

*Research Article*

## Bed-Side Exploratory Laparoscopy For Patients Had Neonatal Enterocolitis Improves Surgical Decision-Making Especially For Non-Therapeutic Laparotomy

**Mohamed Rabea**

Department of General Surgery,  
El-Minia Faculty of Medicine

### Abstract

**Objectives:** To evaluate the predictive value of bed-side laparoscopy for the probable pathological affection and therapeutic policy for patients with clinically and radiologically diagnosed neonatal enterocolitis (NEC). **Patients & Methods:** The study included 69 patients; 41 males and 28 females; with mean gestational age of 36.7±1.9 weeks. All patients were non-responders to medical treatment for a mean duration of 22.0±9.7 days. All patients were anemic with leucocytosis and 22 patients were thrombocytopenic. All patients showed pneumatosis intestinalis (PI); 22 patients were grade I, 31 patients were grade II and 16 patients were grade III; 14 cases had pneumoperitoneum and 3 patients had gas in the portal vein. Bedside diagnostic mini-laparoscopy was performed at bedside in the NICU under intravenous fentanyl anesthesia using 3.0° laparoscope for abdominal exploration and additional incision was made at right lateral side of the abdomen for introduction of suction/irrigation device. Then, patients underwent exploratory laparotomy through supra-umbilical transverse incision and surgical decision was taken according to degree of tissue affection. Postoperative (PO) care was provided at NICU. **Results:** Laparoscopy identified 16 cases had pan-necrosis, 4 cases had long-segment necrosis, 12 cases had perforation; 4 cases showed one evident perforation and 0 cases showed more than one perforation, 31 patients had localized perforation with somewhat healthy intestine and no gangrene and one case showed gangrenous perforated gall bladder with right hypochondrial collection and ceiled with amalgamated jejunal loops. Bed-side laparoscopy could identify cases with pan-intestinal necrosis with 100% sensitivity and accuracy of exploratory bed-side laparoscopy for sparing unnecessary non-therapeutic laparotomy. Moreover, laparoscopy identified cases had long-segment necrosis with 80% sensitivity and accuracy rates, but underestimated the presence of multiple perforation by 20%. Eighteen patients passed smooth PO course and were discharged alive without gaining new morbidities; 19 patients developed controllable surgery-related morbidities and were discharged alive, while 32 patients died during their PO course.

**Conclusion:** Bed-side exploratory laparoscopy allowed sparing unnecessary surgery by 100% accuracy and provides information about the underlying pathology that could aid in correct surgical decision-making by at least 90%.

**Keywords:** Necrotizing enterocolitis, Mini-laparoscopy, Laparotomy and Surgical-decision making

### Introduction

Necrotizing enterocolitis (NEC) is among the most severe conditions that can affect preterm infants. NEC remains a common cause of morbidity and mortality in the neonatal period. Despite many advances in the management of the critically ill neonate, the attempts at prevention and determining best treatment for NEC have been elusive, and unfortunately, the

overall survival for this poorly understood and complex condition has not improved<sup>(1,2,3)</sup>.

Although the etiology and pathogenesis of NEC remain controversial, initial bacterial colonization could play a pivotal role in the development of NEC. It is believed that NEC is secondary to a complex interaction of multiple factors, notably prematurity, that result in

mucosal damage, which leads to intestinal ischemia and necrosis. The mucosal injury may be due to infection, intraluminal contents, immature immunity, release of vasoconstrictors, and inflammatory mediators. The loss of mucosal integrity allows passage of bacteria and their toxins into the bowel wall and then into the systemic circulation, resulting in a generalized inflammatory response and overwhelming sepsis in the severe forms of NEC<sup>(4,5,7)</sup>.

The inflammatory process in NEC leads to increased blood flow in the affected bowel segment. Bacteria penetrate the mucosal defense, and their by-products of metabolism lead to the formation of intramural gas. As NEC progresses, platelet-activating factor produced by inflammatory cells and bacteria propagate the inflammatory cascade, mainly that of cytokines and complement, leading to extensive transmural involvement. Immature regulatory control of mesentery circulation makes the neonatal intestinal microvasculature vulnerable. When neonates are subjected to stress, endothelial cell dysfunction occurs and results in vasoconstriction of arterioles, inflammatory cell infiltration and activation in venules, and endothelial barrier disruption in capillaries. The compromised vasculature increases circulation resistance and therefore decreases intestinal perfusion, and may eventually progress to intestinal necrosis<sup>(9,10)</sup>.

The options for surgical interference range between primary peritoneal drainage or laparotomy. However, the optimum choice between both remains controversial particularly in low birth-weight infants. Peritoneal drainage offers temporary decompression, drainage and stabilization of the patients whilst awaiting surgery, or in patients too unstable to tolerate surgery or anesthesia. The principal surgical objectives of laparotomy are to control sepsis and removal of gangrenous bowel preserving as much bowel length as possible. The surgical options at laparotomy include resection with enterostomy, resection with primary anastomosis, proximal jejunostomy and "clip and drop" technique. The option exercised is influenced by the clinical status of the patient and the extent of the disease<sup>(11,12,13)</sup>.

The current study aimed to evaluate the predictive value of bed-side laparoscopy for the

probable pathological affection and therapeutic policy for patients with clinically and radiologically diagnosed neonatal necrotizing enterocolitis.

### Patients and Methods

The current prospective study was conducted at General Surgery in conjunction with the Neonatal Intensive Care Unit (NICU) in Al-Jafel Hospital, KSA; since January 2008 till Feb 2013 and comprised 69 neonates with gestational age ranging between 20 and 32 weeks and chosen from those admitted for treatment of NEC and failed to respond to medical treatment.

Collected data included patients' demographic data including gestational age, duration of illness, gender and body weight and laboratory investigation including determination of hemoglobin concentration, total and differential leucocytic count and platelet count. All patients underwent serial plain X-ray abdominal films in both supine postero-anterior and lateral decubitus positions for assessment of presence of fixed dilated bowel loop, presence and degree of pneumatosis intestinalis (PI), portal venous air (PVA) and pneumoperitoneum. The PI was graded according to Voss et al.<sup>(14)</sup> as mild (grade I) if confined to one quadrant, moderate (grade II) if confined to 2-3 quadrants and severe (grade III) if present in the four abdominal quadrants; absence of PI was graded as grade 0.

Bedside diagnostic mini-laparoscopy: The procedure was performed at bedside in the NICU under intravenous fentanyl anesthesia with vecuronium muscle paralysis. After preparation of the abdomen, a 3-4mm incision was made slightly above and to the left of the umbilicus till the peritoneum was opened to introduce the port for the camera under direct vision (open technique) and carbon dioxide pneumoperitoneum was established with a maximum pressure of 10 mmHg and maximal flow rate of 2 L/min. A 30° laparoscope was used for inspection and exploration of the abdomen. An additional incision was made at right lateral side of the abdomen for introduction of suction/ irrigation device. When a drain is necessary, a Penrose drain was positioned in one of the port sites.

Thereafter, patients underwent exploratory laparotomy through supra-umbilical transverse incision, peritoneal fluid collections were taken for bacteriological examination and surgical decision was taken according to degree of tissue affection; peritoneal drainage and follow-up in cases without identified intestinal perforation, if no improvement occurred patients underwent laparotomy. In cases with localized disease, bowel resection and primary anastomosis was performed or resection of necrotic segment and exteriorization of viable ends as stoma in those with long intestinal segment necrosis or non-therapeutic laparotomy for those with pan-necrosis.

Postoperative care was provided at NICU with patient maintained on ventilatory cardio-respiratory support, appropriate parenteral antibiotic therapy, oral decompression, adequate fluid and electrolyte replacement and then parenteral nutrition was supplied. Six-weeks after initial laparotomy and disappearance of clinical and radiological signs of NEC, patients with

stoma underwent laparotomy for intestinal re-anastomosis to regain continuity.

**Results**

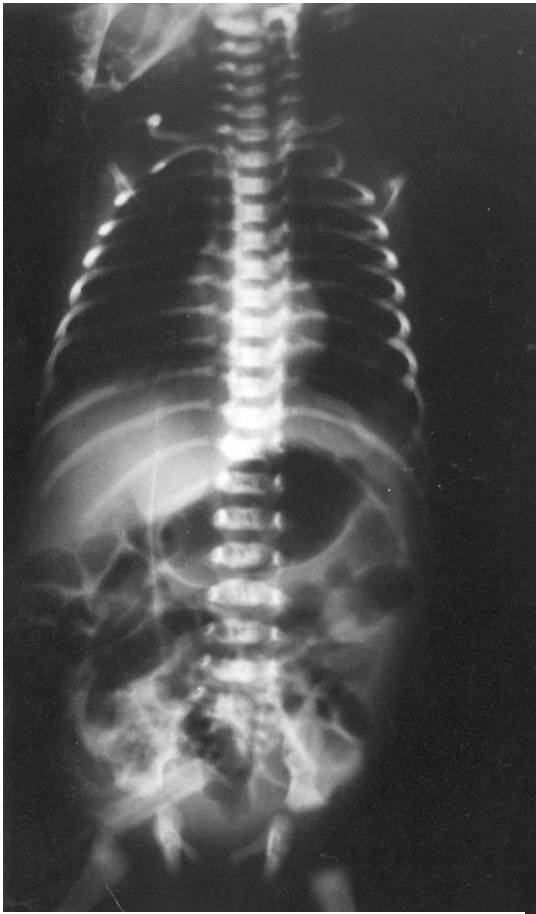
The study included 69 patients; 41 males and 28 females; with mean gestational age of 29.7±1.9; range: 27-33 weeks. Thirty-four patients were younger than 30 weeks gestational age and 30 patients were older. All patients were admitted to the NICU and received medical treatment, but unfortunately were non-responders and were prepared to surgery after a mean duration of 23.0±9.7; range: 7-36 days. All patients were anemic with mean Hb conc. of 7.4±1.1; range: 6-9 mg/dl; however, 41 patients (59.4%) had Hb conc. of ≤7 mg/dl. Total leucocytic count was 11.0±1.44; range: 8.8-10.4 x10<sup>9</sup> cell/mm<sup>3</sup> and platelet count was 103.2±4.9; range 90-240 x10<sup>9</sup> platelet/mm<sup>3</sup>. There were 22 cases (31.9%) had thrombocytopenia with mean platelet count of 101.1±8.19 x10<sup>9</sup> platelet/mm<sup>3</sup>; while the other 47 cases had mean platelet count of 117.6±4.10 x10<sup>9</sup> platelet/mm<sup>3</sup> (Table 1).

**Table (1): Patients' demographic and disease related data and preoperative laboratory findings**

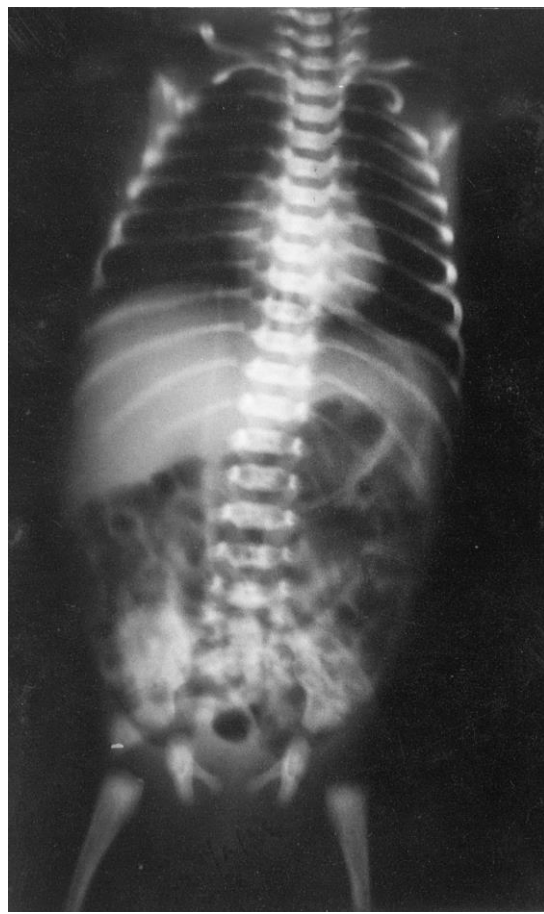
				Number (%)	Mean (range)	
<b>Gender</b>	<b>Male</b>			41 (59.4%)		
	<b>Female</b>			28 (40.6%)		
<b>Gestational age (weeks)</b>	<b>Strata</b>	<30		34 (49.3%)	28.1±0.8 (27-29)	
		≥30		35 (50.7%)	31.3±1.1 (30-33)	
	<b>Total</b>			69 (100%)	29.7±1.9 (27-33)	
<b>Duration of disease (days)</b>	<b>Strata</b>	≤14		17 (24.6%)	8.8±2.2 (7-14)	
		>14-28		21 (30.4%)	22.0±3.2 (17-27)	
		>28		31 (44.9%)	32.3±1.7 (30-36)	
	<b>Total</b>			69 (100%)	23.0±9.7 (7-36)	
<b>Lab data</b>	<b>Hb conc. (gm/dl)</b>	<b>Strata</b>	≤7		41 (59.4%)	7.7±0.0 (7-7)
			>7		28 (40.6%)	8.0±0.0 (8-9)
		<b>Total</b>			69 (100%)	7.4±1.1 (7-9)
	<b>TLC (10<sup>9</sup> cells/mm<sup>3</sup>)</b>	<b>Strata</b>	<10		04 (5.8%)	9.10±0.47 (8.8-9.9)
			≥10		10 (14.5%)	11.90±1.43 (10-10.4)
		<b>Total</b>			69 (100%)	11.0±1.44 (8.8-10.4)
	<b>Platelet count (10<sup>9</sup> platelet/mm<sup>3</sup>)</b>	<b>Strata</b>	≤120		22 (31.9%)	101.1±8.19 (90-120)
			>120		47 (68.1%)	117.6±4.10 (123-240)
		<b>Total</b>			69 (100%)	103.2±4.9 (90-240)

Pneumatosis intestinalis (PI) of variant grades (Fig. 1) was detected in all patients; 27 patients (39.2%) showed grade I, 31 patients (44.9%) grade II and 11 patients (15.9%) showed grade

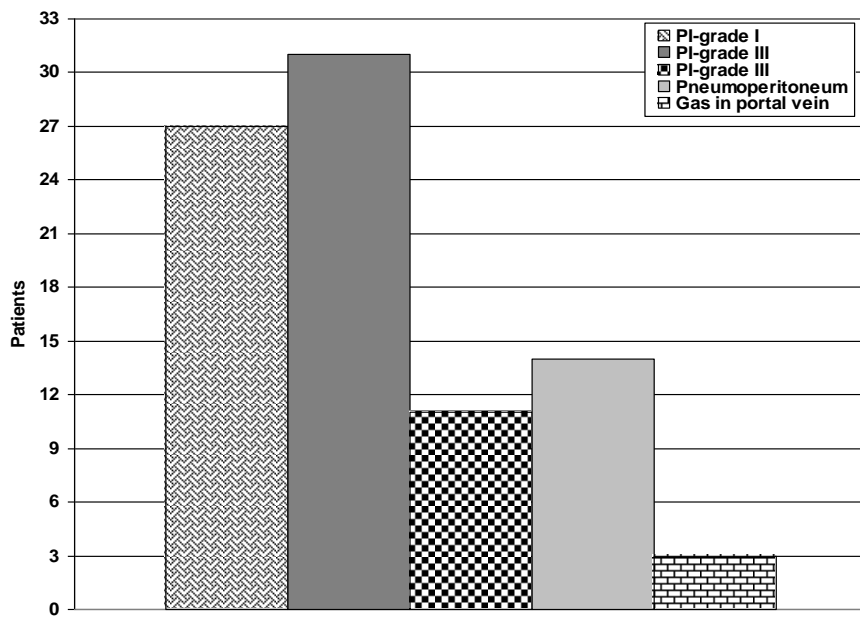
III pneumatosis. Pneumoperitoneum, (Fig. 2) was detected in 14 cases (20.3%) and gas in the portal vein was detected in 3 cases (4.3%), (Fig. 3).



**Fig. (1):** Plain X-ray showing pneumatosis intestinalis in a case of enterocolitis



**Fig. (2):** Plain X-ray showing pneumoperitoneum with ground glass appearance in a case of enterocolitis



**Fig. (3):** Patients' distribution according to radiologic findings

Laparoscopy identified 16 cases (23.3%) had pan-necrosis, 8 cases (11.6%) had long-segment necrosis, 5 cases (7.2%) had perforation; 8 cases showed one evident perforation and 5 cases showed more than one perforation and 31 patients (44.9%) showed localized perforation with somewhat healthy intestine and no gangrene but with patches of covering pyogenic membrane. Laparoscopy identified a case (1.4%) with gangrenous perforated gall bladder associated with right hypochondrial collection and ceiled with amalgam-mated jejunal loops, (Table 2).

At laparotomy, pan-necrosis with non-resectable gangrenous intestine was confronted with in 16 cases and abdomen was drained and closed. These 16 cases were considered as non-therapeutic laparotomy and assured 100% sensitivity and accuracy of laparoscopy for identifying such pathological state and thus could spare laparotomy (Table 2).

Laparotomy defined 10 cases had long-segment necrosis; resection and stoma formation was feasible in 8 cases, while for the remaining two cases, necrotic loops were amalgamated in the form of localized collection and defunctioning jejunostomy was performed. Laparoscopy accurately defined the first 8 cases, but failed to explore the presence and extent of intestinal

necrosis in other two cases and was falsely diagnosed as localized collection for a sensitivity and accuracy rates of 80% for long-segment necrosis, (Table 2).

Laparoscopy defined 13 cases had definite visible intestinal perforation; 8 patients had only one visible perforation and 5 patients had more than one perforation. Laparotomy confirmed the diagnosis of single perforation in 6 patients, while the other two patients diagnosed laparoscopically as having single were found to have multiple perforations, thus, laparoscopy underestimated the presence of multiple perforation by 20%. For patients with multiple perforations, multiple resections and stomas were performed while patients had only single perforation in partially viable intestine underwent resection and primary anastomosis, (Table 2).

The patient diagnosed laparoscopically as having gangrenous gall bladder was found to have gangrenous jejunal loops amalgamated with gangrenous gall bladder as phlegmon; this patient had cholecystectomy and jejunal resection with primary closure. Three patients were diagnosed laparoscopically as having localized peritonitis were found to have colonic perforation and underwent colonic resection and proximal colostomy, (Table 2, Fig. 4).

**Table (2): Laparoscopic and operative findings**

Findings	Laparoscopy	Operative
<b>Pan-necrosis</b>	16 (23.3%)	16 (23.3%)
<b>Long-segment necrosis</b>	8 (11.6%)	10 (14.5%)
<b>Multiple perforations</b>	5 (7.2%)	9 (13%)
<b>Single perforation</b>	8 (11.6%)	6 (8.7%)
<b>Localized peritonitis</b>	31 (44.9%)	24 (34.8%)
<b>Gangrenous gallbladder and jejunal loops</b>	1 (1.4%)	1 (1.4%)
<b>Colonic perforation</b>	0	3 (4.3%)
<b>Total</b>	69 (100%)	69 (100%)

Data are presented as numbers; percentages are in parenthesis

Eighteen patients passed smooth postoperative course and were discharged alive without gaining new morbidities. Nineteen patients (developed surgery-related morbidities, but was controllable and were discharged alive; 6 patients had stomal prolapse, 13 had wound

infection and 3 of them had wound dehiscence with a complication rate among survivors of 31.4% and 27.5% among studied neonates. Thirty-two patients (46.4%) died during their postoperative course; 16 patients had peritoneal drainage for pan-necrosis, 6 patients after

resection of long intestinal segment, 4 after multiple intestinal resections, 2 patients after resection and direct closure of small intestine

and two patients had colonic resection and the patient with gangrenous jejunal loops and gall bladder also died, (Table 3, Fig. 4).

Table (3): Postoperative morbidity and mortality

Mortality		Morbidity among survivors (n=37)	
Diagnosis & procedure	Number (%)	Diagnosis	Number (%)
Peritoneal drainage for pan-necrosis	16 (23.2%)	Stomal prolapse	6 (16.2%)
Long-segment resection	6 (8.7%)	Wound infection but no dehiscence	10 (27.0%)
Multiple-segment resection	4 (5.4%)	Wound infection and dehiscence	3 (8.1%)
Intestinal resection & direct closure	3 (4.1%)	No morbidities	18 (48.6%)
Colonic resection	2 (2.7%)	Total	37 (100%)
Gangrenous gall bladder and jejunal loops	1 (1.4%)		
<b>Total mortalities</b>	<b>32 (46.2%)</b>		

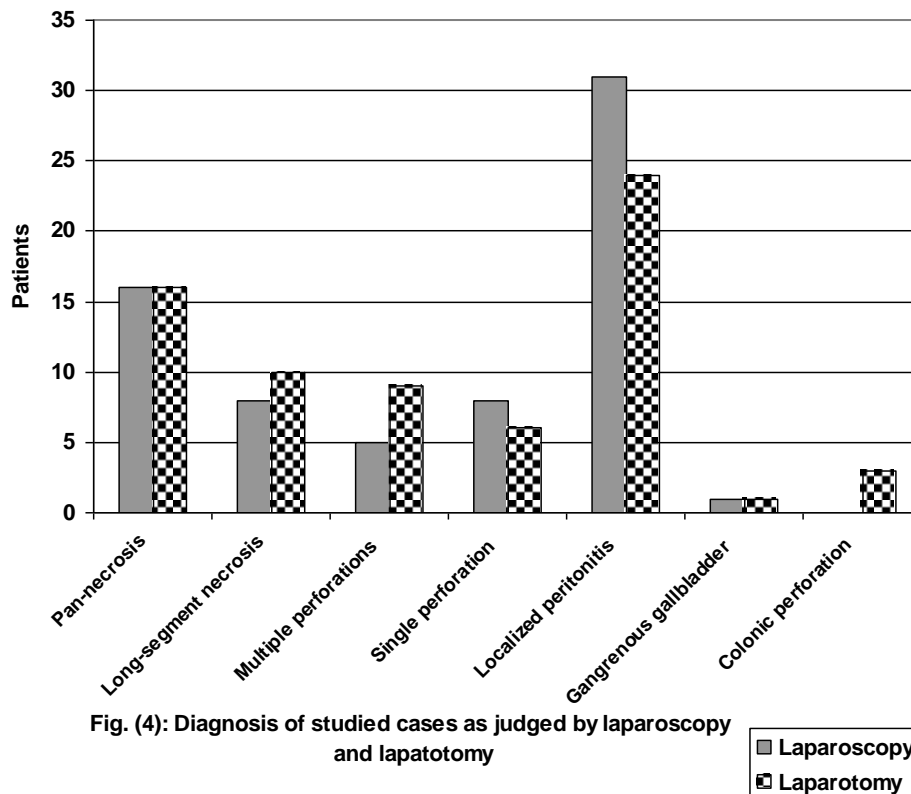


Fig. (4): Diagnosis of studied cases as judged by laparoscopy and laparotomy

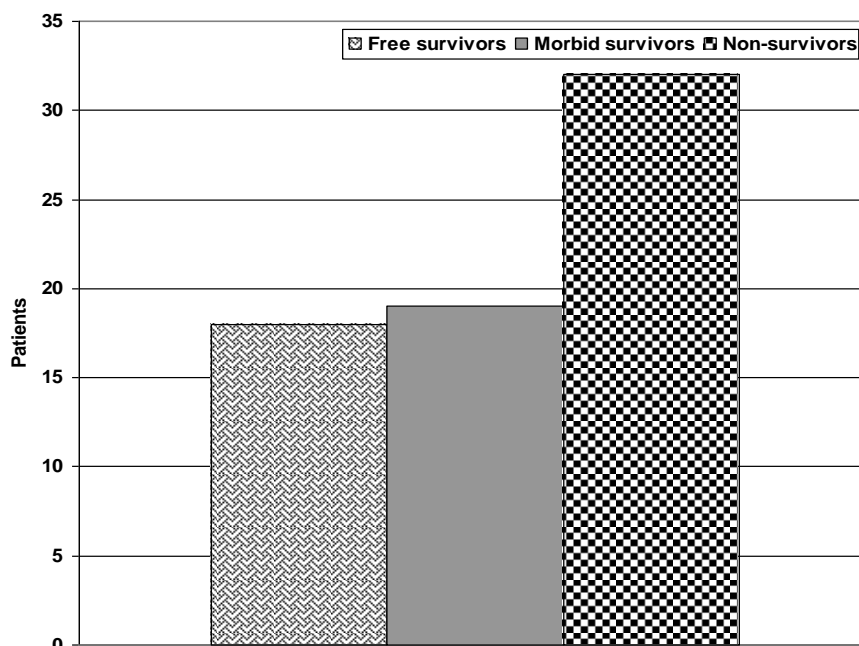


Fig. (5): Patients' distribution according to postoperative outcome

## Discussion

Bed-side laparoscopy could identify cases with pan-intestinal necrosis and the diagnosis was assured by laparotomy giving a 100% sensitivity and accuracy of exploratory bed-side laparoscopy for sparing unnecessary non-therapeutic laparotomy. Moreover, laparoscopy could identify cases had long-segment necrosis with a sensitivity and accuracy rates of 80%. Laparoscopy defined 13 cases had definite visible intestinal perforation; 4 patients had only one visible perforation and 9 patients had more than one perforation; laparotomy confirmed the diagnosis of single perforation in 6 patients, while the other two patients diagnosed laparoscopically as having single were found to have multiple perforations, laparoscopy underestimated the presence of multiple perforation by 20%.

These findings indicated the ability of bed-side exploratory laparotomy for sparing unnecessary surgery by 100% accuracy and help in correct surgical decision-making by at least 90%. These data coincided with that previously reported in literature concerning a probable role of bed-side laparoscopy for prediction of the presence and extent of pathological affection in neonates with clinical diagnosis of NEC; Pierro et al.,<sup>(15)</sup> reported that laparoscopy performed in NICU could provide information regarding intestinal viability which can guide further

surgical management and that 7 of 9 cases (77%) did not require further surgery after laparoscopic evaluation, moreover, it is feasible and tolerated well even in critically ill neonates less than 1,000 g. Clark & Mackinlay<sup>(12)</sup> documented that the versatility of laparoscopy enables good visualization of the bowel and organs and that laparoscopy in the initial evaluation of NEC is invaluable, and can avoid potentially unnecessary surgery in an already extremely unwell infant.

Tan et al.,<sup>(13)</sup> documented that laparoscopy can provide useful information for surgical decisionmaking and allows for precise placement of a microlaparotomy incision over the site of perforation, thus minimizing the trauma from open surgery in this special group of patients. Leva et al.,<sup>(14)</sup> believed that the decision to perform a laparoscopy, despite the very low weight of NEC patients, was crucial in the management of non-detected perforation at X-ray, which may only require washout of the cavity that can be managed with laparoscopy and thus reducing the morbidity of laparotomy for suspicion of perforation in patients affected by NEC who do not respond to medical treatment.

Nah et al.,<sup>(16)</sup> documented that diagnostic laparoscopy can be safely performed in

extremely low-birth weight infants; it allows precise identification of the site of perforation to perform a limited microlaparotomy at this site, thus significantly reducing the surgical trauma of extensive bowel handling. Corona Bellostas et al.,<sup>(13)</sup> evaluated laparoscopy for early diagnosis of intestinal perforation or necrosis in order to avoid unnecessary laparotomies in patients had NEC and found laparoscopy avoided laparotomy in a patient who did well after washing and drainage and magnified lesions in one patient who did not require laparotomy after intestinal bypass, and in other cases, laparoscopy was followed by mini-laparotomy oriented to the lesions and stoma formation.

Numanoglu & Millar<sup>(14)</sup> evaluated 13 patients with presumed NEC and underwent laparoscopy; standard laparoscopy identified perforation in 0 patients and gangrenous bowel in two, one patient was found to have chyle ascites, and one patient had no abnormal findings on laparoscopy; laparotomy and necessary surgical intervention were performed in all 10 patients with positive laparoscopy findings and concluded that laparoscopy helps to improve assessment of patients with a diagnosis of NEC, allows early identification of perforation and necrosis. Smith & Thyoka<sup>(15)</sup> conducted a systematic review of published literature (1990-2012) for the use of laparoscopy for management of acute NEC; and reported that 14% of infants did not require further surgery following laparoscopy, 9% had no evidence of NEC, 0% had no evidence of perforation and/or intestinal gangrene, and 0% had NEC totalis precluding further surgery and concluded that laparoscopy can be useful in selected babies with suspected NEC to avoid unnecessary laparotomy and minimize the trauma of surgery In support of the efficacy of exploratory laparoscopy, Martinez-Ferro et al.,<sup>(16)</sup> evaluated laparoscopy as a therapeutic modality for a series of infants who developed colonic strictures as a sequelae of NEC and reported that laparoscopy was effectively performed in all cases without conversion to open surgery with anastomosis was colocolic in all patients, except in 1 case, in which it was colorectal and all babies recovered uneventfully.

It could be concluded that bed-side exploratory laparoscopy is a useful tool in the armamen-

tarium of surgical management of NEC, allowing sparing unnecessary surgery by 100% accuracy and provides information about the underlying pathology that could aid in correct surgical decision-making by at least 50%.

## References

1. Alfaleh K, Anabrees J, Bassler D: Probiotics reduce the risk of necrotizing enterocolitis in preterm infants: a meta-analysis. *Neonatology*. 2010;97(2):93-9.
2. Downard CD, Renaud E, St Peter SD, Abdullah F, Islam S, Saito JM, Blakely ML, Huang EY, Arca MJ, Cassidy L, Aspelund G; 2012 American Pediatric Surgical Association Outcomes: Treatment of necrotizing enterocolitis: an American Pediatric Surgical Association Outcomes and Clinical Trials Committee systematic review. *J Pediatr Surg*. 2012; 47(11):2111-22.
3. Raval MV, Hall NJ, Pierro A, Moss RL: Evidence-based prevention and surgical treatment of necrotizing enterocolitis-a review of randomized controlled trials. *Semin Pediatr Surg*. 2012; 22(2):117-21.
4. Chokshi NK, Guner YS, Hunter CJ, Upperman JS, Grishin A, Ford HR: The role of nitric oxide in intestinal epithelial injury and restitution in neonatal necrotizing enterocolitis. *Semin Perinatol*. 2008; 32(2):92-9.
5. Emami CN, Petrosyan M, Giuliani S, Williams M, Hunter C, Prasadarao NV, Ford HR: Role of the host defense system and intestinal microbial flora in the pathogenesis of necrotizing enterocolitis. *Surg Infect (Larchmt)*. 2009; 10(5):407-17.
6. Spehlmann ME, Eckmann L: Nuclear factor-kappa B in intestinal protection and destruction. *Curr Opin Gastroenterol*. 2009; 20(2):92-9.
7. Zhang HY, Wang F, Feng JX: Intestinal microcirculatory dysfunction and neonatal necrotizing enterocolitis. *Chin Med J (Engl)*. 2013; 126(9):1771-8.
8. Watkins DJ, Besner GE: The role of the intestinal microcirculation in necrotizing enterocolitis. *Semin Pediatr Surg*. 2012; 22(2):83-7.
9. Yazji I, Sodhi CP, Lee EK, Good M, Egan CE, Afrazi A, Neal MD, Jia H, Lin J, Ma C, Branca MF, Prindle T, Richardson WM, Ozolek J, Billiar TR, Binion DG, Gladwin MT, Hackam DJ: Endothelial TLR4 activation impairs intestinal micro-circulatory



- perfusion in necrotizing enterocolitis via eNOS-NO-nitrite signaling. *Proc Natl Acad Sci U S A*. ٢٠١٣; ١١٠(٢٣):٩٤٥١-٦.
١٠. Lee JH: An update on necrotizing enterocolitis: pathogenesis and preventive strategies. *Korean J Pediatr*. ٢٠١١; ٥٤(٩): ٣٦٨-٧٢.
  ١١. Somaschini M, Breda-Klobus A, Pacati I: Necrotizing enterocolitis (nec): risk factors and genetic susceptibility. *Minerva Pediatr*. ٢٠١٢; ٦٤(١):٣٣-٤٠.
  ١٢. Wu SF, Caplan M, Lin HC: Necrotizing enterocolitis: old problem with new hope. *Pediatr Neonatol*. ٢٠١٢ Jun; ٥٣(٣):١٥٨-٦٣.
  ١٣. Voss M, Moore SW, Merwe VD, Pieper C: Fulminating necrotizing enterocolitis: outcome and prognostic factors. *Pediatr. Surg. Int.*, ١٩٩٨; ١٣: ٥٧٦-٨٠.
  ١٤. Pierro A, Hall N, Ade-Ajayi A, Curry J, Kiely EM: Laparoscopy assists surgical decision making in infants with necrotizing enterocolitis. *J Pediatr Surg*. ٢٠٠٤; ٣٩(٦): ٩٠٢-٦.
  ١٥. Clark C, Mackinlay GA: Laparoscopy as an adjunct to peritoneal drainage in perforated necrotizing enterocolitis. *J Laparoendosc Adv Surg Tech A*. ٢٠٠٦; ١٦(٤):٤١١-٢.
  ١٦. Tan HL, Tantoco JG, Ee MZ: The role of diagnostic laparoscopy in micropremies with suspected necrotizing enterocolitis. *Surg Endosc*. ٢٠٠٧; ٢١(٣):٤٨٥-٧.
  ١٧. Leva E, Di Cesare A, Canazza L, Arnoldi R,
    ١٨. Macchini F, Rossi V, Colnaghi MR, Pugni L, Mosca F, Torricelli M: The role of laparoscopy in newborns affected by NEC. *J Laparoendosc Adv Surg Tech A*. ٢٠١٠; ٢٠(٢):١٨٧-٩.
    ١٩. Nah SA, Tan HL, Tamba RP, Aziz DA, Azzam N: Laparoscopic localization and microlaparotomy for focal isolated perforation in necrotizing enterocolitis: an alternative approach to a challenging problem. *J Pediatr Surg*. ٢٠١١; ٤٦(٢):٤٢٤-٧.
    ٢٠. Corona Bellostas C, Cañizo López A, Tardáguila Calvo AR, Zornoza Moreno M, Peláez Mata D, Cerdá Berrocal JA, Romero Ruiz RM, Parente Hernández A: Role of laparoscopy in premature infants with suspicion of necrotizing enterocolitis. *Cir Pediatr*. ٢٠١١; ٢٤(٣):١٥١-٥.
    ٢١. Numanoglu A, Millar AJ: Necrotizing enterocolitis: early conventional and fluorescein laparoscopic assessment. *J Pediatr Surg*. ٢٠١١; ٤٦(٢):٣٤٨-٥١.
    ٢٢. Smith J, Thyoka M: What role does laparoscopy play in the diagnosis and immediate treatment of infants with necrotizing enterocolitis? *J Laparoendosc Adv Surg Tech A*. ٢٠١٣; ٢٣(٤):٣٩٧-٤٠١.
    ٢٣. Martinez-Ferro M, Rothenberg S, St Peter S, Bignon H, Holcomb G: Laparoscopic treatment of postnecrotizing enterocolitis colonic strictures. *J Laparoendosc Adv Surg Tech A*. ٢٠١٠; ٢٠(٥):٤٧٧-٨٠.