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Neonatal Gastrointestinal Perforations: A 7-year Experience in a Single Centre

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ABSTRACT

Background: Neonatal gastrointestinal perforation presents important challenges to the management. It is is still a significant problem despite improved neonatal care and contributes to high mortality. The aim of this study was to present our experiences with, as well as the factors that affect the management and outcome of patients with neonatal gastrointestinal perforations.

Material and Methods: Records of neonates with GIPs between February 2016 and August 2023 were retrospectively analyzed. Fifty-seven newborn cases that were operated on for gastrointestinal perforation in our hospital's tertiary newborn intensive care unit were evaluated. The patients were divided into the two following groups: group 1, perforations related to necrotizing enterocolitis (NEC), and group 2, non-NEC perforations.

Results: In total, 57 neonates (26 males, 31 females) participated in this study. The perforations were related to NEC in 18 patients (group 1; 31.6 %), and the other 39 patients (group 2; 68.4 %) were classified as non-NEC perforation cases. The incidence of neonatal GIP was 0.43 % in all newborn patients, while the incidence of perforation in NEC cases was 16 %. Of all patients, 36 (63.2 %) were premature. Non-NEC pathologies were the most common cause of GIP (68.4 %) and included gastric perforation (n = 3), band and segmental volvulus (n = 7), intestinal atresia (n = 4), esophageal atresia and tracheoesophageal fistula (n = 2), Hirschsprung's disease (n = 14), appendicitis (n = 2), incarcerated inguinal hernia (n = 2), meconium peritonitis (*n* = 3) and idiopathic causes (n = 2). Primary surgical repair was performed in all cases without a conservative approach. The mortality rate related to GIP in newborn cases was 45.6 % (n = 26). The mortality rate in group 1 was 55.6 % (n = 10), as compared to group 2 (43.5 %, n = 17) ($p < 0.05$). In group 1, among the 10 newborn mortalities, 7 newborns had intestinal perforations (gastric and jejuno-ileal) while rest 3 newborns had colorectal perforations.

Conclusion : GIPs are one of the most significant causes of mortality in newborns. The most common cause of perforations is non-NEC entities and can be seen in the entire intestinal system from the stomach to the colon. Surgical exploration is still the primary management.

Keywords: *Gastrointestinal perforation, Necrotizing enterocolitis, Mortality, Neonate, Etiology*

1. INTRODUCTION

Gastrointestinal perforation and subsequent peritonitis are a major surgical problem in pediatric surgery, especially in the neonatal period. Neonatal gastrointestinal perforations presently have high mortality rates (40–70 %) [1]. Despite advancements in mechanical ventilation, Intensive care management, antibiotics support and anesthesia, morbidity and mortality rates associated with gastrointestinal perforations are still high [2]. Gastrointestinal perforations occurs in wide age group range but particularly commoner with poor outcome premature and low-birth-weight infants as compared to healthy term infants [3].

The etiology of GIP includes immaturity, enteral nutrition, hypoxia, ischemia, inflammation, drugs and maternal causes [4-7]. The most frequent causes of GIP include necrotizing enterocolitis (NEC), sepsis, intestinal obstructions, iatrogenic traumas due to irrigation of nasogastric or rectal catheters, Hirschsprung's disease and spontaneous intestinal perforation (SIP). The frequency of GIP increases as the patient's birth weight and week of birth decrease. However, depending on the underlying cause, it can be seen in any segment of the gastrointestinal (GI) tract from the stomach to the rectum. The aim of this study was to present our experiences with, as well as the factors that affect the management and outcome of patients with neonatal gastrointestinal perforations.

2. MATERIAL AND METHODS

A retrospective analysis of patient files and operative logs was done for all patients diagnosed with GIP admitted to the NICU between February 2016 and August 2023. The patients' demographic data (age, gender and weight), underlying disease, surgery indications, surgery timing, surgical technique, outcome, complications and mortality rates were evaluated. The diagnosis of GIP was based on history, findings on physical examination, and radiological evidence of free air in the abdomen. Diagnosis of GIP based on clinical and radiological findings was confirmed intraoperatively. Similarly, diagnosis of NEC was also based on clinical and radiological findings in consideration of the modified Bell criteria [8]. The cases were divided into two groups as follows: group 1, GIP related to NEC, and group 2, GIP unrelated to NEC. Approval from the Ethics Committee of our hospital was obtained for this study. Data were analyzed using SPSS for Windows software (version 22; SPSS Inc., Chicago, IL, USA). Parametric tests were applied to data with a normal distribution, and non-parametric tests were applied to non-normally distributed data. The distribution of categorical variables in both groups was compared using the Pearson's chi-squared test. Data are expressed as the mean ± standard deviation (SD) or the median as appropriate. A p value <0.05 was considered statistically significant.

3. RESULTS

In total, 57 neonates (26 males, 31 females) participated in this study. The perforations were related to NEC in 18 patients (group 1; 31.6 %), and the other 39 patients (group 2; 68.4 %) were classified as non-NEC perforation cases. The incidence of neonatal GIP was 0.43 % in all newborn patients, while the incidence of perforation in NEC cases was 16 %. The median gestational age was 33 ± 2.3 weeks (range 27–38 weeks), and the median body weight was 1980 ± 47 g (range 990–3000 g). The average birth weight was 1.583 ± 550 g in group 1 and 1.940 ± 422 g in group 2; the difference was significant ($p < 0.05$). The median gestational age was 31.4 ± 3.4 weeks in group 1 and 35.2 ± 2.6 weeks in group 2; the difference was not significant ($p > 0.05$). Of all patients, 36 (63.2 %) were premature. The median postnatal age at the time of surgery was 6.56 ± 4.2 days (range 1–30 days). Complete blood count, biochemistry tests, C-reactive protein and blood gas values were studied preoperatively, and blood culture was taken from all patients. Laboratory test results are given in **Table.1**. Blood culture was negative on 39 (68.4%) patients. Gram-positive bacteria growth was detected in eight patients, Gram-negative bacteria in seven, and fungus in three. It has also been observed that 42 (73.6)% patients had low TLC counts, and 31 (54.3%) patients developed severe metabolic Acidosis (pH<7.25).

Table.1 Laboratory test parameters of patients with gastrointestinal perforation

Laboratory parameters	Mean +/- S.D
Hemoglobin (g/dl)	12.2 +/- 3.8

WBC count ($X10^3$/uL)	13.7 +/- 7.8
Platelets count ($X10^3$/uL)	131.5 +/- 97.8
Metabolic Acidosis	7.25 +/- 1.22
C-reactive protein (mg/L)	48.7 +/- 46.2

The perforations were related to NEC in 18 patients (group 1; 31.6 %), and the other 39 patients (group 2; 68.4 %) were classified as non-NEC perforation cases. Perforations were observed in the small intestine (n = 36), the stomach (n = 3), the colon (n = 16), and the appendix (n = 2). Non-NEC pathologies were the most common cause of GIP (68.4 %) and included gastric perforation (n = 3), band and segmental volvulus (n = 7), intestinal atresia (n = 4), esophageal atresia and tracheoesophageal fistula (n = 2), Hirschsprung's disease (n = 14), appendicitis (n = 2), incarcerated inguinal hernia (n = 2), meconium peritonitis (*n* = 3) and idiopathic causes (n = 2) **Table.2.**

Table.2 non-NEC pathologies contributing to gastro-intestinal perforations

Non-NEC pathologies constituting 68.4 % of GIP (n = 39)	
gastric perforation	3
band and segmental volvulus	7
intestinal atresia	4
esophageal atresia and tracheoesophageal fistula	2
Hirschsprung's disease	14
appendicitis	2
incarcerated inguinal hernia	2
meconium peritonitis	3
idiopathic causes	2

Primary surgical repair was performed in all cases without a conservative approach. The mortality rate related to GIP in newborn cases was 45.6 % (n = 26). 73.1% (n = 19) of the preterm neonates, and only 26.9% (n = 7) of the full-term neonates

died (p <0.05). The overall mortality rate in group 1 was 55.6 % (n = 10) which is comparatively higher as compared to group 2 (43.5 %, n = 17) and the difference was statistically significant (p < 0.05). 7 out of 10 newborn who died in group 1 were preterm, while 11 out of 17 newborns who died in group 2 were preterm. In group 1, among the 10 newborn mortalities, 7 newborns had intestinal perforations (gastric and jejuno-ileal) while rest 3 newborns had colorectal perforations while in group 2, 13 newborns had intestinal perforations (gastric and jejuno-ileal) while rest 4 newborns had colorectal perforations and the difference was statistically significant (p < 0.05) **Table.3**.

Table.3 Comparison of Mortality statistics among patients in both groups

Overall Mortality (n = 26, 45.6%)		Preterm	Term	p-value
		73.1% (n = 19)	26.9% (n = 7)	< 0.05
	Group-1	Group-2	p-value	
Mortality	55.6 % (n = 10)	43.5 %, n = 17	< 0.05	
Intestinal perforations (gastric and jejuno-ileal)	n = 7	n = 13	< 0.05	
Colorectal perforations	n = 3	n = 4		

Birth weights and gestational ages of the deceased patients with NEC were lower than those of the patients who survived. Non-NEC pathologies are the most frequent causes of GIP in newborns, and primary surgical repair is the primary treatment choice for neonatal GIP. However, GIP remains one of the most significant causes of mortality in newborns. While the prognosis for neonatal colon perforation is good, that for stomach and jejuno-ileal perforations is worse.

4. DISCUSSION

with the advances of neonatal intensive care management, the number of premature and LBW patients who are treated is increasing day by day [8,9,10]. Secondary to this increase, the incidence of GI system-related diseases frequently encountered in this patient group is also increasing. GIPs are a serious complication of digestive system diseases, and their mortality is quite high [11].

The prognosis of neonatal GIP is dependent on the underlying pathology, the presence of associated anomalies, the preoperative and postoperative levels of health care, the degree of prematurity, and the birth weight. In a previous study, the mortality rate ranged from 30 to 50 % [3]. Overall, in this study, the mortality rate for all cases of perforation was 45.6%%. It was previously reported that the incidence of perforation was nearly 20 % among NEC patients [12]. In our study the incidence of perforation in NEC cases was 31.6 %. Moreover, the mortality rate reported in the literature for NEC patients with perforations was 50 % [1], while that in our study was high, at 55.6 %. In our series, all patients who died due to NEC-related perforations were premature and/or were low birth-weight infants. 70% of newborn who died in group 1 were preterm.

If we see the previous reports worldwide, the incidence of NEC related perforations is higher than that of non-NEC causes related perforations [13]. Contrary to the literature, in our study, NEC related perforations constituted 31.6 % of all perforations. We attributed this phenomenon to the fully equipped tertiary level NICU of our hospital, as well as to advancements in health care services.

Similar to the literature, the incidence of prematurity in cases with NEC-related perforations was higher than that in cases with non-NEC-related perforations in our study [14,15,16], and mortality rates were higher in patients with NEC related perforations compared with patients with non-NEC related perforations. The median gestational age was 31.4 ± 3.4 weeks in group 1 and 35.2 ± 2.6 weeks in group 2; though the difference was not significant (p > 0.05), 70% newborn who died in group 1 were preterm, while 64.7% newborns who died in group 2 were preterm. Birth weights and gestational ages of the deceased patients with NEC were lower than those of the patients who survived.

Although there is no clear consensus in the literature on the effect of bowel perforation sites on mortality, publications suggest that colon perforation has higher mortality [14,17]. Hakan et al.[3] reported average mortality rates of 30.7 and 22

% for intestinal and colonic perforations, respectively. In this series, the mortality of patients with colon perforation was 26% (7/27), Gastric & jejunoileal perforations was 74% (20/27). Mortality was found to be higher in Intestinal perforations as compared to colonic perforation.

Abdominal distension (92.3%), low TLC count (73.6%), Metabolic acidosis (54.3%) were among the common presenting symptoms with gastro-intestinal perforation. Other studies like byun et.al [18] also featured similar findings. Among the risk factors we investigated, gestational age, birth weight, low TLC count and metabolic acidosis found to be important prognostic factors in terms of overall mortality in newborns with gastro-intestinal perforation.

5. CONCLUSION

Although significant advances have been made in newborn intensive care and surgical treatment in the last few decades, neonatal gastro-intestinal perforation continues to be associated with significant mortality in newborns. In this study, we have observed that multiple factors play a role in the etiology of neonatal GIP, and causes unrelated to NEC are frequently observed. As the risk inherent to laparotomy in neonates is decreasing, other factors, such as the underlying etiology or the site of perforation, play a more important prognostic role. Gastric and intestinal perforations found to be associated with high mortality rates, while prognosis of colonic perforations is relatively more favorable. Surgical exploration is still the primary management.

Compliance with Ethical Standards

Informed Consent

Formal and written informed consents were obtained from parents.

Conflict of Interest

The authors declare that they have no conflict of interest

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