VOLUME-7, ISSUE-12, DECEMBER-2018 • PRINT ISSN No 2277 - 8160

Original Research Paper

Surgery

A STUDY OF PERITONITIS IN NEWBORNS AND INFANTS

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ABSTRACT

Background. To determine the characteristics of peritonitis in newborns and infants in relation to the epidemiology, clinical picture and to study the clinical outcome in newborns and infants admitted with peritonitis

Methods The patients included in the study were divided into 2 groups (Group A) newborns (< 30 day age), and (Group B) 1 month to 1 year age. Patients from both groups underwent thorough clinical evaluation ,lab. Tests and outcome was seen and documented. In patients, undergoing surgery, operative findings and details of the operative procedure performed was recorded in detail. Regular postoperative assessment was performed and any complications recorded in detail. The ultimate outcome was recorded.

Results Approximately half the NEC-PT and NEC-FT patients survived (45.46 % and 40%) while as many as 8/ 9 FIP patients, of whom 8 were FT, survived (88.9 %). Preterm babies with CP had the highest mortality (100 %).

Conclusion Though NEC was a major cause of intestinal perforation in neonatal age group but it was significantly higher in incidence in cases of perforation peritonitis in children up to the age of one year .Focal intestinal perforation was also a major cause of intestinal perforation but factors causing it were different from that of NEC.

KEYWORDS : Necrotizing Enterocolitis,diarrhea, Neonate

INTRODUCTION

Intra-abdominal infections have been well recognized throughout the history of medicine and are very commonly encountered in pediatric surgical practice (1). Peritonitis, by definition, is inflammation of the peritoneum (2). Peritonitis remains a major cause of mortality and morbidity in the pediatric age group, especially in countries like India where a large proportion of the population belongs to the poor socio-economic category and facilities and resources are often lacking in primary and secondary care centers (1).

In the West and developed countries, the major causes of peritonitis in newborns are necrotizing enterocolitis (NEC) and spontaneous or focal intestinal perforation (FIP), both of which are diseases largely affecting a vulnerable group of premature low birth-weight neonates. These conditions have become increasingly common with increasing survival of extremely small, premature newborns in nurseries in developed countries (3, 4). Other major causes of peritonitis in newborns include idiopathic or spontaneous gastric perforation, gastrointestinal perforation secondary to neonatal intestinal obstruction, and meconium peritonitis (1, 5). In infants and older children, the majority of cases of childhood peritonitis are due to perforated appendicitis (16) while other causes include trauma (5), Meckel's diverticulum (5, 7), postoperative adhesions, and intussusceptions (5).

However, in developing countries like India, the causes, epidemiology, and presentation of peritonitis may be quite different (1). Survival rates of premature very low birth-weight (VLBW) infants are still not very high, even in tertiary care centers, and they do not constitute a very high percentage of neonates admitted in nurseries. In addition, a very large percentage of the population lives in poor socioeconomic conditions, with very little access to proper sanitation and hygiene. In this scenario, diarrheal diseases and other infections of the gastrointestinal tract are very common, increasing the risk of secondary peritonitis due to perforations of the gastrointestinal tract (1). Thus, newborns as well as infants constitute a group of very high-risk vulnerable children for the development of peritonitis. There are very few reports of peritonitis in newborns and infants from Asian countries (8-11) and to our knowledge, apart from an earlier study of peritonitis in the pediatric age-group reported from our center (1), no detailed study has been reported from India.

MATERIALS AND METHODS

STUDY TYPE : Descriptive Observational study

STUDY POPULATION : Newborn (0 days) to 1 year age

SAMPLE SIZE : Minimum of 60 consecutive cases from the start of the study period

INCLUSION CRITERIA :

CASE DEFINITION : Cases fulfilling the criteria of peritonitis suspected clinically and confirmed by surgery or by investigations

EXCLUSION CRITERIA : Patients who have undergone either closed drainage or open surgery at another institution prior to presentation at our center.
Immunocompromised patients

The patients included in the study will be divided into 2 groups (Group A) newborns (< 30 day age), and (Group B) 1 month to 1 year age. Patients from both groups will undergo thorough clinical evaluation. History taking will include antenatal history including the results of any maternal antenatal investigations, and the perinatal history.A thorough clinical examination will be performed. All the study candidates will be subjected to the following investigations:

INVESTIGATIONS:

1. Plain radiographs of the abdomen and chest
2. Ultrasound (US) of the abdomen,
3. Complete Blood Counts : Total counts, Differential count
4. Renal function tests [RFT] (Blood urea, Serum creatinine), Serum Electrolytes, Serum Calcium

MANAGEMENT

The management protocol will depend on the results of clinical evaluation and the results of the preliminary investigations. The protocol will include initial resuscitation, correction of dehydration and hypovolemia, and antibiotic therapy. Initial antibiotic therapy will be empiric

SURGICAL MANAGEMENT

In patients, undergoing surgery, operative findings and details of the operative procedure performed was recorded in detail. Regular postoperative assessment was performed and the occurrence of any complications recorded in detail. The ultimate outcome was recorded.

OBSERVATIONS

Sixty patients in the age-group of newborn (0 days) to 1 year age, diagnosed with peritonitis on the basis of the clinical picture,

radiological features, intraoperative findings and laboratory data, admitted in the Department of Pediatric Surgery form the material for this study.

TABLE 1 CASE PROFILE AND CLINICAL PRESENTATION

DIAGNOSIS	Group A n=44 (%)	Group B n=16 (%)
Necrotizing enterocolitis(NEC)	21 (47.7)	4 (25)
Focal intestinal perforation(FIP)	9 (20.45)	5 (31.25)
Meconium peritonitis(MP)	3 (6.8)	-
Primary peritonitis(PP)	-	1 (6.25)
Idiopathic gastric perforation(IGP)	1 (2.2)	1 (6.25)
Not operated (NO)	3 (6.8)	2 (12.5)
Total	n=44	n=16

Table 2. Presenting symptoms in Group A patients.

GROUP		N (%)				
		ABDOMINAL DISTENSION	VOMITING	NON- PASSAGE OF STOOLS	DIARRHEA	FEVER
NEC	PT	11(100)	4(36.36)	1(9.09)	–	1(9.09)
	FT	9(90)	5(50)	5(50)	4(40)	3(30)
FIP	PT	1(100)	1(100)	1(100)	–	–
	FT	8(100)	3(37.5)	1(12.5)	-	1(12.5)
MP	PT	–	–	–	–	–
	FT	2(66.66)	3(100)	1(33.33)	–	–
CP	PT	2(100)	2(100)	1(50)	–	–
	FT	4(80)	2(40)	1920)	-	-
IGP	PT	–	–	–	–	–
	FT	1(100)	1(100)	1(100)	–	–
NO		**3(100)**	1(33.33)	2(66.66)	-	–
TOTAL (n=44)	41(93.18)	22(50)	14(31.81)	4(9.09)	5(11.36)	

TABLE 3. IMPORTANT CLINICAL SIGNS IN GROUP A PATIENTS (N=44)

GROUP		N (%)				
		ABDOMINAL DISTENSION	ERYTHEMA	VISIBLE BOWEL LOOPS	ABDOMINAL TENDERNESS	ABSENT BOWEL SOUNDS
NEC	PT	11(100)	5(45.45)	3(27.27)	2(18.18)	10(90.90)
	FT	5(50)	3(30)	–	1(10)	5(10)
FIP	PT	1(100)	1(100)	–	1(100)	1(100)
	FT	8(100)	2(25)	–	4(50)	7(87.5)
MP	PT	–	–	–	–	–
	FT	2(66.66)	–	–	–	2(66.66)
CP	PT	2(100)	–	1(50)	–	–
	FT	4(80)	–	-	1(20)	2(40)
IGP	PT	–	–	–	–	–
	FT	1(100)	–	–	1(100)	1(100)
NO		3(100)	-	–	-	3(100)
TOTAL	37(84.09)	11(25)	4(9.09)	10(22.72)	31(70.45)	

TABLE 4 OVERALL RESULTS OF MANAGEMENT OF GROUP A PATIENTS

GROUP		Total Number	Mortality (%)
NEC	PT	11	6(54.54)
	FT	10	6(60)
FIP	PT	1	0 (0)
	FT	8	1(12.5)
MP	PT	–	–
	FT	3	1(33.33)
CP	PT	2	2(100)
	FT	5	0(0)
IGP	PT	–	–
	FT	1	1(100)
NO		3	3(100)
TOTAL		44	20(45.45)

Approximately half the NEC-PT and NEC-FT patients survived (45.46 % and 40%) while as many as 8/ 9 FIP patients, of whom 8 were FT, survived (88.9 %). Preterm babies with CP had the highest mortality (100 %).

TABLE 5. COMPLICATIONS RECORDED DURING MANAGEMENT OF GROUP A PATIENTS.

GROUP		SEPSIS	MENINGITIS	RESP FAILURE	RENAL FAILURE	IVH	DIC	APNOEA	SUDDEN CARIAC ARREST
NEC	PT	6	1*	–	1*	1*	1*	–	–
	FT	5	–	–	–	–	–	–	1
FIP	PT	–	–	–	–	–	–	–	–
	FT	1	–	–	–	–	–	–	–

MP	**PT**	–	–	–	–	–	–	–	–
	FT	1	–	–	–	–	–	–	1*
CP	**PT**	2	–	1*	–	–	–	–	–
	FT	1	–	–	–	–	–	–	–
IGP	**PT**	–	–	–	–	–	–	–	–
	FT	1	–	–	–	–	–	–	–
NO		3	–	–	–	–	–	–	–
TOTAL		20	1*	1*	1*	1*	1*		1+1*

TABLE 6 RESULTS OF INVESTIGATIONS, SURGICAL FINDINGS, AND OUTCOME IN GROUP B PATIENTS (N=16)

Pt .no	Hb (gm %)	Platelet count X 10^3	Pneumoperitoneum	Site of perforation	Gangrene	Procedure	Outcome	Δ
1	< 10	9	Yes	--	--	–	D	-
2	< 10	400	Yes	Stomach	--	Perf closure	D	IGP
3	< 10	614	Yes	Sigmoid Colon	--	Perf closure	A	FIP
4	< 10	23	Yes	Sigmoid Colon	--	Perf closure	D	FIP
5	< 10	947	No	Dehiscence of rectal Stump	--	Colostomy	A	SP
6	>10	492	Yes	Ileum	Ileum	Ileostomy	A	NEC
7	<10	342	No	--	DJ-IC	Laprotomy	D	Pan-NEC
8	<10	22	No	--	DJ-IC	Laprotomy	A	Pan-NEC
9	>10	203	Yes	--	--	Laprotomy	A	PP
10	<10	205	Yes	--	--	–	D	-
11	<10	208	No	Ileal stricture leak	--	RA +ileostomy	D	SP
12	<10	486	Yes	Descending colon	Ileocolic intussueption	RA	A	SP
13	>10	22	Yes		DJ-IC	laprotomy	D	Pan-NEC
14	>10	57	No	Ileum	--	Perf closure	A	FIP
15	<10	558	Yes	Sigmoid	--	Perf closure	A	FIP
16	<10	89	Yes	Ileum	--	RA	A	FIP

RESULTS

In 14 cases (31.81 %), the peritoneal fluid did not grow any isolate and was sterile. The most common bacterium isolated was *E*. coli, in 10(22.72%) of cases .The other bacteria that were isolated were *Kliebsella* sp. In 4 cases (9.09%), Coagulase negative *Staphylococcus* in 2 cases (4.54%), *Enterococci* sp. in 3 cases (6.81%), *Enterobcteriaceae* sp. in 1 case (2.27%), *Acinetobacter* sp. in 2 cases (4.54%) and *Citrobacter* sp. in 1 case (2.27%). In two cases one each in NEC-PT and NEC-FT group *Candida* sp. was isolated from peritoneal fluid.

In 5 cases (31.25 %), peritoneal fluid was sterile and did not grow any isolate. The most common bacterium isolated was *E*. coli in 4 (25%) of cases .The other bacteria that were isolated were *Kliebsella* sp. In 2 cases (12.5%), *Enterobcteriaceae* sp. in 1 case (6.25%), *Citrobacter* sp. in 1 case (6.25%) and *Pseudomonas* sp in 1 case (6.25%). Significantly, coagulase negative *Staphylococcus*, *Enterococci* sp and *Acinetobacter* sp. did not grow in peritoneal fluid of patients from Group B.

Bacteria were isolated from blood of patients with peritonitis except in 17 cases (38.63%) where blood culture was sterile. The most common isolate was *E. coli* in 7 cases (15.90%).Other isolates were *Kliebsella* sp. in 6 cases (13.63%),*Acinetobacter* sp in 4 cases (9.09%), *Enterococcus* sp. in 4 cases (9.09%), Coagulative negative *Staph*. sp. in 3 cases (6.81%), *Staphylococcus aureus* in 2 cases (4.54%), *Staphylococcus haemolyticus* in 1 case (2.27%). Fungal isolates namely *Candida* were isolated from 3 patients, one each in IGP-FT, CP-FT, and in one patient who was not operated.

In 7 patients of Group B (43.75 %), blood culture did not grow any isolate and was sterile. *E. coli* and *Kliebsella* sp were isolated in 2 patients each (12.5%), *Acinetobacter* sp in 1 case (6.25%), *Enterobacter* sp. in 1 cases (6.25%), Coagulative negative *Staph*. sp. in 1 cases (6.25%), and *Staphylococcus aureus* in 1 case (6.25%). *Staphylococcus haemolyticus* and *Enterococcus* sp were not isolated in any patient belonging to Group B.

STATISTICAL ANALYSIS

The data of the present study were fed into the computer and after its proper validation, checking for error, coding and decoding were compiled and analysed with the help of SPSS 11.5 software for windows. Appropriate univariate and bivariate analysis and ANOVA (analysis of variance) for more than two means were carried out using t-test and ^{2} test were calculated and tested. All means are expressed as mean $\pm$ standard deviation. The critical values for the significance of the results were considered at 0.05 levels.

Statistical analysis was done using independent t-test to analyze relation of weight at presentation, duration of symptoms, hemoglobin level at presentation and history of diarrhea with that of mortality individually. None of the relations were found to be significant individually. Binary logistic regression was used to analyze cumulative relation of above mentioned factors with mortality.

DISCUSSION

The patients were broadly classified according to the age at presentation and were divided into two groups: Group A: < 1month age (0 to 30 days, n= 44 cases, 73.33 %), and Group B: 1 month- 1year age (16 cases, 36.36%). Patients were categorized on the basis of operative findings into broad groups, namely Necrotizing Enterocolitis (NEC) [n=25, 41.66%], Focal Intestinal Perforation (FIP) [n=14, 23.33%], Meconium Peritonitis (MP) [n=3, 5%], complicated peritonitis (CP) [n=10, 16.66%], and Idiopathic Gastric Perforation (IGP) [n=2, 3.33

GROUP A PATIENTS

among the clinical signs, abdominal distension was the most common sign across all subgroups of patients and was seen in 84.09 % of cases followed by absent bowel sounds in 70.45 % of cases. The least common sign was visible bowel loops, seen in only 9.09 % of cases. Abdominal wall erythema was seen in 8 out of 21(38.09 %) cases of NEC while similar finding was seen in 3 out of 9(33.33%) cases of FIP.

The hemoglobin level in cases of peritonitis varied from 5.6 to 22.4 g/dl with mean ± SD of 15.15± 4.35. Of the 44 cases, 4 had a hemoglobin value less than 10 mg/dl at presentation and all of these patients were in the NEC group. Platelet count varied from 13

to 496 × 10^3/ cu mm with mean ± SD of 176.27± 137.52. Of the total 44 cases 16 (36.36%) platelet count less than 100 ×10^3/cu mm at presentation. Of the cases with thrombocytopenia at presentation, 11 out of 16 (68.75 %) were in the NEC group and 3 out of 16 (18.75 %) were in the FIP group. The values of total leukocyte count varied from 1.7 to 39 × 10^3/ cu mm with a mean ± SD of 9.80± 7.73 ×10^3 /cu mm .Ten patients had leucopenia at presentation out of which 6 were in the NEC group.

OPERATIVE FINDINGS

Forty-one of the 44 patients of Group A underwent surgical exploration as part of the management. The most common site of bowel perforation was the ileum in 18 patients (40.90%) followed by the jejunum in 5 patients (11.36 %). The transverse colon and the sigmoid colon were the next common sites of bowel perforation with 4 patients (9.09 %) each. Ileum was the most common small bowel involved in NEC in 11 of the 21 patients (52.38%) (Figure 7) followed by the colon in 6 patients (28.6 %; transverse colon-3, descending colon-1, and sigmoid colon-2), and the jejunum in 2 patients (9.5 %). In patients with FIP, the sites of perforation were jejunum in 1 patient and the ileum in 2 patients. In as many as 5 of the 11 patients with FIP (45.4 %) who underwent surgery, the perforation was in the colon (ascending, transverse, and descending colon-1 each, and sigmoid colon-2). One 13-day old baby was operated for a perforated appendix with peritonitis .

The most common associated condition along with peritonitis in Group A patients was ileal atresia seen in 3 patients , followed by jejunal atresia in 2 patients.The same patient had ileal atresia with malrotation .Of the 3 cases of MP, one patient had giant cystic meconium peritonitis (GCMP) (case no-27), while one patient each had MP with ileal atresia (case no-44) and jejunal atresia (case no-18).the two cases with extensive intestinal gangrenous involvement of the bowel were in the NEC-FT group. All these patients had gangrene of small bowel from DJ to IC junction . History of top feed was present in both these cases of pan-NEC (NEC Totalis).

OPERATIVE PROCEDURES FOR GROUP A PATIENTS

Forty-one of the 44 patients underwent surgical exploration . Twenty-six patients (59.1 %) underwent primary exploration and of these, 25 cases (96.15%) had weight at presentation more than 1.5 kg. Eighteen cases (40.9 %) had peritoneal drainage (PD) performed, and of these 18 cases, 4 patients (22.22%) had weight at presentation less than 1.5 kg. Three cases (16.66 %) had peritoneal drainage alone as these patients were considered too unstable for laparotomy. Fifteen cases (83.33%) underwent subsequent laparotomy after 1-8 days (mean= 3.6 days).

In 26 patients (59.1 % of the total), primary surgery was performed, while in 15 patients (34.1 %), a formal laparotomy was performed after a period of initial stabilization with insertion of a tube drain into the peritoneal cavity and other supportive measures.

Of the 25 patients who underwent primary surgery 9 (36%) patients died, while in patients who had a peritoneal drainage (PD) prior to definitive surgery 8 out of 15(53.33%) patients died.

Bowel resection with primary anastomosis (RA) was performed in 16 of the 41 patients (39 %). These included 5 patients with NEC, 3 with FIP, 2 patients with MP, and 6 patients with CP. Primary closure of a perforation was performed in 4 patients, while as many as 20 patients (48.8 %) underwent a diverting stoma (ileostomy in 11, a colostomy in 9) after resection of ischemic and/ or gangrenous bowel. In FIP-PT group, 1 patient had both perforation closure and ileostomy done (case no-13). In this group, one patient had an ileal perforation with a gastrointestinal stromal tumor (GIST) (case no-14). In CP-FT group RA with Ladd's procedure was done in two cases (case no-11&21). In one case of MP with poor general condition, the first procedure was only drain placement and, subsequently, surgical excision of the meconium cyst with a proximal ileostomy was performed (case no-27). In both patients with pan-NEC (NEC-totalis), peritoneal lavage with placement of a drain was performed without any resection of bowel or construction of a stoma.

Comparison of mortality with different surgical procedures showed that out of the 16 patients who had RA, 7(43.75%) died, while 2 out 4 (50%) who had simple closure of the perforation(s) died, 6 out 11(54.54%) who underwent ileostomy died, 1 out of 9(11.11%) of patients who had a colostomy died.

Approximately half the NEC-PT and NEC-FT patients survived (45.46 % and 40%) while as many as 8/ 9 FIP patients, of whom 8 were FT, survived (88.9 %). Preterm babies with CP had the highest mortality (100 %).The commonest complications recorded were sepsis in 20/ 44 patients (45.5 %) while one patient each developed meningitis, renal shutdown, intraventricular hemoorhage (IVH), and disseminated intravascular coagulopathy (DIC).

GROUP B PATIENTS (Age 1 month to 1 year)

Group B consisted of 16 patients (26.66% of total patients). The mean age at presentation was 106.87 days. The male to female ratio was 4.3: 1. All the sixteen patients belonged to low socioeconomic status with mean weight± SD at presentation of 3.64± 1.03 kg. Significant feeding history of top feed was noted in 9 patients (56.25%).A history of diarrhea was present in 10 patients (62.5%), the duration of diarrhea before presentation ranging from 3 days to, in one patient, recurrent diarrhea for 360 days. Vomiting was seen in 2 patients (12.5%), and a history of unexplained fever was present in 4 patients (25%). One patient had *dermatitis enteropathica* , seen usually in chronic malnourished patients. One patient had history of administration of concoction *(Ghutti)* for the treatment of diarrhea. Investigations revealed mean± SD hemoglobin at presentation of 9.2± 1.89 mg/dl. Value of less than ten was seen in 12 patients (75%). Free intraperitoneal gas was seen in 11 patients (68.75%) (Figure 11).Final diagnosis was made after laprotomy and patients were classified into broad groups of Necrotizing Enterocolitis (NEC) 4 patients (25%), Focal intestinal perforation (FIP) in 5 patients (31.25%), Idiopathic Gastric Perforation (IGP) in one patient (6.25%), Primary Peritonitis (PP) in one patient (6.25%). An important finding was Secondary Peritonitis (SP) in 3 patients (18.75%) and in these patients, peritonitis occurred as a complication of surgery performed for another condition within a week prior to development of peritonitis. In one patient SP followed dehiscence of a rectal stump closed after surgery for Hirschsprung's disease, and in 2 patients, SP resulted from an anastomotic leak after repair of an ileal stricture [1 patient] and an ileocolic anastomosis for intussusceptions. Two patients (12.5%) could not undergo formal laparotomy due to poor general condition and were managed by insertion only of a peritoneal drain (PD).

Out of 4 patients with the diagnosis of NEC, 3 had Pan-NEC (NEC Totalis) with gangrenous small bowel from DJ to IC junction (Figure 12 & 13). In the FIP group, 3 patients had perforation in the sigmoid colon (Figure 14), and 2 patients in the ileum. One patient had primary peritonitis (PP) in whom although there was inflammation of the bowel, no perforation in the bowel was identified. The patient with IGP had a large perforation in the posterior wall of the stomach (Figure 15).Of the total 16 patients,14 were operated (87.5%) and 5 patients died (Pan-NEC-2, FIP-1, IGP-1, and 1 patient with SP.

Comparative analysis of mean weight at presentation and mortality in various groups was done using independent "T" Test after equal variance assumed by Levene's test.The p value was 0.5 which was > .05 hence the association of mean weight at presentation and mortality was not significant.Comparative analysis of mean duration of symptoms and mortality in various groups was done using independent "T" Test after equal variance assumed by Levene's test. The p value was 0.9 which was > .05 hence the association of duration symptoms and mortality was not significant. Comparative analysis of gestation age and mortality in various groups was done using independent "T" Test after equal variance assumed by Levene's test p value was 0.02 which was < .05 hence the association of gestation age and mortality was significant.

Logistic regression was used for cumulative comparison of gestation age, weight at presentation and duration of symptoms with mortality in various groups and Base value were weight: 0.501, Gestation age: -0.203 and duration of symptoms:-0.080 significant results are considered when a positive value is derived .Weight at presentation showed a positive value in regression and hence can be regarded as significant. The constant value was 6.3 which was >1 which showed that the association was not nullified but other factors were also influencing mortality apart from those mentioned in the comparative analysis.

CONCLUTION

Though NEC was a major cause of intestinal perforation in neonatal age group but it was significantly higher in incidence in cases of perforation peritonitis in children up to the age of one year .Focal intestinal perforation was also a major cause of intestinal perforation but factors causing it were different from that of NEC.

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