causes of MP could not be determined in approximately half of all patients,[11–13] but the most common anomaly was intestinal atresia.[1,2,6,7,11] Surgery was performed in 34 (91.9%) of 37 patients. The remaining 3 patients had peritoneal calcifications without sequelae needing intervention. Conservative treatments, mainly cautious feeding and watchful waiting, were administered to 3 patients who were without signs of sepsis, peritonitis, or bowel obstruction. In the 34 patients who underwent surgery, 23 had anatomical abnormalities. However, our study showed that volvulus of the gastrointestinal tract was the most common anatomical etiology and not intestinal atresia. Although anatomical anomalies and surgical rates were higher in our series, the morbidity (37.8%) and survival (91.9%) rates were in close concordance with those of previous studies.[1,5,7,11] The preponderance of volvulus in our study had no effect on the overall prognosis.

Currently, resection and primary anastomosis is the preferred operative method.[5,6,11] Miyake et al[6] suggest primary anastomosis instead of a multistep operation in cases with MP, except in neonates with very low birth weights because of their vulnerability. In some cases, when the newborn's condition is too critical to allow surgical exploration and viscerolysis, peritoneal drainage, or stoma creation is favored for mitigating a systemic inflammatory response. Definitive surgery is subsequently performed after the newborn has stabilized.[2] In accordance with the previous literature, we performed resection and primary anastomosis with/without enterolysis in 24 (70.6%) patients. Multistep operations were conducted in cases of severe adhesion, uncertain viability of the bowel, and poor clinical conditions such as cardiopulmonary instability. Fourteen babies had morbidities, whereas 3 babies died. One neonate died as result of sepsis caused by multiple microorganisms, whereas the remaining 2 died secondary to extensive bowel necrosis due to volvulus.

The reported survival rate of infants with MP is 80% to 90%. This rate is higher in recent literature.[6,7,9] However, the mortality rate of MP remains as high as 50% in underdeveloped countries.[14] As diagnostic modalities evolve, the accuracy of prenatal diagnosis has improved. It is logical that the survival and morbidity rates could be greatly ameliorated if MP is antenatally detected and appropriately managed during the immediate postnatal period. Ionescu et al[9] also detected a better prognosis in patients with antenatally diagnosed MP. However, a limited number of studies have demonstrated the differences in the characteristics and prognostic features of antenatally versus postnatally diagnosed patients. As such, we divided our patients into prenatally and postnatally diagnosed groups and compared their survival and morbidity rates. The 2 groups had similar profiles, with no statistical differences in the morbidity and survival rates (Table 1). The results did not support the hypothesis of superior outcomes in patients with a prenatal diagnosis of MP. On the basis of our results, it can be inferred that prompt management is more important than the timing of the diagnosis. If babies that are born without a prenatal diagnosis are managed promptly, they can still have favorable outcomes. It is possible that the high hospital density and readily accessible healthcare in Taiwan led to the lack of statistically different outcomes between infants diagnosed prenatally and postnatally.

Table 2 describes subgroup analyses of outborn and inborn infants. Although statistically insignificant, the gestational age and birth weight of the inborn group were lower than those of the outborn group (34.3 weeks vs 36.5 weeks, $P = .09$ and 2425 g vs 2808 g, $P = .13$). However, the rate of prenatal diagnosis was higher (77.3% vs 46.7%, $P = .08$) in the inborn group than that in

the outborn group. This may be attributed to natural selection bias. Because our hospital is a tertiary center that specializes in high-risk pregnancy management, the inborn neonates were more likely to be critically ill or delivered at a lower gestational age and birth weight. There was no significant difference in the morbidity and survival rates between the 2 groups. Nonetheless, there was still a notable trend ($P = .06$) of a higher mortality in outborn infants. This may be because MP is relatively rare and the initial signs can be easily overlooked. MP can be a chronic process with abdominal distention in the absence of continuous leakage or ischemic changes. It can also be an acute ischemic insult, such as a volvulus. Uncomplicated MP may be managed conservatively under close monitoring. However, if signs of a surgical abdomen, such as severe metabolic acidosis, hemodynamic instability, pneumoperitoneum, or other nonreassuring signs—which indicate sepsis or extensive bowel necrosis—are observed, any delay can be catastrophic. Close collaborations between neonatologists and pediatric surgeons are essential for the timely diagnosis and prompt management of MP.

Our limitations included the retrospective nature of this study. There were potential sources of bias, and the data of transferred patients were insufficient. In addition, the procedures performed by different surgeons may have affected our morbidity and mortality rates. The strength of the study was the high volume of cases collected from multiple hospital districts. In addition, to the best of our knowledge, this is the first study to compare the prognoses of MP between inborn and outborn infants.

5. Conclusions

MP is a rare disease entity with polymorphic manifestations. Early detection of the disease and timely management are imperative. Infants diagnosed with MP after birth can still have favorable outcomes if transferred to tertiary centers prior to clinical deterioration or occurrence of complications. It is essential to transport mothers or neonates to tertiary centers staffed with experienced obstetricians, neonatologists, and pediatric surgeons if MP is antenatally suspected or early signs of MP develop after birth.

Author contributions

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