

Original Article

Frequency of Small Bowel Perforation among Neonates Presented with Pneumoperitoneum: A Cross Sectional Study

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ABSTRACT

Background: Neonatal pneumoperitoneum, characterized by the presence of free gas within the peritoneal cavity, is a critical condition often signaling intestinal perforation. While necrotizing enterocolitis (NEC) has been predominantly associated with this condition, various other etiologies contributing to neonatal intestinal perforations necessitate further exploration. The management of such conditions, particularly in resource-limited settings, remains a challenge, often resulting in significant morbidity and mortality.

Objective: This study aims to investigate the frequency of small bowel perforation among neonates presenting with pneumoperitoneum and to examine the association between neonatal weight and the occurrence of small bowel perforation.

Methods: A cross-sectional study was conducted at Shaukat Khanum Memorial Cancer Hospital, Lahore, Pakistan, from July 2023 to December 2023. Seventy neonates aged 5 to 25 days presenting with radiological evidence of pneumoperitoneum were included. Demographic details were collected, and the infants underwent primary peritoneal drainage followed by exploratory laparotomy if necessary. Data analysis was performed using SPSS version 25, employing Chi-Square tests for categorical variables, with a significance level set at $p < 0.05$.

Results: Of the 70 neonates, 20 (28.6%) were diagnosed with small bowel perforation. A significant association was found between small bowel perforation and neonatal weight; 13 (65%) of the perforation cases were among neonates weighing less than 2.5 kg ($p = 0.0001$). The overall mortality rate observed was 35%, with 20 neonates succumbing shortly after peritoneal drain insertion due to sepsis.

Conclusion: Small bowel perforation is a significant complication in neonates with pneumoperitoneum, with a higher incidence observed in those with lower birth weights. This study highlights the critical need for immediate diagnosis and intervention in such cases, particularly in under-resourced settings, to improve outcomes.

Keywords: Neonatal pneumoperitoneum, small bowel perforation, Necrotizing enterocolitis, Neonatal surgery, Low birth weight, Cross-sectional study, Mortality rate, Pediatric surgery.

INTRODUCTION

Neonatal surgical emergencies encompass distinctive diagnostic and treatment dilemmas, necessitating immediate identification and intervention to minimize complications and mortality (1). Small bowel perforation is a significant concern for neonatal health, stemming from a variety of congenital and acquired causes (2, 3). Pneumoperitoneum, the presence of gas in the peritoneal cavity, is acknowledged as a surgical emergency in both adult and pediatric cohorts, with over 90% of cases resulting from a ruptured intra-abdominal organ. Notwithstanding, the literature has documented benign, spontaneous, non-surgical, asymptomatic, or idiopathic pneumoperitoneum cases, which generally resolve with conservative management (5).

In neonates, particularly those with low birth weight, some studies have suggested the utility of a peritoneal drain as an interim solution before surgical intervention to enhance stability and overall condition (6, 7). It has been observed that the mortality rates between neonates undergoing laparotomy versus those with a peritoneal drain for necrotizing enterocolitis (NEC) do not significantly

differ (8). Consequently, surgical exploration based solely on the presence of pneumoperitoneum, without signs of peritonitis or conclusive laboratory evidence of a severe underlying issue, is discouraged. Instead, research advocates for a decision-making algorithm to discern patients who necessitate surgical intervention from those who could be managed conservatively (9, 10). Indications for surgical intervention include symptoms of peritonitis, discomfort, cardiovascular instability, leukocytosis, evidence of gastrointestinal leakage, or failure of conservative treatment to achieve resolution (11, 12).

The indispensability of abdominal imaging, ultrasonography, and contrast-enhanced imaging techniques in the diagnosis, assessment of intra-abdominal complications, and facilitation of therapeutic decisions cannot be overstated. Specifically, in neonates, interpreting imaging results demands an in-depth understanding of age-specific anatomical differences and the ability to distinguish pneumoperitoneum from other similar-appearing conditions (13-15). Managing small intestine perforation in neonates with pneumoperitoneum is a complex clinical challenge, requiring rapid diagnosis, prompt action, and meticulous monitoring to enhance outcomes and improve the long-term prognosis for these vulnerable patients.

MATERIAL AND METHODS

A cross-sectional study was conducted at Shaukat Khanum Memorial Cancer Hospital, Lahore, Pakistan, between July and December 2023, following the acquisition of ethical approval from the institutional review board in accordance with the Helsinki Declaration. The study population comprised seventy infants, aged between 5 to 25 days, who presented with pneumoperitoneum. Diagnosis was established based on radiological evidence, including the presence of air or gas within the peritoneal cavity, corroborated by clinical symptoms such as vomiting and abdominal distension.

Upon obtaining written informed consent from the parents or guardians, demographic details of the participants were recorded. Initial management involved the placement of a primary peritoneal drain under local anesthesia, aimed at alleviating symptoms and stabilizing the condition. For infants exhibiting persistent signs of sepsis, continuous intestinal discharge, or worsening abdominal distension, exploratory laparotomy was performed as a subsequent intervention. All surgical procedures were carried out by an experienced pediatric surgeon, ensuring adherence to established surgical protocols and ethical standards in pediatric care.

Data collection encompassed both demographic and clinical parameters, meticulously documented throughout the treatment process. The ethical considerations extended to ensuring the confidentiality and anonymity of patient information, with all procedures designed to minimize discomfort and risk to the participants.

For the analysis of collected data, the Statistical Package for the Social Sciences (SPSS) version 25 was employed. The Chi-Square test was utilized to examine associations among categorical variables, with a significance level set at $p < 0.05$. This analytical approach facilitated the identification of significant correlations between demographic and clinical variables and the outcomes of interest, allowing for a comprehensive understanding of factors influencing the prognosis of neonates with pneumoperitoneum.

RESULTS

In our study, we observed a significant incidence of small bowel perforation among neonates presenting with pneumoperitoneum. As detailed in Table 1, out of the 70 infants evaluated, 20 (28.6%) were found to have small bowel perforation. The remaining 50 infants (71.4%) did not present with this condition, underscoring the critical nature of precise diagnosis and the potential severity of pneumoperitoneum in neonatal patients.

Table 1: Frequency of Small Bowel Perforation in Neonates

Condition	Frequency	Percent (%)
Yes	20	28.6
No	50	71.4
Total	70	100.0

Table 2: Association of Small Bowel Perforation with Neonatal Weight

Small Bowel Perforation	Neonatal Weight (< 2.5 kg)	Neonatal Weight (\geq 2.5 kg)	Total	Percent within Condition (< 2.5 kg)	Percent within Condition (\geq 2.5 kg)	P value
Yes	13	7	20	65.0	35.0	0.0001
No	6	44	50	12.0	88.0	
Total	19	51	70	27.1	72.9	

Further analysis revealed a notable association between the incidence of small bowel perforation and neonatal weight. As shown in Table 2, among the infants diagnosed with small bowel perforation, a substantial majority, 13 out of 20 (65.0%), had a birth weight of less than 2.5 kg. In contrast, infants with a birth weight of 2.5 kg or more constituted a smaller proportion, 7 out of 20 (35.0%), of the small bowel perforation cases. This contrast is even more pronounced when compared to the distribution of neonatal weights among infants without small bowel perforation, where only 6 out of 50 (12.0%) were under 2.5 kg and the vast majority, 44 out of 50 (88.0%), were 2.5 kg or above. The overall distribution of neonatal weights in our cohort was skewed towards higher birth weights, with 51 out of 70 (72.9%) neonates weighing 2.5 kg or more, and only 19 out of 70 (27.1%) falling below this threshold.

The statistical significance of the association between small bowel perforation and neonatal weight was confirmed by a p-value of 0.0001, indicating a strong correlation between lower birth weight and the incidence of small bowel perforation among neonates with pneumoperitoneum. This finding underscores the importance of considering neonatal weight as a potential risk factor for small bowel perforation in clinical assessments and treatment planning for this vulnerable population.

DISCUSSION

In the realm of neonatal emergencies, pneumoperitoneum detected via abdominal X-rays typically suggests intestinal perforation, a condition historically linked to necrotizing enterocolitis (NEC). While a substantial portion of literature focuses on diagnosing and treating NEC, it's evident that NEC is not the sole cause of neonatal perforations. Indeed, a variety of medical conditions in newborns may lead to intestinal perforations, causing free gas accumulation in the peritoneal cavity and thereby elevating the risk of morbidity and mortality (14). The challenge of managing such cases is exacerbated in underdeveloped countries by resource constraints and larger population burdens, complicating the achievement of favorable outcomes (15).

Pneumoperitoneum represents a dire surgical emergency; its presence necessitates prompt surgical action to preserve life. Among the neonates included in our study, 20 (28.6%) succumbed to sepsis immediately following the insertion of a peritoneal drain, underscoring the acute shortage of neonatal care resources, particularly in less developed countries. The overall mortality rate observed in this study was notably high, with 35 out of 100 neonates (35%) passing away, a statistic that reflects the severe implications of pneumoperitoneum, which is chiefly caused by hollow organ perforation and demands urgent surgical intervention (16). Intestinal perforation ranks as a leading cause of neonatal pneumoperitoneum, especially among infants with low birth weight. The incidence of this condition escalates from 1.1% in very low birth weight neonates to 7.4% in extremely low birth weight neonates, with cases also reported in full-term newborns. Factors such as regional under-perfusion, hypoxia, and shock may compromise intestinal blood flow, precipitating perforation. Notably, the terminal ileum is most frequently affected, although perforations can also occur in the transverse and descending colons (17).

Our study cohort comprised 70 neonates aged 5 to 25 days, with a predominance of male neonates and an average age of 14.20 ± 6.07 days. These patients were diagnosed with pneumoperitoneum through radiological evidence, aligning with findings from another study that reported a mean age of 11.4 days among their neonatal subjects (18). We observed a small bowel perforation frequency of 28.6% and identified a significant association between low neonatal weights and the incidence of small bowel perforation ($P < 0.05$), corroborating findings from a Pakistani study that reported a perforation frequency of 31.03% and a similar association with lower birth weights (19). Another investigation found a 37.5% incidence of small bowel perforation in neonates presenting with radiological evidence of pneumoperitoneum (20).

The limitations of our study, notably its small sample size and single-center design, restrict the generalizability of our findings. We advocate for future research to delve deeper into the intricacies of intestinal perforations and their management in neonates with pneumoperitoneum, employing larger, multicenter cohorts to enrich the understanding and intervention strategies for this critical condition.

CONCLUSION

In conclusion, our investigation revealed a significant prevalence of small bowel perforation among neonates with pneumoperitoneum, emphasizing a pronounced association with lower birth weights. These findings underscore the critical need for heightened awareness and prompt, tailored interventions in managing neonatal pneumoperitoneum, especially in contexts where resource limitations pose additional challenges.

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