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Effect of different pressure-targeted modes of ventilation on transpulmonary pressure and inspiratory effort

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Introduction

Spontaneous breathing during mechanical ventilation improves gas exchange and might prevent ventilator-induced diaphragm dysfunction. In pressure-targeted modes, transpulmonary pressure (P_L) is the sum of pressure generated by the ventilator and muscular pressure. When inspiratory effort increases, P_L and tidal volume (V_T) increase, potentially resulting in lung injury. This effect depends on the degree of inspiratory synchronization (i-sync); pressure-targeted modes can be classified into fully, partially, and non i-sync modes. A bench study [1] demonstrated that non-i-sync mode resulted in lower P_L and V_T than other modes, protecting the lungs from injury. We undertook to assess the effect of varying synchronization during pressure-targeted ventilation in critically ill patients.

Objectives

To compare V_T, P_L, inspiratory effort (esophageal pressure-time product, PTP_{eso}) and respiratory drive (airway occlusion pressure, $P_{0.1}$) during three pressure-targeted modes with different degrees of i-sync.

Methods

We conducted a randomized cross-over physiological study in spontaneously breathing ventilated patients. Twelve patients were enrolled (1 subsequently withdrew). Three pressure-targeted modes (Evita XL, Draeger, Germany) including fully (PC-CMV), partially (PC-SIMV), and non i-sync (APRV) modes were sequentially applied for 20 minutes in random order using the same driving pressure, PEEP and inspiratory time. Airway, esophageal, and gastric pressures, $P_{0.1}$, and flow were recorded along with gas exchange and hemodynamics. P_L and PTP_{eso} were calculated.

Results

11/12 patients successfully completed the study. V_T was significantly lower during non i-sync mode than fully i-sync mode (Table 1, $p = 0.003$) and V_T variability increased from 13 % to 35 % with decreasing inspiratory synchronization. Maximal P_L was significant lower in non-i-sync mode than in partially or fully i-sync modes ($p = 0.008$). There were no significant differences in gas exchange and hemodynamic parameters between modes. PTP_{eso} was significantly higher with non i-sync modes (Table 1, $p = 0.047$). This increase in PTP_{eso} was observed in the 6 patients who were not receiving intravenous sedation; no increase was observed in the 5 patients receiving continuous intravenous sedation (Figure 1).

Conclusions

Non synchronized pressure-targeted ventilation lowers V_T and P_L in comparison to fully and partially synchronized modes in spontaneously breathing ventilated patients, even with the same driving pressure. Appropriate sedation may be important to alleviate increased patient effort during such modes.

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Table 1

	PC-CMV	PC-SIMV	APRV
Tidal volume per predicted body weight (mL/kg)	7.1 ± 1.0	6.5 ± 0.8	5.6 ± 1.2*
Maximal P_L(cmH_2O)	14.3 ± 4.5	14.0 ± 5.2	12.4 ± 4.8*,#
Minute ventilation (L/min)	10.4 ± 2.3	9.8 ± 2.0	9.9 ± 2.2
Breathing frequency (breaths/min)	21.6 ± 2.9	22.5 ± 3.9	26.9 ± 7.1*
PaO_2/FiO_2 ratio	221 ± 65	231 ± 57	227 ± 64
$PaCO_2$ (mmHg)	48 ± 11	49 ± 12	50 ± 11
$P_{0.1}$ (cmH_2O)	2.6 ± 1.9	2.7 ± 1.7	3.9 ± 2.9
PTP_{eso}(cmH_2O*sec/min)	129.6 ± 107.1	130.2 ± 91.4	209.0 ± 174.9*

* $p < 0.05$, PC-CMV vs APRV; # $p < 0.05$, PC-SIMV vs APRV

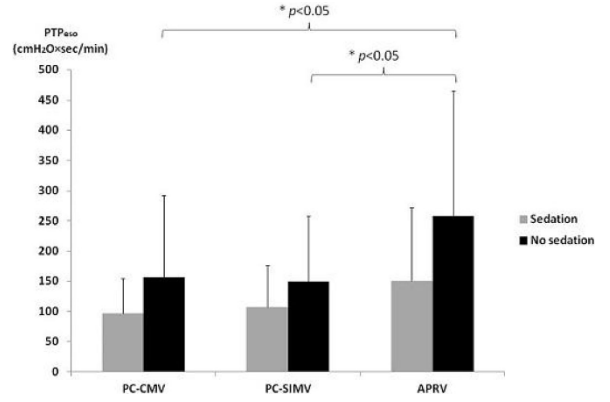

Figure 1 Effect of intravenous sedation on PTPeso.

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