

Anesthetic management of a neonate with congenital diaphragmatic hernia under high-frequency oscillatory ventilation

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Abstract

Perioperative management of a neonate with congenital diaphragmatic hernia (CDH) is challenging because of pulmonary hypoplasia, pulmonary hypertension, and respiratory insufficiency. In this report, we present our intra-operative experience in a 4-days old and 3070 grams CDH neonate. He was admitted to neonatal intensive care unit and intubated due to severe respiratory insufficiency. He showed signs of severe pulmonary hypoplasia and his echocardiography revealed a cardiac dextroversion. The patient was relatively stabilized after four days under combined high-frequency oscillatory ventilation (HFOV) and inhaled nitric oxide (iNO). A corrective surgical intervention was sustained with dopamine, dobutamine, fentanyl and midazolam infusions. Ventilator settings were: 9 cmH₂O MAP; 15-Hz frequency; 30 cmH₂O amplitude and 55% FiO₂. Venous-blood gas analysis indicated pH:7.38 pO₂:36.2, pCO₂:39.2 with SpO₂:98%. We believe that HFOV and iNO combination is an effective alternative for the anesthetic management of CDH cases as it provides better gas exchange and less volutrauma.

Introduction

Congenital diaphragmatic hernia (CDH) is a rare condition (1/2500 births) that overall has a high mortality rate ranging between 42% and 68%.¹ Pulmonary

hypoplasia, pulmonary hypertension and respiratory insufficiency are the factors that make perioperative management of the patients with CDH challenging.¹ During the perioperative management of these patients, the conventional ventilation strategies may be inadequate. On the other hand, for neonates with CDH with low ventilation volumes, high-frequency oscillatory ventilation (HFOV) is a safe and effective choice as it provides better gas exchange and less volutrauma.² In this report, we aim to present our intra-operative experience in a 4-days old neonate with severe lung hypoplasia under ventilatory treatment with HFOV and inhaled nitric oxide (iNO) combination.

Case Report

A 38 weeks of gestational age, 3070-gram newborn male was admitted to neonatal intensive care unit (NICU) and intubated due to severe respiratory insufficiency. Babygram revealed a left posterolateral diaphragmatic hernia with intestinal loops high in the left hemi-thorax. He showed signs of severe pulmonary hypoplasia and his echocardiography revealed cardiac dextroversion. His initial blood gas analysis at NICU was pH: 6.96, pO₂: 38.2, pCO₂: 97.9 and BE: -9.9. HFOV and iNO was initiated as the choice of ventilatory treatment with the ventilator settings of ΔP (amplitude): 34 cmH₂O, mean airway pressure (MAP): 16 mmHg, frequency 6 Hz and FiO₂: 0.9. On his third day of ventilatory treatment, the patient developed bilateral pneumothorax accompanied by massive pneumoperitoneum, related to the presence of the diaphragmatic defect. A right lower abdominal tap using a large bore angiocut was sufficient to drain the free air, thus rendering a thoracic drainage useless. With the improvement in patients' clinical situation and blood gas analysis, his ventilator settings were gradually decreased. On the fourth day, the patient was relatively stabilized allowing us to operate. He was transferred to the operating room and a corrective surgical intervention took place while under the same ventilatory treatment. Patient's blood pressure was monitored via arterial catheterization during the operation. At induction of anesthesia 2 mg rocuronium and 5 μg fentanyl was administered. Dopamine (5 μg/kg/min), dobutamine (2 μg/kg/min), fentanyl (4 μg/kg/min) and midazolam (6 μg/kg/min) infusions sustained during the perioperative period. Ventilator settings were as follows; 19 cmH₂O MAP, 15 Hz frequency, 30 cmH₂O amplitude and 55% FiO₂. Venous-blood gas analysis indicated as pH: 7.38 pO₂: 36.2

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pCO₂: 39.2 and his SpO₂ was 98%. We did not need to change the ventilator settings during the surgery as the operation went uneventful through a left subcostal incision. The patient was safely transferred back to NICU, where he stayed an additional 15 days. On his 3rd postoperative day HFOV was stopped and SIMV mode was initiated. He was extubated in his 10th day in the NICU and discharged from the hospital when he was 30 days old.

Discussion and Conclusions

CDH is a challenging pathology for the NICU intensivist, anesthesiologist, and the pediatric surgeon. We think that a vigilant multidisciplinary approach has utmost importance. Pulmonary hypoplasia, pulmonary hypertension and respiratory failure are the main determinants that effect prognosis.² Pulmonary, cardiac, gastrointestinal, neurological morbidities are often associated with CDH. Growth failure and chest wall deformities such as scoliosis may be encountered in these patients. Contemporary treatment mandates extensive use of HFOV and iNO for patients with CDH in NICU's. HFOV is advocated to improve oxygenation in CDH patients effectively, as HFOV diminishes iatrogenic barotrauma by eliminating CO₂ at low ven-

tilation pressures.¹ During the perioperative management of these patients, the conventional ventilation strategies may be inadequate. HFOV is also reported as a secure method used for maintenance of anesthesia during operation. Close monitoring of arterial pressure during the intraoperative management is strongly suggested, since the distention pressure caused by HFOV may diminish both venous return and cardiac output.³ iNO is another alternative adjunctive treatment for CDH patients in treating pulmonary hypertension. Sildenafil may also be preferred for the pulmonary hypertension therapy.¹ Albeit the contradictory results for the best treatment strategies for CDH patients, we successfully managed our case with iNO and HFOV.

The optimal timing of the surgery for hernia repair is not definite yet and there are conflicting results in the literature. There are studies suggesting a prolonged period of ventilator support to improve pulmonary

compliance and treat pulmonary hypertension.³ Garriboli *et al.* reported no difference between the early or delayed repair of hernia in their study.⁴ Migliazza *et al.* on the other hand, suggest that the physiological state of the CDH patient may be more important than the exact timing of the surgery.² Moreover, they believe that, surgery may deteriorate the thoraco-pulmonary compliance during the early postoperative period.² We had a relatively uneventful operation, with the benefit of preoperative stabilization of the patient using HFOV and nitric oxide. We believe that, pulmonary and cardiac stabilization before surgery is the key point of our CDH patient's successful discharge.

We advocate HFOV and iNO combination as an effective alternative anesthetic management of CDH cases in the operating room when the status of the infant is optimal.

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