THE EFFECTS OF PRONE POSITIONING ON TRANSPULMONARY PRESSURES AND END EXPIRATORY VOLUMES IN HEALTHY PATIENTS

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Introduction: A recent study demonstrated a survival benefit of prone positioning in critically ill patients with Acute Respiratory Distress Syndrome (ARDS). Prone positioning was compared to a control strategy of limitation of tidal volume and plateau pressures and moderate levels of positive end expiratory pressures (PEEP). The mechanism of benefit in prone positioning is however incompletely understood. We hypothesized that one possible mechanism is a reduction in pleural pressure (Ppl), with corresponding increase in the trans-pulmonary pressure (PL), at any given PEEP. The use of esophageal pressure (Pes) as a surrogate for pleural pressure (Ppl) has been validated in previous studies in both upright and supine patients. In the supine position it has been demonstrated that the weight of the mediastinum may elevate Pes and falsely increase estimated Ppl. However, to our knowledge, the use of esophageal manometry in prone ventilated patients under general anesthesia has not been investigated.

Objectives: The objective of this study was to characterize effects of prone positioning on Pes, PL and lung volume at end exhalation in patients under general anesthesia, thereby assessing the potential utility of Pes measurements in setting PEEP in prone patients with ARDS.

Methods: Patients were healthy adults, 8 men and 5 women, undergoing elective spine surgery at a large tertiary care center. After induction of general anesthesia, an esophageal balloon catheter was passed by mouth to a distance of 30-40cm. Position of the balloon was confirmed by externally compressing the chest wall while occluding the airway and demonstrating similar spikes in Pes and airway pressure. Pes, expiratory reserve volume (ERV) and elastance were measured supine and prone position using 6cc/kg PBW tidal volumes and at PEEP levels of 0 and 7 cmH2O. The data were analyzed with Windaq software, and paired t-test was used to assess differences in measurements in the two positions.

Results: Pes in the supine position was 7.325 +/- 2.395 cmH2O and decreased when the patients were placed in the prone position to 4.072 +/- 4.161 cmH2O, (p < 0.0014). The mean difference between supine and prone positions was 3.254 cmH2O (95% CI 1.564 to 4.944). We observed a significant increase in ERV from supine to prone position with a mean difference of 0.211 L (95% CI 0.05332 to 0.3685, p < 0.013). Chest wall compliance decreased from the supine to prone, evidenced by an increase in elastance from 6.67 +/- 3.08 cmH2O/L to 13.93 +/- 4.99 cmH2O /L, (p < 0.0003) respectively. Lung compliance did not appear to differ with position. Supine lung elastance was 19.09 +/- 6.14 cmH2O/L and prone 19.98 +/- 8.84 cmH2O/L (p < 0.67).

Conclusion: Pes decreases and ERV increases when patients are moved from supine to prone. This indicates that, when prone, shifting abdominal contents and mediastinal weight allow for a greater transpulmonary pressure, resulting in greater lung volumes for a given PEEP. This may be one of the mechanisms for the observed clinical benefit with prone positioning and an area for potential application of Pes measurements to guide application of PEEP in the prone position.