PRM Reveals Prone vs. Supine Lung Tissue Expansion Differences in an Ovine Model of ARDS

Zac Althof\textsuperscript{1,2}, David W. Kaczka\textsuperscript{1,2}, Guido Musch\textsuperscript{3}, Joseph M. Reinhardt\textsuperscript{1,2}

University of Iowa\textsuperscript{1}, Iowa Institute for Biomedical Imaging\textsuperscript{2}, Washington University\textsuperscript{3}
Introduction

- Acute respiratory distress syndrome (ARDS)
- Patient positioning during ventilation affects aeration
- Patient outcome could be impacted by ventilation position choice
- Parametric response mapping (PRM)
- Atelectrauma and ventilator induced injury

Cereda, M., Thorax, 2016, Vol. 72, pg. 981-989
Goal

• Develop metric to quantify degree of intratidal recruitment / derecruitment (atelectrauma)
• Use metric to compare prone vs. supine positioning during ventilation
Data

• Respiratory-gated CT scans of nine sheep
  • End-expiratory (EE) and end-inspiratory (EI)
  • Saline lavage induces acute lung injury
  • Scans at onset of injury, two hours, and four hours later
• EE registered to EI to acquire deformed EI image
• PRM of EE vs. EI voxel densities
Methods
Results
### Results

<table>
<thead>
<tr>
<th>Time</th>
<th>Prone ($\Delta_{\text{max}, \text{HU}}$)</th>
<th>Supine ($\Delta_{\text{max}, \text{HU}}$)</th>
<th>P-value (* = significant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>$131.53 \pm 35.79$</td>
<td>$167.61 \pm 30.40$</td>
<td>0.120</td>
</tr>
<tr>
<td>T2</td>
<td>$118.26 \pm 28.25$</td>
<td>$174.49 \pm 21.39$</td>
<td>0.023*</td>
</tr>
<tr>
<td>T3</td>
<td>$116.74 \pm 26.14$</td>
<td>$163.99 \pm 21.67$</td>
<td>0.038*</td>
</tr>
</tbody>
</table>
## Results

<table>
<thead>
<tr>
<th>Time</th>
<th>Prone (Δmax,HU)</th>
<th>Supine (Δmax,HU)</th>
<th>P-value (* = significant)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T1</td>
<td>113.83 ± 6.00</td>
<td>185.12 ± 2.39</td>
<td>1.51 x 10^{-5}*</td>
</tr>
<tr>
<td>T2</td>
<td>104.50 ± 7.13</td>
<td>185.52 ± 11.09</td>
<td>1.78 x 10^{-4}*</td>
</tr>
<tr>
<td>T3</td>
<td>104.48 ± 10.13</td>
<td>175.73 ± 8.66</td>
<td>4.21 x 10^{-4}*</td>
</tr>
</tbody>
</table>
Conclusions

• Significant differences were seen in $\Delta_{\text{max}}$ between prone and supine subjects
• Indicates prone positioning during mechanical ventilation may exhibit less intratidal recruitment / derecruitment compared to supine subjects
• Prone positioning may be lung protective, reducing potential for ventilator-induced lung injury