Peritoneal drainage versus laparotomy as an initial treatment in complicated necrotizing enterocolitis: a single institution experience

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Objective **To determine whether initial peritoneal drainage (PD) or primary laparotomy is the most effective intervention in very-low-birth-weight and extremely low-birth-weight infants who are diagnosed with necrotizing enterocolitis (NEC, Bell's stage II and stage III).**

Patients and methods **It is a retrospective chart review study. Demographic data, clinical characteristics, and outcome were reviewed from records of neonates with severe NEC requiring surgical intervention (Bell's stage II and stage III) at our institution from 2003 to 2009.**

Results **Thirty-two patients were included in our study. Seventeen patients (53.1%) underwent PD and 15 patients (46.8%) underwent laparotomy. Out of 17 patients in the drainage group, 11 patients (64.7%) underwent laparotomy and six patients (35.2%) did not undergo laparotomy because they were sick and died within few days. Difference in gestational age, sex, and birth weights between two groups was not statistically significant. Similarly, difference in variables as mode of delivery and days of enteral feeding was not statistically significant. Mean age at diagnosis was 31.5 days for the laparotomy group and 18.4 days for the drainage group. *P* value was 0.026 in the univariate analysis, but *P* value in the final model of analysis was found to be statistically not significant. It was found from our study that patients with many associated diseases were more in the PD group (*P* value was 0.008). Almost all patients were mechanically ventilated. Mean pH was 7.29 in the laparotomy group and 7.25 in the drainage group, which was statistically not significant. In the PD group, 13 patients required vasopressors; however, only four patients in the laparotomy group were on vasopressors (*P* value was 0.017). Difference in variables such as indomethacin, white blood cell count, and platelet count was found to be statistically not significant between the two groups. Six patients were on steroids in the PD group and only one patient was on steroid in the laparotomy group (*P* value is 0.007). In addition, outcome at 90 days was analyzed; nine patients died in the PD group, whereas four patients died in the laparotomy group (*P* value is 0.081). Data were also analyzed for complications such as stricture, short bowel syndrome, and cholestasis and the difference was not significant. Finally, total parenteral nutrition dependency difference was found to be statistically not significant between two groups.**

Conclusion **Patients were very sick in the PD group and they were on vasopressors and steroids. Moreover, it was found that diagnosis of NEC early in life signifies a higher mortality. Insertion of a PD is still useful in resuscitating small critically ill infants with NEC; however, the majority of these infants will require subsequent laparotomy. Early diagnosis and early intervention are necessary to decrease the inflammatory insults to the body systems and this reflects on survival.** ***Ann Pediatr Surg*** **7:97–100 © 2011 Annals of Pediatric Surgery**

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Introduction

Necrotizing enterocolitis (NEC) is diagnosed in 6% of very-low-birth-weight (VLBW, < 1500 g) and 8% of extremely low-birth-weight (ELBW; < 1000 g) infants [1,2]. Surgical intervention in NEC occurred in 5% of ELBW infants in the study done by the Neonatal Research Network of the National Institute of Child Health and Human Development [2]. Isolated intestinal perforation (IP), a less common disorder that affects approximately 2% of ELBW infants, is thought to be a distinct clinical entity with presenting signs similar to those of NEC [3,4]. These two disease processes are currently treated similarly, both medically and surgically, in part because of the uncertain accuracy of preoperative diagnoses of these disorders. ELBW infants who are surgically treated for NEC or IP have a mortality rate of approximately 50% [5–9]. Moreover, survivors often experience severe morbidity, including prolonged inability to tolerate feedings and a high rate of neurodevelopmental impairment [10,11].

It is unknown whether simple peritoneal drainage or laparotomy (and likely intestinal resection) should be the initial surgical therapy for ELBW infants [12,13]. Laparotomy has been the traditional treatment. During the 1970s, peritoneal drainage was first used as a temporizing measure for critically ill neonates who were considered to be too ill for a laparotomy [14]. The original rationale was to stabilize the infant and later to perform a laparotomy with resection of diseased bowel.

The primary goal of our study was to report the outcome in both groups (treated with laparotomy vs. PD) at 90

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days and the secondary goal was to report the complications and total parenteral nutrition (TPN) dependency between two groups.

Patients and methods

We have retrospectively reviewed the chart of VLBW and ELBW who suffered from NEC requiring surgical intervention (Bell's stage II and stage III) by either peritoneal drainage or laparotomy, treated at our institution from 2003 to 2009. NEC was diagnosed on the basis of the physical examination, clinical course, and radiologic imaging studies by the attending pediatric surgeon. Inclusion criteria were all infants whose birth weight was between 500 and 1500 g and who developed severe NEC that required surgical intervention (Bell's stage II and stage III). This was as judged by the attending pediatric surgeon on the basis of either pneumoperitoneum or fixed bowel loop, which was identified by an abdominal radiograph or by clinical deterioration as worsening of abdominal wall cellulitis, with increasing ventilatory requirement, labile blood pressure, need for vasopressors, and deterioration in the platelet count on a hemogram.

Thirty-two patients were included in our study. Seventeen patients (53.1%) underwent peritoneal drainage, as initial intervention and 15 patients (46.8%) underwent laparotomy. Decision to opt for laparotomy or drainage was based on the clinical and hemodynamical stability of the patient by the attending pediatric surgeon. Data regarding gestational age (weeks), mode of delivery, birth weight (grams), sex, activity, pulse, grimace, appearance, and respiration. APGAR score, days of enteral feeding, associated morbid diseases, and age at diagnosis were collected for all the patients. In addition, patients' clinical status was analyzed by collecting data regarding mechanical ventilation [conventional or high-frequency oscillation ventilation (HFOV)], pH, inotrope and steroid requirement, platelet count, and white blood cell count (WBC). Data of patients who received indomethacin were also collected.

The primary outcome variable was infant mortality within 90 days from initial surgical intervention. Moreover, the secondary outcome variables include prolonged TPN and presence of complications (medical or surgical) after the initial intervention. All outcomes were analyzed at 90 days after initial intervention.

Statistical analysis

All data have been analyzed using SPSS (Chicago, Illinois, USA) program software.

Results

Out of 32 patients diagnosed with severe NEC (Bell's stage II and stage III), 15 patients (46.8%) who were hemodynamically stable, underwent laparotomy as initial intervention and 17 patients (53.1%), who were hemodynamically unstable, underwent peritoneal drainage as initial intervention. Birth weight, gestational age, and sex in both groups were not statistically significant in univariate analysis, as shown in Table 1. Age at diagnosis in the laparotomy group ranged from 4–70 days (mean: 31.5 days). In the PD group, it ranged from 7–34 days (mean: 18.4 days). Statistically, the *P* value (0.026) in univariate analysis was significant. However, we will see later that in the final model when all variables were put together that it was not significant.

As shown in Table 2, variables such as mode of delivery and days of enteral feeding before NEC were also found to be statistically not significant while comparing both groups in the univariate analysis. Associated morbid diseases included were congenital heart disease, sepsis, intraventricular hemorrhage, hyaline membrane disease, and others. It was found that three (20%) patients in the laparotomy group were having one associated disease, whereas one (5.8%) patient in the PD group was having one associated disease. Ten (77%) patients in the laparotomy group and 10 (58.8%) patients in the PD group were having two associated diseases. Two (13%) patients in the laparotomy group and three (17.2%) patients in the PD group were having three associated diseases. In the PD group, two patients (11.7%) were having four associated diseases and one (5.8%) patient was having five associated diseases, whereas none in the laparotomy group was having four or five associated diseases. *P* value in the univariate analysis was 0.054 and we will see later that in the final model it was significant ($P = 0.008$).

Clinical status of patients was analyzed by examining parameters such as vasopressors, steroids, pH, platelets, WBC count, and whether the patient is on conventional ventilation or requires HFOV. Fourteen (93.3%) patients in the laparotomy group were on conventional ventilation and one patient was on room air, with none on HFOV.

Table 1 Characterestics of both groups

Variable	Laparotomy [*n*=15 (46.8%)]	PD [*n*=17 (53.1%)]	*P*
Gestational age [mean (weeks)]	25.6	24.9	0.387
Sex			
Male	7 (46.66%)	8 (47%)	0.98
Female	8 (53.33%)	9 (53%)	
Birth weight [mean (g)]	827	728	0.194
Age at diagnosis [mean (days)]	31.5	18.4	0.026

PD, peritoneal drainage.

Table 2 Variables collected for both groups

Variable	Laparotomy (*n*=15)	PD (*n*=17)	*P*
Mode of delivery			
SVD	6 (40%)	9 (52.9%)	0.185
Assisted breech delivery	2 (13%)	5 (29.4%)	
Cesarean section	7 (47%)	3 (17.6%)	
Days of enteral feeding [mean (days)]	16.5	10.3	0.097
Associated diseases			
One	3 (20%)	1 (5.8%)	0.054
Two	10 (77%)	10 (58.8%)	
Three	2 (13%)	3 (17.2%)	
Four	0	2 (11.7%)	
Five	0	1 (5.8%)	

PD, peritoneal drainage; SVD, spontaneous vaginal delivery.

However, 14 patients in the PD group were on conventional ventilation and three patients were on HFOV. The difference was statistically not significant ($P = 0.29$). As shown in Table 3, variables such as pH and indomethacin were found to be statistically not significant.

Four (26.6%) patients in the laparotomy group and 13 patients (76.4%) in the PD group were on vasopressors. This difference was statistically significant both in univariate analysis ($P = 0.004$) as well as in the final model ($P = 0.017$). One patient (6.7%) in the laparotomy group was on steroids, whereas in six (35.2%) patients in the PD group this difference was not statistically significant ($P = 0.053$) in the univariate analysis but was found to be significant ($P = 0.007$) in the final model.

As shown in Table 4, mean WBC count and mean platelet count at presentation comparing both groups were not significant.

Finally, primary and secondary outcomes were calculated at 90 days between two groups. Eleven (73.4%) patients in the laparotomy group and eight (47.1%) patients in the PD group survived ($P = 0.140$). Three (20%) patients in the laparotomy group were having complications (medical or surgical), whereas five (29.4%) patients in the PD group had complications ($P = 0.555$). Moreover, four (26.6%) patients in the laparotomy group and 10 (58.82%) patients in the PD group were found to be TPN dependent at the end of 90 days starting from intervention ($P = 0.071$).

Table 5 is the final model, which was computed after putting all variables together in regression analysis using the stepwise exclusion method and finally obtaining the significant variables. The regression analysis was useful in taking care of confounders. Associated diseases ($P = 0.008$), use of vasopressors ($P = 0.017$), and steroids ($P = 0.007$) were statistically significant between two groups.

Finally, the difference in primary outcome between two groups was not found to be statistically significant ($P > 0.05$); however, it is being considered in the final model owing to its clinical significance as well as its marginally insignificant P value ($P = 0.081$).

Table 3 Mode of ventilation, pH, and pharmacological drugs used in both groups

Variable	Laparotomy ($n=15$)	PD ($n=17$)	P
Conventional ventilation	14 (93.3%)	17 (100%)	0.29
HFOV	–	03	
pH mean	7.29	7.25	0.458
Vasopressor	4 (26.6%)	13 (76.4%)	0.004
Indomethacin	8 (53.3%)	10 (58.8%)	0.764
Steroids	1 (6.7%)	6 (35.2%)	0.053

HFOV, high-frequency oscillation ventilation; PD, peritoneal drainage.

Table 4 Leukocytes and platelet counts in both groups

Variable	Laparotomy ($n=15$)	PD ($n=17$)	P
WBC (mean)	12.4	12.2	0.978
Platelet at presentation (mean)	161.2	131.2	0.49

PD, peritoneal drainage; WBC, white blood count.

Table 5 Regression analysis for patients either undergoing laparotomy or peritoneal drainage

Variable	P value
Associated diseases	0.008
Steroids	0.007
Vasopressor	0.017
Primary outcome	0.081

Discussion

Our retrospective chart review study demonstrated that mortality in the PD group was 52.9% compared with 26.6% in the laparotomy group. Although the P value calculated is 0.081, which is not significant, yet mortality was higher in the PD group.

Our data are supported by most of the prospective studies that have concluded that early postoperative mortality from NEC and IP is not significantly different after PD or laparotomy [15–19]. In fact, mortality in four of these five prospective studies was higher in the PD group, although only one study found a statistically significant difference. Furthermore, a recent systematic review of a prospective study from January 2000 to December 2008 by Sola *et al* [20]. demonstrated that PD was associated with a statistically significant increased mortality of 55%.

Our study demonstrates the increased survival (73.4%) in the laparotomy group when compared with (47.1%) the PD group. This is supported by the NECSTEPS trial, which noted a statistically significant increased survival rate of eligible but not enrolled infants treated with laparotomy (85%) compared with PD (59%) patients. Although the baseline characteristics of enrolled and nonenrolled patients were similar, nonenrolled patients treated with laparotomy were on average 1.3 weeks older and 165 g heavier than nonenrolled PD patients. The improved survival outcome has been attributed to patient selection and confounding bias. However, an alternative conclusion is that excellent outcomes with laparotomy can be achieved with individual patient assessment and selection by pediatric surgeons [21,22].

Patients in the PD group were very sick and were on vasopressors and steroids when compared with the laparotomy group. Moreover, they have multiple associated diseases, and statistically all these variables were significant.

In addition, 11 of the 17 patients in the PD group (64.7%) required subsequent laparotomy and six patients were too sick to undergo laparotomy and died soon after. However, in the NECSTEPS trial, Moss *et al.* [13] found no statistical significance in 90-day survival, dependence on parenteral nutrition, or length of hospital stay in 117 VLBW infants randomly assigned to PD or laparotomy. In addition, nearly 40% (21 of 55) of patients initially treated with PD required a subsequent laparotomy.

Meta-analysis was previously used by Moss *et al.* [13] to compare the effectiveness of PD and laparotomy in patients with perforated NEC. After analyzing 10 retrospective studies and unpublished raw data from three centers, the investigators concluded that it was not

possible to determine whether PD was superior to laparotomy because of significant differences in gestational age and birth weight between the two groups. Patients treated with PD were on average 4 weeks younger and 650 g lighter compared with those in the laparotomy group. In contrast, Sola *et al.*'s analysis of five prospective studies demonstrates only a difference of less than 1 week in gestational age and 67 g in the birth weight of patients treated with PD compared with laparotomy. Our study also demonstrates gestational age difference of only 1 week and birth weight difference of 100 g between two groups. However, age at diagnosis was significant in the univariate analysis with 13 days less in the PD group, which suggested that earlier the age at diagnosis the higher the mortality.

Conclusion

In conclusion, our study demonstrated that patients in PD group were seriously ill and they were on vasopressors and steroids when compared with the laparotomy group. Furthermore, it was found that diagnosis of NEC early in life signifies a higher mortality. In addition, insertion of a PD is still useful in resuscitating small critically ill infants with NEC; however, the majority of these infants will also require subsequent laparotomy. Early diagnosis and early intervention will ultimately improve the survival, by decreasing the inflammatory insults to various body system caused by inflammatory mediators.

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