

Original Article

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Gastric perforation in neonates: Our experience

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ABSTRACT

Background: Neonatal gastric perforation (NGP) is a life-threatening condition with a high mortality rate. It accounts for 7% of all gastrointestinal tract (GIT) perforations. The number of NGP cases has been increasing due to the rise in premature and low birth weight neonates. In this study, we present our experience with gastric perforation in neonates.

Methods: This retrospective study analyzed all cases of gastric perforation in neonates that were treated at Loma Linda University Medical Center's Neonatal Intensive Care Unit (NICU) between the years 2000 and 2023. The study looked at several variables including patient demographics, birth weight, age at admission and surgery, comorbidities, use of non-steroidal anti-inflammatory drugs (NSAIDs) and steroids, and mortality rate.

Results: We treated 15 patients with neonatal gastric perforation (NGP) during the study tenure. The median age at admission was 2 days, with 67% admitted within that timeframe. Surgery occurred at a median age of 5.5 days, and the median birth weight was 2.075 kg, with 26.67% below 1 kg. Males comprised 67%, and 60% had patent ductus arteriosus. Steroids were given to 46.66%, and 30-day mortality was 26.67%, with higher rates among males. Idiopathic cases were common, with notable etiologies including ischemia, necrosis, and congenital anomalies. Primary surgical repair was the main modality, and perforations occurred at various locations. Two cases had necrotizing enterocolitis. Six patients had favorable outcomes, while others experienced mild to moderate complications.

Conclusion: Our research supports the idea that males have a worse outcome in terms of both prevalence and survival rates in neonatal gastric perforation (NGP) patients. However, our findings did not confirm the notion that NGP mortality risk is higher in neonates with low birth weight. We also discovered that the median time between admission and surgery in our study group was 1.5 days, emphasizing the importance of early detection of NGP in neonates. Early diagnosis can lead to better decision-making regarding treatment options and surgical intervention.

INTRODUCTION

Neonatal gastric perforation (NGP) poses a life-threatening risk, occurring at a rate of 1 in every 2,900 live births, representing 7% of all gastrointestinal tract perforations in newborns.[1-5] The incidence of NGP has risen with the increase in premature and low birth weight neonates. While mortality rates can be as high as 70%, there has been a tenfold decrease from the 1980s to the 2010s, likely due to improved neonatal intensive care. Despite its severe impact, the etiological bases and pathophysiological trajectory of NGP remain poorly understood.[5-7] This study aims to share our institutional experience with NGP, shedding light on

etiological characteristics, prognostic factors, and successful approaches for determining appropriate treatment methodologies in addressing surgical aspects of the condition.

METHODS

This case series received approval from the Loma Linda University Institutional Review Board (IRB No. 5230177). A retrospective analysis was conducted on all neonatal patients who underwent treatment for gastric perforation at Loma Linda University Medical Center's Neonatal Intensive Care Unit (NICU) between 2000 and 2023. The study evaluated several variables, including patient demographics, birth

weight, age at admission and surgery, comorbidities, use of non-steroidal anti-inflammatory drugs (NSAIDs) or steroids, and mortality rate

RESULTS

We had 15 patients who were admitted to our neonatal intensive care unit between 2000 and 2023 and diagnosed with NGP. The median age of admission was 2 days, with 10 (67%) patients admitted within or before 2 days of their birth. The median age for surgery was 5.5 days. The median birth weight was 2.075 kg, and 4 (26.67%) patients had a birth weight of less than 1 kg. Most of the patients were male, with 10 (67%) males and 5 (33%) females in the group. The patients' gestational age at admission ranged from 0-8 days. The demographic breakdown in our group was as follows: Hispanic - 7 (47%) patients, African American - 2 (13%) patients, White - 5 (33%) patients, and Other - 1 (7%) patient.

Out of the 15 patients studied, 9 patients (60%) had patent ductus arteriosus. During treatment, 7 patients (46.66%) were given steroids, while only 1 patient (6.67%) received a combination of steroids and NSAIDs. Only 1 patient (6.67%) had intrauterine growth restriction.

Primary surgical repair was the most common surgical approach used for patients with gastrointestinal perforation. The site of perforation was identified as follows: 5 cases involved greater curvature, 5 cases involved lesser curvature, and 1 case involved the fundus. In terms of other associated conditions and concurrent gastrointestinal perforations, 2 cases presented with NEC, 1 case had two segments of necrotic small bowel, and another case had a perforation located 10 cm proximal to the cecum.

Six patients in our group recovered well, others had mild to moderate outcomes, including feeding difficulties, esophageal reflux disease, mild malnutrition, and cardiorespiratory failure. Unfortunately, 4 patients (26.67%) passed away within 30 days. Among them, 3 were males (75%), and 1 was a female (25%). Several factors contributed to the 30-day mortality rate, including acute respiratory failure, intraventricular hemorrhage (IVH), gastrointestinal bleeding with possible disseminated intravascular coagulation (DIC), and septic shock. While the etiology of the majority of cases was idiopathic, notable etiologies included ischemia and necrosis, overventilation, congenital diaphragmatic hernia, and gastroschisis.

DISCUSSION

Neonatal gastric perforation is a serious condition that can have devastating consequences, including high rates of morbidity and mortality. However, despite extensive research, the causes and

pathophysiology of this condition are not well understood. Various theories have been proposed to explain the initial stages of the disease in newborns. [7-12]

One pioneering theory by Herbut et al. attributes NGP to congenital muscular abnormalities of the stomach, suggesting that improperly formed circular layers during development result in musculature defects, driving the evolution of the disorder. [13] Another theory proposed by Cushing et al. explores neurogenic mechanisms, linking aberrations in patients with central nervous system pathologies to gastric erosion, ulcers, and perforation. [14]

Russel's meconium plug theory posits increased hydrostatic pressure during delivery, causing specific areas of the gastrointestinal tract to rupture. [15] Miller et al. propose excessive acid production as a local etiologic factor, noting adult-level gastric acidity in observed infants, especially at 24 hours after birth. [16]

Idiopathic causes, accounting for up to 47% of NGP cases, include mechanical ventilation, esophageal intubation, and NSAID use, with worse prognoses in premature infants. [7, 10]

One of the important risk factors that may increase the probability of gastric perforation in neonates is the positive pressure respiratory support. This factor is becoming even more crucial in the scope of premature infants, specifically those with respiratory distress syndrome. It has been shown that the implementation of ventilators with leak compensation and high pressure in non-invasive mechanical ventilation (NIMV) mode correlates with an increased number of NGP cases. [17] The usage of bag-mask ventilation for neonatal resuscitation is another component of this concept that may lead to perforation. Delivering positive pressure ventilation plays a central role in neonatal resuscitation algorithm [18], and can represent a crucial risk factor, specifically in infants with respiratory distress syndrome.

Considering the devastating consequences of the disease for children's development for those patients that survive the diseases, and even more importantly the potential death threats that certain factors possess it is very important to address the question of mortality risks and to inscribe prognostic factors of NGP to ensure that correct and appropriate decisions are made in establishing the treatment paradigm, specifically during critical periods of the disease. It has been shown that patients with sepsis, shock, thrombocytopenia, hyponatremia, leukopenia or leukocytosis, serum lactic acid >2.5 mmol/L, and sclerema neonatorum had poor prognosis and higher mortality risks. [19]

Our findings support the previously reported trend in the medical literature that suggests that male neonates have a poorer prognosis and survival rate.

[5, 6] In our study, 10 out of 15 patients (67%) were male, and the 30-day mortality rate among them was 75% (3 patients).

Table 1: Summary of reported cases of gastric perforation in neonates

	Year	Cases	Male: Female	Weight (Kg)	Age (days)	Term: pre-term	Perforation site (greater curvature: lesser curvature: anterior wall: posterior wall)	Mortality
Kiesewetter et al. (15).	1956	4	3:1	N/A	N/A	4:0	2:1:0:0	100%
Linker et al. (21)	1959	13	4:9	2.26±0.4	3.79	5:8	3:4:3:1	53.8%
Wilson et al. (22)	1968	2	0:2	2.17±2.6	3.50	1:1	1:1:0:0	100%
Shashikumar et al. (23)	1975	19	9:10	2.48±0.68	3.32	14:5	14:1:0:1	42.1%
Jones et al. (24)	1980	4	3:1	1.32±0.19	1.0	0:4	0:4:0:0	75.0%
Houck et al. (25)	1981	3	1:2	1.70	4.0	2:1	1:0:2:0	100%
Holgersen et al. (8)	1981	28	16:12	N/A	N/A	12:16	26::2:0:0	32.1%
Rosser et al. (26)	1982	15	13:2	N/A	3.0	9:6	15:0:0:0	7.5%
Chung et al. (27)	1994	12	9:3	2.99±0.57	N/A	8:4	10:1:0:1	58.3%
Leone et al. (28)	2000	7	3:4	1.94±1.0	7.71	3:4	5:2:0:0	57.1%
Jawad et al. (29)	2002	5	2:3	1.83±0.69	6.4	0:5	0:0:4:0	100%
Duran et al. (1)	2007	5	3:2	1.65±1.01	10.4	2:3	2:2:0:1	60%
Lin et al. (5)	2008	15	12:9	2.98±0.5	3.40	9:6	8:0:5:2	46.7%
Terui et al. (4)	2012	11	N/A	2.63±0.49	3.6	9:2	N/A	36.4
Byun et al. (6)	2014	9	5:4	2.76±1.0	2.56	6:3	4:2:1:2	22.2%
Sato et al. (9)	2017	42	26:16	1.88±0.89	N/A	12:16	N/A	14.3%
Chen et al. (30)	2018	2	2:0	2.79±0.76	3.0	1:1	0:0:2:0	0%
Cardiel-Marmolejo et al. (31)	2018	1	1:0	1.88	0	0:1	0:1:0:0	100%
Yang et al. (32)	2018	88	52:16	2.50±1.30	4.0	39:29	50:12:0:0	39.4
Kim et al. (33)	2019	1	1:0	N/A	2.0	1:0	0:1:0:0	100%
Garge et al. (34)	2020	10	N/A	1.745	5.9	1:9	6:0:0:2	40%
Sinnathamby et al. (35)	2021	1	0:1	1.8	0	0:1	1:0:0:0	N/A
Hashim et al. (36)	2021	46	29:17	N/A	N/A*	32:14	27:13:3:3	39.3%
Huang et al. (19)	2021	101	73:28	N/A	3	62:71	28:13:14:3	29.7%
Sakaria et al. (20)	2021	350	N/A	N/A	4	249:101	N/A	7%
Totals	N/A	794	267:142	2.18	3.73	481:311	203:59:34:16	N/A

*Reported majority (n=38) presented within the first 10 days of life. †reported several autopsies in the case report, only 13 were operated on. ‡total compiled from available data

Surprisingly, our findings did not support the prevailing NGP mortality trend observed in neonates with low birth weight. In the 30-day mortality subgroup, the median weight was 3.0135 kg, and only one patient (25%) weighed 2.5 kg. Across all patients, the median birth weight was 2.075 kg, with 4 patients (26.67%) having a birth weight below 1 kg.

Within our cohort, we identified a median time of 1.5 days between admission and surgery, underscoring

the significance of promptly diagnosing neonatal gastric perforation. Early confirmation of disease manifestations enables the implementation of effective approaches and facilitates informed decisions on appropriate treatment methodologies, particularly in addressing the surgical aspects of the condition.

A comprehensive literature review, detailed in Table 1, outlines the reported cases of surgically treated neonatal gastric perforation, aligning closely with

trends observed in our group. A total of 784 cases were scrutinized spanning the years 1956 to 2021. Analysis of this data revealed a male-female sex distribution of 65.3% and 34.7%, respectively, among neonates with gastric perforation. The average weight of these neonates at presentation was 2.18 kg, and the average age upon admission for symptoms related to gastric perforation was 3.73 days. Of these neonates, 60.7% were full-term, while the remaining 39.3% were premature births. Mortality rates varied among studies, and long-term analyses were limited. Notably, the most recent literature by Sakaria et al. (20) reported a mortality rate of 7%. Characteristics of the perforation size exhibited variability, ranging from pin-sized holes to massive tears in the lining of the stomach parenchyma. The average size of reported gastric perforations was 2.64 cm. Spatially, the distribution of these perforations was heavily skewed towards the greater curvature of the stomach, with 65.1% located there, while 18.9% were in the lesser curvature, 10.9% in the anterior wall, and 5.1% distributed within the posterior wall of the stomach.

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CONCLUSION

Our research supports the idea that males have a worse outcome in terms of both prevalence and survival rates in neonatal gastric perforation (NGP) patients. However, our findings did not confirm the notion that NGP mortality risk is higher in neonates with low birth weight. We also discovered that the median time between admission and surgery in our study group was 1.5 days, emphasizing the importance of early detection of NGP in neonates. Early diagnosis can lead to better decision-making regarding treatment options and surgical intervention.

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