MJMR, Vol. 36, No. 2, 2025, pages (29-37).

Open Access
ISSN:2682-4558

Research Article

Exploratory Laparoscopy for Necrotizing Enterocolitis: Cross Section Study

Abdelhalem Shawkat Mohamad[1], Omar Nagy Abdelhakeem[1], Khalaf Yassen Fathy[1], Mohamed Ahmed Mohamed Nagaty[1] and Alaa Ahmed Elsayed Moustafa[1]

[1] Department of Pediatric Surgery, Faculty of Medicine, Minia University, Egypt.

DOI: 10.21608/MJMR.2025.374361.1931

Abstract

Background: Necrotizing enterocolitis (NEC) is an acute condition in neonates and continues to be a primary etiology of neonatal morbidity and mortality. **Aim:** To evaluate the efficacy of exploratory laparoscopy in necrotizing enterocolitis on mid-term follow-up. **Patients and methods:** This were a prospective trial. conducted between April 2022 and October 2024. The study included 50 children who underwent surgical intervention for NEC, consisting of pediatric surgery combined with exploratory laparoscopy. The cases have been divided into two groups based on their weight: Group A (35) (weight < 1000 g) and Group B (15) (weight ≥ 1000 g). **Results:** The mean weight of the investigated cases was 1225.26 ± 44.8; 48% of cases were males, and 52% were females. Mean saturation during surgery was 93.8 ± 0.6, mean systolic pressure during surgery was 59.7 ± 2.3, and mean diastolic pressure during surgery was 34.8 ± 1.8. A statistically insignificant distinction has been observed among the investigated groups as regards Bell stages. A statistically insignificant distinction has been observed among the investigated groups as regards surgical procedure. A statistically insignificant distinction has been observed among the investigated groups as regards outcome. **Conclusion:** Regarding our results, it is concluded that a statistically insignificant distinction has been observed among the investigated groups as regards Bell-Stages, surgical procedure, and regarding outcome.

Key words: NEC; Bell-Stages; Exploratory Laparoscopy.

Introduction

Necrotizing enterocolitis is a serious gastrointestinal emergency affecting kids globally, associated with significant morbidity and mortality. Exploratory laparotomy as a surgical treatment in kids. It predominantly impacts preterm newborns and those with very low birth weight (VLBW; birth weight less than 1500 grams) [1].

The Bell staging criteria describe the severity of necrotizing enterocolitis according to clinical, laboratory, and radiographic signs. Cases may be categorized as stage one (suspected), stage two (confirmed), or stage three (advanced) illness. Additionally, operation is considered for kids with Bell's stage two to three necrotizing enterocolitis, encompassing primary peritoneal drainage (PPD) and/or exploratory laparotomy with bowel resection, despite the absence of consensus regarding the optimal management [2-3].

Prior clinical trials have established that exploratory laparotomy is utilized to manage intra-abdominal sepsis, remove necrotic bowel, and conserve maximal bowel length. Resection of bowel necrosis is succeeded by either primary anastomosis or enterostomy. Surgical necrotizing enterocolitis is associated with increased morbidity and prolonged hospital stays compared to non-surgical treatment [4-5].

NEC is an acute condition in neonates and continues to be a primary etiology of neonatal morbidity and mortality. In the early stages, treatment predominantly involves utilizing antibiotics, enteral feeding cessation, and

total parenteral nutrition, alongside regular repeat X-ray assessments and/or abdominal ultrasound (US) [6].

In certain cases, the condition worsens. despite medical treatments, necessitating operative procedures. In necrotizing enterocolitis cases requiring an operation, the mortality rate might reach fifty percent. Optimizing the timing and decision-making of operative intervention could lead to improved outcomes for cases with operative necrotizing enterocolitis [7].

Traditionally, plain abdominal radiography is the widely utilized imaging modality for assessing necrotizing enterocolitis; however, early stages of necrotizing enterocolitis can't be detected by X-ray. Pathognomonic findings, such as free intraabdominal gas, represent a relatively late finding in illness progression, indicating perforation. Abdominal ultrasound has proven to be a valuable adjunct to radiography in the assessment of necrotizing enterocolitis. The identification of portal venous gas is a significant benefit of ultrasound compared to plain abdominal radiography. Moreover, ultrasound is superior to plain abdominal radiography for assessing accumulated intraperitoneal free fluid, and neonates are subjected to significantly lower radiation exposure [8-9].

Initial investigations indicate that laparoscopy can be significant in assessing intestinal viability and the extent of necrotizing enterocolitis lesions, therefore assisting in the decision-making process for laparotomy necessity. It provides the possibility to aid the surgeon in diagnosing cases that might profit from a laparotomy. A recent global survey demonstrated that just eight percent of pediatric surgeons utilize laparoscopy for the diagnosis and/or management of necrotizing enterocolitis. [10-11].
The goal of this investigation was to assess the effectiveness of exploratory laparoscopy in necrotizing enterocolitis on mid-term follow-up.

Rationale of the study
Numerous clinical trials have reported on short-term postoperative complications in children, and surgical morbidity and mortality from necrotizing enterocolitis continue to be a concern. Fortunately, there is limited data available for infants requiring surgery [12].

Material & Methods
This was a prospective trial. conducted between April 2022 and October 2024. The study included 50 children who underwent surgical intervention for NEC, consisting of pediatric surgery combined with exploratory laparoscopy. The cases have been divided into two groups based on their weight: Group A (35) (weight < 1000 g) and Group B (15) (weight ≥ 1000 g).
Inclusion Criteria: Neonates diagnosed with NEC (Bell's stage 2 or 3) requiring surgical intervention and neonates with a birth weight of less than 1500 grams (very low birth weight, VLBW) or greater than or equal to 1000 grams.
Exclusion Criteria: Infants with congenital gastrointestinal anomalies and cases with severe hemodynamic instability precluding laparoscopic intervention.
Data Collection: Demographic Data: Birth weight, gestational age, sex, and Bell's staging of NEC were recorded. Operative Data: Intraoperative parameters such as oxygen saturation, systolic and diastolic blood pressure, and duration of surgery were documented. Outcome Measures: Post-operative outcomes, including survival, complications (e.g., anastomotic leakage, stoma-related issues), and length of hospital stay, were evaluated.

Surgical procedures
Laparotomy with stoma formation (Surgery) **1**) involved a midline laparotomy to access the abdominal cavity, identify and resect necrotic or perforated bowel segments, and create a stoma by bringing the proximal end of the bowel to the abdominal wall for fecal diversion. This procedure was indicated in cases of severe NEC with extensive bowel necrosis or perforation, or when primary anastomosis was deemed unsafe due to poor bowel viability or hemodynamic instability. The technique included exteriorizing the bowel through a separate incision, maturing the stoma with interrupted sutures, and applying a stoma bag postoperatively. Advantages included allowing bowel rest, reducing the risk of anastomotic leakage, and facilitating monitoring of bowel viability and healing. Disadvantages included the need for a second surgery for stoma closure and potential complications such as stoma

prolapse, necrosis, and skin excoriation. Laparotomy with anastomosis (**Surgery 2**) involved resection of necrotic bowel followed by primary anastomosis, reconnecting the healthy ends of the bowel using hand-sewn or stapled techniques. It was indicated in cases of focal or limited NEC with viable bowel margins and stable cases with adequate bowel perfusion and no signs of peritonitis. The technique included resecting the necrotic bowel, anastomosing the healthy ends, checking for leaks, and irrigating the abdominal cavity before closure. Advantages included avoiding the need for a stoma and subsequent closure surgery, shorter duration of parenteral nutrition, and faster recovery of intestinal function.

Disadvantages included a higher risk of anastomotic leakage in compromised or inflamed bowel and the need for careful patient selection to ensure bowel viability. Laparotomy for exploration only (**Surgery 3)** involved exploratory laparotomy to assess the extent of bowel necrosis and viability without performing definitive resection or anastomosis, often followed by a second-look procedure to reassess bowel viability. It was indicated in cases where bowel viability was uncertain due to extensive inflammation or ischemia, or in cases with peritonitis or sepsis requiring source control but not immediate resection.

The technique included exploring the abdominal cavity, assessing the extent of NEC, and, if bowel viability was questionable, leaving the abdomen open with a temporary closure device or planning a second-look laparotomy within 24–48 hours. Advantages included allowing thorough assessment of bowel viability and disease extent and reducing the risk of unnecessary resection or anastomosis in compromised bowel. Disadvantages included requiring a second surgical procedure, which increases the risk of complications, and prolonged hospitalization and recovery time. Laparoscopic-assisted surgery involved using laparoscopy as an adjunct to laparotomy in selected cases. A 3-mm or 5-mm trocar was inserted, and the abdominal cavity was insufflated with CO_2 to a pressure of 6–8 mmHg.

The extent of NEC lesions, bowel viability, and the presence of perforation or peritonitis were assessed laparoscopically. This approach was indicated in cases where the extent of NEC is unclear on imaging or in cases with suspected focal NEC who may benefit from minimally invasive assessment. The technique included performing laparoscopic exploration and making decisions regarding further surgical intervention, such as resection, anastomosis, or stoma formation, based on laparoscopic findings. Advantages included a minimally invasive approach with reduced postoperative pain and faster recovery, as well as providing real-time assessment of bowel viability and disease extent. Disadvantages included limitations due to the small abdominal cavity in preterm neonates and the requirement for expertise in neonatal laparoscopy. Each surgical approach had distinct indications, techniques, advantages, and disadvantages, tailored to the patient's condition and the severity of the disease.

Postoperative Management

Postoperative management involved close monitoring of cases in the neonatal intensive care unit (NICU) for signs of sepsis, anastomotic leakage, or stoma-related complications. Parenteral nutrition is initiated postoperatively, with gradual reintroduction of enteral feeds once bowel function resumes. Early detection and management of complications, such as wound infection, anastomotic leakage, or stoma-related issues, are prioritized to ensure optimal recovery and outcomes.

Statistical analysis

Data will be collected and tabulated. Then SPSS 25 will be used for statistical analysis. Categorical data will be expressed as a percentage and number utilizing "chi square," Fisher's exact test, or "Z" test for analyzing them. Odds ratios will be computed to detect the risk factors. Continuous variables will be presented as standard deviation and mean utilizing the "Student t" test for analyzing them. Alternative appropriate tests of significance will be utilized if indicated based on the situation. The accepted level of significance in this work will be ($P<0.05$ will be considered significant).

Results

Table (1): Distribution of baseline characteristics among the investigated group

		Investigated group Number=50
Weight (g) Mean± SD		1225.26± 44.8
Sex	**Male**	24 (48%)
	Female	26 (52%)

SD: standard deviation

Table 1 shows that the mean weight of the investigated cases was 1225.26 ± 44.8, 48% of cases were males, and 52% were females.

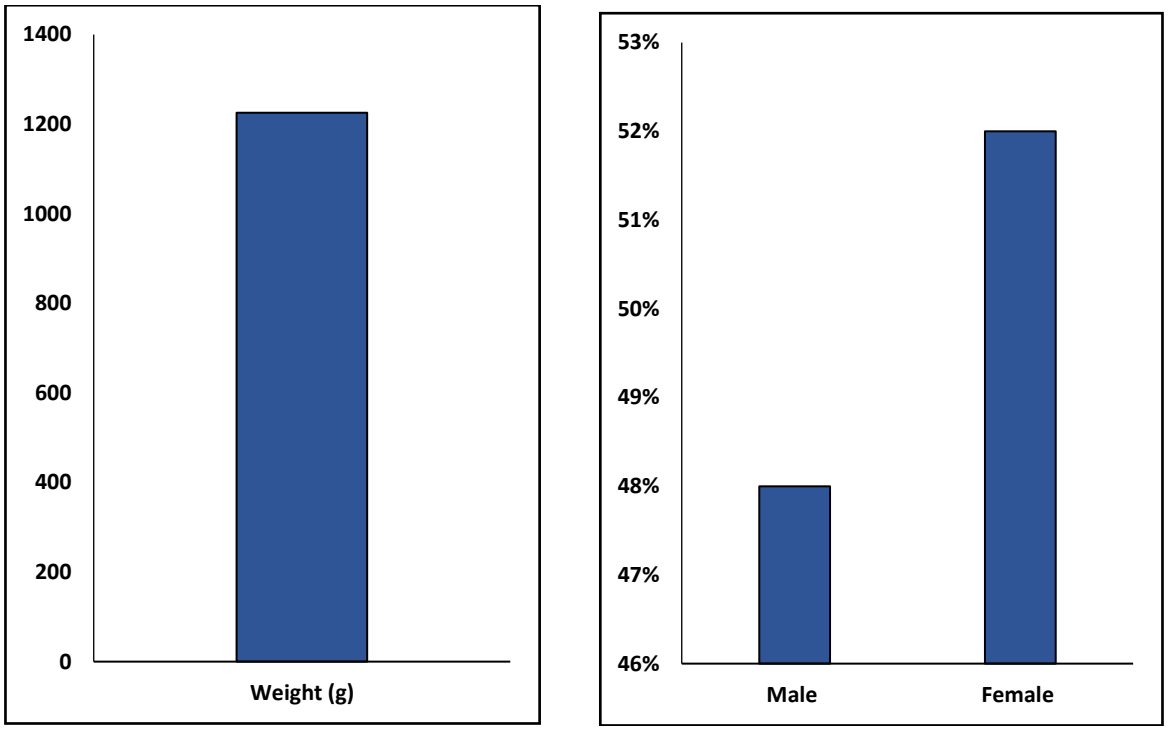

Figure (1): Distribution of baseline characteristics among the investigated group

Table (2): Distribution of operative data among the investigated group

	Investigated group Number=50
Saturation during surgery Mean± SD	93.8 ± 0.6
Systolic pressure during surgery Mean± SD	59.7 ± 2.3
Diastolic pressure during surgery Mean± SD	34.8 ± 1.8

Table 2 shows that mean saturation during surgery was 93.8 ± 0.6, mean systolic pressure during surgery was 59.7 ± 2.3, and mean diastolic pressure during surgery was 34.8 ± 1.8.

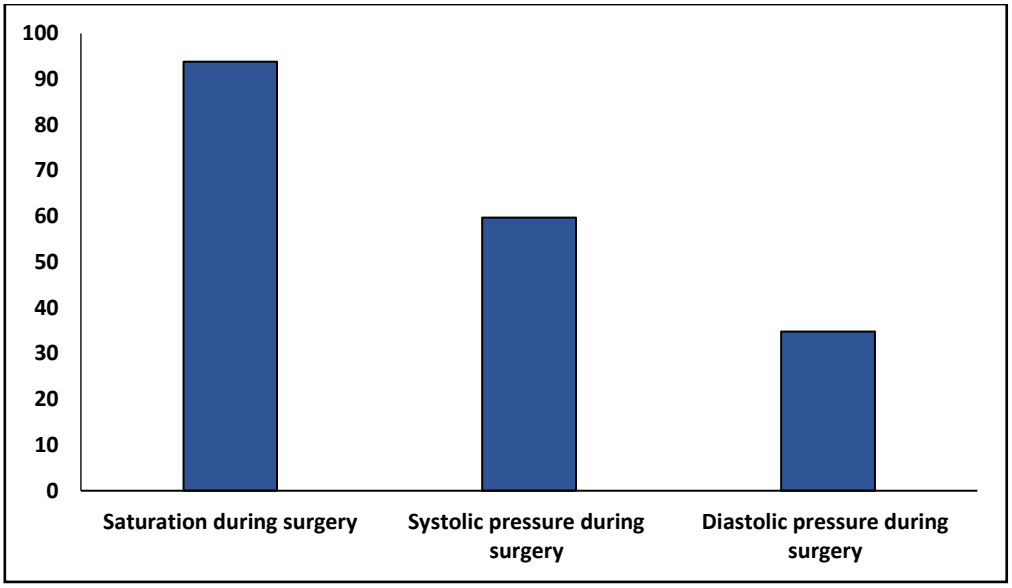

Figure (2): Distribution of operative data among the investigated group

Table (3): Distribution of Bell-Stages among the investigated groups

	Group A (<1000 g) Number=35	Group B (≥1000 g) Number=15	Test	p-value
Bell-Stage 3a	13 (37.14%)	9 (60%)	X^2=2.226	0.13
Bell-Stage 3b	22 (62.85%)	6 (40%)		

X2: chi-square

Table 3 shows that a statistically insignificant distinction has been observed among the investigated groups as regards Bell stages.

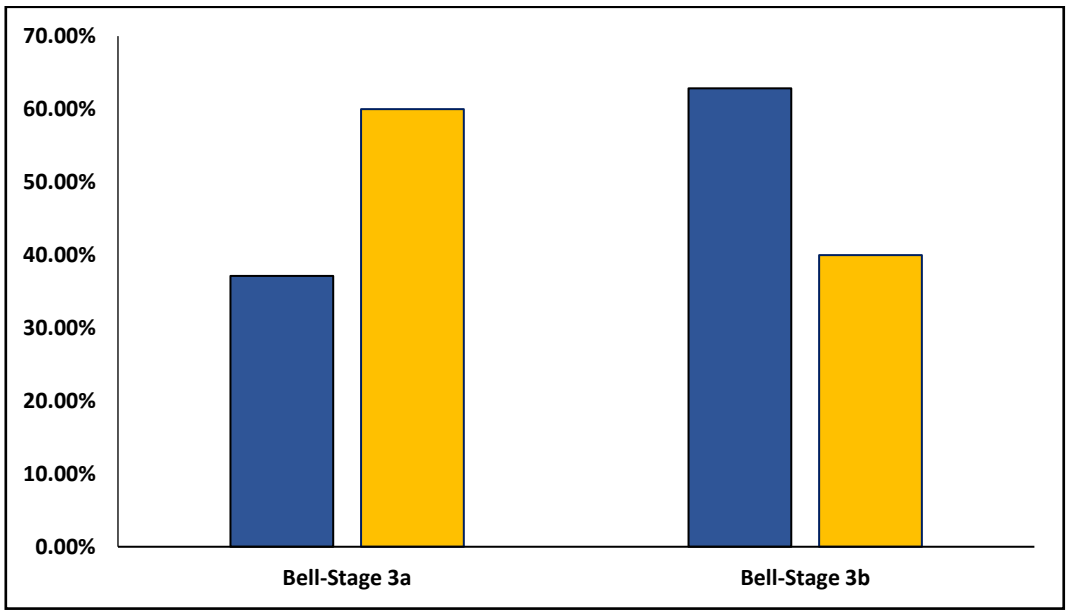

Figure (3): Distribution of Bell-Stages among the investigated groups

Table (4): Distribution of surgical procedure among the investigated groups

	Group A (<1000 g) Number=35	Group B (≥1000 g) Number=15	Test	p-value
Surgery 1	27 (77.14%)	11 (73.33%)	X^2:0.265	0.87
Surgery 2	3 (8.57%)	2 (13.33%)		
Surgery 3	5 (2.85%)	2 (13.33%)		

Surgery 1: Laparotomy + stoma formation; Surgery 2: Laparotomy + anastomosis; Surgery 3: Laparotomy (only exploration)

Table 4 shows that a statistically insignificant distinction has been observed among the investigated groups as regards surgical procedure.

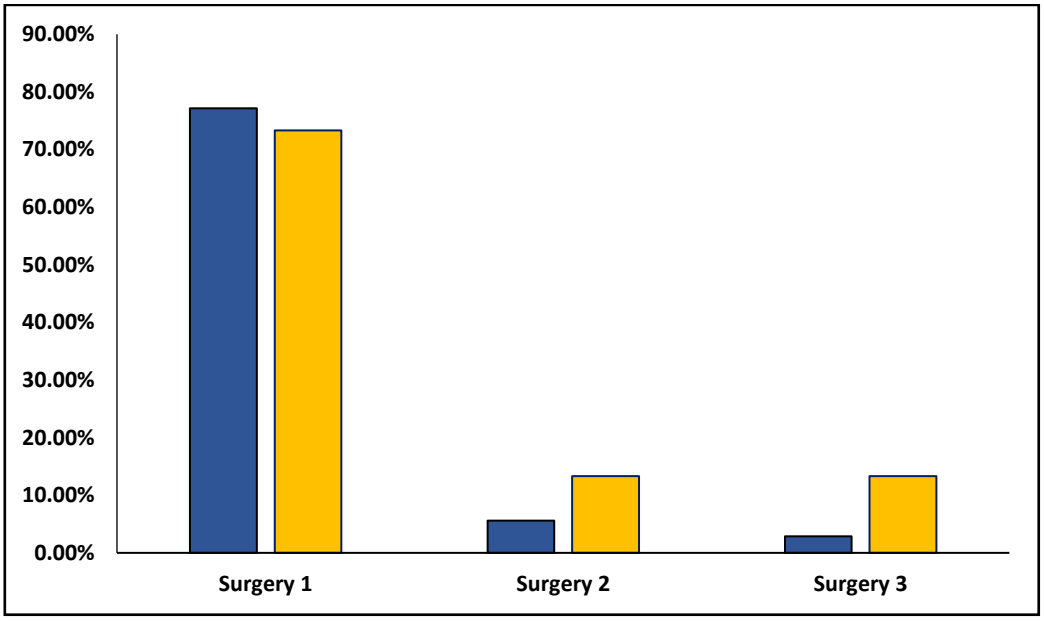

Figure (4): Distribution of surgical procedure among the investigated groups

Table (5): Distribution of outcome among the investigated groups

	Group A (<1000 g) Number=35	Group B (≥1000 g) Number=15	Test	p-value
Alive	28 (80%)	13 (86.66%)	X^2: 0.316	0.57
Died	7 (20%)	2 (13.33%)		

Table 5 shows that a statistically insignificant distinction has been observed among the investigated groups as regards outcome.

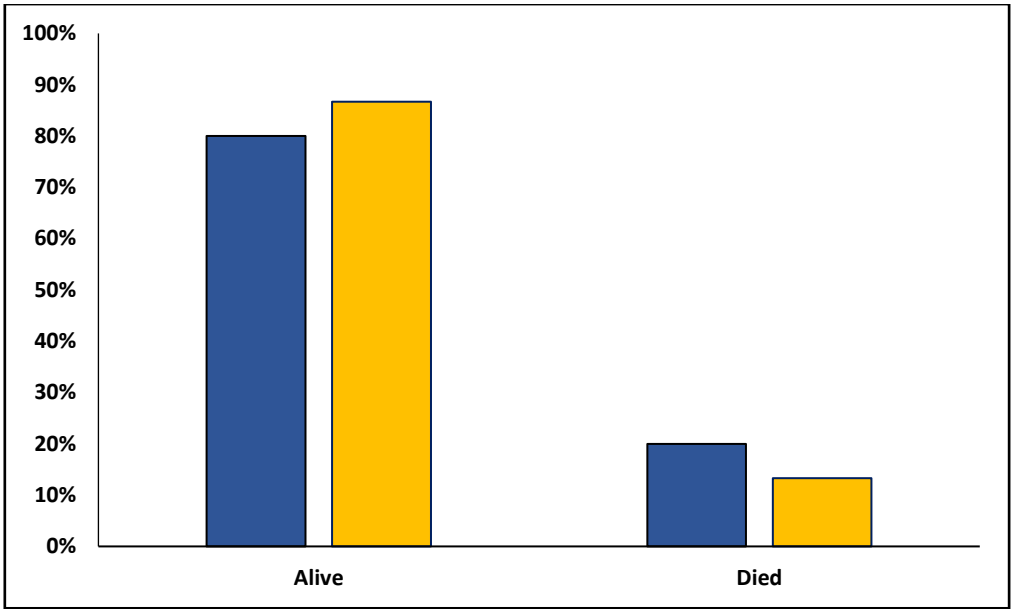

Figure (5): Distribution of outcome among the investigated groups

Discussion

Necrotizing enterocolitis (NEC) refers to the death of intestinal tissue. Primarily impacting premature infants or ill neonates, it happens when the intestinal wall's lining dies and the tissue falls off. Operation for Necrotizing enterocolitis is understandably related to an elevated death rate of thirty-five percent, escalating to fifty percent in very low birth weight infants (weighing less than 1500 grams), along with significant long-term morbidities, including intestinal failure and neurodevelopmental impairment **[13].**

Laparoscopy was initially documented as a diagnostic instrument for suspected necrotizing enterocolitis in 2004. The rate of death related to this method appeared low, with only fourteen percent of premature neonates experiencing a documented fatal result. While this low death rate can partially result from selection bias, the writers proposed that laparoscopy might serve as a diagnostic instrument that minimizes the delay among the start of digestive symptoms and surgical intervention [14-15].

Additionally, laparoscopy could trigger an anti-inflammatory response via carbon dioxide (CO2) insufflation. Experimental investigations indicate that carbon dioxide pneumoperitoneum and laparoscopy reduce local and systemic inflammatory responses in various models of peritonitis or abdominal sepsis [16-17].

Our findings showed that the mean weight of the investigated cases was 1225.26 ± 44.8 grams; 48% of cases were males, and 52% were females.

This came in concordance with Montalva et al.,[10] aim was to compare post-operative result following early laparoscopy-assisted operation and classical laparotomy for Necrotizing enterocolitis, they reported that in the Laparoscopy necrotizing enterocolitis group, the median weight of the investigated cases was 1360 gram with range (1100-1868) gram. There were 23 (48%) males.

Also, Smith et al.,[18] who aimed to review the present proof for the utilization of diagnostic and therapeutic laparoscopy in necrotizing enterocolitis, they reported that 44 infants with NCE (weighing 0.5–2.9 kg) were enrolled in their study.

In addition, Gfroerer et al.,[19] who stated that Fifty-seven infants with NEC were enrolled in their investigation, there were 39 infants with a birth weight <1,000 grams (group A) and 18 infants with a birth weight ≥1,000 g (group B). The weight at surgery was <1,000 grams in 33 cases and ≥1,000 grams in 24 cases.

Moreover, Lamireau et al., [20] who stated that, in infants with NEC, the median weight was 1245 gram, with a range of [925–1636] gram. Otherwise, there were 67 (59.3%) males.

Furthermore, Feng et al., [21] who stated that in NEC group, the mean weight of the investigated cases was 1,142.6 ± 220.30 gram. Otherwise, there were 27 (69.2%) males.

In the present investigation, our findings revealed that the mean saturation during surgery was 93.8 ± 0.6, mean Systolic pressure during surgery was 59.7 ± 2.3 and mean Diastolic pressure during surgery was 34.8 ± 1.8.

Our results matched with Gokce et al., [22] who reported that, in NEC group, the mean saturation was 94.9±1.3.

Similarly, Knudsen et al., [16] who stated that in NEC cases, the mean Saturation during surgery was 95.8 ± 0.5, the mean Systolic pressure throughout operation 57.7 ± 2.2 and the mean Diastolic pressure throughout operation was 32.8 ± 1.8.

Our current research revealed that a statistically insignificant distinction has been observed among the investigated groups as regards Bell-Stages. A statistically insignificant distinction has been observed among the investigated groups as regard surgical procedure. A statistically insignificant distinction has been observed among the investigated groups as regard outcome.

Our findings are supported by Gfroerer et al.,[19] who stated that a statistically insignificant distinction has been observed among the investigated groups as regards Bell-Stages. A statistically insignificant distinction has been observed among the investigated groups as regard surgical procedure. A statistically insignificant distinction has been observed among the investigated groups as regard outcome.

Conclusion

Regarding our results, we concluded that a statistically insignificant distinction has been observed among the investigated groups as regards Bell-Stages, surgical procedure and regarding outcome.

References

1. Neu J, Walker WA. Necrotizing enterocolitis. New England Journal of Medicine. 2011 Jan 20;364(3):255-64.
2. Pierro A. The surgical management of necrotising enterocolitis. Early human development. 2005 Jan 1;81(1):79-85.
3. Rao SC, Basani L, Simmer K, Samnakay N, Deshpande G. Peritoneal drainage versus laparotomy as initial surgical treatment for perforated necrotizing enterocolitis or spontaneous intestinal perforation in preterm low birth weight infants. Cochrane Database of Systematic Reviews. 2011(6).
4. Guner YS, Friedlich P, Wee CP, Dorey F, Camerini V, Upperman JS. State-based analysis of necrotizing enterocolitis outcomes. Journal of Surgical Research. 2009 Nov 1;157(1):21-9.
5. Rees CM, Eaton S, Pierro A. National prospective surveillance study of necrotizing enterocolitis in neonatal intensive care units. Journal of pediatric surgery. 2010 Jul 1;45(7):1391-7.
6. Hackam DJ, Sodhi CP. Bench to bedside—new insights into the pathogenesis of necrotizing enterocolitis. Nature reviews Gastroenterology & hepatology. 2022 Jul; 19(7):468-79.
7. Zouari M, Ben Ameur H, Ben Saad N, Rhaiem W, Ghariani O, Ben Hamad A, Mhiri R. Predictive factors for mortality in pre-term neonates with necrotizing enterocolitis: a retrospective cohort study. Surgical Infections. 2023 Feb 1;24(1):52-7.
8. Mishra V, Cuna A, Singh R, Schwartz DM, Chan S, Maheshwari A. Imaging for diagnosis and assessment of necrotizing enterocolitis. Newborn (Clarksville, Md.). 2022 Jan;1(1):182.
9. Gao HX, Yi B, Mao BH, Li WY, Bai X, Zhang Y, Tang JM, Liu PQ, Cheng K. Efficacy of abdominal ultrasound inspection in the diagnosis and prognosis of neonatal necrotizing enterocolitis. Clinics. 2021 Mar 26;76:e1816.
10. Montalva L, Incerti F, Qoshe L, Haffreingue A, Marsac L, Frérot A, Peycelon M, Biran V, Bonnard A. Early laparoscopic-assisted surgery is associated with decreased post-operative inflamemation and intestinal strictures in infants with necrotizing enterocolitis. Journal of Pediatric Surgery.2023Apr.1;58(4):708-14.

11. Bethell GS, Jones IH, Battersby C, Knight M, Hall NJ. Methods of identifying surgical Necrotizing Enterocolitis—a systematic review and meta-analysis. Pediatric Research. 2024 Jun 7:1-1.
12. Sola JE, Tepas III JJ, Koniaris LG. Peritoneal drainage versus laparotomy for necrotizing enterocolitis and intestinal perforation: a meta-analysis. Journal of Surgical Research. 2010 Jun 1;161(1):95-100.
13. Yang S, Wei X, Zhong Y, Guo C, Liu X, Wang Z, Tu Y. Programmed death of intestinal epithelial cells in neonatal necrotizing enterocolitis: a mini-review. Frontiers in Pediatrics. 2023 Jun 5;11: 1199878.
14. Yu L, Liu C, Du Q, Ma L. Predictive factors for surgical intervention in neonates with necrotizing enterocolitis: a retrospective study. Frontiers in Surgery. 2022 May 17; 9:889321.
15. Ietto G, Amico F, Pettinato G, Iori V, Carcano G. Laparoscopy in emergency: why not? Advantages of laparoscopy in major emergency: a review. Life. 2021 Sep 3;11(9):917.
16. Knudsen KB, Thorup J, Thymann T, Strandby R, Nerup N, Achiam MP, Lauritsen T, Svendsen LB, Buelund L, Sangild PT, Ifaoui IB. Laparoscopy to assist surgical decisions related to necrotizing enterocolitis in preterm neonates. Journal of Laparoendoscopic & Advanced Surgical Techniques. 2020 Jan 1; 30(1):64-9.
17. Wang D, Zhang F, Pan J, Yuan T, Jin X. Influencing factors for surgical treatment in neonatal necrotizing enterocolitis: a systematic review and meta-analysis. BMC pediatrics. 2024 Aug 9;24(1):512.
18. Smith J, Thyoka M. What role does laparoscopy play in the diagnosis and immediate treatment of infants with necrotizing enterocolitis?. Journal of Laparoendoscopic & Advanced Surgical Techniques. 2013 Apr 1;23(4):397-401.
19. Gfroerer S, Fiegel H, Schloesser RL, Rolle U. Primary laparotomy is effective and safe in the treatment of necrotizing enterocolitis. World journal of surgery. 2014 Oct;38: 2730-4.
20. Lamireau N, Greiner E, Hascoët JM. Risk factors associated with necrotizing enterocolitis in preterm infants: a case–control study. Archives de Pédiatrie. 2023 Oct 1;30(7):477-82.
21. Feng B, Zhang Z, Wei Q, Mo Y, Luo M, Jing L, Li Y. A prediction model for neonatal necrotizing enterocolitis in preterm and very low birth weight infants. Frontiers in Pediatrics. 2023 Oct 18;11: 1242978.
22. Gokce IK, Oguz SS. Can high average oxygen saturation be a risk factor for necrotizing enterocolitis in VLBW infants?. International Journal of Preventive Medicine. 2019 Jan 1;10(1):196.