Primary congenital pulmonary hypoplasia of a neonate


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Abstract

Pulmonary hypoplasia is a rare but usually lethal disease. We report a full-term male neonate who presented with respiratory failure immediately after birth. Chest X-ray revealed a small lung volume despite advanced ventilator support. Respiratory failure persisted and this baby died at 40.5 hours of age. The autopsy showed a lung-to-body weight ratio of 0.69% and a radial alveoli count of 2.97. All this information confirmed the diagnosis of primary congenital pulmonary hypoplasia.

Keywords: lung-to-body weight ratio; persistent pulmonary hypertension of the newborn; primary congenital pulmonary hypoplasia; radial alveoli count

1. Introduction

Congenital pulmonary hypoplasia is a rare but usually lethal disease. The incidence of congenital pulmonary hypoplasia may range from 9 to 11 per 10,000 live births, and its mortality rate as reported by previous studies is 71–95%.1,2

Primary congenital pulmonary hypoplasia is defined as congenital pulmonary hypoplasia occurring in the absence of other maternal or fetal disorders. We report a full-term male neonate presenting with respiratory distress immediately after birth, for whom the final autopsy diagnosis was primary congenital pulmonary hypoplasia.

2. Case report

A 37-week-old male baby was born via cesarean section due to maternal history of intracranial arteriovenous malformation. The mother was gravida 2, para 2 and had no other abnormality in her maternal history and no medications were used during the course of the pregnancy. Antenatal sonography showed no fetal abnormalities and normal volume of amniotic fluid. The previous sibling born at full-term normal delivery had a history of mild respiratory distress during the neonatal period and was quite well now.

The present neonate developed central cyanosis, bradycardia, and floppy posture after birth. The Apgar score was 1 at 1 minute and 1 at 5 minutes. Resuscitation was performed in the delivery room, and then this neonate was sent to our neonatal intensive care unit (NICU). The Apgar score deteriorated to 0 in the NICU, so we performed chest compression, positive pressure ventilation, and then endotracheal intubation with intermittent mandatory ventilation (IMV) for respiratory support. The initial ventilator settings were: fractional inspired oxygen concentration (FiO₂): 60%, peak inspiratory pressure/positive end expiratory pressure (PIP/PEEP): 20/5 cmH₂O, and rate: 25/minute. Hypothermia therapy was arranged for perinatal asphyxia with hypoxic ischemic encephalopathy. The initial venous blood gas analysis in the NICU was pH: 6.974, PO₂: 52.1 mmHg, PCO₂: 106.6 mmHg, HCO₃⁻: 24.2 mmol/L,
and base excess: −10.3 mmol/L. Hemography showed white blood cell count: 33,600/mm³, hemoglobin: 16.6 g/dL, and platelet count: 384,000/mm³. The value for C-reactive protein was 0.13 mg/dL. The initial chest X-ray revealed small lung volume and poor lung expansion, and the range of lung expansion was at around the sixth intercostal space (Fig. 1). The patient’s diaphragm was elevated and was suspicious for small thoracic lung volume. His birth body weight was 3.4 kg, in the 75–90th percentile; body length was 47 cm (25–50th percentile); head circumference was 34.5 cm (75–90th percentile); and chest circumference was 35 cm (75–90th percentile).

There was no improvement in the patient’s condition and desaturation occurred frequently after initial ventilator support, therefore, we adjusted the ventilator settings gradually to FiO₂: 100%, PIP/PEEP: 20/5 cmH₂O, and rate: 30/minute. However, he remained cyanosed and poorly oxygenated. Sonography demonstrated patent ductus arteriosus with bidirectional shunt and severe pulmonary hypertension; the mean pulmonary artery pressure was 74 mmHg. Normal development of the pulmonary vessels was disclosed by echography. There were no abnormal echographic findings with regard to bilateral diaphragm movement, cardiac anatomy, and bilateral kidney structures. Persistent pulmonary hypertension of the newborn was suspected, and the ventilator support was adjusted to high-frequency oscillatory ventilation (HFOV) accompanied with inhaled NO therapy. The initial HFOV settings were FiO₂: 100%, amplitude: 30 cmH₂O, and mean airway pressure: 17 cmH₂O, and the concentration of inhaled NO was 20 ppm. Repeated chest X-ray still revealed poor lung expansion (Fig. 2) and required advanced ventilator support and FiO₂ 100% to maintain oxygen saturation > 65%. Congenital pulmonary hypoplasia with surfactant deficiency was highly suspected. Surfactant instillation via endotracheal tube was prescribed but failed to improve oxygen saturation. Barotrauma with right-side pneumothorax developed about 29 hours after birth, and a right-side pig-tail chest drain was inserted (Fig. 3). Repeated surfactant plus steroid instillation was given again, but there was still no improvement of the clinical situation. Despite maximum resuscitative measures and maximal respiratory support and intervention, the patient developed progressive respiratory failure and died at 40.5 hours after birth.

Autopsy was performed and small and underdeveloped lungs were noted (Fig. 4). The weight of the lungs was 23.5 g, which was much lower than the average lung weight of 58.7 g for a 3-day-old male neonate. The lung-to-body weight ratio was 0.69% and was much lower than the 10th percentile of the lung-to-body weight ratio for a 37–41-week-old neonate.
which is 1.24%. Microscopy revealed that lung development was in the alveolar stage. Radial alveoli count (RAC) averaged 2.97, which was lower than the normal value of 5 (Fig. 5). Postmortem examination confirmed the diagnosis of primary congenital pulmonary hypoplasia.

3. Discussion

The incidence of congenital pulmonary hypoplasia is 1 per 1000 births; this includes both primary and secondary pulmonary hypoplasia. Primary pulmonary hypoplasia may result from idiopathic deficiencies in certain transcription factors or growth factors, or other syndromes and congenital anomalies, such as multiple pterygium syndrome, fetal aki-nesia–hypokinesia sequence, Scimitar syndrome, trisomy 21 or a familial condition. The causes of secondary pulmonary hypoplasia can be classified as: (1) abnormal thoracic cavity such as congenital diaphragmatic hernia and congenital adenomatoid malformation; (2) abnormal fetal breathing movements, such as in central nervous system lesions or neuromuscular disorders; (3) abnormalities of fetal lung fluid and lung fluid pressure such as oligohydramnios; and (4) congenital heart diseases with poor pulmonary blood flow.

Clinical presentations of congenital pulmonary hypoplasia include immediate respiratory distress, decreased breath sound, and normal or small bell-shaped external chest with or without scoliosis. In certain cases, patients may present with a V-shaped mouth, and muscle weakness associated with neuromuscular disorder.

Diagnostic criteria of pulmonary hypoplasia are as follows: (1) lung-to-birth weight ratio of $\leq 1.2\%$, and if the ratio is $\leq 0.9\%$, pulmonary hypoplasia is very likely; and (2) RAC $\leq 4.1$, which is defined as the number of alveoli cut by a line from the respiratory bronchiolar epithelium to the nearest connective tissue septum. The lung-to-birth weight ratio was 0.69% for this patient, and the RAC was 2.97. All this information confirmed the diagnosis of pulmonary hypoplasia. The
pulmonary manifestations in this baby, both clinical and radiological, could not confirm the diagnosis of pulmonary hypoplasia.

The most important thing in treatment of congenital pulmonary hypoplasia is ventilation support, including intermittent mandatory ventilation, HFOV, and even extracorporeal membrane oxygenation. The prognosis depends on the size of the lungs and the underlying cause.

In a review of the reported cases from 1977 to 2003, mortality was high, with only three out of more than 30 infants with congenital primary pulmonary hypoplasia surviving to discharge from the NICU (Table 1).6–15 Of the infants who died in the neonatal period, the median age at death was only 9 hours, whereas our patient died at 40.5 hours after birth. All of these reported neonates with severe primary pulmonary hypoplasia presented with immediate respiratory distress after birth.

In conclusion, primary congenital pulmonary hypoplasia should be highly suspected in neonates who present with immediate respiratory distress and small lung volume despite advanced respiratory support. Most of these neonates have low lung-to-body weight ratio, and some also show low RAC. The deteriorated respiratory status of these neonates may lead to respiratory failure and even death.

References


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### Table 1

Summary of reported cases with primary congenital pulmonary hypoplasia.

<table>
<thead>
<tr>
<th>Reporter and year</th>
<th>Case no.</th>
<th>Mortality</th>
<th>Lung-to-body weight ratio</th>
<th>RAC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mendlesohn &amp; Hutchins (1977)6</td>
<td>1</td>
<td>1/1</td>
<td>0.21%</td>
<td>Not checked</td>
</tr>
<tr>
<td>Boylan et al (1977)7</td>
<td>2</td>
<td>2/2</td>
<td>1.15%</td>
<td>Not checked</td>
</tr>
<tr>
<td>Swischuk et al (1979)8</td>
<td>8</td>
<td>6/8</td>
<td>0.98%</td>
<td>Reduced</td>
</tr>
<tr>
<td>Langer &amp; Kaufmann (1986)9</td>
<td>9</td>
<td>8/9</td>
<td>2.14%</td>
<td>Reduced</td>
</tr>
<tr>
<td>Chambers (1991)10</td>
<td>1</td>
<td>1/1</td>
<td>0.85%</td>
<td>Not checked</td>
</tr>
<tr>
<td>Frey et al (1994)11</td>
<td>3</td>
<td>3/3</td>
<td>0.57%</td>
<td>Normal</td>
</tr>
<tr>
<td>Hamel (1995)12</td>
<td>2</td>
<td>2/2</td>
<td>0.35%</td>
<td>Not checked</td>
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<tr>
<td>Moerman et al (1998)13</td>
<td>2</td>
<td>2/2</td>
<td>0.69%</td>
<td>Not checked</td>
</tr>
<tr>
<td>Green et al (1999)14</td>
<td>1</td>
<td>1/1</td>
<td>Not check</td>
<td>Not checked</td>
</tr>
<tr>
<td>Odd et al (2003)15</td>
<td>1</td>
<td>1/1</td>
<td>2.56%</td>
<td>Not checked</td>
</tr>
<tr>
<td>Hsu et al (2010)</td>
<td>1</td>
<td>1/1</td>
<td>0.69%</td>
<td>Reduced</td>
</tr>
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RAC = radial alveoli count.