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Radiographic diagnosis of meconium peritonitis. A report of 200 cases including six fetal cases

E. Y. Pan[1], L. Y. Chen[1], J. Z. Yang[1], Z. Lee[2] and Z. Z. Wang[3]

[1]Departments of Radiology, [2]Surgery and [3]Pathology of the Second Affiliated Hospital of the China Medical College, Shenyang, Liaoning, China

Abstract. The radiographic findings of 200 cases of meconium peritonitis were analyzed; 194 cases were discovered in newborn infants and six cases in fetuses. The radiographic features in the newborn group could be categorized as pneumoperitoneum with intestinal obstruction (adhesions) and calcification (35 cases), intestinal obstruction with calcification (143 cases), intestinal obstruction with no radiographically visible calcification (5 cases), and calcification alone (11 cases). All six cases of the fetal group were diagnosed when the mothers had been hospitalized for polyhydramnios and a plaque-like or ring-like calcification showed up in the fetal abdomen on the plain radiograph. Meconium peritonitis is one of the few conditions that can be diagnosed before birth and is almost the only condition around the time of birth to produce calcification in the abdomen. Therefore, if there is any sign of polyhydramnios, radiographs or ultrasonograms of the maternal abdomen should be obtained to detect any calcification within the peritoneal cavity of the fetus. A simple experiment carried out in rats showed that it takes at least eight days after the meconium escapes into the peritoneal cavity for calcification in the meconium to be radiographically demonstrable.

Key words: Meconium peritonitis – Polyhydramnios

Meconium peritonitis has been defined as a nonbacterial chemical inflammation of the peritoneum caused by the escape of sterile meconium into the peritoneal cavity through a perforation in the bowel wall [1, 2]. Although the mortality rate has decreased in recent years it is still high, and this disease remains one of the most serious acute abdominal diseases of the perinatal period. We wish to report the radiographic features of 200 cases of meconium peritonitis.

Table 1. Radiographic features according to age at onset of symptoms in 194 newborn infants with meconium peritonitis

Radiographic features	Number of infants	Age at onset of symptoms					
		Less than 1 month			More than 1 month		
		1–7 day(s)	8–10 days	11–30 days	1–3 month(s)	4–10 months	11–24 months
Pneumoperitoneum with obstruction (adhesions) and calcification	35	28	3	4	0	0	0
Intestinal obstruction with calcification	143	43	9	37	38	10	6
Intestinal obstruction with no radiographically visible calcification	5	1	0	2	2	0	0
Calcification alone	11	1	0	8	2	0	0
Total	194	73	12	51	42	10	6

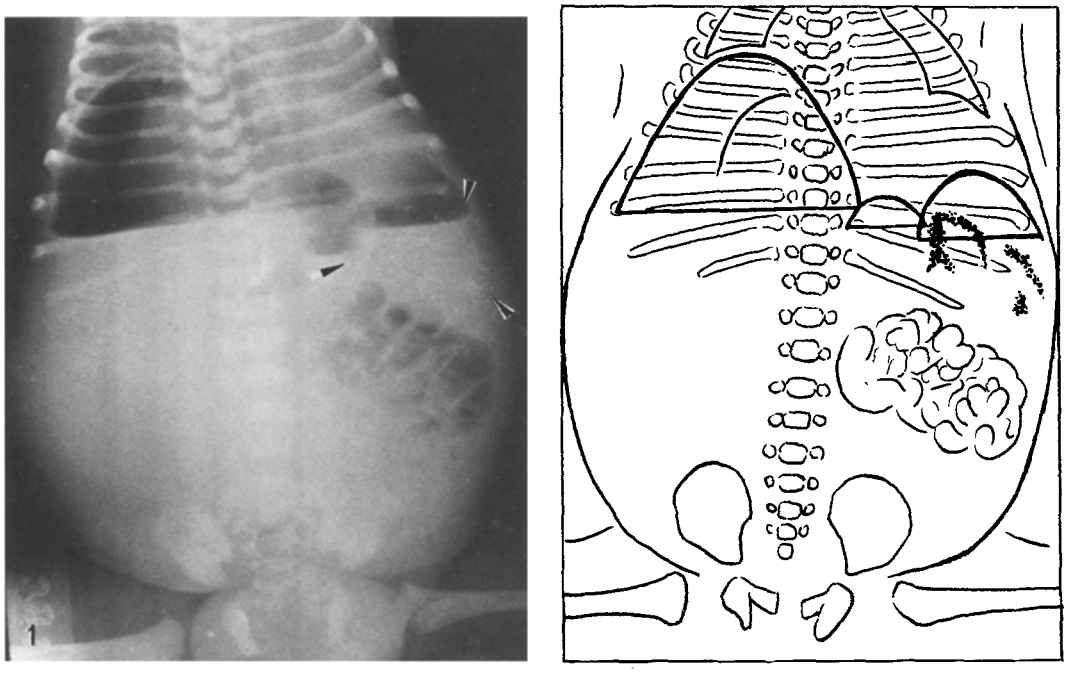

Fig. 1. Anteroposterior radiograph (left) and its schematic representation (right) of a 1-day-old male infant hospitalized because of vomiting and abdominal distention. Pneumoperitoneum is visible. Plaque-like calcifications (arrowheads) are in the left upper quadrant. Intestines are adhered into a mass, seen in the left side of the abdomen

Material

Our series represents 200 cases of meconium peritonitis diagnosed from May 1954 through December 1968 and from May 1973 through February 1980. One hundred ninety-four cases were seen in newborn infants and six cases were in fetuses. The male to female ratio was 2.5 : 1.0. In more than 70% (136) of the newborn infants, symptoms occurred within one month after birth.

Radiographic features

The characteristic features seen on plain radiographs were calcification within the abdominal cavity, intestinal obstruction, and pneumoperitoneum. The newborn group exhibited these findings in various combinations at the time of onset of symptoms (Table 1).

Pneumoperitoneum with intestinal obstruction (adhesions) and calcification

In all 35 infants showing these radiographic features, the onset of symptoms was within one month after birth; in 33 (94%), it was within the first week after birth. Nineteen infants exhibited pneumoperitoneum with air-fluid levels, 13 had pneumoperitoneum that was encapsulated, two also had a large amount of ascites, and one had only a large amount of free air in the peritoneal cavity. Adhesions in this subgroup were much more severe and extensive (Fig. 1) than in the newborns having intestinal obstruction without pneumoperitoneum (see below). In 23 infants (66%), most of the intestinal tract was densely adhered into a mass the size of an egg or slightly larger. The whole mass closely adhered to some part of the abdominal wall.

The calcifications in this subgroup appeared as round plaque-like densities (18 infants), large ring-like densities (10 infants), small flecks or spots (9 infants), and small streaks (4 infants). Two infants had calcification within the scrotum.

Intestinal obstruction with calcification

In the 143 infants in this subgroup, symptoms generally occurred later than in the infants having pneumoperitoneum. Only 43 infants (30%) had symptoms within the first week after birth. As many as 54 (35%) first showed symptoms later than one month after birth.

In 91 infants (64%), the calcification appeared as a localized, small, plaque-like density, mostly (80/91) in the right middle or right lower abdomen (Fig. 2). One infant had two plaque-like calcifications, one in the peritoneal cavity and the other within the intestinal lumen. Because the radiographs

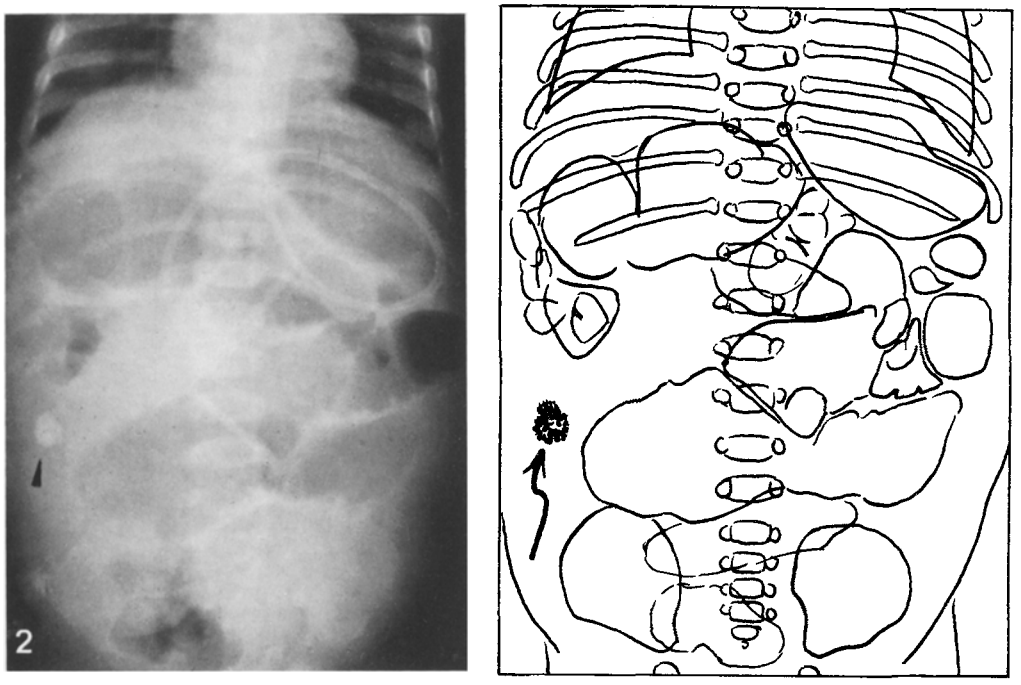

Fig. 2. Anteroposterior radiograph (left) and its schematic representation (right) of an 8-month-old female infant who, after 3–4 days of diarrhea, suddenly had abdominal pain and distention. Small bowel distention is visible. A plaque-like calcification (arrowhead) is in the right middle abdomen. At surgery, two fibrous bands were found strangulating the ileum at 2 and at 21 cm from the ileocecal valve

were taken at different times, it was not difficult to differentiate the sites of these two calcifications. In 14 infants (10%), the calcification was not immediately obvious and could only be seen on good-quality radiographs; these calcifications were all confirmed at surgery.

Intestinal obstruction with no radiographically visible calcification

In these five infants, there were only signs of intestinal obstruction. Diagnosis could only be made by surgery or autopsy.

Calcification alone

The 11 infants with this finding were hospitalized because of pneumonia (four infants), small abdominal mass (two infants), or mild nausea or abdominal distention (five infants). Meconium peritonitis was diagnosed incidentally from the radiographs. All 11 infants recovered after conservative treatment.

Fetal cases

The six fetal cases were discovered when the mothers were hospitalized for symptoms of polyhydramnios during the 7th or 8th month of pregnancy (Table 2). On the radiographs of the maternal abdomen, there were plaque-like (Fig. 3a and b) or small or large ring-like (Figs. 4 and 5) calcifications within the fetal abdominal cavity. Four of the babies were subsequently delivered in our hospital. In three of them, the calcifications had demonstrated plaque-like densities (Fig. 3a and b). Two of the three were well and symptom-free after delivery until, at the age of 6 months and 15 months, they showed clinical signs of intestinal obstruction. The diagnosis of meconium peritonitis was then proved radiographically and surgically. In the third case, the mother, after taking a dose of Chinese herbal medicine, delivered a stillborn female infant; it had an enlarged abdomen and anencephaly. The diagnosis of meconium peritonitis was confirmed at autopsy. The site of perforation was at the ascending colon, and severe adhesion and meconium were found nearby. The chromosomes of the mother and infant were normal, as was the immunologic function.

Discussion

A number of conditions have been listed [2, 3] as causes of meconium peritonitis but not a single one is sufficient to explain all of the reported cases. The cases can be divided into those due to: (1) congenital anomalies of the alimentary tract, (2) cystic fibrosis of the pancreas associated with atresia of the intesti-

Table 2. Radiographic features of six cases of fetal meconium peritonitis

Case	Status of mother			Radiographic features on maternal abdominal radiograph	Type of delivery	Status of infant after delivery
	Age (years)	Gestation period (months) when hospitalized	Onset of symptoms of polyhydramnios			
1	37	7.5	6th month	Polyhydramnios; round, plaque-like calcification (21 × 25 mm) within fetal abdomen	Normal	Boy, symptom-free until 6 months of age when he underwent surgery for adhesive intestinal obstruction
2	25	7.5	6th month	Polyhydramnios; thick, ring-like calcification (53 × 42 mm) within fetal abdomen	Lost to follow-up	–
3	30	8.0	6th month	Polyhydramnios; round, plaque-like calcification (25 × 23 mm) within fetal abdomen	Normal	Boy, symptom-free until 15 months of age when he underwent surgery for adhesive intestinal obstruction. During surgery, extensive adhesions, 10 × 10 mm calcification, and congenital malrotation of the small intestine were found
4	30	7.0	5–6th month	Polyhydramnios; round, plaque-like calcification (10 × 13 mm) within fetal abdomen	Lost to follow-up	–
5	38	8.0	6–7th month	Polyhydramnios; large, ring-like and small, scattered, plaque-like calcifications within fetal abdomen	Chinese herb to induce labor	Girl with enlarged abdomen, died 20 min after delivery
6	29	8.0	6–7th month	Polyhydramnios; round, plaque-like calcification (9 × 14 mm) within fetal abdomen	Chinese herb to induce labor	Girl stillborn, perforation at ascending colon with intestinal adhesion and plaque-like calcification

nal tract, (3) cystic fibrosis of the pancreas not associated with atresia of the intestinal tract, (4) perforation of the bowel wall, and (5) unknown cause. In the literature of Europe and America [2–5], cystic fibrosis is emphasized as an important etiologic factor. In China, there have been more than a hundred cases reported [6–9], but they are rarely associated with cystic fibrosis. In our hospital, of 37 autopsy-proved cases of meconium peritonitis, 30 were histologically evaluated; not a single case could be associated with cystic fibrosis. Neither can this association be concluded from cases reported in the Japanese literature [10]. Therefore, we believe the cause remains unclear and requires further study.

For early diagnosis, even in the fetal stage, it is important to know when the disease starts. Three conditions must be fulfilled in order to make the evolution of meconium peritonitis possible, i.e., there must be meconium in the bowel; perforation of the bowel wall; and peristalsis, which produces the intestinal rupture [11]. Meconium is formed at about the third gestational month [5, 11] and reaches the cecum and rectum at about the fourth and fifth month respectively [12]; no peristalsis is seen before the fifth month [5]. Therefore, it has been estimated that meconium peritonitis commences not earlier than the fifth month [13]. In our six cases from the fetal group, the common symptom of the mothers was polyhydramnios. This indicates that the swallowed amniotic fluid did not pass through the intestinal tract of the fetus because meconium peritonitis was present. Polyhydramnios became evident as early as the fifth month of gestation in one mother. We thus assume that the onset of meconium peritonitis can be within the fourth rather than the fifth gestational month at the earliest.

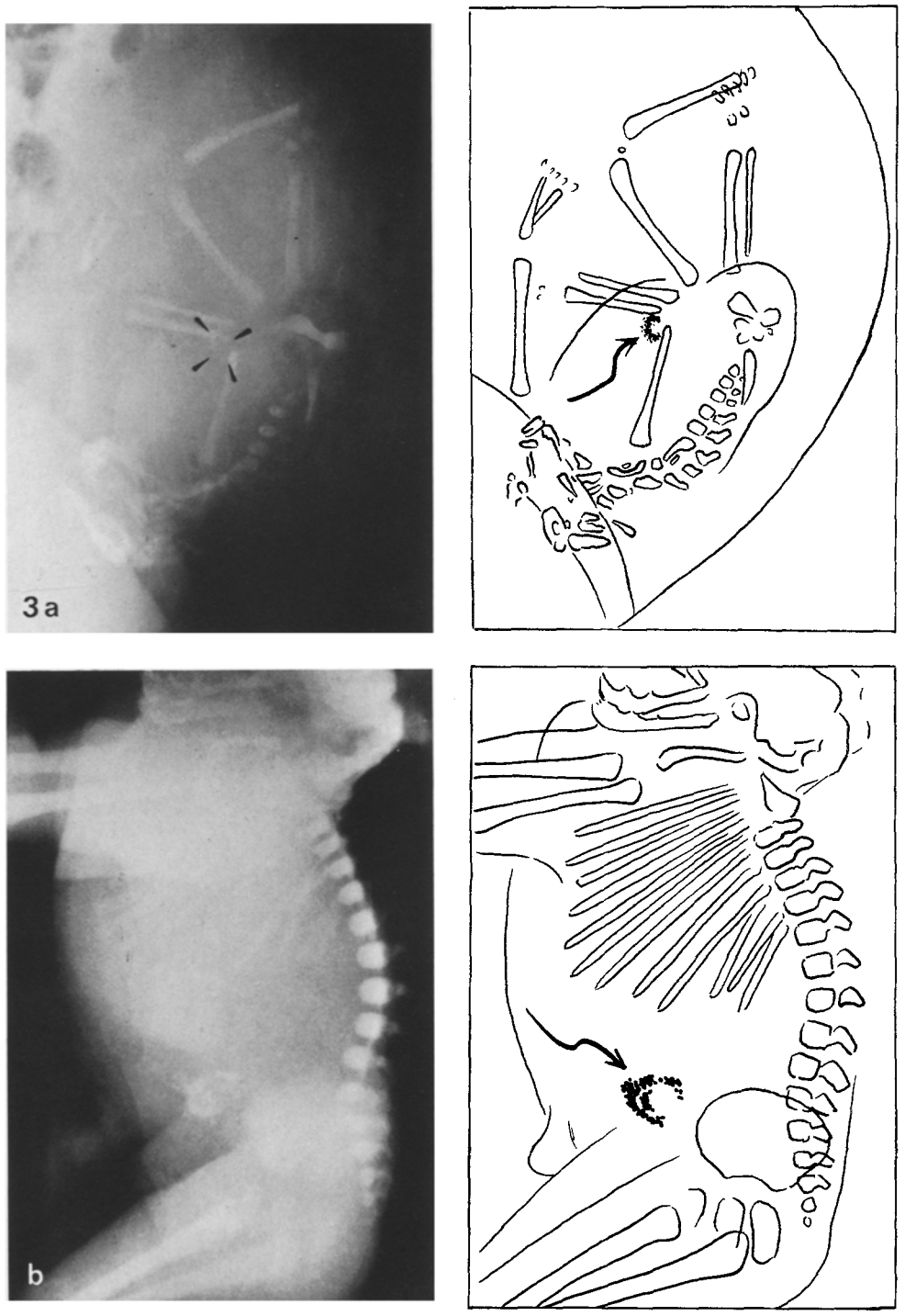

Fig. 3a Before delivery. Radiograph (left) and its schematic representation (right) of a fetus (Case 6) show plaque-like calcification (arrowheads) and anencephaly. **b** After delivery

Intra-abdominal calcification has come to be regarded as pathognomonic of meconium peritonitis. It has been reported [1, 5, 11, 13, 14] that calcification can occur within 24 h after meconium escapes into the peritoneal cavity. According to the experience of Tucker et al. [15], it may take a few weeks for calcification to become dense enough to be visible in the patient radiographically.

We carried out a simple experiment in order to observe how long it requires for calcification to be radiographically visible after its escape into the peritoneal cavity. Under sterile conditions, we obtained

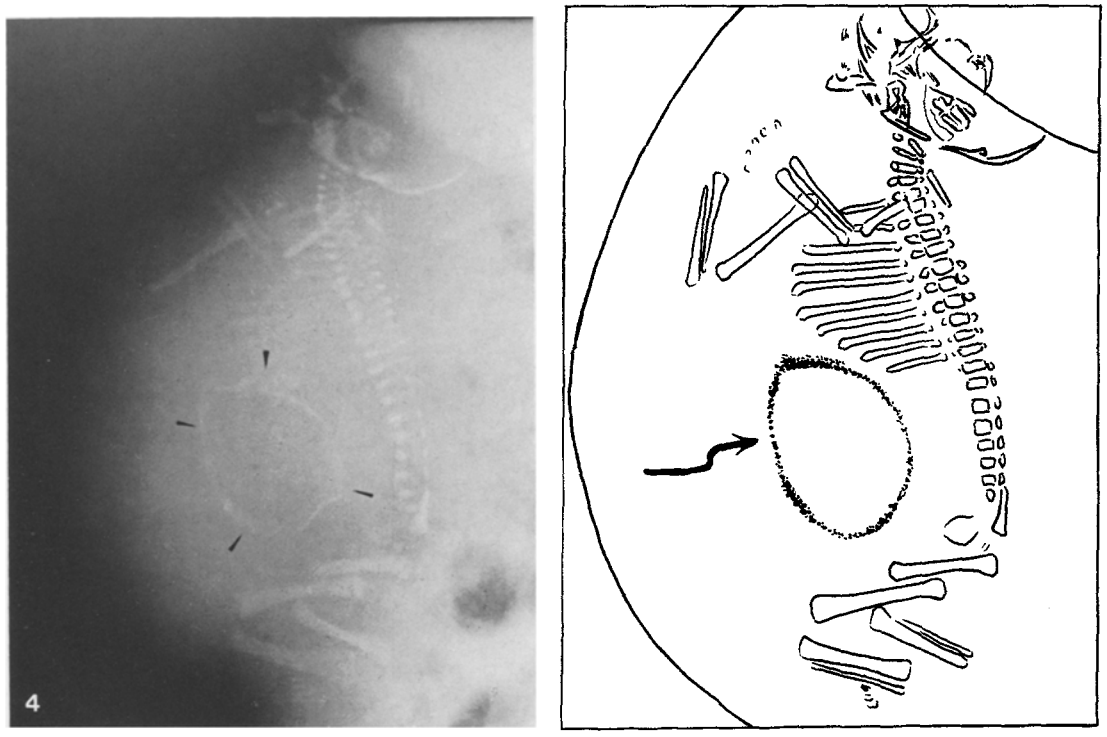

Fig. 4. Radiograph (left) and its schematic representation (right) of a fetus (Case 5) showing a large ring-like calcification (arrowheads) and small scattered calcifications in the enlarged fetal abdomen

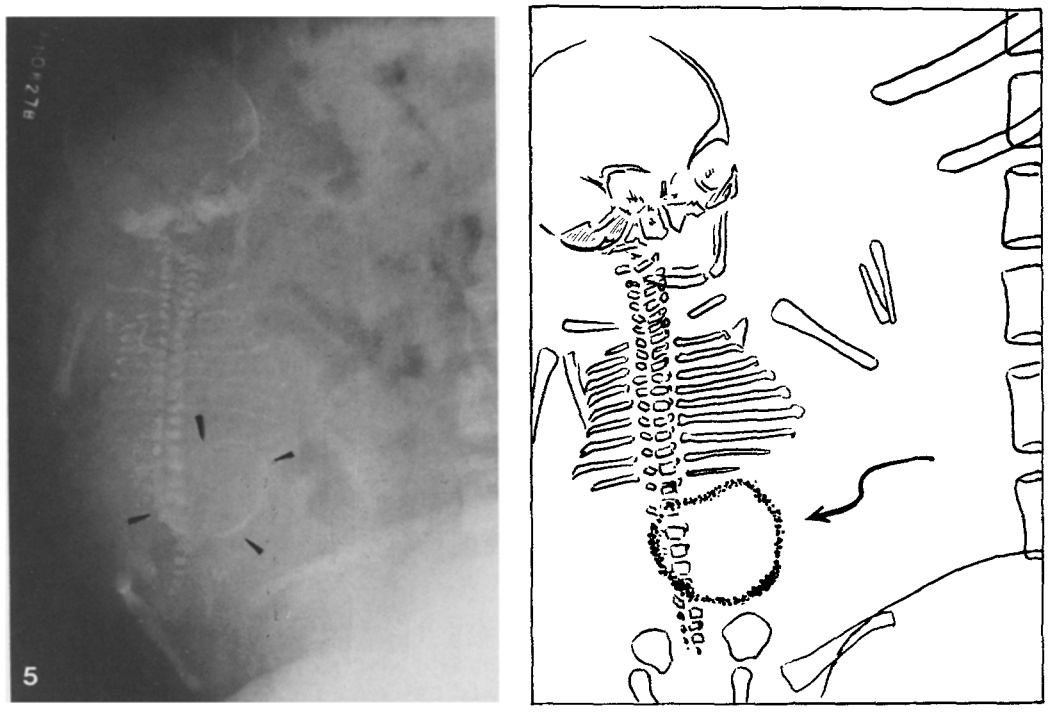

Fig. 5. Radiograph (left) and its schematic representation (right) of a fetus (Case 2) showing a thick ring-like calcification (arrowheads) in its abdomen

meconium from the intestine of one of the fetuses in our study. Twenty-five rats were injected intraperitoneally with the sterile meconium. Radiographs (using a molybdenum focus) of each rat's abdomen were taken at regular intervals for 14 days. Nine rats died separately within the 14 days and the remaining 16 rats were killed on the fourteenth day. All 25 rats underwent autopsy and histological examination. Radiographs were also obtained on the days they died. Before the eighth day, no rats showed calcification radiographically, and none of the rats that died before the eighth day showed calcification microscopically. From the eighth day through the fourteenth day, only six rats showed calcification microscopically. Only one of these six exhibited calcification radiographically, and that was on the eighth day. The radiographic density of this calcification was not great, i.e., it was less than that of a zinc-oxide tape on the radiograph (taken by the molybdenum focus tube). We conclude that it takes at least eight days for calcification to become dense enough to be radiographically visible.

We also conclude that meconium peritonitis and its calcification takes place during intrauterine life. Eighty-five of our 194 newborn infants were seen within 10 days after birth (Table 1). Eighty-four of these 85 showed distinct radiographic calcification. Of the 51 newborns seen between 11 days and one month, 49 showed distinct calcification radiographically. The remaining 58 infants were symptom-free at birth and, consequently, we did not evaluate them until intestinal obstruction or another condition brought them to our attention (one month to two years after birth). All but two of these 58 infants showed calcification on the radiographs. We think that, in these 58 infants, the perforation of the intestine had sealed before the time of birth and, therefore, that the symptoms of obstruction, due to adhesion, would not have occurred until a later time. Dayalan and Ramakrishnan [16] offer this explanation for five cases of meconium peritonitis that they diagnosed between one and eight months after birth of the infants. In the five newborns in our study who did not exhibit radiographically distinct calcification, the calcification was probably already formed but just not visible radiographically because it was too faint or the film quality was not good enough.

Meconium peritonitis is one of the few conditions that can be diagnosed before birth because it is almost the only disease around the time of birth to produce calcification in the abdominal cavity of the fetus [17]. Our experience with the fetal group leads us to recommend that radiographs or ultrasonograms be obtained of the maternal abdomen if there is any sign of polyhydramnios after the fifth month of pregnancy so that any calcification within the peritoneal cavity of the fetus can be detected.

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Dr. Li Ying Chen
Department of Radiology of the
Second Affiliated Hospital of the
China Medical College
Shenyang, Liaoning
China