

Original research article

A study on clinical presentation, diagnosis and management of pneumoperitoneum neonates in a tertiary care hospital

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Abstract

Background: Pneumoperitoneum is the presence of air within the peritoneal cavity. It has an incidence of 16.5% of neonatal admissions. In neonates, about 10% of the pneumoperitoneum demonstrated radiologically occur without hollow viscus perforation. Pneumoperitoneum is said to occur more in neonates than in infants and most cases are idiopathic. However it may be caused by necrotizing enterocolitis (NEC), gastrointestinal tract perforation, iatrogenic causes such as mechanical ventilation and intrathoracic pathology (pneumothorax, pneumomediastinum).

Objectives:

1. To evaluate various etiology conditions of pneumoperitoneum in new-borns.
2. To evaluate various clinical presentations of pneumoperitoneum in new-borns.
3. To evaluate various regulate options in pneumoperitoneum in new-borns.
4. To evaluate the outcomes and following management of pneumoperitoneum in new-borns.

Material & Methods

Study design: Prospective Observational study.

Study location: Department of Pediatric Surgery, Niloufer Institute of Women and Child Health, Hyderabad, Telangana.

Duration of the study: January 2019-December 2021

Study population: All neonates who were admitted with radiographic evidence of Pneumoperitoneum.

Sample size: Study consisted a total of 100 subjects.

Sampling technique: Convenient sample technique.

Study tools and data collection procedure: All neonatal pneumoperitoneum cases were evaluated by a preformed proforma containing the age, sex, weight and detailed history regarding the symptoms. After detailed history and complete physical examination, the neonate has been investigated for biochemical and haematological abnormalities. The neonates were admitted into the Neonatal Intensive care. Their hydration was assessed and corrected. Preoperative antibiotics (Cefotaxime and Metronidazole) were given. All patients had a nasogastric tube placed, which aspirated every 2 hours and kept on dependent drainage. Their acid-base balance was evaluated and corrected. Urine output was monitored and body temperature was monitored and maintained.

Results: Out of total 100 cases 60 (60%) were males and 40(40%) were females. Out of 60 males, 31 survived and 30 cases died, mortality was 50% among males. Out of 40 females 20 survived and 19 cases died, mortality was 47.5% among females. P value was 0.36, it has no statistical significance.

Conclusion: Neonatal pneumoperitoneum is one of the common neonatal surgical emergencies for pediatric surgeons. In our study, 5.28% of neonatal admissions were of pneumoperitoneum. It was more common among males, low birth weight neonates. Necrotising Enterocolitis was the most common etiology of neonatal pneumoperitoneum. In our study ileum was the most common site of perforation.

Keywords: Neonatal pneumoperitoneum, necrotising Enterocolitis, hirschsprung's disease, meckel's diverticulum

Introduction

Neonatal pneumoperitoneum denotes the occurrence of free gas within the abdominal cavity of newborns for various reasons, often manifesting as abdominal distension. Around 90% of neonatal pneumoperitoneum instances result from gastrointestinal perforation, necessitating immediate surgical intervention. However, a minority of these newborns exhibit no signs of perforation within the pneumoperitoneum, presenting no symptoms other than abdominal distension. Abdominal paracentesis in these cases reveals the presence of gas without fluid, indicating a rare condition known as neonatal benign pneumoperitoneum (NBPP), also referred to as idiopathic pneumoperitoneum, non-operative pneumoperitoneum, or unexplained pneumoperitoneum. Diagnosing NBPP requires caution; it is essential to carefully rule out pneumoperitoneum resulting from perforation or peritonitis. Unlike the common approach leading to unnecessary laparotomies, conservative treatment is advised for newborns diagnosed with NBPP. This paper reports three instances of NBPP successfully managed at our hospital over the past decade and integrates these experiences with existing literature to offer clinical guidance for the accurate diagnosis and effective treatment of this condition. Other uncommon causes of infant intestinal perforation include diverticula^[2,3], resuscitation with oxygen under pressure in patients with distal pyloric or duodenal obstruction, mechanical injury from ryles tubes, rectal thermometers, and rectal tubes used for rectal washings^[1-3]. Operative care is the generally acknowledged way of treatment for new-borns with pneumoperitoneum and necrotizing enterocolitis (NEC) with pneumoperitoneum^[5]. Over the past few decades, there has been a significant paradigm shift in the management of pneumoperitoneum since 1966, when an article determined that every new-born infant with pneumoperitoneum must have laparotomy^[6-10].

Hence the present study was undertaken to evaluate the clinical presentation, causes, management and outcome of neonates admitted with pneumoperitoneum.

Objectives

1. To evaluate various causes of pneumoperitoneum in new-borns.
2. To evaluate various clinical presentation of pneumoperitoneum in new-borns.
3. To evaluate various management options in pneumoperitoneum in new-borns.
4. To evaluate the outcome following management of pneumoperitoneum in new-borns.

Material & Methods

Study design: Prospective Observational study.

Study area: Department of Pediatric Surgery, Niloufer Institute of Women and Child Health, Hyderabad, Telangana.

Study period: January 2019-December 2021.

Study population: All neonates who were admitted with radiographic evidence of Pneumoperitoneum

Sample size: Study consisted a total of 100 subjects.

Sampling technique: Convenient sample technique.

Inclusion criteria: All neonates with radiographic evidence of pneumo-peritoneum were included in the study.

Exclusion criteria: child "s age>28days.

Ethical consideration: Institutional Ethical committee permission was taken prior to the commencement of the study.

Study tools and data collection procedure

All neonatal pneumoperitoneum cases were evaluated by a preformed proforma containing the age, gender, weight and detailed history regarding the symptoms. After detailed history and complete physical examination, the neonate has been investigated for biochemical and haematological abnormalities.

The neonates were admitted into the Neonatal Intensive care. Their hydration was assessed and corrected. Preoperative antibiotics (Cefotaxime and Metronidazole) were given. All patients had a nasogastric tube placed, which aspirated every 2 hours and kept on dependent drainage. Their acid-base balance was evaluated and corrected. Urine output was monitored and body temperature was monitored and maintained. In the surgical neonatal intensive care unit under aseptic precautions, Primary peritoneal drainage using a middle finger of a rubber glove is done by giving a small stab incision in the dependant position of the right flank. Abdomen is decompressed and the contaminated fluid is let out. This procedure is done as a protocol for every case of pneumoperitoneum. After stabilization of the child, child was taken up for laparotomy. Laparotomy is done by right upper transverse incision. Exploration of the entire bowel was done to identify the cause for the pneumoperitoneum. Site of perforation noted and treatment is tailored depending on the cause of pneumoperitoneum. Intra operative findings and type of surgery performed was noted and post-operative outcome is evaluated in terms of mortality.

Statistical analysis

The collected data was entered in Microsoft office Excel spread sheet. Descriptive analysis was carried out by mean and standard deviation for quantitative variables, number and proportion for categorical variables. Statistical analysis was performed using the statistical software "IBM SPSS version 20". Statistical significance was assessed using chi square test and only p value <0.05 was considered as statistically significant.

Observations & Results

There were total 100 neonates who presented with radiograph evidence of pneumoperitoneum during the study period of 2 years (January 2019-December 2021) and were included in the study. There were total 1892 surgical NICU admissions during the study period.

Table 1: Incidence of neonatal pneumoperitoneum

Total number of neonates With pneumoperitoneum	Total Surgical NICU Admissions (2019-20)	Percentage (%)
100	1892	5.28%

Neonatal pneumoperitoneum accounted for around 5.6% of total surgical NICU admissions.

Table 2: Sex distribution

Sex	Number	Percentage (%)
Male	65	65%
Female	35	35%
Total	100	100%

Out of total 100 neonates with pneumoperitoneum, males were 65 (65%) and females were 35 (35%).

Table 3: Age distribution

Age	Number	Percentage (%)
Early neonatal period (<7days)	63	63%
Late neonatal period (7-28 days)	37	37%
Total	100	

Out of total 100 neonates with pneumoperitoneum, there were 63 (63%) neonates who presented in the early neonatal period (<7days) and 37 (37%) neonates who presented in the late neonatal period (7-28days). Mean age of presentation was 8 days with a standard deviation of 8.1763, minimum age of presentation was 1day, and maximum age was 28 days.

Weight Distribution: Out of total 100 neonates with pneumoperitoneum, 27(27%) were having normal weight (>2.5kgs), 49 (49%) were having low birth weight (LBW) (1.5- 2.5kgs), and 24 (24%) were having very low birth weight (VLBW) at presentation. Mean weight was 2 kgs with a standard deviation of 0.562, minimum weight was 1kg and maximum weight was 3.5 kgs.

Gestational Age Distribution: Out of total 100 neonates with pneumoperitoneum, Preterm (<37 weeks) were 42(42%) and term were 58 (58%).

Clinical Presentation: Out of total 100 neonates with pneumoperitoneum, abdominal distension was a universal presentation in all the neonates. Around 29 (29%) neonates presented with gross abdominal distension peritonitis, feature of generalized sepsis with shock. Around 49 (49%) neonates had bilious vomiting with feeding intolerance.

Table 4: Causes of pneumoperitoneum

Cause	Number	Percentage
NEC	42	42
Gastric	19	19
HD	14	14
Arm	10	10
Atresia	5	5
Meconium Ileus	5	5
Enteric Duplication Cyst	1	1
Meckels	2	2
Idiopathic	2	2
Total	100	100

In this study necrotizing enterocolitis was the commonest cause of neonatal gastrointestinal perforation with **42** cases, accounting for around **42%** of all the total cases. Gastric perforations are second most common seen in **19** cases, Hirschsprung’s disease in **14** cases, Anorectal malformations **10** cases, Intestinal atresias **10** cases, Meconium ileus **5** cases.

Other less common causes are enteric duplication cyst **1** case; Meckel’s diverticulum perforation in **2** cases; Idiopathic **2** cases where in one case diagnosis was not possible; in one case neonate had pneumoperitoneum on radiograph but perforation was not found on laparotomy.

Out of **19** Gastric perforations, **2** cases were associated with trachea esophageal fistula, **3** cases were associated with malrotation, **1** case was associated with left congenital diaphragmatic hernia, **2** cases had history of resuscitation, **3** cases cause couldn’t be found out.

Out of **14** cases of Hirschsprung’s disease, **1** case had total colonic aganglionosis. Out of **6** cases of intestinal atresia, **3** cases had type **3**, **2** had type **4**, and **one** case had type **2** intestinal atresia.

Table 5: Site of Perforation in relation to cause

State of Peroration	NEC	ARM	Atresia	HD	Gastric	Meconium Ileus	Duplication Cyst	Meckel's	Idiopathic	Total
Gastric					19					19
Jejunum	2		3							5
Ileum	17		2	1		4	1	2		28
Cecum	3			2						5
Ascending Colon	2									2
Transverse Colon	6								1	7
Descending Colon	1									1
Sigmoid Colon	2	5		2					1	10
Rectum		5		8						13
Multiple	9			1		1				11
Total	42	10	5	14	19	5	1	2	2	100

The site of perforation was ileum in **28** cases, gastric in **19** cases, **20** were colonic, jejunum **5** cases, rectum **13** cases. In Colon; **5** in cecum, **6** in transverse colon, **8** in sigmoid colon, **2** in ascending colon, **1** in descending colon. Multiple perforations were seen in **11** cases.

Out of total **42** NEC cases, **5** were not operated as cases succumbed before intervention, in **2** cases perforation were not found. Out of remaining **41**, ileal perforations were seen in **17** cases, **1** in jejunum, **3** in cecum, **2** in ascending colon, **6** in transverse colon, **1** in descending colon, **2** in sigmoid colon, **9** were multiple.

Out of **19** gastric perforations, multiple perforations were seen in **9** cases, anterior wall perforations were **6**, and posterior wall perforations were **3**. Out of **14** Hirschsprung’s disease cases, multiple perforations were seen in **1** case, rectal perforations were seen in **8** cases (2 were iatrogenic due to rectal probing/forceful contrast enema), **2** in sigmoid colon, **2** in cecum and **1** in ileum.

Out of **5** intestinal atresia cases **3** were seen in jejunum, **2** were seen in ileum. Out of **4** Anorectal malformation cases **2** were seen in rectum, **2** were seen in sigmoid colon. Out of **5** cases of meconium ileus **one** case had multiple perforations, remaining 4 perforations was in ileum. Sigmoid colon perforation was seen in one idiopathic case.

Table 6: Treatment done in relation to cause

Surgery done	NEC	ARM	Atresia	HD	Gastric	Meconium Ileus	Duplication Cyst	Meckel's	Idiopathic	Total
Colostomy	9	10		1					1	21
Ileostomy	20		1	10		4				35
Primary closure	2			2	11 (Gastrostomy-3)					13
Resection & Anastomosis	3		4			1	1	2		11
Peritoneal Lavage	3								5	4
Surgery not done	5									5
Total	42	10	5	14	19	5	1	2	2	100

Surgery done	NEC	ARM	Atresia	HD	Gastric	Meconium Ileus	Duplication Cyst	Meckel's	Idiopathic	Total
Colostomy	9	4	1	6					1	21
Ileostomy	26		1	4		4				35
Primary closure	2				11 (Gastrostomy-3)					13
Resection & Anastomosis	3		4			1	1	2		11
Peritoneal Lavage	3								1	4
Surgery not done	5									5
Total	48	4	6	10	11	5	1	2	2	89

Out of 42 cases of necrotizing enterocolitis, ileostomy was done in 20 cases, colostomy in 9 cases, primary closure done in 2 cases, resection of diseased segment and primary anastomosis done in 3 cases, peritoneal lavage done in 3 cases, 5 cases succumbed before surgery.

Out of 11 cases of gastric perforation primary closure was done in all 11 cases; gastrostomy was done in 3 along with primary closure. Out of 14 cases of Hirschsprung’s disease colostomy was done in 6 cases and ileostomy was done in 4 cases where there were cecal perforations in 2 cases, multiple perforations in one case, ileal perforation in one case. Colostomy was done for all the cases of anorectal malformations.

Out of the 5 cases of atresia, primary anastomosis was done in 4 cases, colostomy was done in one case where there was a sigmoid perforation, primary anastomosis was done for atresia followed by closure of sigmoid perforation with sigmoid colostomy, and in one case ileostomy was done. Out of 5 cases of meconium ileus, ileostomy was done in 4 cases and primary anastomosis was done in 1 case.

In one case of enteric duplication cyst, resection of duplication cyst along with perforated segment and primary anastomosis was done. In meckel’s diverticulum perforation resection of meckel’s diverticulum with primary anastomosis was done. In one case perforation couldn’t be found out where peritoneal lavage was done.

Mortality: The overall mortality was 49 cases out of 100 cases that accounted for 35% of all the cases.

Gender-Related Mortality: Out of total 100 cases 60 (60%) were males and 40(40%) were females. Out of 60 males, 31 survived and 30 cases died, mortality was 50% among males. Out of 40 females 20 survived and 19 cases died, mortality was 47.5% among females. P value was 0.36, it has no statistical significance.

Table 7: Cause related mortality

Diagnosis	Death	Discharge	Total
Arm	5 50.00%	5 50.00%	10
Atresia	3 60.00%	2 40.00%	5
Enteric Duplication Cyst	0 0.00%	1 100.00%	1
Gastric	10 52.00%	9 48.00%	19
HD	8 57.00%	6 43.00%	14
Idiopathic	0 0.00%	2 100.00%	2
Meckel’s	0 0.00%	2 100.00%	2
Meconium Ileus	3 60.00%	2 40.00%	5
NEC	20 47.00%	22 53.00%	42
Total	49 49.00%	51 51.00%	100

Age Related Mortality: Out of total 100 neonates with pneumoperitoneum, there were 52 neonates who presented in the early neonatal period (<7days) and 48 neonates who presented in the late neonatal period (7-28days). Out of 52 cases in early neonatal period 29 survived and 22 died mortality was 42.30%. Out of 48 cases in late neonatal period 21 survived and 27 died, mortality was 56.25%. P value was 0.23 (no statistical significance).

Weight Related Mortality: Out of total 100 neonates with pneumoperitoneum, 61(61%) were having normal weight (>2.5kgs), 25 (25%) were having low birth weight (LBW) (1.5-2.5kgs), and 14(14%) were having very low birth weight (VLBW) at presentation. Out of 61 neonates with normal birth weight 31 survived and 30died, mortality was 48%. Out of 25 neonates with low birth weight 15survived and 10died, mortality was 40%. Out of 14neonates with very low birth weight 7 survived and 9died, mortality was 64%. Mortality was more among low birth weight and very low birth weight cases.

Out of total 49 mortality cases, NEC was the most common cause of mortality accounting for 42 cases, 47.00% among total NEC cases. Second common was Gastric perforations; 19 cases 52.00% among total cases of gastric perforation. Remaining 16 cases, 3 were meconium ileus, 8 were due to Hirschsprung’s disease, 5 Anorectal malformation and one intestinal atresia case.

Site of Perforation Related Mortality: Out of 49 mortality cases, 5 cases succumbed before surgery, multiple perforations had more mortality 9 cases died out of total 11 cases, 81.82% mortality among multiple perforations. Remaining; 4 cases of gastric perforations, 6 cases of ileal perforation, 4 cases of

colonic perforations, 1 case of jejunal perforation, 2 cases of rectal perforations.

Treatment Related Mortality: Out of 49 mortality cases; 5 cases expired before any surgical intervention; 5 out of 21 cases expired where colostomy was done; 14 out of 35 cases expired where ileostomy was done, 4 out of 13 cases expired where primary closure was done, 2 out of 11 cases expired where resection and primary anastomosis was done, 1 out of 4 expired where only peritoneal lavage was done.

Table 8: Results Summary

Cause of pneumoperitoneum	Surgery done	Site of Perforation	Mortality
NEC(n-48)	Notoperated-5 Peritoneallavage-3 Diversion-35 (ileostomy-26, colostomy-9) Primary closure-2 Resection and anastomosis-3	Small bowel-18 (ileum-17, jejunum-1) Colon-14 Multiple-9	20 (41%)
Gastric perforation (n-11)	Primaryclosure-8 Primary closure with gastrostomy-3	Multiple-2 Anterior wall-6 Posteriorwall-3	10(20)
Hirschsprung's disease (n-10)	Colostomy-6 Ileostomy-4	Ileum-1 Cecum-2 Sigmoidcolon-2rectum-4 Multiple- 1	8(16)
Atresia (n-6)	Primaryanastomosis-4 Double barrelileostomy-1 Colostomy-1	Jejunum-3 Ileum-2 Sigmoidcolon-1	1 (2)
Meconium ileus (n-5)	Bishop Koops distalchimney-2 Double barrelileostomy-2 Primary anastomosis-1	Multiple-1 Ileum-4	3 (6)
ARM(n-4)	Colostomy-4	Sigmoidcolon-2 Rectum-2	1 (2)
Meckel's diverticulum perforation (n-2)	Primary anastomosis after resection of meckel's	Ileum-2	-
Idiopathic (n-2)	Colostomy-1 Peritoneallavage-1	Sigmoidcolon-1 Perforationnotfound-1	-
Duplication Cyst (n-1)	Resection and anastomosis	Ileum-1	-

Discussion

Gastro intestinal perforations in neonates remain a challenging surgical emergency. Its incidence is close to 1% of total neonatal intensive care unit admissions [5]. 80% of them are caused by primary bowel pathology, rarely an intestinal perforation occurs with atresia, stenosis, meconium ileus, aganglionosis and volvulus [5]. They are considered a major factor of morbidity and mortality in the neonatal age group despite advances in anaesthesia and neonatal care [6].

In our study there were total 1852 surgical neonatal intensive care unit admissions out of which 100 neonates presented with pneumoperitoneum accounted for around 5.28% of total neonatal admissions. This incidence is comparatively less when compared to other studies of similar topic. In a study by Wang QY *et al.*, [11], incidence was 14.2% of total admissions, in a study by. Deb A *et al.*, [15], incidence was 15.6% of total admissions.

The incidence of pneumoperitoneum was more common among males compared to females, around 60% males with male: female ratio 2:1. This was nearly comparable to other studies, M: F 3:1 in a study by Wang QY *et al.*, [8]; 2:1 in a study by Deb A *et al.*, [7].

The mean age of presentation was about 7.29days late neonatal period, which was comparable to other studies. In Deb A *et al.* [8] study the mean age was 10.8 days; In Abo-Deb A *et al.* [9] study the mean age was 14.31 days; In Deb A *et al.*, [7] the mean age was 4.9 days. The mean weight at presentation was 2kgs in our study which was comparable to other studies. In Abo-Halawa *et al.*, [9] study mean weight was 2.54kgs; In Deb A *et al.*, [7] study mean weight was 2.3kgs. In our study around 56.18% of neonates were full term which was comparable to other studies. In Deb A *et al.*, [8] study term neonates were 49.3%.

In Necrotizing enterocolitis, there was difference in presentation in neonates in terms of age at presentation, weight and gestational age. The mean age of presentation was 10.9 days, most of them presented in the late neonatal period. Mean weight was 1.7kgs; most of them were having low birth weight (60%). Most of them were preterm neonates 65% which was comparable to other studies.

In a study by Grewal JS [18], mean birth weight was 1.3kgs when compared to non NEC related perforations where the mean weight was 2.2kgs and most of the neonates were preterm neonates and mean age of presentation was 16 days, in late neonatal period. In other study by Wang QY *et al.*, [11], mean birth weight was 1.2kgs when compared to non NEC related perforations where mean weight was 2.3 kgs and most of the neonates are preterm.

Three cases were associated with malrotation. In a study by Deb A *et al.*, [15], most common gastrointestinal

malformations associated with gastric perforations was malrotation followed which accounted for around 49% of the total gastric perforations included in that study. The reason for the gastric perforation was thought to be due to increased gastric pressures due to distal obstruction.

Spontaneous neonatal gastric perforation is a rare neonatal event, occurring in 1 in 3100 live births, and its aetiology is controversial. Deb A *et al.*,^[15] and Grewal JS^[18], reported a congenital muscular defect in the muscularis as a causative factor in neonatal spontaneous gastric perforation. Although the stomach is well vascularised, spontaneous perforations and necrosis do occur in neonates. The majority of defects are proximal linear tears along the greater curvature.

The most common sites of the perforation were known to be the proximal colon and appendix^[13]. Perforation was considered not to be related to the enterocolitis but to the increased intraluminal pressure^[14].

In our study there were 4 cases associated with anorectal malformations. There was sigmoid colon perforation in 2 cases, rectal perforation in 2 cases. Gastrointestinal perforations are a rare clinical entity in neonates with Deb A *et al.*,^[7]. Reported four cases of ARM with intestinal perforations, most of which were secondary to delayed presentation, while Harvey JJ^[16]. Reported five neonates of high ARM with intestinal perforations. In all the cases descending loop colostomy was done.

In our study there were total 5 cases associated with meconium ileus. There were 4 ileal perforations and 1 case of multiple perforations. Harvey JJ^[16]. In his study noted. Around 20% incidence of perforation in meconium ileus patients and this was attributed to proximal bowel dilatation or enema during a trial of conservative management.

In our study mortality was 49%, 49 cases out of 100. NEC accounted for around 65% of total mortality cases. From our study NEC, prematurity, low birth weight, multiple perforations are identifiable mortality risk factors of neonatal gastrointestinal perforation. Several other authors have documented similar findings^[11, 14, 16, 18].

Conclusion

Neonatal pneumoperitoneum is one of the common neonatal surgical emergencies for pediatric surgeons. In our study, 5.28% of neonatal admissions were of pneumoperitoneum. It was more common among males, low birth weight neonates. Necrotising Enterocolitis was the most common etiology of neonatal pneumoperitoneum. In our study ileum was the most common site of perforation. Laparotomy and diversion was the surgery done as a lifesaving procedure in most of the neonates with pneumoperitoneum. Mortality is dependent on multiple factor like timing of presentation, duration between clinical presentation and surgical intervention, prematurity, low birth weight, number of perforations.

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