Is pneumoperitoneum an absolute indication for surgery in necrotizing enterocolitis?

Vijai D. Upadhyaya, A. N. Gangopadhyay, Anand Pandey, Ashish Upadhyaya, T. Vittal Mohan, S. C. Gopal, D. K. Gupta

Varanasi, India

Background: **Necrotizing enterocolitis (NEC) is the most common gastrointestinal medical/surgical emergency in neonates. Non-operative support is needed in 70% of NEC cases, and surgical intervention in the rest 30%. Historically, pneumoperitoneum has been considered as an absolute indication for laparotomy. In the present study we emphasize that pneumoperitoneum is not an absolute indication for exploratory laparotomy in NEC cases.**

Methods: **We prospectively studied 58 patients with severe NEC having pneumoperitoneum on abdominal X-ray in the last 5 years. At the time of admission, the patients were given intravenous fluid, total parental nutrition, blood transfusion and broad spectrum antibiotics followed by abdominal tapping (paracentesis). All the patients with pneumoperitoneum were closely monitored for 48 hours if abdominal tapping was repeated. When the disease seemed to worsen clinically, radiologically and laboratorially, the patient was subjected to exploratory laparotomy.**

Results: **Of the 58 patients, 40 were treated conservatively whereas 18 underwent surgical intervention. The overall mortality in the present study was 12.1%, including 5% of the patients managed conservatively and 27% of the patients undergoing surgery.**

Conclusions: **Pneumoperitoneum is not an absolute indication for surgery in cases of neonatal NEC. Most of the patients can be treated conservatively.**

World J Pediatr 2008;4(1):41-44

Key words: **necrotizing enterocolitis; neonates; pneumoperitoneum; surgery**

Author Affiliations: Department of Pediatric Surgery, IMS, BHU, Varanasi, India (Upadhyaya VD, Gangopadhyay AN, Pandey A, Upadhyaya A, Moahan TV, Gopal SC, Gupta DK)

Corresponding Author: Vijai D. Upadhyaya, Department of Pediatric Surgery, IMS, BHU, Varanasi, 221005, India (Tel: +91-0542-2309275; Email: upadhyayavj@rediffmail.com)

Introduction

Necrotizing enterocolitis (NEC) is an inflammatory gastrointestinal disease of unknown etiology that primarily affects the preterm neonates or sick newborns.[1] It is characterized by intestinal necrosis with an incidence of 0.3-2.4 per 1000 live births and is the most common gastrointestinal emergency in neonates.[2] NEC is present in 6% of very low birth weight (<1500 g) and 8% of extremely low birth weight (ELBW; <1000 g) infants.[3] The exact cause of NEC is unclear but it is believed that an ischemic insult damages the bowel lining so that mucus is not produced, leaving the bowel susceptible to bacterial invasion. Infants may present with ileus manifested by abdominal distention, bilious gastric residuals (after feedings) that may progress to bile emesis and gross or microscopic blood in the stools. Sepsis may be manifested by lethargy, temperature instability, increased apneic spells, and metabolic acidosis. Certain newborns are at a particular risk like premature infants, those with amnionitis caused by prolonged rupture of membranes, with asphyxia at birth, fed with hyperosmolar formula, and those requiring exchange transfusion.[4] Commonly patients with NEC have involvement of the terminal ileum followed by colon and proximal bowel.[4,5] Most of these patients respond to conservative treatment and only one-third patients require surgical intervention. It is important to differentiate NEC from isolated intestinal perforation (IP),[6-8] which is less common and affects about 2% of ELBW infants. NEC carries a high mortality rate[9-11] and is responsible for 50% of the mortality[12] in ELBW babies who are treated surgically. This study was conducted to show whether pneumoperitoneum in NEC cases is an absolute indication for surgical treatment.

Methods

This prospective study was undertaken in the Department of Pediatric Surgery, University Hospital, Institute of Medical Sciences, Banaras Hindu University, Varanasi India from January 2000 to

December 2005. A total of 58 consecutive clinically suspected neonates with severe NEC associated with pneumoperitoneum (evident on plain X-ray either erect or lateral decubitus positions) were studied. The suspected cases of NEC without pneumoperitoneum were excluded. The study was approved by the Ethical Committee of the University and informed consent was obtained from the parents. Seventy-two percent of the patients were referred from medical neonatal intensive care unit (NICU) and the rest 28% were directly admitted to the neonatal surgical ICU. On admission, intravenous fluid and broad spectrum antibiotics were prescribed (ceftazidime, metrogyl and amikacin). All the patients were subjected to abdominal X-ray at erect and lateral decubitus positions, routine blood investigation, complete blood test, analysis of serum electrolytes, arterial blood gas, blood culture and renal function tests. Abdominal girth, erythema of anterior abdominal wall, along with other clinical parameters such as respiratory rate, heart rate, temperature, capillary filling time, SaO2 and blood pressure were monitored. All these patients with pneumoperitoneum were subjected to abdominal tapping (paracentesis) using a No. 20 French cannula and the aspirate was sent for culture and sensitivity test. All patients were assessed clinically by improvement of vital parameters, abdominal girth and erythema of the anterior abdominal wall, biochemical or hematological parameters, and serial abdominal X-rays (decrease in diameter of bowel and/or number of air fluid level, and whether pneumoperitoneum was resolved or not). If pneumoperitoneum was evident after 24 hours of the 1st tapping, repeated abdominal tapping was done. When pneumoperitoneum was even evident after the 2nd abdominal tapping or if there was any deterioration in clinical or investigation parameters, the patients were subjected to surgical intervention, usually 24 hours after the 2nd tapping. The patients were followed up at an interval of 4 months for 1 year and then an interval of 6 months for 3 years.

Table 1. Sex, age distribution, and hospital stay of the 58 patients

Premature infants	49 (84.5%)
Full-term infants	9 (15.5%)
Male	31 (53.4%)
Female	27 (46.6%)
Hospital stay (conservative treatment)	12-18 days (mean 16 days)
Hospital stay (surgical treatment)	22-68 days (mean 31 days)

Table 2. Clinical and laboratory parameters of the 58 patients

Mean heart rate at time of presentation	76/min-196/min (mean: 159.5/min, SD: 31.82, median: 163)
Mean respiratory rate at time of presentation	18/min-72/min (mean: 51.62/min, SD: 12.92, median: 53)
Abdominal wall erythema	26 (44.8%)
Bleeding per rectum	17 (29.3%)
Vomiting	34 (58.6%)
Radiological evidence	
Pneumoperitoneum	58 (100%)
Pneumatosis intestinalis	43 (74.1%)
Fixed bowel loop	37 (63.8%)
Cultures	
Peritoneal fluid culture	21 (36.2%)
Blood culture	18 (31.0%)
Stool for occult blood	22 (37.9%)
Hematological parameter	
Total leukocyte count at time of presentation	2000 to 18000 (mean 3200)/mm^3
Total platelet count at time of presentation	60000 to 90000 (mean 76000)/mm^3
Acidic blood pH (on arterial blood gas analysis)	31 (53.4%) pH < 7.35

Results

In the present study, 49 patients were premature and 9 were full-term neonates (Table 1). Their mean weight was 1674 g (range 950-3000 g). All of them suffered from severe NEC with radiological evidence of pneumoperitoneum with or without pneumatosis intestinalis and fixed loop. The complaints and clinical manifestations of the patients are summarized in Table 2. In 87.9% (51/58) of the patients, blood biochemistry was abnormal but later was corrected by intravenous fluid. In 21 patients with positive peritoneal fluid culture results, 17 (80.9%) were reported to have Gram-negative bacterial growth. Of the 58 patients in whom abdominal tapping was done as an initial treatment, 21 improved clinically and required no further surgical intervention, in the rest 37 patients with repeated abdominal tapping 19 patients responded well and 18 patients required surgical intervention because they did not improve clinically and/or radiologically after two

Table 3. The number of abdominal tapping and need of exploratory laparotomy

Mode of treatment	Total patients	Survivors	Deaths
Conservative	40	38	2*
Surgery	18	13	5*
Response to abdominal tapping			
First tapping	21/58	-	-
Second tapping	19/58	-	-
Exploratory laparotomy	18/58	-	-

*: The difference in mortality of the two groups was not statistically significant.

trails of abdominal tapping or the clinical deterioration was suspected. All these patients on exploration had massive NEC, which required bowel resection combined with colostomy or ileostomy. Of the 18 patients undergoing surgical intervention, 16 were premature and 2 were full-term. The mean hospital stay of the patients treated conservatively was 16 days, whereas that of the the patients who required surgical treatment was 31 days. The overall mortality was 12.1% in the total 58 patients, including 2 of the 40 patients (5%) managed conservatively and 5 of the 18 patients (27%) requiring surgery (Table 3). Of the 7 deaths, 5 occurred in the patients requiring surgical intervention. During follow up, 5 patients managed conservatively developed intestinal stricture, none of the patients treated surgically developed intestinal stricture.

Discussion

NEC, one of the lethal diseases, accounts for 15% of deaths in premature infants weighing less than 1500 g. Two-thirds of patients with NEC respond well to conservative treatment, whereas one-third of patients required surgical treatment. Medical treatment of NEC is dependent on orogastric decompression, parenteral antibiotics, and fluid electrolyte acid base normalization with or without parenteral nutrition. Options for surgical treatment include (a) peritoneal drainage[13] when the patient is very sick or (b) laparotomy with definitive surgery when the condition of the patient is stable. Few studies recommend peritoneal drainage as an initial treatment (termed as primary peritoneal drainage, PPD) followed by surgery when the condition of the patient is stable,[13] whereas others suggest that PPD may serve as a definitive therapy.[14,15] Most studies on the outcome of PPD and laparotomy showed similar survival rates.[16] Moss et al[17] stated that the type of operations for perforated NEC does not influence the survival rate in preterm infants.

The absolute indication for surgery in NEC is bowel perforation, characterized by either pneumoperitoneum[4,9,18] or positive paracentesis[2,19-21] because occult perforation can be found in up to 50% of patients.[15] Other indications for surgery are signs of peritonitis, absent bowel sounds with diffuse guarding and tenderness, erythema and edema of the abdominal wall,[22] clinical deterioration,[20] persistent abdominal tenderness,[22] persistently dilated loop[23] and gasless abdomen with ascites on abdominal radiograph.[21,22] The present study was conducted to investigate whether pneumoperitoneum is an absolute indication for surgery in cases of NEC.

Spontaneous intestinal perforation (SIP),[24-26] which mimics NEC, can be distinguished from NEC by lack of systemic involvement, absence of other clinical signs common to bowel perforation, lack of pneumatosis intestinalis, its earlier onset in infants of smaller birth weight, and extreme prematurity. Focal intestinal perforation[27] seen in a few premature infants of low birth weight is similar to SIP in appearance. In the present series, all patients had two or more signs of severe NEC according to Bell's classification.[28]

About 65.5% of the patients recovered after abdominal tapping and supportive treatment, whereas 31.0% required exploratory laparotomy. A mortality of 5% was observed in the patients who responded to conservative treatment but the rate was 27% in patients who underwent surgical intervention. The difference was of no statistical significance. Goyal et al[29] and Sharma et al[30] reported the similar results.

In conclusion, pneumoperitoneum seems not to be an absolute indication for surgical intervention in cases of NEC. Initial abdominal tapping (paracentesis) may be effective and safe in patients with NEC with clinical and radiological evidence of pneumoperitoneum.

Funding: None.
Ethical approval: The study was approved by the Ethical Board of Banaras Hindu University and valid written informed consent was obtained from the parents.
Competing interest: None.
Contributors: Upadhyaya VD, Pandey A and Moahan TV contributed to the manuscript construction. Gangopadhyay AN, Gopal SC and Gupta DK helped in manuscript design and discussion, and Upadhyaya A helped in statistical analysis.

References

1 Neu J. Neonatal necrotizing enterocolitis: an update. Acta Paediatr Suppl 2005;94:100-105.
2 Kulkarni A, Vigneswaran R. Necrotizing enterocolitis. Indian J Pediatr 2001;68:847-853.
3 Uauy RD, Fanaroff AA, Korones SB, Phillips EA, Phillips JB, Wright LL. Necrotizing enterocolitis in very low birth weight infants: biodemographic and clinical correlates. National Institute of Child Health and Human Development Neonatal Research Network. J Pediatr 1991;119:630-638.
4 Ruangtrakool R, Laohapensang M, Sathornkich C, Talalak P. Necrotizing enterocolitis: a comparison between full-term and pre-term neonates. J Med Assoc Thai 2001;84:323-331.
5 Narang A, Rao R, Bhakoo ON. Neonatal necrotizing enterocolitis: a clinical study. Indian Pediatr 1993;30:1417-1422.
6 Ein SH, Marshall DG, Girvan D. Peritoneal drainage under local anesthesia for perforations from NEC. J Pediatr Surg 1977;12:963-967.
7 Stoll BJ. Epidemiology of necrotizing enterocolitis. Clin Perinatol 1994;21:205-218.
8 Calisti A, Perrelli L, Nanni L, Vallasciani S, D'Urzo C, Molle P, et al. Surgical approach to neonatal intestinal perforation.

An analysis on 85 cases (1991-2001). Minerva Pediatr 2004;56:335-339.
9 Buonomo C. The radiology of necrotizing enterocolitis. Radiol Clin North Am 1999;37:1187-1198.
10 Berdon WE, Grossman H, Baker DH, Mizrahi A, Barlow O, Blanc WA. Necrotizing enterocolitis in premature infant. Radiology 1964;83:879-887.
11 Sántulli TV, Schullinger JN, Heird WC, Gongaware RD, Wigger J, Barlow B, et al. Acute necrotizing enterocolitis in infancy: a review of 64 cases. Pediatrics 1975;55:376-378.
12 de Souza JC, da Motta UI, Ketzer CR. Prognostic factors of mortality in newborns with necrotizing enterocolitis submitted to exploratory laparatomy. J Pediatr Surg 2001;36:482-486.
13 Morgan LJ, Shochat SJ, Hartman GE. Peritoneal drainage as primary management of perforated NEC in the very low birth weight infant. J Pediatr Surg 1994;29:310-315.
14 Lessin MS, Luks FI, Wesselhoeft CW Jr, Gilchrist BF, Iannitti D, DeLuca FG. Peritoneal drainage as definitive treatment for intestinal perforation in infants with extremely low birth weight (<750 g). J Pediatr Surg 1998;33:370-372.
15 Rovin JD, Rodgers BM, Burns RC, McGahren ED. The role of peritoneal drainage for intestinal perforation in infants with and without necrotizing enterocolitis. J Pediatr Surg 1999;34:143-147.
16 Snyder CL, Gittes GK, Murphy JP, Sharp RJ, Ashcraft KW, Amoury RA. Survival after necrotizing enterocolitis in infants weighing less than 1,000 g: 25 years' experience at a single institution. J Pediatr Surg 1997;32:434-437.
17 Moss RL, Dimmitt RA, Barnhart DC, Sylvester KG, Brown RL, Powell DM, et al. Laparotomy versus peritoneal drainage for necrotizing enterocolitis and perforation. N Engl J Med 2006;354:2225-2234.
18 Andiran F, Dayi S, Dilmen U. Pneumoperitoneum: an absolute indication for surgery in infants with necrotizing enterocolitis: report of a case. Surg Today 2001;31:250-252.
19 Ricketts RR, Jerles ML. Neonatal necrotizing enterocolitis: experience with 100 consecutive surgical patients. World J Surg 1990;14:600-605.
20 Dudgeon DL, Coran AG, Lauppe FA, Hodgman JE, Rosenkrantz JG. Surgical management of acute necrotizing enterocolitis in infancy. J Pediatric Surg 1973;8:607-614.
21 Rabinowitz JG, Siegle RL. Changing clinical and roentgenographic patterns of necrotizing enterocolitis. Am J Ronentgenol 1976;126:560-566.
22 Touloukian RJ. Neonatal necrotizing enterocolitis: an update on etiology, diagnosis, and treatment. Surg Clin North Am 1976;56:281-298.
23 Leonidas JC, Krasna IH, Fox HA, Broder MS. Periotoneal fluid in necrotizing enterocolitis: a radiologic sign of clinical deterioration. J Pediatr 1973;82:672-675.
24 Harms K, Lüdtke FE, Lepsien G, Speer CP. Idiopathic intestinal perforations in premature infants without evidence of necrotizing enterocolitis. Eur J Pediatr Surg 1995;5:30-33.
25 Williams NM, Watkin DF. Spontaneous pneumoperitoneum and other nonsurgical causes of intraperitoneal free gas. Postgrad Med J 1997;73:531-537.
26 Zerella JT, McCullough JY. Pneumoperitoneum in infants without gastrointestinal perforation. Surgery 1981;89:163-167.
27 Hou JW, Liu HC, Tsou Yau KI, Li YW, Chen CC. Spontaneous focal intestinal perforation in prematurity: report of three cases. Zhonghua Min Guo Xiao Er Ke Yi Xue Hui Za Zhi 1989;30:326-332.
28 Bell MJ, Ternberg JL, Feigin RD, Keating JP, Marshall R, Barton L, et al. Neonatal necrotizing enterocolitis. Therapeutic decision based upon clinical staging. Ann Surg 1978;187:1-7.
29 Goyal A, Manalang LR, Donnell SC, Lloyd DA. Primary peritoneal drainage in necrotizing enterocolitis: an 18-year experience. Pediatr Surg Int 2006;22:449-452.
30 Sharma R, Tepas JJ 3rd, Mollitt DL, Pieper P, Wludyka P. Surgical management of bowel perforations and outcome in very low-birth-weight infants. J Ped Surg 2004;39:190-194.

Received June 27, 2007
Accepted after revision November 25, 2007