Institutional experience with elective high-frequency oscillatory ventilation for neonatal thoracoscopic surgery

Arlyne K. Thung MD, Karen Diefenbach MD, Christopher McKee MD, David P. Martin MD and Joseph D. Tobias MD, FAAP
Nationwide Children’s Hospital and Wexner Medical Center, The Ohio State University, Columbus, Ohio

Introduction
Thoracoscopy is a minimally invasive technique for surgical repair of congenital diaphragmatic hernia (CDH) and tracheoesophageal fistula (TEF) - esophageal atresia (EA) in neonates. Reported advantages of the technique include enhanced surgical visualization, avoidance of an open thoracotomy, shorter duration of mechanical ventilation, decreased opioid requirements, and quicker return to enteral feeds. In the neonate, concerns regarding oxygenation, ventilation and hypercarbia associated with CO₂ insufflation may be more pronounced. High-frequency oscillatory ventilation (HFOV) maintains mean airway pressure and optimal lung volume while limiting peak inflating pressures and lung over-distension.

Methods
- IRB approved, prospective data collection in five patients for surgical procedures (3 CDH, 2 TEF) using HFOV.
- Intraoperative variables of HR, BP, transcutaneous CO₂ (TC-CO₂), PaCO₂, PaO₂. HFOV ventilation settings, and insufflation pressures were recorded at baseline and subsequent intervals during the case.
- Patient demographic data and postoperative recovery characteristics were obtained including:
  1. time to tracheal extubation
  2. time to oral feeds
  3. opioid consumption
  4. time to discharge

Results
- Thoracoscopic repair of CDH and TEF/EA was successfully performed in all patients except for the 36 week, 2.2 kg neonate with TEF/EA.
- Patient age at surgery ranged from 36 to 39 weeks with weights from 2.2 to 3.3 kilograms.
- All patients were transitioned to HFOV from conventional ventilation in the operating room.
- Anesthesia was maintained with dexmedetomidine (0.5-0.8 µg/kg/hr), remifentanil (0.05-0.2 µg/kg/min), morphine (0.1-0.15 mg/kg), and rocuronium.
- Adjustments in HFOV settings were guided by TC-CO₂ which correlated with PaCO₂ values prior to and during thoracic insufflation (difference of 2-8 mmHg) in 4 of 5 patients. Adequate oxygenation and ventilation were maintained using HFOV.
- In 2 of the 3 CDH patients, tracheal extubation occurred on postoperative day #1 with full feeds on day #3 and #4. Total 48 hour opioid consumption was significantly less in the neonates with thoracoscopic versus open repair.

Discussion
- Intraoperative use of HFOV can provide adequate oxygenation, ventilation, surgical visualization, and effective CO₂ elimination during neonatal thoracoscopic surgery.
- TC-CO₂ guided HFOV settings and adjustments correlated well with PaCO₂ values following proper calibration in 4 of the 5 patients.
- TC-CO₂ may not be reliable in neonates ≤ 2.2 kilograms.
- Rapid tracheal extubation, minimal use of opioids, and quick transition to enteral feeds were seen in 2 of the 3 patients who had isolated CDH.
- Intraoperative HFOV is an effective ventilation strategy in neonates undergoing thoracoscopic surgery.

<table>
<thead>
<tr>
<th>Patient</th>
<th>Age (weeks)</th>
<th>Weight (kilograms)</th>
<th>Extubation (postoperative day)</th>
<th>Full feeds (postoperative day)</th>
<th>Discharge (postoperative day)</th>
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<tbody>
<tr>
<td>CDH#1</td>
<td>37.4</td>
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<td>5</td>
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References