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Original Article

Twelve years of experience in the treatment of newborns with intrauterine gastrointestinal perforation

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ABSTRACT

Background. Meconium peritonitis occurs when meconium leaks into the peritoneal cavity as a result of intrauterine gastrointestinal perforation. In this study, we aimed to evaluate the results of newborn patients who were followed and treated due to intrauterine gastrointestinal perforation in the pediatric surgery clinic.

Methods. All newborn patients who were followed up and treated for intrauterine gastrointestinal perforation in our clinic between December 2009-2021 were analyzed retrospectively. Newborns who had no congenital gastrointestinal perforation were not included in our study. The data were analyzed using NCSS (Number Cruncher Statistical System) 2020 Statistical Software.

Results. Within twelve years, intrauterine gastrointestinal perforation was detected in 41 newborns, including 26 (63.4%) males, and 15 (36.6%) patients who were operated on in our pediatric surgery clinic. Surgical findings of 41 patients diagnosed with intrauterine gastrointestinal perforation revealed the presence of volvulus (n=21), meconium pseudocyst (n=18), jejunoileal atresia (n=17), malrotation-malfixation anomaly (n=6), volvulus due to internal hernia (n=6), Meckel's diverticulum (n=2), gastroschisis (n=2), perforated appendicitis (n=1), anal atresia (n=1), and gastric perforation (n=1). Eleven patients (26.8%) died. Total intubation time was significantly higher in deceased cases. Postoperatively, deceased cases passed their first stool significantly earlier than surviving newborns. Besides, ileal perforation was seen significantly more frequently in deceased cases. However, the frequency of jejunoileal atresia was significantly lower in the deceased patients.

Conclusions. Although sepsis has been held primarily responsible for the deaths in these infants from past to present, insufficiency in lung capacity necessitating intubation negatively affects their survival. Early passage of stool is not always an indicator of good prognosis after the operation, and patients may die due to malnutrition and dehydration, even after they are discharged after feeding, defecating and having weight gain.

Key words: intestinal perforation, newborns, peritonitis, prenatal diagnosis.

Meconium peritonitis, which is a sterile condition, occurs when meconium leaks into the peritoneal cavity as a result of perforation in the small intestine of the fetus during the intrauterine period.[1,2] Meconium peritonitis should be considered when obstetric ultrasound (US) performed in the second and third trimesters of pregnancy shows hyperechoic areas and pseudocyst-like structures in the fetal abdomen.[1] As is the case with all other gastrointestinal malformations, prenatal diagnosis of meconium peritonitis is of great importance in terms of ensuring that the mother gives birth in a well-equipped hospital with a neonatal intensive care unit and pediatric surgery clinic.[3]

In this retrospective study, we aimed to evaluate the outcomes of newborn patients who were followed up and treated due to intrauterine gastrointestinal perforation in the pediatric surgery clinic of a tertiary health center.

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Material and Methods

The study was designed in accordance with the principles of the World Medical Association Declaration of Helsinki. Permission was obtained from the Clinical Research Ethics Committee of Zeynep Kamil Maternity and Children's Diseases Training and Research Hospital (dated 19.01.2022, numbered 12).

Informed consent of the families was obtained preoperatively during the hospitalization of their infants. The parents of all cases had been informed about the disease, all procedures performed before the treatment and surgery, and their consent was obtained.

All newborn patients monitored and treated for intrauterine gastrointestinal perforation in the Pediatric Surgery Clinic of Zeynep Kamil Maternity and Children's Diseases Training and Research Hospital between December 2009 and 2021 were analyzed retrospectively.

Newborns who had no intestinal perforation at birth but developed it later on during the postnatal period due to necrotizing enterocolitis, jejunoileal atresia or intestinal volvulus were not included in our study.

Descriptive characteristics including age at diagnosis, gender, presence of antenatal diagnosis, antenatal US findings, gestational age, birth weight, mode of delivery, presence of additional disease; clinical data including physical, radiographic and echocardiographic (ECHO) findings; surgery-related information including surgical indication on the day of birth, age at operation, presence and type of intraabdominal pathology, number and site of the perforation, intestinal circulation status, operation and ostomy types, resected bowel segment, presence of synchronous operation, and short bowel status; and outcome information including postpartum intubation status, total intubation time, initiation of oral feeding after birth, first day of post-operative defecation and feeding, the need for total parenteral nutrition (TPN), total number of days on TPN, early and late postoperative complications (wound infection, detachment, incisional hernia, anastomotic leak, adhesive intestinal obstruction, etc.), presence of sepsis, histopathological results, total hospitalization period, discharge or exitus status, outpatient follow-up findings and genetic test results (for cystic fibrosis) were retrieved retrospectively from the patient files and computer records.

Statistical analysis

NCSS (Number Cruncher Statistical System) 2020 Statistical Software (Utah, USA) program was used for statistical analysis. While evaluating the study data, descriptive statistical methods (mean, standard deviation, median, frequency, ratio) as well as Shapiro- Wilk test and boxplot graphs were used to check the fitness of the variables to the normal distribution. Mann-Whitney U test was used for the comparisons between groups of non-normally distributed parameters. Pearson chi-square test, Fisher's exact test and Fisher-Freeman-Halton test were used to compare qualitative data. Kaplan- Meier survival analysis was also used. Statistical significance was evaluated at the $p<0.05$ level.

Results

In our pediatric surgery clinic, intrauterine bowel perforation was detected in 26 (63.4%) male, and 15 (36.6%) female newborns over a 12-year period. The patients were 0-4 days old (mean age: 0.78±0.93 days) when they were first evaluated by pediatric surgeons. The distribution of descriptive characteristics of the patients are shown in Table I.

The age of the patients at surgery varied between 1 and 5 days (mean age: 1.66±1.35 days). The general health condition of one patient who was operated on the fifth day after birth deteriorated, and required insertion of an intra-abdominal drain.

Oral feeding had been started in 12 (29.3%) cases without application of nasogastric tube drainage during their follow-up and treatment in the neonatal intensive care unit. Bowel dilatation and presence of intra-abdominal

Table I. Distribution of descriptive characteristics.

		n (%)*
Age (days)	Mean±SD	0.78±0.93
	Median (Min-Max)	1 (0-4)
Gender	Male	26 (63.4)
	Female	15 (36.6)
Antenatal Diagnosis	Yes	21 (51.2)
	No	20 (48.8)
Antenatal US findings (n=21)	Intestinal dilatation	16 (76.2)
	Intraabdominal cyst	4 (19)
	Intraabdominal mass	1 (4.8)
	Intraabdominal fluid	1 (4.8)
	Gastroschisis	2 (9.5)
	Double-bubble	1 (4.8)
Gestational age (weeks)	Mean±SD	34.9±3.51
	Median (Min-Max)	36 (25.39)
Birth weight (g)	Mean±SD	2646±701
	Median (Min-Max)	2730 (1250-3900)
Type of delivery	Spontaneous vaginal delivery	15 (36.6)
	Cesarean section	26 (63.4)
Comorbid diseases	None	24 (58.5)
	Cardiac pathologies	16 (39.0)
	Hirschsprung's disease	3 (7.3)
	Cystic fibrosis	2 (4.9)
	Urinary pathologies	2 (4.9)
	Esophageal atresia + TEF	1 (2.4)
	Phocomelia	1 (2.4)
	Vertebra anomalies	1 (2.4)
	Central hypothyroidism	1 (2.4)
	Hypoplasic thymus	1 (2.4)
	Polydactyly	1 (2.4)
	Trisomy 13	1 (2.4)
ECHO findings (n=16)	Patent ductus arteriosus	10 (24.4)
	Patent foramen ovale	8 (19.5)
	Pulmonary hypertension	4 (9.8)
	Atrial septal defect	4 (9.8)
	Ventricular septal defect	4 (9.8)
	Mitral insufficiency	3 (7.3)
	Tricuspid insufficiency	2 (4.9)
	Aortic hypoplasia	1 (2.4)
	Left ventricular hypoplasia	1 (2.4)
	Aortic insufficiency	1 (2.4)

ECHO: echocardiography, SD: standard deviation, TEF: tracheoesophageal fistula.
*Unless indicated otherwise.

Table II. Distribution of characteristics specific to disease states, and surgery.

		n (%)
Symptoms/Signs	Rectal bleeding	2 (4.9)
	Abdominal distension	33 (80.5)
	Inability to defecate	10 (24.4)
	Biliary vomiting / nasogastric drainage	21 (51.2)
	Abdominal skin lesion	3 (7.3)
	Poor intestinal blood circulation	2 (4.9)
	Palpable intra-abdominal mass	1 (2.4)
	Imperfore anus	1 (2.4)
Radiography findings	None	1 (2.4)
	Absence of meteorism	19 (46.3)
	Free air under diaphragm	12 (29.3)
	Air-fluid levels	8 (19.5)
	Calciifed cyst	8 (19.5)
Presence of abdominal pathology	No	3 (7.3)
	Yes	38 (92.7)
	Jejunoileal atresia	17 (41.5)
	Volvulus	21 (51.2)
	Malrotation	6 (14.6)
	Internal hernia	6 (14.6)
	Meconium pseudocyst	18 (43.9)
	Meckel's diverticulum	2 (4.9)
	Gastric perforation	1 (2.4)
	Transition zone pathology	2 (4.9)
	Gastroschisis	2 (4.9)
	Anal atresia	1 (2.4)
	Appendicitis	1 (2.4)
Locations of perforation	Terminal ileum	12 (29.3)
	Transvers colon	2 (4.9)
	Ileum	22 (53.7)
	Stomach	1 (2.4)
	Meckel's diverticulum	1 (2.4)
	Cecum	4 (9.8)
	Colon	2 (4.9)
	Appendix	1 (2.4)
Numbers of perforation	Single	25 (61.0)
	Multiple	16 (39.0)
Intestinal blood circulation	Good	32 (78.0)
	Poor	9 (22.0)
Type of surgery	Anastomosis	18 (43.9)
	Ostomy	14 (34.1)
	Both	9 (22.0)
Ostomy types (n=23)	Ileostomy	19 (46.3)
	Colostomy	3 (7.3)
	Cecostomy	1 (2.4)
Length of resected intestinal segment (cm)	Mean±SD	11.19±15.32
	Median (Min-Max)	7 (0-80)
Synchronous surgeries*	No	24 (58.5)
	Yes	17 (41.5)
Short bowel syndrome	Yes	9 (22.0)
	No	32 (78.0)

* Synchronous surgeries: appendectomy, adhesiolysis, central catheterization; excision of Meckel's divetticulum, ınsertion of a nephrostomy catheter, umbilical vein catheterization, rectal biopsy

Table III. Distribution of follow-up features of patients.

Surgery at birth, n (%)	Yes	7 (17.1)
	No	34 (82.9)
Timing of surgery, n (%)	At Birth	7 (17.1)
	Postnatal- Day 1	17 (41.5)
	Postnatal- Day 2	7 (17.1)
	Postnatal- Day 3	4 (9.8)
	Postnatal- Day 4	5 (12.2)
	Postnatal- Day 5	1 (2.4)
Intubation in the preoperative period, n (%)	Yes	18 (43.9)
	No	23 (56.1)
Total duration of intubation, days	Mean±SD	7.02±11.09
	Median (Min-Max)	2 (0-39)
Initiation of oral feeding after birth, n (%)	Yes	12 (29.3)
	No	29 (70.7)
Time to first passage of stool after surgery, days	Mean±SD	4.22±3.0
	Median (Min-Max)	4 (0-13)
Time to postoperative oral feeding, days	Mean±SD	5.17±3.59
	Median (Min-Max)	5 (0-13)
Treatment with TPN, n (%)	Yes	33 (80.5)
	No	8 (19.5)
Total duration of TPN, days	Mean±SD	12.66±15.22
	Median (Min-Max)	7 (0-48)
Total duration of hospitalization, days	Mean±SD	23.38±18.38
	Median (Min-Max)	19 (1-85)
Final outcome, n (%)	Died	11 (26.8)
	Survived	30 (73.2)

fluid were described prenatally in one of these cases. These 12 patients were consulted on the second postnatal day because they could not tolerate oral feeding.

The surgical findings of 41 patients diagnosed with intrauterine bowel perforation revealed the presence of volvulus in 21 (51.2%), meconium pseudocyst in 18 (43.9%), jejunoileal atresia in 17 (41.5%), malrotation malfixation anomaly in 6 (14.6%), internal hernia in 6 (14.6%), Meckel's diverticulum in 2 (4.9%) (including one case in invaginated bowel segment), gastroschisis in 2 (4.9%), appendix perforation in 1 (2.4%), anal atresia in 1 (2.4%), stomach perforation in 1 (2.4%), and Hirschsprung's disease in 3 (7.3%) patients. The distribution of disease states and their surgical characteristics are shown in Table II.

Postoperatively, 26 (63%) were intubated, and 15 extubated cases (37%) were followed up and treated in the intensive care unit. Seven patients who did not defecate post-operatively did not survive. The distribution of characteristics related to the follow-up of the patients are shown in Table III.

Wound infection, wound detachment, and incisional hernia were not observed in any of the patients in the early postoperative period. Postoperatively, 11 patients (26.8%) died before being discharged.

One patient (2.4%), who underwent an emergency operation due to postoperative umbilical catheter-induced liver hematoma and intra-abdominal bleeding, died on the 3rd postoperative day. One of two patients who were operated for the second time due to lack of a gastrointestinal passage, and the other two patients who were operated on for the third time died due to sepsis. Sepsis was the cause of exitus in 6 (54.5%) of 11 deceased cases. Seven (64%) deceased cases were intubated after delivery and could not be extubated until their death. The diagnosis of cystic fibrosis was confirmed based on genetic test results in 2 of 16 cases and, one of these cases died.

Table IV. Assessments based on mortality status.

		Deceased (n=11)	Survived (n=30)	p
Age, mo				
	Mean±SD	0.6±0.7	0.8±1	[a]0.762
	Median (Q1-Q3)	1 (0-1)	0.5 (0-2)	
Gender, n (%)				
	Female	5 (45.5)	10 (33.3)	[b]0.491
	Male	6 (54.5)	20 (66.7)	
Duration of intubation, days				
	Mean±SD	13.7±14.5	4.6±8.6	[a]0.005**
	Median (Q1-Q3)	6 (2-30)	0 (0-7)	
	None, n (%)	0	16 (53.3)	
	1-7 days, n (%)	7 (63.6)	8 (26.7)	
	8-14 days, n (%)	0	2 (6.7)	[c]0.004**
	15-30 days, n (%)	2 (18.2)	3 (10.0)	
	≥31 days, n (%)	2 (18.2)	1 (3.3)	
Time to surgery, n (%)				
	The first 24 hrs	9 (81.8)	15 (50)	[b]1.000
	>24 hrs	2 (18.2)	15 (50)	
Time to the first passage of stool, days				
	Mean±SD	2.5±2.8	4.9±3.4	[a]0.032*
	Median (Q1-Q3)	2 (0-5)	4 (2-6)	
Time to the first oral feeding, days				
	Mean±SD	3.5±4.1	5.8±3.2	[a]0.056
	Median (Q1-Q3)	2 (0-6)	5 (4-7)	
Treatment with TPN, n (%)				
	No	4 (36.4)	4 (13.3)	[b]0.178
	Yes	7 (63.6)	26 (86.7)	
Total duration of TPN, days				
	Mean±SD	15.4±18	11.7±14.3	[a]0.779
	Median (Q1-Q3)	5 (0-33)	7 (2-12)	
Gestational Week				
	Mean±SD	33.4±3.4	35.4±3.4	[a]0.065
	Median (Q1-Q3)	33 (30-36)	36 (35-38)	
Birth weight, g				
	Mean±SD	2243.2±735.7	2793.3±638.3	[a]0.068
	Median (Q1-Q3)	2600 (1500-2900)	2875 (2380-3110)	
Length of resected bowel segment, cm				
	Mean±SD	14.9±23.8	9.8±11.1	[a]0.836
	Median (Q1-Q3)	4 (2-20)	7 (1.5-15)	
	<10 cm, n (%)	7 (63.6)	18 (60.0)	[b]1.000
	≥10 cm, n (%)	4 (3.4)	12 (40.0)	
Short bowel syndrome, n (%)		3 (27.3)	6 (20.0)	[b]0.680
Rectal bleeding , n (%)		2 (18.2)	0	[b]0.067
Abdominal distension, n (%)		9 (81.8)	24 (80.0)	[b]1.000
Biliary vomiting / nasogastric drainage, n (%)		7 (63.6)	14 (46.7)	[d]0.335
Resection anastomosis, n (%)		5 (45.5)	22 (73.3)	[b]0.140
Ostomy, n (%)		8 (72.7)	15 (50.0)	[b]0.291
Perforation, n (%)				
	Single	6 (54.5)	19 (63.3)	[b]0.723
	Multiple	5 (44.5)	11 (36.7)	
Terminal ileum perforation, n (%)		6 (54.5)	6 (20.0)	[b]0.052
Transverse colon perforation, n (%)		1 (9.1)	1 (3.3)	[b]0.470
Ileum perforation, n (%)		3 (27.3)	19 (3.3)	[d]0.040*
Perforation of Meckel's diverticulum, n (%)		0	1 (3.3)	[b]1.000
Cecum perforation, n (%)		0	4 (13.3)	[b]0.559
Colon perforation, n (%)		1 (9.1)	1 (3.3)	[b]0.470
Jejunoileal atresia, n (%)		1 (9.1)	16 (53.3)	[b]0.014*
Meconium pseudocyst , n (%)		3 (27.3)	15 (50.0)	[b]0.291
Cardiac pathology, n (%)		3 (27.3)	13 (43.3)	[b]0.478
Total duration of hospitalization, days				
	Mean±SD	24.0±20.6	23.1±17.9	[a]0.743
	Median (Q1-Q3)	34 (3-44)	19 (13-30.5)	

[a]Mann Whitney U test, [b]Fisher's exact test, [c]Fisher-Freeman Halton test, [d]Pearson chi square test

*p<0.05, **p<0.01

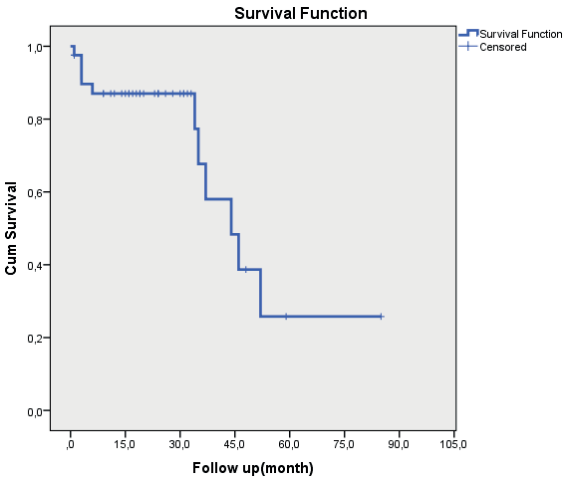

Fig. 1. Survival curve.

While ganglion positivity was reported in the histopathological examinations of intestinal specimens of 11 deceased patients, our diagnosis of Hirschsprung's disease was confirmed pathologically in 3 of our surviving cases.

From the outpatient follow-up information, it was learned that 5 (16.7%) of the 30 patients discharged died during follow-up period due to cardiac problems (n=1), food aspiration (n=1), and dehydration (n=3).

In our study; any statistically significant difference was not found between the mean age and gender distribution of the patients according to mortality rates ($p>0.05$).

Total intubation time was significantly longer in deceased cases ($p<0.01$). Postoperatively deceased patients had recovered their first bowel movements earlier than the other cases ($p<0.05$).

Ileal perforation was significantly associated with higher mortality, and jejunoileal atresia with lower mortality rates ($p<0.5$), but there were no statistically significant associations between mortality and the timing or type of feeding, length of the resected segment, or number of perforations, and other clinical parameters. Evaluations made according to mortality status are shown in Table IV.

Survival analysis

A total of 41 surgical operations were performed. Postoperatively 30 (73.2%) cases survived, and 11 cases did not. The mean, and median survival times were 47.987±6.791 (95% CI: 34.67-61.29), and 44.0 days, respectively. The latest death was seen on the postoperative 37th day; and the cumulative survival rate in one month was 25.6% with a standard error of 14.2%.

The survival curve of our patients is shown in Fig. 1.

Discussion

Meconium peritonitis was first described by Morgagni in 1761, but the first corrective surgery was successfully performed by Agerty in 1943.[4] Especially with the widespread use of US, prenatal diagnosis in fetuses with gastrointestinal anomalies has been increasing since 1975. With the referral of prenatally diagnosed cases to appropriate centers and the development of neonatal intensive care facilities, the survival rates are gradually increasing.

The underlying pathology in intrauterine gastrointestinal perforations affects the mortality and morbidity of infants. The main causes of intrauterine gastrointestinal perforation are jejunoileal atresia, intrauterine invagination, Hirschsprung's disease, meconium ileus (cystic fibrosis), segmental jejunoileal volvulus due to cystic fibrosis, midgut volvulus due to malrotation-malfixation anomalies, colonic atresia, Meckel's diverticulum and intrauterine mesenteric vascular insufficiency.[1,2,5] In our study covering a period of 12 years, 51.2% of 41 cases with intrauterine bowel perforation were antenatally diagnosed, and volvulus (51.2%), meconium pseudocyst (43.9%), and jejunoileal atresia (41.5%) were the most common etiologic factors. In our study, significantly lower mortality rates were detected in cases with jejunoileal atresia.

In some cases, intrauterine gastrointestinal perforation can resolve spontaneously and

these cases can continue their lives without any sequelae.[3] Successful results in a limited number of these patients followed with conservative treatment have been reported.[2] Surgery should be performed without delay when there are signs and symptoms of intestinal obstruction in these cases followed up with conservative treatment.[2]

In a study of 79 cases with meconium peritonitis, male patients constituted 60%, and 54% of the patients were operated on in the first 24 hours and afterwards.[6] In another study, male patients comprised 72.7% of 11 patients who had developed meconium peritonitis secondary to primary segmental volvulus.[7] In our study, male patients constituted 63.4% of the patients with meconium peritonitis. Although intrauterine gastrointestinal perforation was more common in our male patients as in many other studies[6-8], there was no significant difference between genders in terms of both incidence rates and prognosis of intrauterine gastrointestinal perforation.

Meconium peritonitis is rarely diagnosed prenatally before the 20th gestational week due to the lack of initiation of intestinal peristalsis.[9] The median gestational age at the first diagnosis of meconium peritonitis has been reported as 24 weeks.[9] In our study, the age at diagnosis of 17 prenatally diagnosed patients was found to be after 24 weeks (earliest: 25th week), which is consistent with the literature.

Ultrasonographic diagnosis of prenatal meconium peritonitis is made when ascites, calcified meconium and intestinal dilatation are seen together in the abdominal cavity of the fetus.[1] In a study of 15 cases with established prenatal diagnoses, meconium peritonitis had been observed in 73%, intestinal dilatation in 53%, ascites in 33%, pseudocyst in 13%, and polyhydramnios in all cases.[10] In another study, fetal ascites was the most common antenatal US finding.[9] In another study of 79 cases, the most common finding was bowel dilatation (78.6%).[6] Similar to the rates reported in the literature in our study, prenatal diagnosis was made in 51.2% of the cases and the most common antenatal US finding was intestinal dilatation (76.2%). With technical developments in US, the diagnosis of gastroschisis can be made at increasing rates, but it is difficult to diagnose antenatal intestinal perforation that rarely develops in cases with gastroschisis.[11] Although gastroschisis was diagnosed antenatally in our two cases, intrauterine bowel perforation could be diagnosed after birth.

The mean gestational ages at diagnosis of meconium peritonitis were reported as 37.2±2.3[6] and 37.2±2.3[7] weeks in two separate studies. In our study, the mean gestational age of the patients diagnosed as meconium peritonitis was 34.9±3.51 weeks. The mean birth weight of these patients was 3162±532 g in a study conducted regardless of the etiology of intestinal perforation[6] and as 3022±797[7] g in another study of cases with intestinal perforation due to primary segmental volvulus. In our study, the mean birth weight of these patients was 2646±701 g contrary to the literature findings. The mean gestational age of our patients with meconium peritonitis is lower compared to the literature findings, which can be naturally attributed to the lower average birth weight of our patients. Although elective preterm birth has been shown to be beneficial in improving surgical outcomes in prenatally diagnosed cases with gastroschisis, currently insufficient clinical evidence fails to support early prophylactic Caesarean delivery for all infants with gastroschisis.[11] However, the rate of Caesarian section (C/S) was high in many studies, as is the case with our study (63.4%).[6,7,12,13]

Newborns usually present with tense abdominal distension, visible veins on shiny abdominal skin, edematous abdominal wall, respiratory distress, biliary vomiting / nasogastric drainage, inability to pass meconium, and peritonitis.[2] Accordingly, abdominal distension (80.5%), biliary vomiting / nasogastric drainage (51.2%), and inability to defecate (24.4%) were the most common findings in our cases.

Intra-abdominal calcifications are observed in 86% of the cases with meconium peritonitis.[14] In our study, 19.5% of the patients had calcifications suggestive of meconium cysts. We think that our lower incidence of calcification compared to the literature is related to the etiology of the perforation and the time of occurrence of the event.

When meconium peritonitis occurs, early surgery is a valid way to prevent exacerbation of intra-abdominal inflammation, hyperemia and edema of the intestinal wall, and is important for reducing rates of intestinal adhesion, severe infection, and mortality.[6] In our study, the mean age at operation was 1.66±1.35 days, and the patients were operated within the first 24 hours after their admissions to our clinic.

The incidence of chromosomal abnormalities and genetic syndromes is low in cases with meconium peritonitis, but a relatively strong association with cystic fibrosis has been reported in 8-40% of the patients.[2] In a study, cystic fibrosis was reported in two cases diagnosed with intrauterine perforation due to prenatal volvulus.[5] Cystic fibrosis was suspected in the prenatal period in 2 patients in our study, and genetic test results confirmed this suspicion.

Recent studies do not provide clear guidelines on surgical strategies for the management of meconium peritonitis. Enterostomy, primary anastomosis, Bishop-Koop ileostomy and Santulli ileostomy are commonly used procedures.[15] Although the selection of the type of surgical procedure appears to depend on clinical signs, the patient's general condition and the technique preferred by the surgeon also matter , however few comparative studies have been conducted so far.[2] In one study, it was reported that peritoneal drainage was performed in 1.3%, intestinal resection-anastomosis in 43%, enterostomy in 54.5% of the patients, and the remaining mean bowel length was 105.3±42.3 cm.[6] In another study, segmental resection and ileostomy were performed in 63.6%, and segmental resection and primary anastomosis in 36.4% of patients.[7] In our study, resection-anastomosis was applied in 43.9%, ostomy in 34.1%, and resection-anastomosis and ostomy in 22% of the patients. The median length of the total resected bowel segment was 7 cm. In our study, dimensions of resected bowel segment and criteria of ICD-10-cm classification were also not statistically significantly correlated with mortality rates.

In the literature, it has been reported that the terminal ileum or ileum is the most common perforation site in the fetal period, and appendiceal perforation is very rare.[12] Two cases of perforated fetal appendix were presented in the study of Wang et al.[12] In our study, the perforation site was in the ileal segments in 53.7%, the terminal ileum in 29.3%, and appendix in 2.4% of the cases. In our study, rates of ileum perforation were significantly higher in deceased patients.

The prognosis of meconium peritonitis varies depending on its etiology.[1] If the diagnosis of meconium peritonitis can be made in the antenatal period, fetal morbidity and mortality can be reduced.[1] While the mortality rate was found to be 11-14% in cases diagnosed during pregnancy, mortality rates between 40 and 50% were reported in babies diagnosed after birth.[1] Recently, the survival rate for meconium peritonitis has exceeded 90%.[2] This higher rate of improvement is the result of advances in prenatal diagnostic techniques, timely intervention and the ability to provide intensive care services starting from birth of the infants.[2,10]

In one study, early surgery was shown to improve outcomes for severely affected patients by reducing intra-abdominal and systemic inflammation.[10] In a study of 79 patients, 95% of 40 patients who had been operated within the first 24 hours of life compared to only 79.5% of 39 patients who had been intervened later, survived.[6] In our study, 62.5% of the 24 patients who were operated within the first 24 hours of life compared to 88% of the 17 patients who were operated after 24 hours survived. In our study, the relationship between early surgery and prognosis was not statistically significant.

We thought that higher mortality rate in our study despite early surgery, compared to the literature was related to the greater number of premature cases with low birth weight and pulmonary dysfunction.

In a study of 20 cases, an average mortality rate of 60% was found in cases with short bowel syndrome. While these cases were lost due to sepsis in the early years of pediatric surgery practice, losses due to sepsis and liver failure due to TPN have come to the forefront in recent years.[8] Short bowel syndrome, defined as a type of malabsorption, occurs most commonly after massive bowel resections performed for the management of malrotation-volvulus, gastroschisis, intestinal atresia and necrotizing enterocolitis.[8] The prognosis in short bowel syndrome is closely related to the remaining bowel length, presence of ileocecal valve, intestinal motility and feeding tolerance and also to sepsis and liver failure, which are the complications of parenteral nutrition.[8] In our study, as in this above-mentioned study, sepsis was the primary cause of mortality. Besides sepsis, problems related to the patients' lung and intestinal motility were also other causes of mortality. In our study, 43.9% of our patients were intubated in the preoperative period. The prognosis of preoperatively intubated patients was statistically significantly deteriorated. Total intubation time was significantly longer in exited cases. They had problems regarding the insufficiency of their lung capacity. Prolonged intubation and long hospitalization also increased risk of sepsis. While our mortality rate was 33% (n=9) in patients with short bowel syndrome, our overall survival rate was 73.2%. The preservation of the ileocecal valve in all of our patients with short bowel syndrome may have contributed to the ineffectiveness of short bowel syndrome on mortality. Patients with short bowel syndrome may have passed their first stool in the early postoperative period because of their rapid bowel movements. The statement 'Switching to oral feeding' mistakenly considering that the patient has passed the critical postoperative follow-up period may delay and mask the recognition of secondary complications.

In conclusion, mortality and morbidity rates in newborns with complicated meconium peritonitis vary according to the etiology of intrauterine perforation. Although sepsis has been held primarily responsible for the deaths in these infants from past to present, the insufficiency of their lung capacity requiring intubation increases the mortality rates of these infants. Early passage of stool does not always result in satisfactory outcomes in these babies who have been operated on, and patients may be lost due to malnutrition and dehydration, even after they are discharged, despite oral intake, defecation and weight gain.

Ethical approval

Ethical approval was obtained from the Clinical Research Ethics Committee of Zeynep Kamil Maternity and Children's Diseases Training and Research Hospital (dated 19.01.2022, numbered 12).

Author contribution

The authors confirm contribution to the paper as follows: study conception and design: ODA, data collection: ODA,SC analysis and interpretation of results: ODA,SC,AC; draft manuscript preparation: ODA, SC, AC, MHÇ. All authors reviewed the results and approved the final version of the manuscript.

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Conflict of interest

The authors declare that there is no conflict of interest.

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