High-frequency ventilation: Rescue during tracheo-esophageal fistula repair in the setting of congenital heart disease

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INTRODUCTION

- Thoracoscopic repair of tracheo-esophageal fistula/esophageal atresia (TEF/EA) poses unique challenges to the anesthesiologist
- Complex comorbidities such as congenital heart disease can introduce significant complexity to anesthetic management
- Optimal ventilation strategies have not yet been elucidated

CASE

- 3 day old, 2.2 Kg female, born at term, presented for thoracoscopic repair of type C TEF/EA
- Comorbidities:
  - Trisomy 21
  - Large PDA with bidirectional flow
  - Large secundum ASD with left-to-right shunt
  - Dextroposition with left sided aorta
- Inhalation induction with sevoflurane maintaining spontaneous ventilation until PPV was demonstrated
- Rigid bronchoscopy showed a large fistula, one centimeter proximal to the carina
- Intubated via direct laryngoscopy
- Monitors: right radial arterial line, pre and post ductal SpO2
- Poor surgical visualization thoracoscopically
- Manual ventilation initiated with no improvement, despite increased respiratory rate and lower tidal volumes

DISCUSSION

- Thoracoscopic repair (TR) of TEF/EA, first performed in 2000, is frequently attempted by pediatric surgeons due to:
  - Decreased incidence of scoliosis and shoulder girdle weakness
  - Decreased stress response (as measured by IL-6)
  - Theoretically better view of intra-thoracic anatomy and fistula
  - Improved cosmetic results
- TR poses unique anesthetic challenges
- In a published series of patients with TEF/EA undergoing repair, PCO2 levels were not higher in the TR versus open repair group and the TR group had a shorter time to extubation (no CHD) 2
- However, in another series of patients with coexisting CHD, hypercapnia and hypoxemia were significant complications associated with TR 3
- In the case presented, hypercapnia, hypoxemia and acidosis likely lead to elevation in pulmonary vascular resistance and reversal of shunt to right-to-left
- Different modes of ventilation can be useful in the anesthetic management of these patients
- Unique to the high frequency jet ventilator:
  - Frequency – up to 11 Hz (660 bpm)
  - Inspiratory time – 0.02 to 0.034 seconds
  - I/E ratio – dependent on the frequency
  - Delta P – generates the tidal volume (∆P= PIP–PEEP)
  - Important to keep MAP constant to avoid atelectasis and desaturation
- Disadvantages:
  - Inability to monitor end tidal CO2
  - Need of additional personnel to manage HFJV complex settings
- Our case demonstrates a clinical scenario in which HFJV improved the anesthetic management of a TEF/EA thoracoscopic/open repair
- Further research is needed to target the use of intraoperative HFJV

References:

Serial arterial blood gases demonstrated significant hypercapnea and hypoxemia (see table)
- Pre and post ductal oxygen saturation gap widened
- Despite conversion to open repair, ventilation and oxygenation failed to improve
- High frequency jet ventilation initiated
- Marked improvement in oxygenation
- Followed by improvement in ventilation
- After successful completion of the surgery the baby had an uneventful recovery

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<th>ABG</th>
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<th>B</th>
<th>C</th>
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<tr>
<td>PaCO2</td>
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A. Pre HFJV
B. Immediately after initiation of HFJV
C. Conclusion of surgery