Pediatric Radiology (2018) 48:1755–1762
https://doi.org/10.1007/s00247-018-4198-5

ORIGINAL ARTICLE

Meconium peritonitis: the role of postnatal radiographic and sonographic findings in predicting the need for surgery

Pablo Caro-Domínguez[1,2] · Augusto Zani[3] · David Chitayat[4,5] · Alan Daneman[1]

Received: 18 January 2018 / Revised: 9 May 2018 / Accepted: 24 June 2018 / Published online: 16 July 2018

Abstract

Background The role of imaging in meconium peritonitis is not limited to establishing a diagnosis; rather, it might also be helpful in determining which neonates require surgery. However, few data in the literature correlate the postnatal radiographic and sonographic findings with the need for surgery.

Objective To compare the role of postnatal radiographic and sonographic findings in predicting the need for surgery in neonates with meconium peritonitis.

Materials and methods We conducted a retrospective analysis of clinical, imaging and surgical findings in all neonates with meconium peritonitis in the period 1999–2014. We divided the children into operative or non-operative groups and then correlated each group with the presence or absence of the following findings on both the radiographs and sonograms: peritoneal calcification, meconium pseudocyst, intestinal obstruction, volvulus, ascites and pneumoperitoneum.

Results Thirty-seven neonates (22 males, 15 females) had meconium peritonitis in this period, of whom 23 (62%) required surgery and 14 (38%) were successfully treated non-surgically. None had an antenatal infection and three had cystic fibrosis (8%). Bowel obstruction identified on radiography (12/23, P=0.01) and sonography (9/23, P=0.04) and ascites identified with sonography (7/23, P=0.01) were associated with the need for surgical intervention. The presence of pneumoperitoneum and volvulus were also associated with surgical intervention. There was no significant statistical difference in the number of neonates with diffuse peritoneal calcification who were treated operatively or non-operatively. Four (33%) of the 12 neonates with meconium pseudocysts were successfully treated non-operatively.

Conclusion Imaging findings that predicted the need for surgery were intestinal obstruction, ascites, volvulus and pneumoperitoneum. Neonates with meconium pseudocysts did not require surgery if they were not associated with the described findings. The findings in our patients also indicate that those with diffuse peritoneal calcification as an isolated finding can be successfully treated non-operatively.

Keywords Meconium peritonitis · Neonates · Radiography · Sonography · Surgical management

✉ Alan Daneman
alan.daneman@sickkids.ca

[1] Department of Diagnostic Imaging,
Hospital for Sick Children,
Department of Medical Imaging,
University of Toronto,
555 University Ave.,
Toronto, ON M5G 1X8, Canada

[2] Unidad de Imagen Pediátrica, Health Time,
Hospital VIAMED Santa Ángela de la Cruz,
Sevilla, Andalucía, Spain

[3] Division of General and Thoracic Surgery,
Department of Surgery, Hospital for Sick Children,
University of Toronto,
Toronto, ON, Canada

[4] The Prenatal Diagnosis and Medical Genetics Program,
Department of Obstetrics and Gynecology, Mount Sinai Hospital,
University of Toronto,
Toronto, ON, Canada

[5] Division of Clinical Genetics and Metabolism,
Department of Pediatrics, The Hospital for Sick Children,
University of Toronto,
Toronto, ON, Canada

Introduction

Meconium peritonitis is a condition that occurs following intrauterine intestinal perforation [1, 2]. This allows meconium to leak into the peritoneal cavity, causing an inflammatory reaction that can then calcify [3]. Some neonates with meconium peritonitis require emergency surgery but others can be successfully managed non-surgically [3].

The role of imaging in these neonates is not limited to establishing a diagnosis; rather, it might also be helpful in predicting the neonates who require surgery [4–8]. However, few data in the literature correlate the postnatal radiographic and sonographic findings and the need for surgery.

The purpose of this study is to identify the postnatal radiographic and sonographic findings that predict the need for surgical intervention in a large series of neonates with meconium peritonitis.

Materials and methods

Our institution's research ethics board approved this study.

We retrospectively analyzed the clinical, radiographic, sonographic, surgical and pathological findings in all neonates with meconium peritonitis based on findings on the radiographs and sonograms in the 15-year period of 1999–2014.

We prepared the list of patients by reviewing the imaging reports in the picture archiving and communication system (PACS; GE, Healthcare, Milwaukee, WI) of our tertiary-care pediatric hospital. We searched for the words "meconium peritonitis" and "intra-abdominal calcifications" in children younger than 1 year.

The inclusion criteria were children with proven meconium peritonitis that were studied postnatally with both radiography and sonography. Final diagnosis of the non-operative group was based on imaging and clinical notes of the surgeons during hospitalization and follow-up appointments. The exclusion criteria included lack of clinical follow-up, other causes of neonatal intra-abdominal calcification such as enteroliths or calcified intra-abdominal masses, and those who were not evaluated with both radiography and sonography.

Two pediatric radiologists (A.D. and P.C.-D., with 38 and 2 years of post-fellowship experience, respectively) and a pediatric surgeon (A.Z., with 3 years of experience) reviewed all of the radiographs and sonograms of these neonates in consensus. The three were initially blinded to outcome in these children and to the original imaging reports. There were no disagreements among them. We then reviewed the clinical, surgical and pathological findings and divided the children into two groups based on whether they were treated surgically or non-surgically. These two groups were then correlated with the presence or absence of the following findings on both the radiographs and sonograms: peritoneal calcification, meconium pseudocyst, intestinal obstruction, volvulus, ascites and pneumoperitoneum. Bowel obstruction was considered present when there was dilatation of bowel with air-fluid levels on abdominal radiographs or dilated bowel with a caliber change on ultrasound.

At our institution, sonographic examinations of the abdomen and pelvis include an initial evaluation of the entire upper abdomen and pelvis with vector and curved-array transducers followed by magnified images focused on the gastrointestinal (GI) tract utilizing high megahertz (8–15-mHz) linear-array transducers. The linear-array images are initially obtained in gray-scale and then in color and power Doppler images to evaluate the major intestinal vessels and perfusion of the intestinal wall. Most of these studies were performed by experienced sonographers. However, if the study was performed at night or during the weekend it might have been done by a fellow under direct supervision of a pediatric radiologist. The plain radiographs of the abdomen included anteroposterior (AP) supine and lateral shoot-through views.

All of the neonates were screened for cystic fibrosis (by a postnatal sweat chloride test and deoxyribonucleic acid [DNA] analysis for the 39 most common mutations associated with cystic fibrosis in the Caucasian population) and for congenital infections using immunoglobulin G and immunoglobulin M serology studies for herpes simplex virus, cytomegalovirus, rubella, parvovirus B19 and toxoplasmosis and urine culture for cytomegalovirus.

We performed a two-tailed independent-samples *t*-test to compare continuous variables between radiography and sonography. We used a Fisher exact test to compare nominal variables between radiography and sonography and between the operative and non-operative groups. *P*-values <0.05 were considered statistically significant. We used Prism version 7.0 for Mac OS X (GraphPad, La Jolla, CA) for the statistical analysis.

Results

Using our criteria, we identified 46 neonates with meconium peritonitis. We excluded nine from the final study group: two died from complications of extreme prematurity, two did not have any radiographs and five did not have any postnatal sonography.

Table 1 Imaging findings in 37 children diagnosed with meconium peritonitis

Imaging findings		Radiographs	Ultrasound	*P*-value
Median day performed (standard deviation)		1 (34)	2 (36)	NS
Calcifications	Diffuse peritoneal calcification	21	22	NS
	Meconium pseudocyst	8	11	NS
Signs of obstruction		13	9	NS
Pneumoperitoneum		1	3	NS
Ascites		3	7	NS
Volvulus		0	1	NS

NS not significant

We included the remaining 37 infants in the final analysis. These included 22 males and 15 females. Thirty-three presented within the first week of age, two during the first month and two at 4 months and 5 months. Twenty (54%) neonates were premature and eight (22%) were born from twin pregnancies.

Imaging findings

The imaging findings on radiography and sonography are summarized in Table 1. The presence of intestinal obstruction was more often depicted by radiography than sonography (Fig. 1). The detection of diffuse peritoneal calcification was

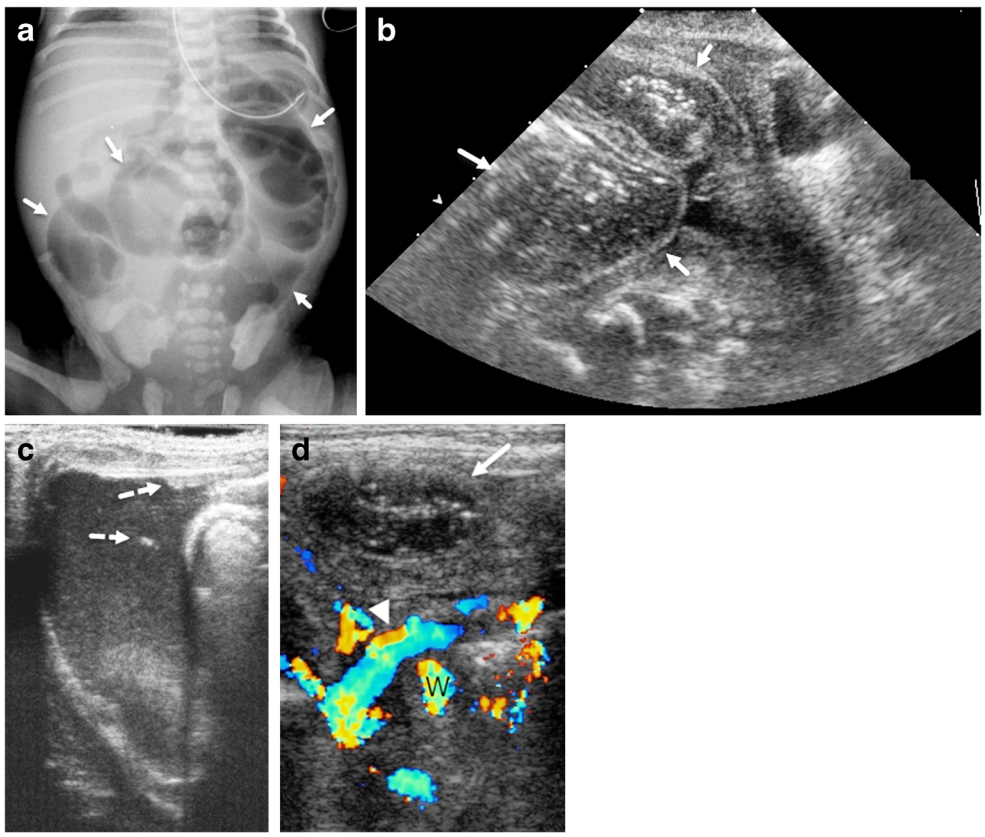

Fig. 1 Small-bowel obstruction in a term boy with a fetal diagnosis of meconium peritonitis (gestational age 36 weeks). **a** Anteroposterior supine portable radiograph of the abdomen obtained at 1 day old shows multiple dilated small-bowel loops (*arrows*), in keeping with distal small-bowel obstruction. No calcifications are identified. **b**, **c** Transverse ultrasound images of the abdomen performed at 2 days old demonstrate (**b**) dilatation of small-bowel loops (*solid arrows*) with (**c**) ascites between the loops. Non-calcified meconium (*dashed arrows*) is floating in the ascites. **d** Transverse color Doppler ultrasound image of the upper abdomen raises the suspicion of the whirlpool sign (*W*) because of a swirling appearance of the mesenteric vessels (*arrowhead*), in keeping with a midgut volvulus. The baby underwent surgery, which uncovered small-bowel obstruction with two idiopathic perforations of the small bowel. At surgery, volvulus was not identified

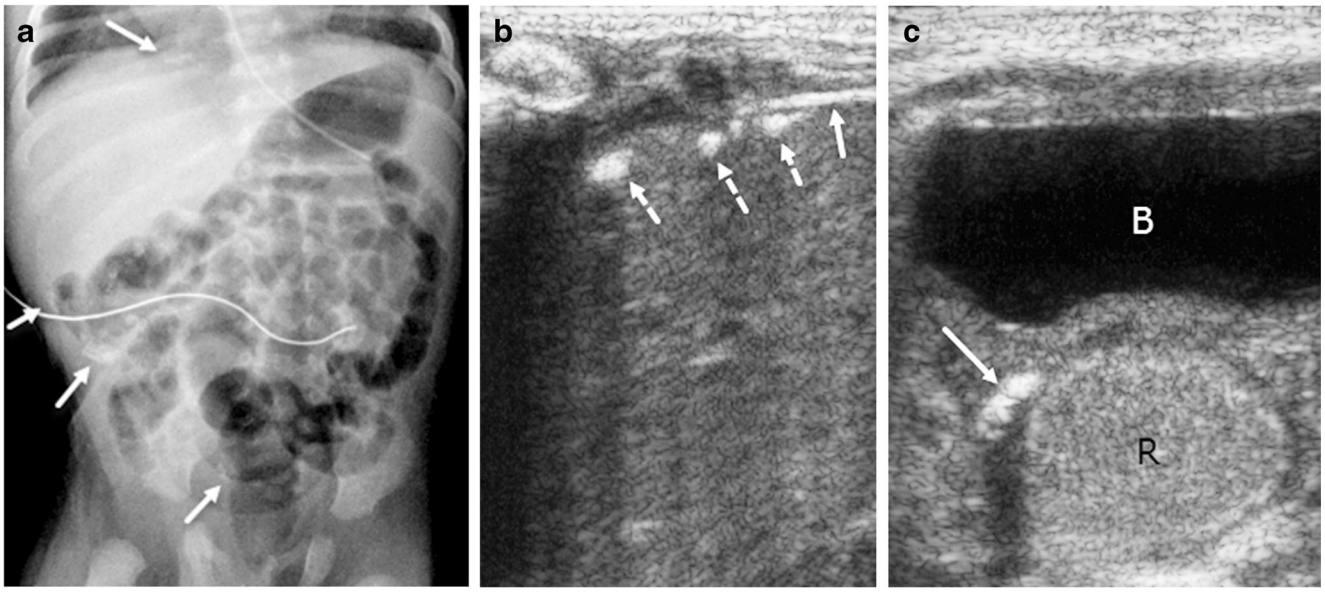

Fig. 2 Diffuse peritoneal calcification in a preterm boy born with fetal diagnosis of meconium peritonitis (gestational age 32 weeks). **a** Anteroposterior portable supine radiograph of the abdomen obtained the first day of age shows calcifications (*arrows*) in the right upper quadrant, right flank and pelvis. **b** Transverse ultrasound image obtained with a linear probe of the liver done the same day demonstrates multiple calcifications with acoustic shadowing within the periphery of the liver (*dashed arrows*) and calcifications of the peritoneal surface of the liver (*solid arrow*). **c** Transverse ultrasound image obtained with a linear probe of the midline of the pelvis demonstrates a calcification lateral to the rectum (*R*). This baby was asymptomatic and was treated conservatively *B* bladder

about equally depicted by both radiographs and sonography (Fig. 2). However, meconium pseudocysts (Fig. 3), ascites, volvulus and pneumoperitoneum (Fig. 4) were all more often depicted by sonography. Nevertheless, in none of these findings did the differences reach statistical significance.

Table 2 summarizes the radiographic and sonographic findings correlated with the operative and non-operative groups, respectively.

Bowel obstruction identified on either radiography (12/23, P=0.01) or sonography (9/23, P=0.04) and ascites identified with sonography (7/23, P=0.01) were associated with the need for surgical intervention. Four children had turbid ascites (mixed with floating meconium) and three clear ascites, all of them requiring surgery. The presence of pneumoperitoneum (present in three cases on sonography and one on radiography) and midgut volvulus (present in one on sonography) were also associated with the need for surgical intervention, but the small numbers did not reach statistical significance.

There was no significant statistical difference in the number of neonates with diffuse peritoneal calcification who were treated operatively vs. those treated non-operatively. In 10 (27%) of these infants, the diffuse peritoneal calcification was an isolated

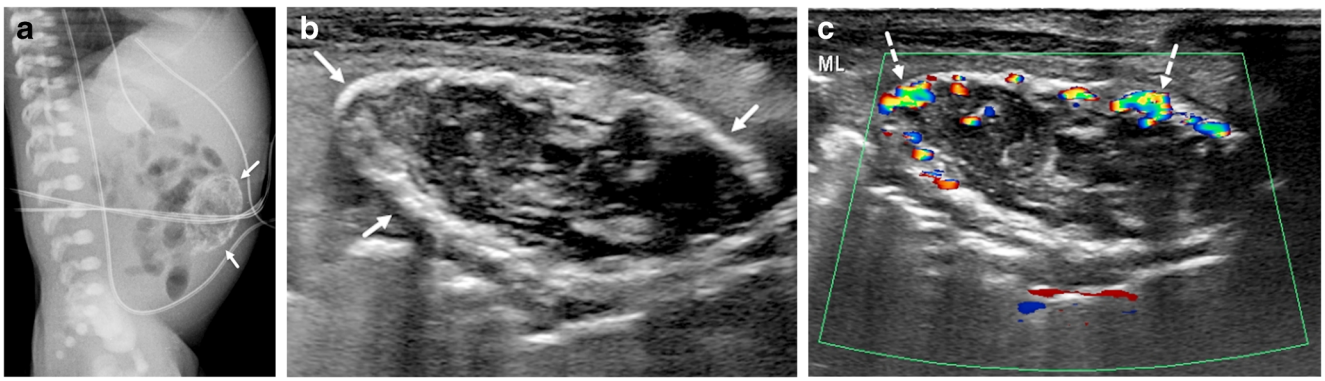

Fig. 3 Meconium pseudocysts in a preterm twin girl with fetal diagnosis of meconium peritonitis (gestational age 31 weeks). **a** Lateral portable cross-table radiograph of the abdomen obtained at 1 day old demonstrates a round peripherally calcified mass in the mid abdomen (*arrows*), in keeping with meconium pseudocyst. **b**, **c** Sagittal ultrasound (**b**) and Doppler ultrasound (**c**) images obtained with a linear probe the same day show calcification of the periphery of the mass (*solid arrows*), with twinkling artifact on color Doppler (*dashed arrows*) and heterogeneous contents. This girl was asymptomatic regarding the gastrointestinal tract, was treated conservatively and remained asymptomatic 4 years later

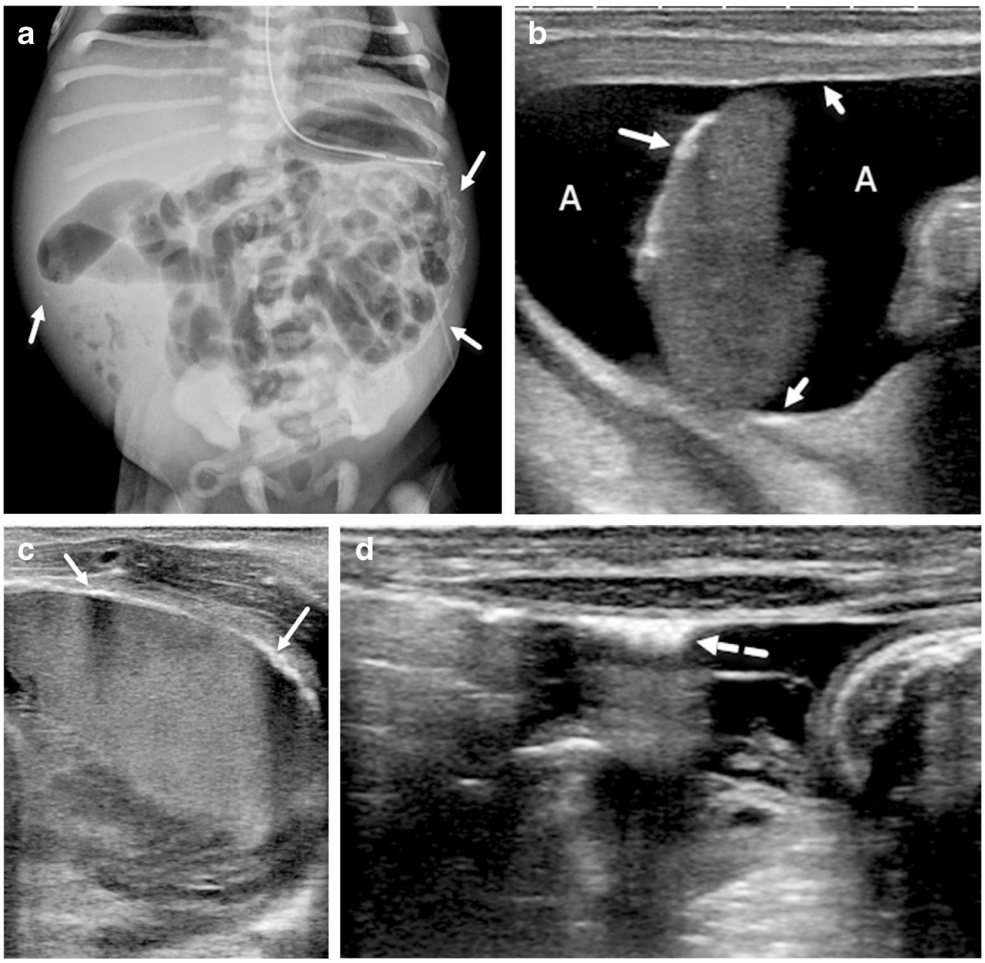

Fig. 4 Pneumoperitoneum in a term boy with meconium ileus and findings consistent with cystic fibrosis (gestational age 40 weeks). **a** Anteroposterior supine radiograph of the abdomen obtained at 1 day old shows diffuse nodular peritoneal calcifications (*arrows*) in both flanks. **b**, **c** Transverse and sagittal ultrasound images obtained the second day of age of the (**b**) right and (**c**) left upper quadrants, respectively, demonstrate a large amount of anechoic ascites (*A*) and calcifications (*arrows*) along the peritoneal surfaces. **d** Transverse linear probe demonstrates pneumoperitoneum (*arrow*) in the abdominal cavity. Surgery demonstrated signs of cystic fibrosis and meconium ileus, and a perforation in the terminal ileum. Deoxyribonucleic acid (DNA) analysis confirmed the diagnosis of cystic fibrosis

finding on radiographs. Two of these required surgical intervention because sonography also revealed the presence of a pneumoperitoneum in one and a meconium pseudocyst in the other. Four of the seven children who had ascites detected with ultrasound presented with pneumoperitoneum. The other three, interestingly, had a meconium pseudocyst.

Table 2 Radiographic and sonographic findings in neonates with meconium peritonitis treated operatively and non-operatively

Findings on radiography		Non-operative group (*n*=14)	Operative group (*n*=23)	*P*-value
Calcifications	Diffuse peritoneal	9	12	NS
	Meconium pseudocyst	4	4	NS
Signs of obstruction		1	12	0.01
Pneumoperitoneum		0	1	NS
Ascites		0	3	NS
Findings on sonography		Non-operative group (*n*=14)	Operative group (*n*=23)	*P*-value
Calcifications	Diffuse peritoneal	11	11	NS
	Meconium pseudocyst	3	8	NS
Signs of obstruction		0	9	0.04
Pneumoperitoneum		0	3	NS
Ascites		0	7	0.01
Volvulus		0	1	NS

NS not significant. *P*-values <0.05 were considered statistically significant

In the remaining eight infants the diffuse peritoneal calcification was an isolated postnatal finding on both radiographs and sonography, and all eight infants were associated with successful non-operative management. In such children the diagnosis is based on the prenatal and postnatal imaging findings, with no surgical confirmation. In these children it is assumed that a perforation had occurred and then sealed over antenatally without residual abnormalities that could cause obstruction. They are closely followed clinically the first year after birth.

Furthermore, four (33%) of the 12 neonates with meconium pseudocysts did not require surgical intervention. In these children the pseudocysts did not cause obstruction and were thought to resorb and resolve over time.

These children had multiple follow-up appointments at the surgery clinic during their first year of age, and those with complications were followed further as clinically indicated. Follow-up radiography and sonography were not routinely performed in this series. However, progressive decrease in size and number of the peritoneal calcifications was noted on both the radiographs and sonograms in the three children who had follow-up examinations.

Upper GI series was performed in 11 symptomatic neonates between birth and 26 days of age. Three were positive, showing signs of duodenal atresia in one, jejunal atresia in one and malrotation with volvulus in one. Contrast enema was performed in 19 neonates between birth and 19 days of age. Ten of these were positive: three showed signs of meconium ileus; another three showed signs of atresia of the distal ileum; two showed jejunal atresia; one showed atresia of the sigmoid; and one showed malrotation, volvulus and atresia of the jejunum.

Final diagnosis

Three (8%) neonates had cystic fibrosis confirmed by both sweat chloride and genetic testing. Tests for antenatal infections were negative in all patients. There were single cases of VACTERL (vertebral defects, anal atresia, cardiac defects, trachea-esophageal fistula, renal anomalies and limb abnormalities) association, primary ciliary dyskinesia (based on DNA analysis) and Alagille syndrome (based on DNA analysis for mutation in the *JAG1* gene).

Twenty-three (62%) of the neonates required surgical intervention because of symptoms related to gastrointestinal obstruction or perforation. The surgical findings are summarized in Table 3. The most common causes of meconium peritonitis were idiopathic perforation in seven, ileal atresia in six and jejunal atresia in three.

Fourteen (38%) children were successfully managed non-operatively. Twelve of these were neonates who had the diagnosis of meconium peritonitis made either on antenatal sonography or incidentally on postnatal abdominal radiographs or sonography. The other two presented with scrotal swelling at 4 months and 5 months of age, at which time sonography depicted intra-scrotal calcification from meconium periorchitis and plain radiographs and sonography showed calcifications in the abdomen.

Table 3 Surgical findings in 23 children with meconium peritonitis

Surgical findings	Number of patients
Idiopathic perforation	7
Ileal atresia	6 (2 with volvulus)
Jejunal atresia	3 (1 with volvulus)
Volvulus of small bowel without cause	3
Meconium ileus in cystic fibrosis	2
Ileal stenosis	1
Multiple small-bowel atresias and one colonic atresia	1

Discussion

This study shows that postnatal radiographs and sonograms are valuable tools in predicting the need for surgical intervention in neonates with meconium peritonitis. The specific radiographic and sonographic findings, correlated with the operative and non-operative groups, are summarized in Table 2.

Bowel obstruction identified on either radiography (12/23, P=0.01) or sonography (9/23, P=0.04), and ascites identified with sonography (7/23, P=0.01) were highly associated with a need for surgical intervention. The presence of pneumoperitoneum (present in three cases on sonography and one on radiography) and volvulus (present in one on sonography) were also associated with surgical intervention but the small numbers did not reach statistical significance.

There was no significant statistical difference between the number of neonates with diffuse peritoneal calcification who were treated surgically and those treated non-surgically. In 10 (27%) of these infants, the diffuse peritoneal calcification was an isolated finding on radiographs. Two of these required operative intervention because sonography also revealed the presence of a pneumoperitoneum in one and a meconium pseudocyst in the other. However, in the remaining eight infants the diffuse peritoneal calcification was an isolated postnatal finding on both radiography and sonography and all eight were associated with successful non-operative management. Furthermore, four (33%) of the 12 neonates with meconium pseudocysts were successfully treated non-operatively.

Correlation between prenatal imaging findings and indication for surgery is well established [4–7]; persistent intestinal dilatation and meconium pseudocyst require surgery after birth while isolated peritoneal calcification can be treated non-operatively. While the indications for surgery postnatally

are based on clinical symptoms and the child's general condition, asymptomatic infants, even with evidence of calcifications and fluid collections, might be managed non-operatively [8]. Our study has shown that similar guidelines can be used postnatally for intestinal obstruction but not for meconium pseudocyst because one-third of our cases did not require surgery. Our study confirms that ascites is a predictor of surgery when found postnatally and infants with isolated peritoneal calcifications can be managed conservatively with slow feeding regimens and follow-up.

Table 1 summarizes the findings we evaluated on both radiography and sonography in our series of 37 infants. It shows that the presence of intestinal obstruction was more often depicted by radiography than sonography; the detection of diffuse peritoneal calcification was equally depicted by both radiography and sonography; and meconium pseudocysts, ascites, volvulus and pneumoperitoneum were all more often depicted by sonography. However, while both radiography and sonography have certain advantages and disadvantages in defining specific imaging features in infants with meconium peritonitis, the differences in the two modalities did not reach statistically significant values because of the relatively small numbers of children with each of the specific features in our series.

Sonography and radiography were in agreement as an indication for surgery in most of the children. However in two children sonography revealed a finding (pneumoperitoneum) that was not appreciated on radiography and that suggested the need for surgery. This fact could be explained by the time interval between imaging studies but also highlights the importance and benefits of utilizing both modalities over time in all of these children.

Sonography provides additional information about peristalsis, thickness, echogenicity and vascularity of the intestinal wall and about the characteristics of the ascites that might show echogenic meconium floating in the fluid with a characteristic snowstorm appearance (Fig. 1), which is specific in the newborn for meconium peritonitis [9].

Postnatal sonography also depicted meconium periorchitis, a pathology that presents as a soft hydrocele at birth that becomes harder as the meconium calcifies and can become inflamed [10].

In this series, a remarkable number of children (38%) with meconium peritonitis were asymptomatic and did not require surgery. In three published fetal series, nonsurgical cases ranged between 24% and 38%, similar to our results [4, 7, 8, 11]. Zerhouni et al. [4] reported a series of 23 children with meconium peritonitis and reported a non-surgical rate of 87%. In all fetal series, non-surgical cases are related to an early recognition in utero [4, 11, 12], to the absence of bowel dilatation [4, 7], and to the absence of meconium pseudocysts [6].

The etiology of meconium peritonitis is variable, with the main causes being intestinal atresia, volvulus, intussusception and meconium ileus [1]. In these series, we identified all of these causes except intussusception. We have confirmed that in most cases the etiology of the perforation cannot be identified, although it might be related to a deficient vascular supply and, second most commonly, to bowel atresia. However the bowel atresia might be the result of vascular insult, followed by necrosis and atresia [1]. Viruses (cytomegalovirus, rubella, parvovirus B19) have been linked to meconium peritonitis [5]. In all our cases, TORCH (toxoplasmosis, other, rubella, cytomegalovirus, herpes) infection was excluded.

The incidence of cystic fibrosis in infants with meconium peritonitis has been reported to vary between 15% and 40% [3]. In our series, diagnosis of cystic fibrosis was documented in only 8% of the cases, all of whom required surgical intervention (two for meconium ileus and one for jejunal atresia).

Mortality and morbidity rates in meconium peritonitis have been reported to vary depending on the countries and their economic resources, with a survival rate in developed countries being up to 80% [13, 14]. In our cohort of 37 children, all children survived. However, when we were searching for the patients we noted that two children with signs of meconium peritonitis who died from complications of severe prematurity (severe intracranial hemorrhage and sepsis, respectively) were excluded because they did not have an ultrasound before surgery. Four children had significant gastrointestinal morbidity: a child with VACTERL syndrome had constipation and fecal incontinence, a child had short bowel syndrome and autism, another child with cystic fibrosis had severe constipation and one child had an episode of small-bowel obstruction that required hospitalization.

This study has some limitations. The major limitation is the lack of correlation with prenatal ultrasound. Unfortunately, prenatal ultrasound is performed at other institutions and we did not have access to the images for re-evaluation. Other limitations are its retrospective nature; the relatively small sample size from a single hospital, which limited the statistical analysis; the inconsistent imaging approach depending on the physicians and surgeons involved in the case; and the search methodology, which might have increased the number of cases with radiologically proven meconium peritonitis and included fewer cases that did not have radiographs or ultrasound, especially in asymptomatic patients. Because this was a retrospective study, it was very difficult to determine how the imaging findings affected the decision of the surgeons whether to operate in each individual case. However this does not decrease the importance of the imaging findings. The presence of intestinal obstruction, ascites, volvulus and pneumoperitoneum is often not apparent clinically and these findings on plain radiographs of the abdomen or US are crucial for appropriate decision-making in these neonates.

Conclusion

This study shows that postnatal radiographs and sonograms are valuable tools in predicting the need for surgical intervention in neonates with meconium peritonitis, and that it is important to image these children over time with both modalities. In this series, only two-thirds of the children required surgery. Imaging findings that predicted the need for surgery were intestinal obstruction, ascites, volvulus and pneumoperitoneum. Neonates with meconium pseudocysts did not always require surgical intervention. Those with diffuse peritoneal calcification as an isolated finding were successfully treated non-operatively. Only a minority of the neonates in this series were found to have cystic fibrosis.

Compliance with ethical standards

Conflicts of interest None

References

1. Forouhar F (1982) Meconium peritonitis. Pathology, evolution, and diagnosis. Am J Clin Pathol 78:208–213
2. Pan EY, Chen LY, Yang JZ et al (1983) Radiographic diagnosis of meconium peritonitis. A report of 200 cases including six fetal cases. Pediatr Radiol 13:199–205
3. Chan KL, Tang MH, Tse HY et al (2005) Meconium peritonitis: prenatal diagnosis, postnatal management and outcome. Prenat Diagn 25:676–682
4. Zerhouni S, Mayer C, Skarsgard ED (2013) Can we select fetuses with intra-abdominal calcification for delivery in neonatal surgical centres? J Pediatr Surg 48:946–950
5. Zangheri G, Andreani M, Ciriello E et al (2007) Fetal intra-abdominal calcifications from meconium peritonitis: sonographic predictors of postnatal surgery. Prenat Diagn 27:960–963
6. Pelizzo G, Codrich D, Zennaro F et al (2008) Prenatal detection of the cystic form of meconium peritonitis: no issues for delayed postnatal surgery. Pediatr Surg Int 24:1061–1065
7. Saleh N, Geipel A, Ulrich G et al (2009) Prenatal diagnosis and postnatal management of meconium peritonitis. J Perinat Med 37: 535–538
8. Nam SH, Kim SC, Kim DY et al (2007) Experience with meconium peritonitis. J Pediatr Surg 42:1822–1825
9. Lawrence PW, Chrispin A (1984) Sonographic appearance in two neonates with generalized meconium peritonitis: the snowstorm sign. Br J Radiol 57:340–342
10. Williams HJ, Abernethy LJ, Losbty PD et al (2004) Meconium periorchitis — a rare cause of a paratesticular mass. Pediatr Radiol 34:421–423
11. Wang CN, Chang SD, Chao AS et al (2008) Meconium peritonitis in utero — the value of prenatal diagnosis in determining neonatal outcome. Taiwan J Obstet Gynecol 47:391–396
12. Brasseur-Daudruy M, Eurin D, Labadie G et al (2007) Fetuses with features of first-trimester peritonitis and a favorable outcome. Ultrasound Obstet Gynecol 29:96–97
13. Martinez Ibanez V, Boix-Ochoa J, Lloret J et al (1990) Meconium peritonitis: conclusions based on 53 cases. Cir Pediatr 3:80–82
14. Ali SW, ul Hassan M (1996) Meconium peritonitis — a leading cause of neonatal peritonitis in Kashmir. Indian J Pediatr 63:229–232