

Original Research Article

Outcome of primary peritoneal drainage in perforated necrotizing enterocolitis: an experience with 96 infants

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ABSTRACT

Background: Necrotizing enterocolitis is a life-threatening inflammation of neonatal intestine of multifactorial etiology. In early stages, medical management is considered; while as a transmural disease with pneumatosis or perforation needs surgical attention. Primary peritoneal drainage has evolved as an alternative to classic exploratory laparotomy especially in sick preterm and very low birth weight infants.

Methods: In our study, we tried to employ primary peritoneal drainage as an initial intervention in all surgical necrotizing enterocolitis patients and analyzed the results and final outcome in terms of total days in neonatal intensive care unit, total parenteral nutrition days, days to start oral feeds, need for laparotomy, mortality and other complications.

Results: Around one-third patients were either very low or extremely low birth weight and 80% patients were preterm. Primary peritoneal drainage was successful without need for laparotomy in around 65% of patients. In the rest 34 patients, 24 were subjected to rescue laparotomy, while 10 could not be stabilized for major surgery. Overall mortality was 29.16%.

Conclusions: Early bedside primary peritoneal drainage can be employed in all cases of NEC with perforation with rescue laparotomy to be determined by subsequent monitoring. This strategy seems to be safe and cost-effective in a resource challenged set up and lifesaving in sick and extremely low birth weight infants.

Keywords: Necrotizing enterocolitis, Pneumatosis intestinalis, Primary peritoneal drainage

INTRODUCTION

Necrotizing enterocolitis (NEC) is a disease of high morbidity and mortality predominantly involving preterm and low birth weight neonates and infants.¹ The incidence ranges from 5% to 10% in very low birth weight infants with about 25% mortality.² Though the exact etiology is not known, various factors seem to have a role. The preventive strategies are directed towards these factors.³ The current treatment strategy, whether medical or

surgical, is governed by well described clinico-radiological staging.⁴ Surgical treatment options include primary peritoneal drainage (PPD) or formal laparotomy. Although there is no major difference in terms of outcome between the two surgical treatment modalities, primary peritoneal drainage is of considerable importance in sick preterm very low birth weight neonates wherein a major surgery cannot be contemplated.^{5,6} The superiority of one surgical technique over other is still debatable. We present our experience

with peritoneal drainage as primary surgical treatment in all cases of NEC with perforation irrespective of birth weight and gestation. The objective of this study was to look for feasibility of PPD as the only surgical treatment in NEC.

METHODS

With approval from the Institutional Ethics Committee, this prospective cohort study was carried out from June 2015 till December 2020 by the department of pediatric surgery in collaboration with the neonatology division of the department of pediatric medicine, Government Medical College, Srinagar (India). The non-probability consecutive sampling technique was applied. The sample size of 96 patients was calculated by using the Epi Info 7, keeping the confidence level at 95% and the expected percentage of success at 75%. The inclusion criteria were as follows: all the patients admitted in the neonatal intensive care unit (NICU) with diagnosis of surgical NEC (NEC with perforation). Patients with early NEC without perforation or perforation without NEC were excluded. With informed consent from the parents, peritoneal drainage was considered in all these neonates, irrespective of birth weight, gestational age and clinical status. A corrugated rubber drain was inserted bedside in ICU under local Lidocaine anesthesia by the pediatric surgeon in the lower quadrant of the abdomen by making a 1.5-2 cm incision. The egress of the peritoneal contents was facilitated by gently compressing the abdomen. The drain was secured in place by silk suture and a gauze dressing was used to cover the wound along with the drain. All the patients were resuscitated and monitored preoperatively and post-operatively in intensive care unit. Besides the physiological monitoring, other clinical parameters monitored were the drain output, nasogastric tube output, abdominal signs and nature and frequency of stooling. Drain output was quantified in terms of number of gauzes soaked in 24 hours. Nasogastric tube aspirates were also quantified over 24 hours. Besides this, color and odor of both drain and nasogastric tube contents were noted. Abdominal ultrasound and X-rays were ordered as and when needed. The decision about drain removal, feeding and rescue laparotomy, if PPD was ineffective, was taken as follows:

Starting feeds: Clinical improvement with the decreased abdominal distension and presence of bowel sounds with no significant aspirate in nasogastric tube.

Drain removal: Hemodynamically stable with no peritoneal collection with nil drain output for >24 hours.

Rescue laparotomy: 1. Progressive abdominal distension, 2. Increasing fluid or fecal drainage from drain site, 3. Progressive abdominal wall edema and erythema, 4. Continued deterioration in clinical and biochemical parameters (ABG, electrolytes) after drain placement, 5. Features of the intestinal obstruction.

Various parameters studied were patient characteristics (gender, birth weight, and gestational age), clinical features, intensive care unit stay, need for parenteral nutrition, days from drain insertion to first feed, any drain manipulation or reinsertion or second drain placement, need for laparotomy and mortality. The statistical analysis was carried out using Statistical Package for Social Sciences (SPSS Inc., Chicago, IL, version 15.0 for windows). All quantitative variables were estimated using measures of central location (mean and median) and measures of dispersion (standard deviation and standard error).

The final outcome was defined as follows:

Success: Clinical improvement followed by complete recovery with or without need for drain manipulation/reinsertion or second drain placement without need for laparotomy.

Failure: No improvement or transient improvement with need for laparotomy or death.

RESULTS

There was a total of 96 (55 male and 41 female) babies with diagnosis of NEC with bowel perforation that underwent primary peritoneal drainage during the study period. Half of them were low birth weight while 24% were very low birth weight. Around 80% patients were preterm with 32% being late preterm. Majority of patients i.e., 66 (69%) were hemodynamically unstable at presentation and needed resuscitation with (n=47) or without (n=19) inotropic support. Around 35% patients needed mechanical ventilation. Parenteral nutrition was instituted in all the patients kept nil per oral for more than 3 days. Approximately 38% patients needed parenteral nutrition for more than 2 weeks. Feeding was initiated after infants showed improvement in general condition with minimal nasogastric tube secretions and presence of bowel sounds. The duration between insertion of peritoneal drain to commencement of feeds (drain to feed time) was variable ranging from days to weeks. In one-fourth of patients, feeds could be started in less than 5 days after drain placement while 60% patients had to wait for more than 10 days for feeds to start. Overall peritoneal drainage sufficed (without need for laparotomy) in around 65% (62 out of 96) patients, including 17 that needed second drain insertion. Laparotomy was considered in those that didn't improve with drainage or developed complications. Thirty-four patients merited laparotomy after having undergone primary peritoneal drainage, however 10 gravely sick patients were considered unfit for surgery under general anesthesia. A total of 24 patients underwent salvage laparotomy with resection of gangrenous gut. Bowel exteriorization (ileostomy or colostomy) was done in 19 while as 5 underwent end to end anastomosis. Nine patients improved (5 of stoma and 4 of anastomosis subgroups) while as 15 patients died. Overall mortality was 29% (28 out of 96).

Table 1: Results of PPD in NEC with perforation.

Variables		N (%)	Success (%)	Failure (%)	Mortality (%)
Sex	Male	55 (57.3)	34 (61.8)	21 (38.2)	18 (32.7)
	Female	41 (42.7)	28 (68.3)	13 (31.7)	10 (24.4)
Birth weight (gm)	<1000	8 (8.3)	4 (50.0)	4 (50.0)	4 (50.0)
	1000-1500	23 (24.0)	14 (60.9)	9 (39.1)	8 (34.8)
	1500-2500	48 (50.0)	32 (66.7)	16 (33.3)	13 (27.1)
	>2500	17 (17.7)	13 (76.5)	4 (23.5)	3 (17.6)
Gestational age (weeks)	<28	12 (12.5)	5 (41.7)	7 (58.3)	6 (50.0)
	28-32	33 (34.4)	18 (54.5)	15 (45.5)	14 (42.4)
	32-37	31 (32.3)	21 (67.7)	10 (32.3)	6 (19.4)
	>37	20 (20.8)	18 (90.0)	2 (10.0)	2 (10.0)
Shock	Yes	66 (68.7)	40 (60.6)	26 (39.4)	24 (36.4)
	No	30 (31.3)	22 (73.3)	8 (26.7)	4 (13.3)
NICU stay (days)	<5	15 (15.6)	13 (86.7)	2 (13.3)	0 (0.0)
	5-10	17 (17.7)	11 (64.7)	6 (35.3)	3 (17.6)
	10-15	22 (22.9)	12 (54.5)	10 (45.5)	10 (45.5)
	>15	42 (43.8)	26 (61.9)	16 (38.1)	15 (35.7)
Ventilation (days)	0	63 (65.6)	45 (71.4)	18 (28.6)	13 (20.6)
	<5	13 (13.5)	9 (69.2)	4 (30.8)	4 (30.8)
	>5	20 (20.8)	8 (40.0)	12 (60.0)	11 (55.0)
Parenteral nutrition (days)	<7	28 (29.1)	24 (85.7)	4 (14.3)	2 (7.1)
	7-14	30 (31.3)	23 (76.7)	7 (23.3)	6 (20.0)
	>14	38 (39.6)	15 (39.5)	23 (60.5)	20 (52.6)
Drain to feed (days)	<5	25 (26.0)	23 (92.0)	2 (8.0)	2 (8.0)
	5-10	13 (13.5)	9 (69.2)	4 (30.8)	3 (30.8)
	10-15	35 (36.5)	21 (60.0)	14 (40.0)	12 (34.3)
	>15	23 (24.0)	9 (39.1)	14 (60.9)	11 (47.8)
Drain manipulation	Repositioning	38 (39.6)	34 (89.5)	4 (10.5)	1 (2.6)
	Reinsertion	23 (23.9)	11 (47.8)	12 (52.2)	11 (47.8)
	Second drain insertion	35 (36.5)	17 (48.6)	18 (51.4)	16 (45.7)

DISCUSSION

Initially peritoneal drainage was considered as a temporising measure to stabilize the patients before subjecting them to laparotomy. Later on, many investigators showed that significant numbers of patients improved with primary peritoneal drainage (PPD) only and no additional surgical interventions were needed. But it remained a matter of debate whether PPD should be used as a primary procedure or as a method of stabilization before laparotomy. In 1988 Cheu et al reported their experience with primary peritoneal drainage and concluded that PPD was useful in resuscitation of low-birth-weight babies of NEC with perforation and considered it as a method of stabilization and not an alternative to laparotomy.⁷ In 1990, Ein and co-workers presented their 13 years' experience with primary peritoneal drainage and showed that one-third of their patients completely recovered after PPD only.⁶ But

they recommended PPD for extremely low birth-weight babies not stable enough for surgery. Several researchers have tried to compare PPD with laparotomy and have found variable results. Some have claimed superiority of one surgical treatment over the other, while some have found no difference between the two.^{5,7,9,10} Peritoneal drainage in patients of NEC with perforation reduces the abdominal distension by evacuating air and free fluid from the peritoneal cavity. Thus, it reduces the septic load in peritoneal cavity and improves circulation and respiration by relieving the abdominal compartment syndrome. Increased abdominal distension also causes splanchnic hypoperfusion which causes more insult to already injured intestinal mucosa.⁸ This mucosal injury permits the intestinal flora to breach the mucosal barrier through a process called translocation and amplifies the inflammatory process. The PPD helps in halting this process by reducing the abdominal pressure.

Theoretically, PPD seems to be a good approach in patients with solitary perforation with relatively healthy adjacent bowel. In cases with extensive disease, laparotomy with resection of gangrenous gut rather than mere PPD can be curative. However there seems to be no such difference between the two treatments in terms of survival.¹¹

The impact of surgical treatment on neurodevelopmental outcome amongst survivors of NEC has also been a matter of debate. Majority of literature now favours laparotomy over PPD in this regard. The explanation for this is the sustained exposure of the neonatal brain to deleterious inflammatory mediators from the necrotic intestine through gut-brain-axis (GBA) in cases treated with PPD.¹² There are other factors that might play a role in neurodevelopmental outcome and can confound the results like prematurity, general anesthesia and long-term TPN use. The same has been found in other neonatal surgical conditions.¹³ We believe that further studies, that take all confounding factors into account, are needed before a final decision in this regard is made.

In our study 62 of 98 (64.58%) required no other operative procedure and they were considered cured by PPD only. In a study by Goyal et al (2006), 69% patients showed good response to PPD with overall survival of 67%. However, majority of the patients underwent laparotomy after initial PPD, with only 7 out of 42 patients recovering without need for laparotomy.¹⁴ This is contrary to our results where only 35% (34/96) required rescue laparotomy. The possible explanation for decreased incidence of rescue laparotomy in our study could be as follows: (a) Increased number of patients with isolated perforation or limited disease (b) Decreased delayed worsening after initial good response with PPD. It is hard to distinguish between NEC involving fairly good length of bowel from a disease with solitary perforation or very limited bowel involvement. Further the infection rate also varies from one setup to another. Prolonged hospitalization, invasiveness of intravenous lines and tubes (Ryle's tube, endotracheal tube) and sterility of dressing at PPD site are some of the factors that can alter the clinical course of such patients. Twenty four out of 34 patients who needed laparotomy underwent resection with either primary anastomosis or exteriorization of bowel. There is a theoretical risk of increased incidence of short bowel syndrome if early laparotomy is favoured over PPD, especially in extensive disease. Rather than chopping out large segment of apparently unhealthy gut, PPD can prove to be a good damage control in such scenario. During PPD days, a proper demarcation between healthy and unhealthy bowel would occur and delayed laparotomy and resection could be planned.

Overall mortality was 29% in our study. This high mortality was due to prematurity and delayed presentation of these sick babies to our hospital. The patients who died after 'PPD only' were too sick and

septicemic, that they could not be resuscitated and prepared for definitive surgery. So, it cannot be concluded that they could be saved if they were subjected to direct laparotomy. We want to emphasise that PPD can act as a definitive or temporizing surgical treatment in these high-risk babies with low general condition. The need for extensive procedures under general anaesthesia, which would be poorly tolerated by these sick babies, can thus be avoided. In our study, PPD proved successful in about 60% of patients who presented with shock and in about 70% patients who required mechanical ventilation for less than 5 days. The success rate dropped to 40% in patients wherein mechanical ventilation was required for more than 5 days. As described by Moss et al (2006), there is no difference between PPD and laparotomy in terms of mortality, hospital stay and gastrointestinal morbidity.⁵ Rate of dependence on TPN (47% in PPD vs 40% in laparotomy group) was also unrelated to type of surgical treatment.⁵

With advances in neonatal care and safer anesthesia practices, even premature neonates with extremely low birth weight are increasingly subjected to laparotomy for surgical NEC in developed countries. However, in developing countries like India, the situation is different. PPD still remains the only option in very sick and extremely low birth weight infants with surgical NEC; and as good an alternative as laparotomy in the rest.

The limitations of our study include lack of the data on long term follow up like neurodevelopmental outcome and comparison between PPD and laparotomy. As described above, various researchers have attributed method of surgical treatment to the neurodevelopmental outcome. However fresh research is needed taking all confounding factors into account in order to reach a conclusion in this regard. Various research articles exist which compare the two techniques. The final outcome in NEC with perforation has been found to be unrelated to the surgical treatment chosen.

CONCLUSION

Although the primary peritoneal drainage is not a definitive cure in all the patients of NEC with perforation, yet it certainly reduces the number of laparotomies. Peritoneal drainage can help buy some time to stabilize and prepare sick babies for surgery under general anesthesia as may be needed in some cases. We recommend an early bedside peritoneal drainage in all patients of NEC with bowel perforation followed by close clinical monitoring. The patients where the clinical deterioration continues after PD or whose condition does not show the expected improvement, definitive surgical procedure should not be delayed.

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