

Increased Spatial Distribution of Airflow in Lungs with Low-Level Pressure Support Ventilation Compared to Maintenance Ventilation

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Introduction

Vibration response imaging (VRI) is a novel technology that utilizes sophisticated software and surface skin sensors placed on the back to record, analyze and display vibrations as a non-invasive measure of lung ventilation (Fig. 1).



Fig. 1

Vibration Response Images at Mid Inspiration
 Assist Volume Control Pressure Support Ventilation

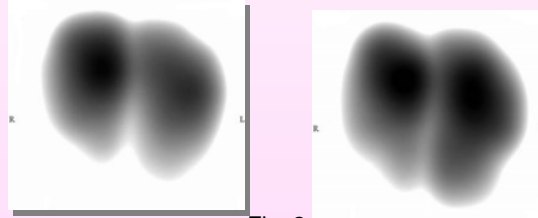


Fig. 2

Hypothesis

Compared to assist volume control ventilation (AVC), pressure support ventilation (PSV) will result in a greater spatial distribution of vibration as a likely surrogate of airflow.

Methods

We performed serial VRI during maintenance assist volume control and immediately following initiation of spontaneous breathing trial using low-level pressure support ventilation in 26 mechanically ventilated patients. Recordings were performed over 12-20 second periods of respiration. Respiratory cycles free of noise or motion artifacts were chosen for analysis and images at mid inspiration were analyzed (Fig. 2). Areas of images were calculated digitally using the program Image J. The areas of the lungs measured at mid-inspiration were compared, AVC versus PSV (Fig. 3). Statistical analysis was performed using t-test and the t-distribution.

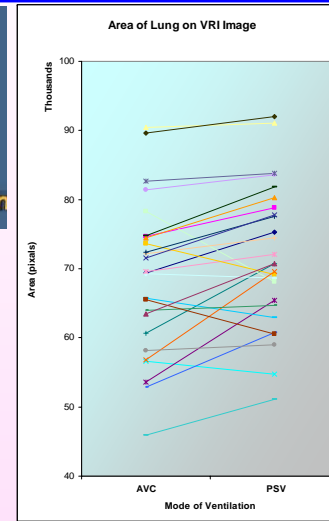


Fig. 3

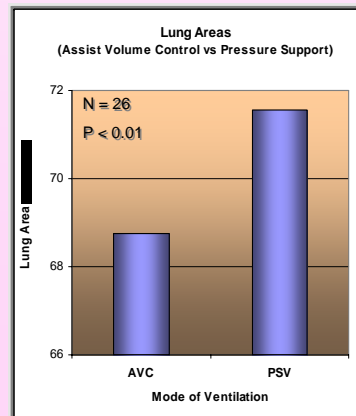


Fig. 4

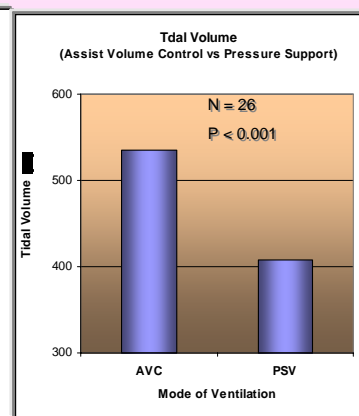


Fig. 5

Results

The mean areas of both lungs were 68.75 ± 11.06 and 71.57 ± 10.50 (mean in kilopixels \pm stdev) in AVC and PSV images, respectively ($p = 0.00985$) (fig. 4). There was a mean increase of $4.73\% \pm 9.09$ in the areas of the lungs during PSV compared to AVC ($p = 0.039$). Tidal volume (VT) was $534.8 \text{ ml} \pm 69.4$ for AVC and decreased to $407.6 \text{ ml} \pm 152.1$ for PSV ($p = 0.00015$) (fig. 5).

Conclusion

Despite lower tidal volume, pressure support ventilation (compared to assist control volume) produced an increase in the geographic area of vibration response image. Possible mechanisms of this pressure support ventilation associated increase are the increase in patient generated negative intrapleural pressure during inspiration and better synchronization of patient negative pressure with positive pressure from the ventilator. VRI may allow a clinically useful, non-invasive quantitation of airflow distribution during different modes of mechanical ventilation.