

Anaesthetic management of a preterm neonate with congenital lobar emphysema undergoing left upper lobectomy.

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ABSTRACT

Congenital lobar emphysema (CLE) is a rare congenital pulmonary malformation causing progressive hyperinflation of a pulmonary lobe with compression of the surrounding structures. Anaesthetic management is particularly challenging because positive pressure ventilation may rapidly convert the lesion into a life threatening tension phenomenon. We report the perioperative management of a preterm male neonate , who initially developed respiratory distress syndrome and culture proven neonatal sepsis. After an initial period of clinical stability, he deteriorated on day 14 of life with worsening respiratory distress. Radiological imaging confirmed left upper lobe congenital lobar emphysema, for which left upper lobectomy was performed through a left posterolateral thoracotomy under general anaesthesia. Anaesthetic management focused on maintaining spontaneous ventilation until thoracotomy to avoid further hyperinflation, minimizing airway pressures after decompression using lung-protective ventilation, and electively continuing postoperative mechanical ventilation. This case highlights the unique anaesthetic challenges of CLE in a preterm neonate, including prevention of tension pneumothorax during induction, the impracticality of lung isolation in a low birth weight neonate , and optimisation of peri-operative care in the presence of prematurity and ongoing neonatal sepsis.

Keywords: Congenital lobar emphysema; Premature neonate; Neonatal lobectomy; Spontaneous ventilation; Neonatal anaesthesia

Introduction:

Congenital lobar emphysema (CLE) is a rare congenital pulmonary anomaly characterised by progressive hyperinflation of one or more pulmonary lobes due to partial bronchial obstruction, [1] with an estimated incidence of approximately 1 in 20,000–30,000 live births.[1,2] It occurs more frequently in males, and the left upper lobe is the most commonly affected site, followed by the right upper and middle lobes.[3] The underlying mechanism is usually a check-valve phenomenon resulting from intrinsic bronchial abnormalities such as deficient bronchial cartilage or mucosal folds, or from extrinsic bronchial compression, allowing air entry during inspiration while limiting expiration.[1,2] Progressive air trapping leads to enlargement of the affected lobe, compression of adjacent normal lung tissue, and varying degrees of mediastinal shift, which may result in severe respiratory and haemodynamic compromise if not recognized promptly.[3, 4,5] Clinically, neonates commonly present with respiratory distress, tachypnoea, chest retractions, grunting, and diminished breath sounds over the affected hemithorax. Because its clinical and radiological features may resemble conditions such as tension pneumothorax, congenital pulmonary airway malformation, or bronchogenic cyst, careful interpretation of imaging findings is essential to establish the diagnosis and avoid inappropriate interventions.[4,6,7] Surgical lobectomy remains the treatment of choice for symptomatic patients.[1,3] From an anaesthetic perspective, induction and airway management are particularly challenging because positive-pressure ventilation before surgical decompression may worsen hyperinflation of the affected lobe, leading to increased mediastinal shift, impaired venous return, and cardiovascular collapse.[1,3,5] These challenges become even

more complex when additional factors such as prematurity and concurrent neonatal sepsis, necessitating meticulous peri-operative planning. We report the successful anaesthetic management of a preterm neonate with left upper lobe CLE undergoing lobectomy, highlighting the strategies employed to minimize perioperative risk.

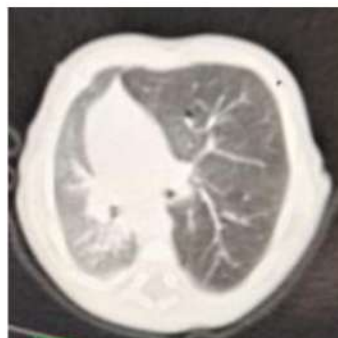
Case Report

A 14-day-old preterm male neonate was referred to our tertiary care centre for further management of congenital lobar emphysema (CLE) with progressive respiratory distress. The infant was born at 33 weeks + 5 days of gestation (birth weight 1.88 kg) by normal vaginal delivery. Apgar scores were within normal limits and no resuscitation was required at birth.

During the initial neonatal intensive care unit (NICU) stay the baby was managed for prematurity with respiratory distress syndrome and culture proven klebsiella sepsis. Respiratory support with non-invasive ventilation (continuous positive airway pressure CPAP) was required initially, and the patient was successfully weaned to room air by the third day of life. Intravenous meropenam was administered as per sensitivity, and one episode of apnoea was documented during the NICU stay. Neurosonography performed on day 6 of life demonstrated a Grade I germinal matrix hemorrhage, with no other significant intracranial abnormalities.

On the 14th day of life, the baby developed worsening respiratory distress characterised by

tachypnoea, chest retractions and increased work of breathing. Chest radiography demonstrated marked hyperinflation of the left lung with mediastinal shift, raising the possibility of congenital lobar emphysema or tension pneumothorax. Chest ultrasonography showed reduced lung sliding on the left without pleural effusion or pneumothorax. High resolution computed tomography (HRCT) of the thorax confirmed marked hyperinflation of the left upper lobe and lingula with herniation across the midline, significant rightward mediastinal shift, compressive atelectasis of the adjacent lung, and patchy consolidation of the left lower lobe, consistent with congenital lobar emphysema.



The patient was subsequently referred to our institution for definitive surgical management. On admission, the baby weighed 1.92 kg and remained on treatment for ongoing sepsis. Clinical examination revealed tachypnoea with subcostal and intercostal retractions, reduced air entry over the left hemithorax, and desaturation requiring supplemental oxygen. The heart rate was 160 beats/min, respiratory rate 72 breaths/min, and peripheral oxygen saturation was 86% on room air. The baby was stabilised on high-flow nasal cannula (HFNC) oxygen therapy while continuing intravenous antibiotics, supportive care, and close cardiorespiratory monitoring in the neonatal intensive care unit. After optimisation and multidisciplinary discussion involving the neonatology, pediatric surgery and anaesthesia teams, emergency left posterolateral thoracotomy and left upper lobectomy were planned.

Pre-anaesthetic Evaluation

A detailed pre-anaesthetic evaluation was performed. The planned procedure was left posterolateral thoracotomy with left upper lobectomy.

At the time of evaluation, the patient was receiving respiratory support with high-flow nasal cannula (HFNC) oxygen therapy and maintained an oxygen saturation of 100% on supplemental oxygen. Respiratory examination revealed tachypnoea with increased work of breathing and decreased air entry over the left hemithorax. Cardiovascular examination demonstrated normal first and second heart sounds without an audible murmur, and no congenital cardiac anomaly had been documented. Preoperative investigations revealed a hemoglobin concentration of 11.9 g/dL, total leukocyte count of 10,600/ μ L, platelet count of 5.7×10^5 / μ L, and hematocrit of 35.6%. C-reactive protein was 1.5 mg/L. Cerebrospinal fluid examination was normal. Blood group was O positive, and random blood glucose (RBS) was 79 mg/dL. Renal function tests were within normal limits. Liver function tests demonstrated elevated total bilirubin (6.99 mg/dL) with direct bilirubin (0.85 mg/dL), mildly elevated aspartate aminotransferase (44 U/L), reduced total protein (4.0 g/dL), and hypoalbuminemia (2.6 g/dL), likely related to prematurity and ongoing neonatal sepsis. Alanine aminotransferase, alkaline phosphatase, coagulation parameters, and thyroid-stimulating hormone were within acceptable limits for surgery.

Intra-operative Anaesthetic Management

Intraoperative anaesthetic management was carefully planned to minimise further hyperinflation of the affected lobe while maintaining cardiorespiratory

stability. Standard American Society of Anesthesiologists (ASA) monitors, including electrocardiography, non-invasive blood pressure, pulse oximetry, and end-tidal carbon dioxide (EtCO₂), were applied. A peripheral intravenous line was secured, and maintenance intravenous fluids were administered according to neonatal requirements. Active warming was maintained throughout the procedure using a forced-air warming device to prevent perioperative hypothermia.

Following adequate preoxygenation with 100% oxygen, anaesthesia was induced with incremental concentrations of sevoflurane while preserving spontaneous ventilation. Considering the risk of progressive hyperinflation of the emphysematous lobe with positive-pressure ventilation, assisted ventilation was deliberately avoided during induction. The surgical team was scrubbed and prepared to perform an emergency thoracotomy in the event of complications during induction.

After achieving an adequate depth of anaesthesia, the trachea was gently intubated with a 3.0mm uncuffed endotracheal tube, secured at 8 cm at the lip, without the administration of a neuromuscular blocking agent. Anaesthesia was maintained with sevoflurane in 100% oxygen initially, followed by an oxygen–air mixture, while spontaneous ventilation was continued until thoracotomy and surgical clamping of the affected left upper lobe. Intravenous fentanyl 1mcg/kg was administered for intraoperative analgesia, and intravenous dexamethasone 0.2mg/kg was administered for airway edema prophylaxis.

Following surgical clamping of the emphysematous lobe, intravenous atracurium was administered to facilitate neuromuscular blockade, and controlled mechanical ventilation was initiated using lung-protective ventilation with low airway pressures. Ventilation became easier, with a noticeable reduction in peak airway pressures and improved

oxygenation following decompression of the affected lobe. Intravenous crystalloid ringer's lactate with 1% dextrose was administered judiciously to maintain euvolemia while avoiding fluid overload.

The surgical duration was approximately 90 minutes. Intraoperative blood loss was minimal, and no blood transfusion was required. A left-sided intercostal drain (ICD) was kept in situ for postoperative drainage. At the completion of the procedure, the operating surgeon administered an intercostal nerve block with 1ml of 0.25% bupivacaine to provide postoperative analgesia.

The intraoperative course remained haemodynamically stable throughout the procedure. Heart rate ranged between 160 and 180 beats/min, while peripheral oxygen saturation was maintained between 85% and 96%, with progressive improvement following decompression and resection of the emphysematous lobe. In view of the prematurity, low birth weight, ongoing neonatal sepsis, and the nature of thoracic surgery, elective postoperative mechanical ventilation was planned. The infant was transferred intubated to the neonatal intensive care unit for planned ventilatory support and further postoperative management.

Postoperative Course

The patient remained haemodynamically stable in the postoperative period. Mechanical ventilation was gradually weaned, and the baby was successfully extubated to high-flow nasal cannula (HFNC) on postoperative day 1 with HFNC at 4 L/min with an FiO₂ of 25%, maintaining oxygen saturation between 95% and 98%. Respiratory rate ranged from 35 to 46 breaths/min, with bilaterally equal air entry on auscultation. The left-sided ICD showed

minimal serosanguinous drainage, with a total output of approximately 20 mL.

Postoperative laboratory evaluation revealed serum sodium of 134 meq/L and potassium of 5.7 meq/L. In view of hyperkalemia, maintenance intravenous fluids were changed to a potassium-free solution. A postoperative chest radiograph demonstrated partial right lung collapse with the left intercostal drain in situ, which resolved with conservative management. Enteral feeding with paladai was gradually reintroduced and advanced as tolerated. Intravenous antibiotics continued, along with calcium and vitamin D3 supplementation.

On subsequent assessment, Progressive clinical improvement was observed during the NICU stay, the baby was active and alert, with stable haemodynamic parameters and maintained an oxygen saturation of 98% in room air, and the baby was discharged on postoperative day 12.



Discussion

Congenital lobar emphysema (CLE) is an uncommon congenital pulmonary anomaly characterised by progressive hyperinflation of a pulmonary lobe secondary to a partial bronchial obstruction with a check-valve mechanism.[1,2] Progressive air trapping causes compression of adjacent normal lung tissue and mediastinal shift, leading to respiratory

compromise.[1,2] Symptomatic neonates generally require surgical lobectomy, while anaesthetic management remains particularly challenging because positive-pressure ventilation may rapidly convert compensated hyperinflation into life-threatening tension pneumothorax with severe hypoxemia and cardiovascular compromise.[1,3,5]

The principal anaesthetic objective in symptomatic CLE is to prevent further expansion of the affected lobe during induction of anaesthesia. Preservation of spontaneous ventilation until surgical decompression has therefore been widely recommended in the literature, particularly in infants presenting with significant respiratory distress and mediastinal shift.[1,3,5] In the present case, inhalational induction with incremental concentrations of sevoflurane was performed while maintaining spontaneous ventilation, and assisted positive-pressure ventilation was deliberately avoided until thoracotomy. During induction, the surgical team remained scrubbed and ready for immediate thoracotomy if required. Following surgical clamping of the affected lobe, neuromuscular blocker was administered and controlled lung-protective ventilation was safely instituted, resulting in improved oxygenation and reduced peak airway pressures.

Another important consideration was the physiological vulnerability of neonates. Prematurity, low body weight, and ongoing sepsis, significantly reduced physiological reserve and increased the risk of perioperative hypothermia, hypoglycemia, fluid imbalance, and altered pharmacokinetics of anesthetic agents.[9] These concerns were addressed by meticulous temperature management using active warming, judicious administration of maintenance fluids, careful titration of anaesthetic drugs, and continuation of appropriate antimicrobial therapy throughout the perioperative period.

Elective postoperative ventilation was planned because of the combined effects of prematurity, thoracotomy, recent lung resection, and the need to ensure adequate respiratory recovery before extubation.

Airway management in neonates with CLE presents additional challenges because conventional lung isolation techniques, including double-lumen tubes and bronchial blockers, are not feasible in very small infants.[1,5] Consequently, ventilation strategies rely on maintaining spontaneous ventilation before surgical decompression and employing lung-protective controlled ventilation after clamping of the affected lobe[1,2]. Our patient was successfully managed using this approach without the need for specialized lung isolation devices.

Postoperative respiratory complications remain common following lobectomy in neonates because of residual atelectasis, altered pulmonary mechanics, and limited respiratory reserve.[3] In the present case, elective postoperative mechanical ventilation allowed gradual respiratory stabilisation. A transient contralateral lung collapse observed on postoperative chest radiography resolved with conservative management, and mild postoperative hyperkalemia was successfully managed by changing to potassium-free maintenance fluids. The infant subsequently showed progressive clinical improvement and was successfully weaned to high-flow nasal cannula oxygen therapy.

This case highlights that successful perioperative management of congenital lobar emphysema depends on meticulous planning, anticipation of physiological deterioration during induction, maintenance of spontaneous ventilation until surgical decompression, lung-protective ventilation thereafter, and close multidisciplinary collaboration among the anaesthesia, pediatric surgery, neonatology, and intensive care teams.

Conclusion

Anaesthetic management of congenital lobar emphysema in a premature neonate requires meticulous perioperative planning and a thorough understanding of the underlying pathophysiology. Preservation of spontaneous ventilation during induction, avoidance of positive-pressure ventilation until surgical decompression, lung-protective ventilation, and planned postoperative ventilatory support were key to the successful outcome in our patient. We report this rare case to highlight the unique anaesthetic challenges posed by the coexistence of prematurity, congenital lobar emphysema, and neonatal sepsis, and to contribute to the existing literature on the perioperative management of this high-risk population.

Conflict of Interest :NIL

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