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Three in One: Pneumopericardium, Pneumomediastinum, and Pneumothorax in an X-ray

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Abstract

We report the case of a term neonate (39+2 weeks' gestation) who developed concurrent pneumothorax, pneumomediastinum, and pneumopericardium, diagnosed incidentally during investigation of persistent tachypnoea. The infant was born by category 2 caesarean section in the context of prolonged rupture of membranes and maternal intrapartum pyrexia, and required brief positive end-expiratory pressure support for transient respiratory distress shortly after birth. A chest radiograph obtained on day 4 of life, performed to investigate the ongoing tachypnoea, unexpectedly revealed pneumomediastinum, a left anterior pneumothorax, and pneumopericardium. All three air leaks were managed conservatively with close clinical and cardiorespiratory monitoring and serial imaging; no invasive intervention was required. Pneumothorax and pneumopericardium resolved by day 6 of life, and the pneumomediastinum had resolved by outpatient review on day 12, with no ongoing concerns. This case highlights that multi-compartment air leak syndrome can present with subtle, nonspecific signs such as persistent tachypnoea rather than acute decompensation, and underscores the value of a low threshold for chest radiography in neonates with unexplained respiratory findings, even when initial concern centres on sepsis.

Categories: Radiology, Emergency Medicine, Pediatrics
Keywords: air leak syndrome, paediatrics and neonatology, pneumomediastinum, pneumothorax (ptx), positive end-expiratory pressure (peep), thoracic radiology

Introduction

Respiratory distress is one of the most common presentations in the neonatal period, and transient tachypnoea of the newborn (TTN) is among the most frequent diagnoses in term infants, resulting from delayed clearance of fetal lung fluid and consequent reduction in pulmonary compliance [1]. Positive end-expiratory pressure (PEEP), a well-established intervention for neonatal respiratory distress, facilitates alveolar recruitment and improves oxygenation. However, positive pressure ventilation in neonates carries an inherent risk of iatrogenic pulmonary air leak, including pneumothorax, pneumomediastinum, and pneumopericardium [1].

Neonatal pneumothorax occurs spontaneously in ~1-2% of live births; however, it occurs at a significantly higher rate in neonates receiving positive pressure respiratory support [2]. Pneumomediastinum may occur concurrently and, while frequently self limiting, represents an important marker of pulmonary air leak. Pneumopericardium is by far the rarest of the three, but is of clinical significance, as even a modest volume of pericardial air can precipitate tamponade in the neonatal heart [2-3].

We present a case of a term neonate (39+2 weeks' gestation) who required brief PEEP in the immediate postnatal period for presumed TTN, and who subsequently developed all three forms of pulmonary air leak: pneumopericardium, pneumothorax, and pneumomediastinum. All were identified simultaneously on a single chest radiograph obtained during evaluation for persistent tachypnoea. This case illustrates the need to consider PEEP-associated air leak as a differential diagnosis in any neonate with ongoing respiratory distress following positive pressure support, however brief. Previous reports describe neonatal pneumopericardium occurring with other air leaks, including in term infants without ongoing ventilatory support. The present case adds an example of concurrent pneumothorax, pneumomediastinum, and pneumopericardium identified during investigation of persistent tachypnoea after brief delivery-room respiratory support. Its educational contribution is the recognition of air in three anatomical compartments on a single radiograph and the clinical assessment underpinning management without invasive drainage.

Case Presentation

A term neonate (39+2 weeks' gestation) was born by category 2 caesarean section due to failure to progress. The mother had gestational diabetes mellitus, managed with metformin, and hypothyroidism, managed with levothyroxine. Rupture of membranes had been prolonged, at 34 hours, and the mother developed intrapartum pyrexia of 37.8°C, for which she received intravenous antibiotics before delivery.

The neonatal team was in attendance at delivery. The infant was born with a birth weight of 3.46 kg and Apgar scores of 9, 9, and 10 at one, five, and ten minutes, respectively. The infant was initially well, but at three minutes of life appeared cyanosed, with oxygen saturation of 67%. PEEP (5 cmH_2O, FiO_2 21%, subsequently up-titrated to 80%) was applied. The infant's condition improved by approximately seven minutes of life; however, saturation fell again when PEEP was withdrawn, and respiratory support was therefore continued until one hour of life, at which point the infant was able to maintain saturation in air without further support. The initial respiratory compromise was attributed to TTN or to the delayed cardiorespiratory transition. The infant's initial blood gas on day 1 of birth was normal (Table *1*).

Parameter	Result	Reference range
pH (capillary)	7.385	7.35-7.45
pCO_2 (capillary)	5.21 kPa	4.3-6.0 kPa
pO_2 (capillary)	6.73 kPa	5.3-9.3 kPa
Base excess	-1.4 mmol/L	-4 to +4 mmol/L
Bicarbonate	23.4 mmol/L	20-26 mmol/L
Lactate	3.2 mmol/L	0.5-2.2 mmol/L

TABLE 1: Capillary blood gas results from day 1 of life

The infant remained on the postnatal ward with intermittent tachypnoea, prompting daily neonatal review. On day 1, the recorded respiratory rate ranged from 44 to 79 breaths/min. Across days 2-4, respiratory rates ranged from 50 to 68 breaths/min, heart rates from 118 to 142 beats/min, and temperatures from 36.6 to 37.3°C (Table *2*). Although respiratory rates charted on days 2-4 of life ranged from 50 to 68 breaths/min, the heart rate (118-142 beats/min) and temperature (36.6-37.3°C) remained within normal neonatal limits across these days. Within these daily reviews, the baby was consistently examined well, noted to be alert and pink, with normal heart sounds and peripheral pulses, no increased work of breathing, and feeding adequately, which was confirmed by the acceptable weight loss of the baby (from 3.460 kg to 3.335 kg, a 3.6% weight loss). By day 3 of life, given persistent tachypnoea, a partial septic screen was performed.

Day of life	RR (/min)	HR (/min)	Temp (°C)	SpO_2
1	44-79	130-171	36.7-37.4	94-100%
2	50-66	130-142	36.6-37.3	Not recorded
3	59-68	132-139	36.7-37.2	Not recorded
4	59-63	118-131	36.6-37.0	Not recorded
5	46-60	119-152	36.5-37.1	99%
6	48-60	131-140	36.7-37.0	Not recorded

TABLE 2: Vitals recorded throughout neonate's admission

RR: respiratory rate; HR: heart rate; SpO_2: oxygen saturation of peripheral haemoglobin

C-reactive protein (CRP) was 4.6 mg/L, and blood cultures were negative at 36 hours (Table *3*).

Investigation	Result	Reference range
C-reactive protein (CRP)	4.6 mg/L	<5 mg/L
Blood culture	No growth at 5 days	-

TABLE 3: Laboratory results from day 3 of life

As tachypnoea persisted into day 4 of life, a repeat capillary blood gas and CRP measurement were performed, empirical intravenous antibiotics were commenced as a precaution, and a chest radiograph was obtained (Table *4*).

Parameter	Result	Reference range
pH (capillary)	7.418	7.35-7.45
pCO_2 (capillary)	4.80 kPa	4.3-6.0 kPa
pO_2 (capillary)	8.77 kPa	5.3-9.3 kPa
Base excess	-0.6 mmol/L	-4 to +4 mmol/L
Bicarbonate	23.2 mmol/L	20-26 mmol/L
Lactate	1.2 mmol/L	0.5-2.2 mmol/L
C-reactive protein (CRP)	1.5 mg/L	<5 mg/L

TABLE 4: Laboratory results from day 4 of life

Investigations

The chest radiograph on day 4 of life demonstrated a left anterior pneumothorax, pneumomediastinum, and pneumopericardium, with no associated lobar collapse or consolidation (Figure *1*). Repeat radiography 48 hours later showed resolution of the pneumothorax and pneumopericardium, with persistent but stable pneumomediastinum (Figure *2*).

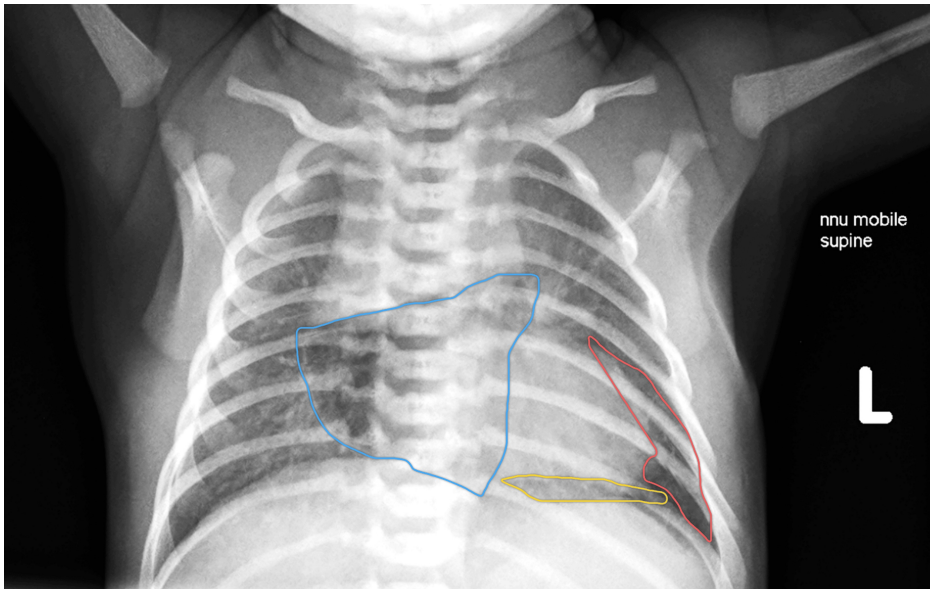


FIGURE 1: Chest radiograph, day 4 of life, demonstrating left anterior pneumothorax (red), pneumomediastinum (blue), and pneumopericardium (yellow), without lobar collapse or consolidation.

The red outline highlights the deep sulcus sign associated with the pneumothorax. The yellow outline delineates the halo of air surrounding the cardiac silhouette, consistent with pneumopericardium. The blue outline highlights air outlining the mediastinal structures and a sail sign just above the blue highlight, consistent with pneumomediastinum.

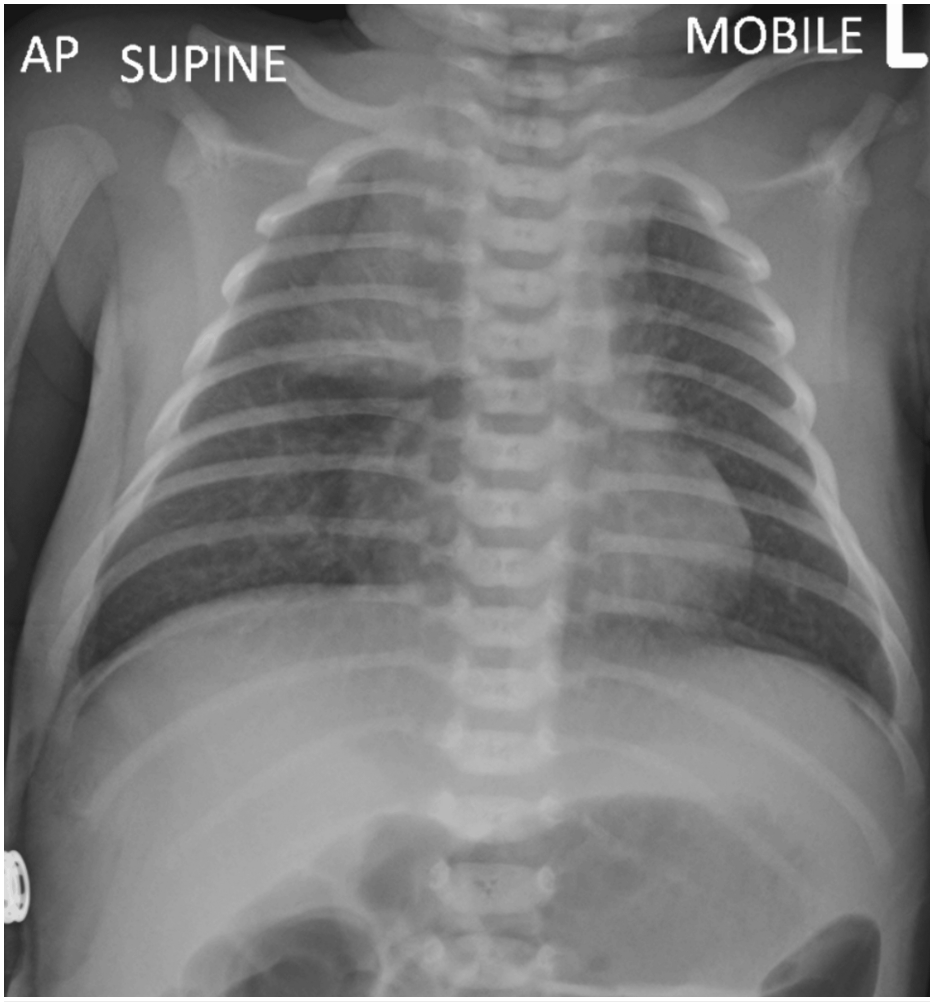


FIGURE 2: Repeat chest radiograph, 48 hours after the first chest radiograph (day 4, Figure 1), showing resolution of the pneumothorax and pneumopericardium with persistent pneumomediastinum.

Differential diagnosis

Given the combination of prolonged rupture of membranes, maternal intrapartum pyrexia, and persistent neonatal tachypnoea, early neonatal sepsis was the initial leading differential and was appropriately investigated in parallel with a partial septic screen. Other differentials for persistent neonatal tachypnoea considered included ongoing or evolving TTN, congenital pneumonia, and congenital cardiac disease. The diagnosis of concurrent multi-compartment air leak syndrome was established only once chest radiography was performed on day 4 of life, having not been clinically apparent from history and examination alone.

Treatment

The infant completed a 48-hour course of intravenous antibiotics, discontinued once the septic screen remained reassuring. The low and falling CRP concentration, from 4.6 to 1.5 mg/L, together with negative blood cultures and the reassuring clinical course, reduced concern for bacterial infection. The findings supported discontinuation of empirical antibiotics after 48 hours. Neither a low CRP nor a negative blood culture independently excludes neonatal infection; the results were interpreted alongside the infant's clinical progress (Table *2*) with daily reviews. All three air leak syndromes were managed conservatively, with close clinical and cardiorespiratory monitoring and serial chest radiography. No invasive intervention (needle decompression, chest drain, or pericardiocentesis) was required at any point.

Outcome and follow-up

The infant remained clinically stable throughout, without requiring further respiratory support. The pneumothorax and pneumopericardium had resolved by day 6 of life. The infant was discharged and reviewed in the outpatient clinic on day 12 of life, by which point the pneumomediastinum had also resolved, with no ongoing clinical concerns.

Discussion

Pulmonary air leak syndromes are a recognised complication of positive pressure ventilation in the neonatal period [1]. The pathophysiological mechanism is one of barotrauma and alveolar overdistension: positive pressure disrupts the normally negative intrapleural environment, increasing shear stress across the alveolar wall. Once alveolar structural tolerance is exceeded, rupture occurs, and air dissects along the perivascular sheaths toward the mediastinum, from where it may decompress further into the pleural space (causing pneumothorax) or pericardial space (causing pneumopericardium) [4].

Pneumopericardium is the rarest of the three air leak syndromes but is disproportionately important clinically, as even a small volume of pericardial air can precipitate cardiac tamponade in the neonatal heart, occasionally necessitating emergency pericardiocentesis [3]. In this case, all three compartments were affected simultaneously, despite the infant having received only one hour of low-pressure PEEP (5 cmH_2O).

The air leaks were identified after a brief period of delivery-room PEEP. This temporal relationship does not establish causation, and the timing of their onset is unknown. Although positive pressure provides a plausible contributing mechanism, spontaneous neonatal air leak remains an alternative explanation.

A further point of interest in this case is the diagnostic pathway. The presence of perinatal sepsis risk factors, prolonged rupture of membranes and maternal pyrexia, appropriately directed initial clinical suspicion toward neonatal sepsis, and a septic screen was undertaken accordingly. However, this focus on an infective cause meant that the underlying air leak syndrome was not identified until chest radiography was performed on day 4 of life. This illustrates a recognised diagnostic pitfall: in any tachypnoeic neonate with a history of previous positive pressure support, a mechanical aetiology should be considered in parallel with an infective one, and early chest imaging should not be delayed on the assumption that sepsis is the more likely explanation [5]. Pneumomediastinum and pneumopericardium in particular may be radiographically subtle and easily overlooked if not specifically sought.

Maternal gestational diabetes has also been associated with neonatal respiratory morbidity. Large cohort data show modestly increased odds of respiratory distress syndrome and transient tachypnoea of the newborn at term [6], but the evidence is not uniform: in a US cohort of pregnancies at high risk of late preterm birth, gestational diabetes was not associated with increased respiratory morbidity [7]. To our knowledge, a direct link between maternal diabetes and neonatal air leak has not been established, and any contribution here is likely to be indirect, for example through a greater need for respiratory support. In this case, diabetes was controlled with metformin and the infant was not macrosomic (3.46 kg); therefore, we regard it as a possible, non-specific contributor only.

Conservative management is well established as safe and effective for haemodynamically stable neonates with pneumothorax, with treatment decisions guided by the severity of respiratory compromise rather than pneumothorax size alone [8]. Conservative management has been described for pneumopericardium, similarly, provided there exits a close haemodynamic monitoring and immediate readiness for pericardiocentesis should the infant deteriorate [3]. In this case, all three syndromes were managed successfully without invasive intervention, resolving fully by day 12 of life.

Previous reports provide useful comparisons regarding presentation and treatment of neonatal air leaks. Roychoudhury et al. described a term infant who required no resuscitation at birth but subsequently developed pneumothorax, pneumopericardium and subcutaneous emphysema [9]. Increasing respiratory distress and oxygen requirements prompted needle aspiration of the pneumothorax. Pneumopericardium was observed with cardiorespiratory monitoring and serial radiographs and resolved without pericardial drainage. This case illustrates that different air leak compartments in the same infant may require different management.

Rocha and Guimarães described a term infant born by caesarean section who developed spontaneous pneumomediastinum without preceding resuscitation or positive pressure support [10]. The infant maintained reassuring oxygen saturations, and the pneumomediastinum resolved by day 9 without invasive drainage. Supplemental oxygen was administered in that report. The case demonstrates that mediastinal air may persist after the presenting symptoms improve and that neonatal air leaks can occur without preceding positive pressure support.

The present case differs in the simultaneous identification of pneumothorax, pneumomediastinum and pneumopericardium, followed by improvement without drainage of any compartment. Taken together, these reports illustrate a range of presentations and treatment requirements. They support consideration of observation in selected clinically stable infants, while emphasising the need to assess respiratory and cardiovascular status. As individual case reports, they cannot establish comparative treatment effectiveness or define reliable thresholds for intervention.

Conclusions

This case demonstrates that pneumopericardium, pneumothorax and pneumomediastinum can occur concurrently even after a brief period of low-pressure positive pressure support in an otherwise well term

neonate. Concurrent perinatal sepsis risk factors may understandably direct initial clinical suspicion toward an infective cause, but clinicians should maintain a parallel index of suspicion for mechanical air leak in any neonate with persistent tachypnoea following previous positive pressure ventilation, however brief. Early chest radiography is essential to avoid diagnostic delay, as pneumomediastinum and pneumopericardium may be radiographically subtle. All three air leak syndromes in this case resolved fully with conservative management and close monitoring alone.

Additional Information

Author Contributions

All authors have reviewed the final version to be published and agreed to be accountable for all aspects of the work.

Concept and design: Guillaume Lambert, Nabeela Bhaloo, Satish Bangalore

Acquisition, analysis, or interpretation of data: Guillaume Lambert, Nabeela Bhaloo, Satish Bangalore

Drafting of the manuscript: Guillaume Lambert, Nabeela Bhaloo, Satish Bangalore

Critical review of the manuscript for important intellectual content: Guillaume Lambert, Nabeela Bhaloo, Satish Bangalore

Supervision: Satish Bangalore

Disclosures

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