Predicting lung pressure exposure in high frequency oscillatory ventilation by utilizing a novel carinal endotracheal tube
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INTRODUCTION

• High frequency oscillatory ventilation (HFOV) is used to treat respiratory distress syndrome (RDS) in neonates.
• Delivered pressure during HFOV is attenuated due to the endotracheal tube (ETT) and therefore higher airway pressures than used during conventional ventilation are employed. [1]
• Pressure attenuation is based on factors including ETT lumen size, HFOV settings, and lung compliance making it difficult to predict lung pressure exposure.
• A novel ETT (Carinal VitaLine TM, Medtronic, CO) allows carbon dioxide to be sampled at the carinal level via an internal lumen in the distal portion of the ETT [2,3]:
  • This lumen may permit adequate pressure transmission, facilitating pressure monitoring without pressure attenuation from the ETT.
  • We hypothesized measuring pressure via a carinal ETT lumen provides a closer estimation of delivered pressure to a test lung than using pressures sampled at the proximal wye connector.
  • We conducted a bench study to determine if this hypothesis was correct.

METHODS

• An infant test lung (Michigan Instruments, MI) with a compliance of 3ml/cmH2O with no added resistance was connected to a HFOV, via a size 3.0 Carinal Vitaline ETT.
• Pressure was sampled continuously at the proximal wye connector, carinal portion of the ETT and the test lung.
• These pressures were measured with a device (Bicore II, CareFusion), and recorded with IT software (Polybench, Applied Biosignals).
• We recorded pressures at HFOV settings of Amplitude: 40, 50, 60, and Hz: 7, 10, 13 at a mean airway pressure 30cmH2O and bias flow 20LPM. We calculated peak, trough, and delta pressures over 3 consecutive breaths.
• We report the mean and standard deviation difference between test lung pressure and pressure sampled either at the wye or via the carinal portion.

RESULTS

• We found a significant difference between airway pressure measured at the patient wye and pressure delivered to the test lung (see figure 1.)
• This difference was variable depending on ventilator settings.
• The difference between pressure measured at the carinal port of the ETT and pressure delivered to the test lung was minimal.

<table>
<thead>
<tr>
<th>Amplitude (L)</th>
<th>Frequency (Hz)</th>
<th>Lung Pressure – Airway Pressure (cm H2O, mean ± SD)</th>
<th>Lung Pressure – Carinal Pressure (cm H2O, mean ± SD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>10</td>
<td>-34.28 ± 0.40</td>
<td>0.72 ± 0.03</td>
</tr>
<tr>
<td>50</td>
<td>7</td>
<td>-37.79 ± 0.29</td>
<td>0.35 ± 0.06</td>
</tr>
<tr>
<td>50</td>
<td>13</td>
<td>-16.81 ± 2.00</td>
<td>0.70 ± 0.06</td>
</tr>
<tr>
<td>40</td>
<td>10</td>
<td>-23.40 ± 0.06</td>
<td>0.72 ± 0.07</td>
</tr>
<tr>
<td>60</td>
<td>10</td>
<td>-46.27 ± 0.10</td>
<td>0.72 ± 0.09</td>
</tr>
</tbody>
</table>

Figure 1 showing difference between the airway and carinal pressure compared to actual lung pressure

CONCLUSIONS

• During HFOV, measuring pressure at the patient wye overestimates pressure delivered to a simulated infant test lung.
• Measuring pressure via the distal lumen of Carinal VitaLine ETT provides an improved approximation of pressure delivered to the test lung.
• Lung protective strategies aimed at minimizing pressures delivered to the lungs may benefit from this type of sampling technique.

REFERENCES